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MATERIAL REQUISITION FOR CENTRIFUGAL PUMPS – LOW FLOW HIGH HEAD

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HOLD STATUS

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| SECTION | PARAGRAPH NO. | DESCRIPTION OF HOLD |
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| G | 18 | Supplier Documentation Procedure document no. on HOLD |
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SUPPLIER:

This requisition is composed of the documents listed hereafter:

| DESCRIPTION | REFERENCE (DOCUMENT NO.) | Rev | ATTACHMENT | |
|---|-----------------------------|-------|-------------------|------------------|
| | | | INCLUSION DATE | DELETION DATE |
| A SCOPE OF SUPPLY | | | | |
| 1 Scope of Supply for Centrifugal Pumps (Equipment/Bulk Material and associated documentation) | 216119C-032-SR-0910-0002 | 0 | 10-Oct-24 | |
| B APPLICABLE DOCUMENTS | | | | |
| 1 Technical Notes for Centrifugal Pumps | USBT-000-TE-MR-TCN-0001 | 0 | 10-Oct-24 | |
| 2 Inspection & Test Plans for Centrifugal Pumps | 216119C-000-ITP-0910-0001 | 0 | 10-Oct-24 | |
| 3 Quality Requirements for Centrifugal Pumps | IOGP S-615Q | V 2.0 | 10-Oct-24 | |
| C EQUIPMENT DATASHEET | | | | |
| 1 Mechanical Data Sheet for Centrifugal Pumps HCU1-P821 A/B | USBT-032-TE-MR-DDS-0004 | 1 | 10-Oct-24 | |
| D MECHANICAL | | | | |
| 1 Baytown Area Facilities – Local Design Requirements | GP 99-01-03D | V 1.0 | 10-Oct-24 | |
| 2 Shaft-Sealing System for Centrifugal and Rotary Pumps | USBT-000-TE-MR-EQS-0003 | 0 | 10-Oct-24 | |
| 3 General Purpose Gear Unit | USBT-000-TE-MR-EQS-0011 | 0 | 10-Oct-24 | |
| 4 Lubrication Shaft-Sealing and Oil-Control Systems and Auxiliaries | USBT-000-TE-MR-EQS-0012 | 0 | 10-Oct-24 | |
| 5 Special Purpose Coupling | USBT-000-TE-MR-EQS-0013 | 0 | 10-Oct-24 | |
| 6 Machinery Protection System API Standard 670 Fifth Edition | USBT-000-TE-MR-EQS-0016 | 0 | 10-Oct-24 | |

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|----------|---|-------------------------|-------|-----------|--|
| 7 | Positive Displacement Pumps - Rotary | USBT-000-TE-MR-EQS-0005 | 0 | 10-Oct-24 | |
| 8 | Technical Notes for Valve | USBT-000-TE-MP-PSP-0005 | 0 | 10-Oct-24 | |
| E | P&ID | | | | |
| 1 | HCU1 P821A/B D811 Sour Water Pump Master Flow Diagram | P-032-500-0113-A24 | B | 10-Oct-24 | |
| F | ELECTRICAL | | | | |
| 1 | Data Sheet for Low Voltage Induction Motor - ABB | USBT-000-TE-EA-DDS-0009 | B | 10-Oct-24 | |
| 2 | Data Sheet for Medium Voltage Induction Motor - ABB | USBT-000-TE-EA-DDS-0012 | A | 10-Oct-24 | |
| 3 | Data Sheet for Medium Voltage Induction Motor - SIEMENS | USBT-000-TE-EA-DDS-0013 | A | 10-Oct-24 | |
| G | MISCELLANEOUS | | | | |
| 1 | Approved Vendor List | Annexure-IV | - | 10-Oct-24 | |
| 2 | Motor Frame Agreement | Annexure-V | - | 10-Oct-24 | |
| 3 | Vendor 3D Model Attributes (AWP) | Annexure A | - | 10-Oct-24 | |
| 4 | Vendor BOM (AWP) | Annexure B | - | 10-Oct-24 | |
| 5 | Packing List format (AWP) | Annexure C | - | 10-Oct-24 | |
| 6 | External Paint and Protective Coatings | BTDP 19-1-1-1 | 0 | 10-Oct-24 | |
| 7 | Paint and Protective Coatings | GP 19-01-01D | V 4.3 | 10-Oct-24 | |
| 8 | Centrifugal Pump Summary Sheet Format | Annexure D | | 10-Oct-24 | |
| 9 | Spare part list | Annexure E | | 10-Oct-24 | |
| 10 | Welding Procedure | GP 18-07-01D | V 5.0 | 10-Oct-24 | |
| 11 | Pressure Casting Quality and Inspection | GP 18-03-04D | V 2.0 | 10-Oct-24 | |
| 12 | Positive Material Identification | GP 18-12-01D | V 3.1 | 10-Oct-24 | |
| 13 | Piping Shop Fabrication, Testing, Flushing, Cleaning and Field Erection | USBT-000-TE-MP-PSP-0002 | A | 10-Oct-24 | |
| 14 | Valve Selection | GP 03-12-01D | V 4.3 | 10-Oct-24 | |

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|----|--|--------------|-------|-----------|--|
| 15 | Piping Selection and Design Criteria | GP 03-10-01D | V 3.0 | 10-Oct-24 | |
| 16 | Winterizing Against Ambient Temperature | GP 03-09-01D | V 3.0 | 10-Oct-24 | |
| 17 | Centrifugal Pump & Mechanical Seal Experience sheet format | Annexure F | | 10-Oct-24 | |
| 18 | Supplier Documentation Procedure | Later | - | - | |

Note: "Date of attachment" corresponds with the issue date of the MR at which the attachment (with attachment Revision number as indicated) has been included in the MR. This is not related to the issue date indicated on the attachment itself.

H. Preamble

The purpose of this document is to emphasize the most important topics of this inquiry, in order to give the Vendor a summary of the main requirements of the inquiry, thus allowing Vendor to efficiently and promptly establish a fairly good proposal.

The offer shall be conceived in such a way to allow an easy understanding and appraisal of all the commercial and technical aspects and the services included in the scope of supply.

In the light of above, the offer shall:

- Confirm the full compliance with the requirements as specified on the Material Requisition.
- Indicating all deviations from the Material Requisition and its Technical Annexures.
- Submit typical information/documentation etc. to support/clarify the offer.

Note: In the exceptional case that a document which is referred to in the requisition is not included in the list of attachments, then the Vendor shall ask for the missing document.

I. Presentation of the Technical Proposal

The technical proposal shall include the following parts:

Part 1: Pump selection Data sheet, Performance Curve, Typical GA drawing with weight and dimension, Seal & Seal plan Selection / Seal vendor recommendation, Motor datasheet.

Part 2: Filled-in Checklist for Completeness of Technical Requirements (Appendix 2) attached with Technical Notes for Centrifugal Pumps.

Part 3: Filled-in Checklist for Scope of Supply (Appendix 3) attached with Technical Notes for Centrifugal Pumps.

Part 4: Applicable list of deviations/Exceptions (Appendix 1) attached with Technical Notes for Centrifugal Pumps.

Part 5: List of references

This list shall indicate proven references of same or similar equipment for the same or similar operating conditions.

Part 6: Filled in Centrifugal Pumps summary sheet (Annexure-D)

Part 7: Filled in Centrifugal Pumps & Mechanical seal Experience Sheet (Annexure-F).

USGC BAYTOWN GOLD REVAMP

EQUIPMENT / BULK MATERIAL MATERIAL REQUISITION FOR CENTRIFUGAL PUMPS – LOW FLOW HIGH HEAD

Material Requisition SR

SCOPE OF SUPPLY

This supply is composed of two parts

Part I : Equipment / Bulk Material Supply

Part II : Documents and Drawings Supply

| | | | | | |
|------|------------|--------------------------|-----------------------------|-----------------------------|------------------------------|
| 0 | 9-Oct-2024 | IFQ-Issued for Quotation | Amandeep Singh | Dilip Kumar | Subhrajeet Nandi |
| Rev. | Date | Status | Written by (name & visa) | Checked by (name & visa) | Approved by (name & visa) |

USGC BAYTOWN GOLD REVAMP

EQUIPMENT / BULK MATERIAL MATERIAL REQUISITION FOR CENTRIFUGAL PUMPS – LOW FLOW HIGH HEAD

PART I : EQUIPMENT / BULK MATERIAL SUPPLY

| Pos - Sub Pos | Tag Number | Description | Current Qty | Purc. Dest. |
|---------------|-------------|---|-------------|-----------------------|
| 1 - 1 | HCU1-P821A | D811 SOUR WATER PUMPS | 1 | PWP-HC03-MECH-REQP-01 |
| 1 - 2 | HCU1-PM821A | D811 SOUR WATER PUMPS MOTOR | 1 | PWP-HC03-MECH-REQP-01 |
| 2 - 1 | - | Start up and Commissioning Spare Parts For Tag no. HCU1-P821A/B | 1 | PWP-HC03-MECH-REQP-01 |
| 3 - 1 | HCU1-P821B | D811 SOUR WATER PUMPS | 1 | PWP-HC03-MECH-REQP-01 |
| 3 - 2 | HCU1-PM821B | D811 SOUR WATER PUMPS MOTOR | 1 | PWP-HC03-MECH-REQP-01 |

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EQUIPMENT / BULK MATERIAL MATERIAL REQUISITION FOR CENTRIFUGAL PUMPS – LOW FLOW HIGH HEAD

PART II : DOCUMENTS AND DRAWINGS SUPPLY

| VDR (1) | Description | First Issue | | | Final Issue (5) |
|---------|---|---------------------------|-------------|-------------------|-------------------|
| | | Issue Date (2) | Purpose (3) | Quantity Type (4) | Quantity Type (4) |
| * A0001 | List of VENDOR's Documents and Drawings | +2 W | IFR | 1E | 13C + 1E |
| * A0103 | Piping & Instrument Diagrams | +4 W | IFR | 1E | 13C + 1E |
| A0104 | Equipment List | +4 W | IFR | 1E | 13C + 1E |
| A0105 | Noise Data Sheet <i>(Including noise calculation / estimate)</i> | +16 W | IFR | 1E | 13C + 1E |
| A0106 | External Painting / Coating Procedure | +16 W | IFR | 1E | 13C + 1E |
| A0129 | Bill of Material - As per AWP Requirement <i>(As per AWP requirements)</i> | +10 W | IFR | 1E | 13C + 1E |
| A0401 | VENDOR Engineering Data-Book | 2 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |
| A0401A | Index of VENDOR Engineering Data-Book | 3 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |
| A0402 | Final Documentation Electronic Files | 1 M BEFORE DELIVERY | IFI | 1E | 13C + 1E |
| * A1001 | Equipment Data-Sheet <i>Including Seal Datasheet</i> | +4 W | IFR | 1E | 13C + 1E |
| * A1002 | Performance Curves | +4 W | IFR | 1E | 13C + 1E |
| A1006 | Auxiliaries Data Sheets | +8 W | IFR | 1E | 13C + 1E |
| A1007 | Lateral Critical Speed Analysis | +8 W | IFR | 1E | 13C + 1E |
| A1009 | Torsional Critical Speed Analysis | +8 W | IFR | 1E | 13C + 1E |
| A1014 | Utility Balance | +8 W | IFR | 1E | 13C + 1E |
| A1015 | Completed Lubricant Charts | +10 W | IFR | 1E | 13C + 1E |
| * A1101 | Cross Sectional and Assembly Drawings (With Part List) | +4 W | IFR | 1E | 13C + 1E |
| * A1102 | Drawings of Auxiliaries and Itemized Equipment Supplied Loose <i>(Including Lube oil skid, coupling & Seal plan dwg)</i> | +4 W | IFR | 1E | 13C + 1E |
| A1106 | Mechanical Seal Or Packing Drawings (With Material List) | +4 W | IFR | 1E | 13C + 1E |
| A1112 | Nameplate Drawing | +10 W | IFR | 1E | 13C + 1E |
| * A1117 | Coupling Drawings (With Material List) | +4 W | IFR | 1E | 13C + 1E |
| * A2001 | General Arrangement Drawings | +4 W | IFR | 1E | 13C + 1E |
| A2006 | Foundation Layout and Loading Plan | +6 W | IFR | 1E | 13C + 1E |
| A2013 | VENDOR 3D Model <i>(As per AWP requirements)</i> | +16 W | IFR | 1E | 13C + 1E |
| A3001 | Instruments and I-O Lists | +8 W | IFR | 1E | 13C + 1E |
| A3002 | List of Instrument Cables | +8 W | IFR | 1E | 13C + 1E |
| A3003 | List of Junction Boxes Control Boxes Cabinets and Panels | +8 W | IFR | 1E | 13C + 1E |
| A3101 | Instrument Data Sheets | +12 W | IFR | 1E | 13C + 1E |

A = Added - M = Modified - X = Canceled - D = Canceled in a previous revision

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EQUIPMENT / BULK MATERIAL MATERIAL REQUISITION FOR CENTRIFUGAL PUMPS – LOW FLOW HIGH HEAD

PART II : DOCUMENTS AND DRAWINGS SUPPLY

| VDR (1) | Description | First Issue | | | Final Issue (5) |
|---------|--|---------------------|-------------|-------------------|-------------------|
| | | Issue Date (2) | Purpose (3) | Quantity Type (4) | Quantity Type (4) |
| A3403 | Junction Boxes-Cabinets and Panels Wiring Diagrams | +12 W | IFR | 1E | 13C + 1E |
| A3404 | Instruments-Junction Boxes-Control Boxes-Cabinets and Panel Location Drawings | +12 W | IFR | 1E | 13C + 1E |
| A3406 | Instrument Hook-Up Drawings | +12 W | IFR | 1E | 13C + 1E |
| A4102 | Electric Motor Data Sheets | +6 W | IFR | 1E | 13C + 1E |
| A4104 | Torque Versus Speed / Current / Power Factor Curves | +6 W | IFR | 1E | 13C + 1E |
| A4206 | Electrical Terminal Box Detail Drawing With Termination Details | +6 W | IFR | 1E | 13C + 1E |
| * A4207 | Electric Motor Drawings | +4 W | IFR | 1E | 13C + 1E |
| A5001 | Special Precautions for Handling Prior and During Erection-Installation | 2 M BEFORE DELIVERY | IFI | 1E | 13C + 1E |
| A5002 | Recommendations for Storage and Preservation Prior and After Erection-Installation | 2 M BEFORE DELIVERY | IFI | 1E | 13C + 1E |
| A5007 | List of Spare Parts for Erection-Installation Commissioning and Start-Up <i>(Including Capital Spares)</i> | +8 W | IFI | 1E | 13C + 1E |
| A5015 | Installation Start-Up and Commissioning Manuals <i>(Including Operation & Maintenance Manual)</i> | 2 M BEFORE DELIVERY | IFI | 1E | 13C + 1E |
| * B1001 | Job Quality Assurance Plan | +4 W | IFR | 1E | 13C + 1E |
| B1002 | Fabrication Quality Control Plan | +8 W | IFR | 1E | 13C + 1E |
| B1003 | Index of VENDOR Manufacturing Data Book | 3 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |
| B1004 | VENDOR Manufacturing Data Book | 2 M BEFORE DELIVERY | IFI | 1E | 13C + 1E |
| B1103 | Testing and Control Procedures <i>(Including PMI & Base plate flatness procedure)</i> | +18 W | IFR | 1E | 13C + 1E |
| B1105 | Test and Control Report <i>Including Following: a) - Inspection and test equipment calibration certificates b) - Rotating component balancing certificates c) - Baseplate flatness and coplanarity certificates d) PMI Report e) Hydrotest Report</i> | 3 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |
| B1201 | PWHT Procedure | +10 W | IFR | 1E | 13C + 1E |
| B1202 | NDT Procedure | +10 W | IFR | 1E | 13C + 1E |
| * B1203 | Material Specification for Main Sub-Orders | +4 W | IFR | 1E | 13C + 1E |
| B1204 | Welders Qualification Certificates | +10 W | IFR | 1E | 13C + 1E |
| B1206 | NDT Operators Certificates | +10 W | IFR | 1E | 13C + 1E |
| B1207 | NDT Record Certificates for Location of Sketches of Radiographs and Other NDT | +10 W | IFR | 1E | 13C + 1E |
| B1209 | Hydraulic and Others Shop Tests Records <i>a) TPI approved Performance & Mechanical run test report b) Wear part clearance certificate c) Shaft TIR Records d) Hardness test Records</i> | 2 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |

A = Added - M = Modified - X = Canceled - D = Canceled in a previous revision

USGC BAYTOWN GOLD REVAMP

EQUIPMENT / BULK MATERIAL MATERIAL REQUISITION FOR CENTRIFUGAL PUMPS – LOW FLOW HIGH HEAD

PART II : DOCUMENTS AND DRAWINGS SUPPLY

| VDR (1) | Description | First Issue | | | Final Issue (5) |
|------------|--|---------------------------|----------------|----------------------|----------------------|
| | | Issue Date (2) | Purpose (3) | Quantity Type (4) | Quantity Type (4) |
| B1210 | Material Certificates | 2 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |
| B1211 | Heat Treatment Records Certificates <i>(Including Charts)</i> | 2 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |
| B1223 | Ex Certificates <i>Including - Hazardous area certificate (type)</i> | 2 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |
| B1304 | Welding Book (Welding Map-Welding Procedure Specification-Procedure Qualification Report) <i>(Including weld repair records)</i> | +10 W | IFR | 1E | 13C + 1E |
| C1001 | Engineering-Procurement-Manufacturing-Testing and Traffic Schedule | +6 W | IFR | 1E | 13C + 1E |
| C1002 | Progress Report | +2 W | IFR | 1E | 13C + 1E |
| C1003 | Sub-Vendors and Suppliers List | +6 W | IFR | 1E | 13C + 1E |
| C1005 | Unpriced Copy of Sub-Orders | +8 W | IFR | 1E | 13C + 1E |
| C1007 | Preliminary Packing List <i>(As per AWP requirements)</i> | 1 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |
| C1008 | Recommendations for Protection during Transportation | 1 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |
| C1012 | Shipping Documents, Transport Authorization | 1 M BEFORE DELIVERY | IFR | 1E | 13C + 1E |

NOTES :

- (1) * Priority document subject to penalization or term of payment
- (2) ISSUE DATE: number of D = Days / W = Weeks / M = Months after purchase order effective date (unless otherwise specified)
- (3) PURPOSE: IFR = Issue for review and comments / IFI = Issue for information
- (4) QUANTITY: per type / TYPE : C = Copy, E = Electronic file, CD = CDROM, OR = Original
- (5) FINAL ISSUE: Document without comments (with document status = 3)

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TECHNICAL NOTES FOR CENTRIFUGAL PUMPS

THIS DOCUMENT IS UNCONTROLLED WHEN REPRODUCED

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| | 216119C | 000 | TEN | 0910 | 0001 | 0 | 4/62 |
| Exxon Doc. No. | USBT-000-TE-MR-TCN-0001 | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit Info | 000-General | | | | | | |

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1. INTRODUCTION

1.1 Project Overview

“ExxonMobil Corporation (“COMPANY”) has awarded a CONTRACT to Technip Energies India (“CONTRACTOR”) for performing the FEED and EP work for reconfiguring COMPANY’s BAYTOWN refinery to produce a more resilient product slate, while enabling future GHG emission reductions.

The project includes scope in three major areas of the refinery: the Hydrocracking Unit (HCU-1), the Raffinate Hydro-Conversion Unit (RHC) and Offsites and Utilities.

The project will convert the HCU-1 to a lubes hydrocracker, using light Virgin Gas Oil (VGO) streams as charge to be cracked into diesel and additional feed from HCU-1 will be supplied to the RHC to produce the light-neutral grades”.

1.2 Scope of this document

This Technical Note along with the equipment data sheets, applicable codes and standards, specifications attached and referred to, describes the minimum requirements for the Design, Engineering, Manufacture, Testing and Supply of Centrifugal Pumps. Vendor shall also provide a representative for supervision of erection & commissioning of the “Centrifugal Pumps”.

The Scope of Supply is provided in the SR- Part 1 for the itemized pieces of equipment and SR- Part 2 for the documents and drawings (deliverables) to be issued by the Vendor.

This Technical Note, in combination with the applicable industry standards, Project standards, technical specifications and specific datasheets referenced herein, and in the Material Requisition, (Doc No. USBT-000-TE-MR-REQ-0001) outlines the requirements for the supply of Centrifugal Pumps as described in the Scope of Supply (Doc. No. 216119C-000-SR-0910-0001).

1.3 Definitions

| | |
|----------------------|--|
| COMPANY | Exxon Mobil Corporation |
| CONTRACTOR | Technip Energies India Ltd |
| PROJECT | EP Services for USGC Reconfiguration Project, GOLD Baytown |
| VENDOR | Manufacturer and / or Supplier of Material or Equipment |
| MATERIAL REQUISITION | The documents (referred to hereinafter as “MR”) in which all the Project procedures, specifications, data sheets and standards applicable to the Centrifugal Pumps and its accessories are listed. |

1.4 Order of Precedence (Technical):

1.4.1 In case of any conflict between this Technical Note and other technical documents in the MR, the following preferential order shall govern:

- US Federal & Local laws, regulations and legal requirements
- Local Area requirements for Baytown Area (GP 99-01-03D)
- Equipment Datasheet
- Project Technical Specifications
- International and national Codes and Standards

- 1.4.2 However, in case of any conflict or discrepancy, the same shall be brought to the notice of Contractor by the Vendor and noted as such in the contract.
- 1.4.3 Compliance with this Technical Note shall not relieve the Vendor of the responsibility of furnishing equipment and auxiliaries of proper design, material and workmanship to meet the specified operating conditions.
- 1.4.4 Vendor shall be the “Single Point Responsibility Vendor (SPRS) for the offered equipment.
- 1.4.5 Vendor shall make all possible efforts to comply strictly with the requirements specified in the specifications and other documents. However, Vendor is to note that only those deviations to specifications, codes and standards, which are either equipment specific (or) are technically infeasible to be complied with, may be considered provided a suitable justification for the same is furnished in the format attached along with this specification. The contractor’s decision on such deviations shall be treated as final. Any deviations/ clarifications shall be listed in the format attached with this Technical Note (Refer Appendix 1).

2. APPLICABLE CODES AND STANDARDS

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition.

2.1 Project Specifications

| | |
|-------------------------|---|
| JIP 33 (IOGP S-615) | Supplementary Specification to API standard 610 for Centrifugal Pumps |
| USBT-000-TE-MR-EQS-0013 | Special Purpose Coupling |
| USBT-000-TE-MR-EQS-0003 | Shaft-Sealing Systems for Centrifugal and Rotary Pumps |
| USBT-000-TE-MR-EQS-0012 | Lubrication Shaft-Sealing and Oil-Control Systems and Auxiliaries |
| USBT-000-TE-MR-EQS-0005 | Positive Displacement Pumps - Rotary |
| USBT-000-TE-MR-EQS-0011 | General Purpose Gear Box |
| USBT-000-TE-MR-EQS-0016 | Machinery Protection System |
| USBT-000-TE-MP-PSP-0002 | Piping Shop Fabrication, Testing, Flushing, Cleaning and Field Erection |
| BTDP 19-1-1-1 | External Paint and Protective Coatings |
| GP 18-03-04D | Pressure Casting Quality and Inspection |
| GP 18-12-01D | Positive Material Identification |
| GP 18-07-01D | Welding Procedures |
| GP 03-12-01D | Valve Selection |
| GP 03-10-01D | Piping Selection and Design Criteria |
| USBT-000-TE-MP-PSP-0005 | Technical Notes for Valves |
| GP 03-09-01D | Winterizing Against Ambient Temperature |

2.2 Industry Standards

| | |
|-----------------------------------|--|
| API 610, 12 th Edition | Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries |
| API 682, 4 th Edition | Pumps Shaft Sealing Systems for Centrifugal and Rotary Pumps |

| | |
|-------------------------------------|---|
| API 614, 6 th Edition | Lubrication, Shaft-sealing, and Oil control Systems and Auxiliaries |
| API 671, 5 th Edition | Special-purpose Couplings for Petroleum, Chemical, and Gas Industry Services |
| API 677, 4 th Edition | General-Purpose Gear Units for Petroleum, Chemical and Gas Industry Services |
| API 676, 4 th Edition | Positive Displacement Pumps—Rotary |
| API 670, 5 th Edition | Machinery Protection Systems |
| API RP 520, 6 th Edition | Sizing, Selection, and Installation of Pressure Relieving Devices in Refineries. Part 1 – Design, Part 2 – Installation |
| API 521, 6 th Edition | Pressure Relieving and Depressurizing System |
| API RP 550 | Manual on Installation of Refinery Instruments and Control Systems – Part I Process Instrumentation and Control |
| API 551 RP, 6 th Edition | Process Measurement Instrumentation |
| ANSI B11/STD B11.19 - 2019 | Performance Requirements for Risk Reduction Measures: Safeguarding and other Means of Reducing Risk |
| ISO 5167 | Measurement of Fluid Flow by Means of Pressure Differential Devices Inserted in Circular Cross-Section Conduits Running Full |
| ISA 5.1 - 2024 | Instrumentation Symbols and Identification |
| ISA 5.3 | Graphic Symbols for Distributed Control / Shared Display Instrumentation, logic, and computer Systems |
| ISA 84.00.01 | P1 Functional Safety: Safety Instrumented Systems for the Process Industry Sector - Part 1: Framework, Definitions, System, Hardware, and Software Requirements |
| ASME B16.11 - 2021 | Forged Fittings, Socket-Welding and Threaded |
| ASME B31.3 - 2022 | Process Piping |
| ASME/BPVC SEC VIII D1 | BPVC Section VIII - Rules for Construction of Pressure Vessels - Division 1 |
| ASTM A 487/A 487M - 21 | Standard Specification for Steel Castings Suitable for Pressure Service |
| BSI BS EN ISO 14120: 2015 | Safety of Machinery - Guards - General Requirements for the Design and Construction of Fixed and Movable Guards |
| NEMA 250 - 2018 | Enclosures for Electrical Equipment (1000 volts Maximum) |
| NEMA ICS 6 | Industrial Control and Systems Enclosures |
| NFPA 70 | National Electrical Code (NEC) |
| NACE MR0103/ISO 17945 | Petroleum, Petrochemical, and Natural Gas Industries - Metallic Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments |
| UL 913 Ed. 8-2013 | Standard for Safety Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations |

3. VENDOR QUALIFICATION CRITERIA

- 3.1 Pumps rated over 375 kW (500 hp), pumps handling liquids at –45 °C (–50 °F) or lower, or pumps with a discharge pressure above 35 barg (500 psig) shall be supplied by vendors qualified by experience to manufacture the units proposed. To qualify, Vendor shall have manufactured (at the proposed point of manufacture) at least two units of comparable power, speed, pressure, temperature, pumped fluid, and

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impeller design(s) (including number of vanes and diameter) that have been operating and performing satisfactorily for at least 1 year each.

- 3.2 Proposals to furnish pumps that do not meet all requirements of this Technical Notes (based on specific nonflammable, nonhazardous service conditions) shall be submitted for Owner's/ Contractor's Engineer approval.

4. SCOPE OF SUPPLY AND EXCLUSIONS

4.1 Scope of Supply

- 4.1.1 VENDOR's scope, as a minimum, shall include all components and auxiliary equipment's as detailed in the "Checklist for scope of supply/work (Appendix-3)" of this technical note and as indicated elsewhere in the inquiry document so as required to make a complete and safe operating package.
- 4.1.2 Specific project philosophy regarding equipment tag numbering, instrument tag numbering, P&ID numbering, standard symbols and nomenclature (lines numbering, service designations, insulations, general abbreviations, instrument symbols & legend), typical cooling water piping and typical motor type representation etc. shall be provided post order stage during KOM, and VENDOR shall follow the same for detail engineering and documentation.

4.2 Exclusions from VENDOR scope

- 4.2.1 Supply of utilities such as cooling water, power, etc., for construction and Installation.
- 4.2.2 All Civil works (Foundations and Grouting).
- 4.2.3 Gaskets and bolting at termination points, except non-standard mating flanges.
- 4.2.4 Fire and Gas Extinguish systems.
- 4.2.5 Motor Starter
- 4.2.6 Power cabling between switchboard and motors (electrical)
- 4.2.7 Control cabling between control room and Local JB's (instrumentation)
- 4.2.8 Interconnection to plant main earth grid

5. LIMIT OF SUPPLY AND TERMINATION POINTS / BATTERY LIMITS

5.1 Piping Termination and Battery Limits

- 5.1.1 Owner / Contractor shall provide single point supply connection at each pump skid edge for all the utilities such as Cooling water, Instrument air, etc. Further engineering and detailing of all necessary piping from the tie-in points to the consumption points of each pump and piping routing within the skid shall be done by VENDOR.
- 5.1.2 Pump package VENDOR shall indicate the utility requirements and nozzle sizes of the utility connections for the pump skid for necessary engineering & execution by Contractor.
- 5.1.3 All Piping (Process & Utility) including inter-connecting piping between lube oil skid and pump skid shall be in VENDOR's scope and shall be prefabricated, tested and shipped to site, requiring minimum erection activities facilitating just the hook-up as per VENDOR supplied isometrics, except as indicated otherwise.
- 5.1.4 All piping terminating points connected to Owner's / Contractor's connection shall terminate at the edge

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of the baseplate.

5.2 Instrumentation

5.2.1 The following are general instrumentation requirements that shall be considered:

- 5.2.1.1 Design, material, equipment, and installation shall meet the specified electrical area classification without purging unless accepted by Purchaser.
- 5.2.1.2 The instrumentation scope of supply shall comply with requirements specified under this Document (USBT-000-TE-MR-TCN-0001) and Machinery Protection System API STANDARD 670 FIFTH EDITION (USBT-000-TE-MR-EQS-0016).
- 5.2.1.3 Instruments in flammable or toxic service shall minimize leakage when exposed to fire. Low melting point metal materials, such as aluminum and brass, shall not be used for the construction of pressure bearing, instrument body, or retaining parts.
- 5.2.1.4 Materials shall be suitable for the process and environmental conditions specified. If not specified, 316 stainless steel shall be used as a minimum.
- 5.2.1.5 Bodies of cast iron, ductile iron, brass or bronze shall not be used for control valves, regulators, instrument valves, or level instrument chambers, except in water or air services in non-hazardous unclassified areas. Purchaser acceptance is required.
- 5.2.1.6 All instrument equipment shall be enclosed in environmentally appropriate enclosures per NEMA 250.
- 5.2.1.7 Transmitters to use 4 to 20 mA signal to I/O devices with HART capability.
- 5.2.1.8 Pressure retaining welds on all instruments shall be full penetration welds and shall be in compliance with the requirements of ASME B31.3.
- 5.2.1.9 Vendor's standard field instruments are acceptable provided they comply with project requirements as specified in this document.
- 5.2.1.10 Vendor will use Purchaser's tagging scheme. The Vendor will provide instrument data sheets and wiring format so SPI data base can be used during detail design. Purchaser's P&ID's will represent all wiring interfaces, so control functions and interfaces are clearly defined.
- 5.2.1.11 Neither mercury nor asbestos shall be permitted.
- 5.2.1.12 Instruments and electrical components and materials shall be listed by a nationally recognized testing laboratory.
- 5.2.1.13 All pre-wired assemblies shall be UL listed or approved by a testing organization acceptable to the authority having jurisdiction.
- 5.2.1.14 Instruments that require field installation and items that were removed and shipped loose shall be identified on the drawings, packing lists, and on the item itself. The "shipped loose items list" shall be issued to Purchaser at the time of Vendor engineering.
- 5.2.1.15 Vendor engineering data transfer to Purchaser shall include ISA Data Sheets for all instruments, Instrument Index & Range, Alarms & setpoints Summary, DCS & PLC I/O, Signal & Power Junction Box Terminations, and Wiring & Cable Schedules, shall be provided via SPI. The contactor will provide necessary templates from SPI (for ease of porting data to SPI) during post order stage.
- 5.2.1.16 Dry instrument air is available at an operating pressure of 40 psig. Instrument Air shall be provided at a single point for package instrumentation. The further distribution, if any within package equipment scope of supply shall be considered in vendor scope of supply.
- 5.2.1.17 Instrument ranges, pressure ratings, and materials of construction shall be based on specified fluid

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properties, operating conditions, and design basis.

- 5.2.1.18 Instruments shall have a parallel tagging structure. The instrument tagging structure shall follow a (AREA)(UNIT)(SERVICE CODE)(FUNCTION CODE)(LOOP NUMBER)(TAG SUFFIX) configuration, i.e. AUSFnnnM. The contactor will provide a block of reserved instrument tag numbers for this package. If a larger quantity of tag numbers is required, a request to the purchaser must be made for a further allocation of tag numbers. Vendor is not to use their own tag numbers without Purchasers approval.
- 5.2.1.19 All signal and communication wiring (as applicable) required to communicate to a plant control system shall be pre-terminated in junction boxes mounted on the package. Wiring required to interface with a plant SIS shall be terminated in separate dedicated junction boxes.
- 5.2.1.20 All Instruments shall be Loop Powered. In case of any External power Supply, only AC Power 120V AC shall be provided at single point for package instrumentation. The further distribution if any within package equipment scope of supply shall be considered in vendor scope of supply. If any DC Power supply is required, vendor shall consider necessary AC to DC power supply conversion
- 5.2.1.21 Purchaser will provide an electrical power supply of the voltage, phase, and frequency specified at a connection point on the packaged equipment. All equipment and components shall be designed and rated for operation at this voltage. Vendor shall indicate the number of circuits required and shall depict the location where the power source is to be connected on plan view and elevation drawings. The packaged equipment shall be designed to allow purchaser to provide only one, three-phase electric power supply.
- 5.2.1.22 Fireproofing shall be installed on instrumentation and enclosures located in fire hazardous areas.
- 5.2.1.23 Usage of switches (Pressure, Level, flow etc) is not permitted without Owner's approval.
- 5.2.1.24 Preparation of Shipment:
 - a. Instruments that may be susceptible to physical damage shall be disconnected, packaged separately, and shipped with the Packaged Equipment.
 - b. Instruments removed from the equipment before shipment shall be tagged and boxed separately from any mechanical parts or equipment. The container(s) for the removed instruments shall be clearly marked as required by the purchase order.
 - c. Instrument electrical conduit, fittings, and openings shall be sealed with a threaded, lubricated plug.
 - d. Pneumatic, vent, and drain connections shall be weather protected using plastic plugs or caps.
 - e. Instruments shipped separately shall be protected by sealed packaging and shipped with desiccant inside the instrument or sealed package.
 - f. Instruments shipped installed on the Packaged Equipment shall be weatherproofed for shipment and for outdoor storage at the Purchaser's facility.
 - g. Instruments, equipment, and enclosures shall be identified before shipment by permanently affixing a name tag, or affixing stainless steel tag with stainless steel fasteners.
 - h. Plastic nameplates shall be three-layer laminate material with black lettering engraved on a white background. Safety systems shall have white lettering on a red background.
 - i. Instrument nameplates shall be engraved with the instrument tag number and service description.

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5.2.2 Hazardous Area Certification

Recommended equipment selection and circuit design for classified areas shall be in accordance with the following:

- a. Field instruments shall be provided with explosion proof/non-incendive certification for Class 1 Division 2 areas. Intrinsically safe certification is acceptable only in special cases with Owner's Engineer approval. For class 1 Division 1 areas, Intrinsically safe certification is acceptable. Purging methods shall be used only when other options are exhausted.
- b. Circuit design - Class I Division 2 areas, 4 to 20 mA and discrete circuits shall be non-incendive. Intrinsically safe design shall be used for Class 1 Division 2 areas only in special cases with Owner's Engineer approval. For Class I, Division 1 areas, 4 to 20 mA, and digital circuits shall be intrinsically safe.
- c. If a non-incendive electrical wiring systems is used as the protection method to meet the area classification, then it shall be identified to clearly inform all personnel in the facility that the circuits are of non-incendive design. Labeling requirements of non-incendive wiring shall be per NFPA 70 500.8(C)(6)(c) or ISA 12.12.01 Section 9 Marking.

5.2.3 Instrument Installation

5.2.3.1 Instruments shall be located and installed such that:

- a. Accuracy and reliability are not impaired due to vibration, pulsation, temperature, or contamination.
- b. Device readability, functional operation, and maintainability are not impaired.
- c. The length of instrument impulse lines connected to process pipelines or equipment is minimized. Sufficient length shall be provided for high temperature processes so that the process temperature does not adversely affect the transmitter.
- d. Personnel can easily and safely inspect and perform maintenance and repair (e.g., not under grating or in any place or manner not providing a safe footing or access).

5.2.3.2 To ensure accessibility, instruments (e.g., transmitters, and control valves including their isolation valves) shall be located to satisfy one of the following conditions:

- a. No higher than 6 ft above an unobstructed working platform level and no lower than 2 ft above skid deck surface.
- b. No greater than 1.5 ft from fixed ladders, or ladder access with Purchaser acceptance.

5.2.3.3 Instruments requiring frequent calibration or maintenance that are not accessible from grade or a fixed platform shall require Purchaser acceptance. Examples include in-line meters, analyzers, sample systems, and safety system instruments. All access platforms and permanently affixed ladders shall be furnished by the Package Equipment Vendor.

5.2.3.4 Instruments in steam, liquid, liquid-sealed, or condensing service shall be located below the process connection point.

5.2.3.5 Instruments in gas or vapor (non-condensing) service shall be self-draining and located above their process connection point.

5.2.3.6 Local instruments that are not line mounted shall be securely anchored; of rigid construction; plugged or sealed at top of the pipe to prevent water entry; provided with 1/4 in hole above the base plate to allow water drainage; not mounted on rails.

5.2.3.7 Welded areas, drilled holes, and pipe threads on galvanized steel pipe stands shall be prepped and

sprayed with cold galvanization.

5.2.4 Instrumentation - Vibration, Position and Temperature Detectors

Unless otherwise specified, provisions for mounting two accelerometers shall be provided at each radial bearing housing as follows:

- a. For all pumps and steam turbines over 15 kW (20 hp)
- b. For all motors over 150 kW (200 hp)

The center of the flat spot shall be drilled and tapped with a $\frac{3}{8}$ -24 UNF threaded hole.

5.2.5 Instrumentation—Vibration, Position and Temperature Detectors

The vibration and temperature detectors shown in Table B: Pump Monitoring Instrumentation Requirements shall be installed in the following circumstances:

- a. Equipment in hydrocarbon services greater than or equal to 1.1 MW (1,500 hp), multistage pumps (BB2, BB3, BB4, BB5, VS6, and VS7), pumps with rolling element bearings that exceeds nd_m limits of 350,000 and pump services with high process criticality as defined by Owner's Engineer.
- b. Equipment greater than 15 kW (20 hp) and less than 1.1 MW (1,500 hp) meeting any of the criteria in Table A: Pump Monitoring Selection Criteria.

Table A: Pump Monitoring Selection Criteria

| Group | Selection Criteria |
|---|--|
| Pumps handling hot hydrocarbon fluids | Hydrocarbon pumps handling fluids > 232 °C (450 °F) or handling a fluid at or above auto-ignition temperature. |
| Pumps handling flammable fluids with a high potential to form a vapor cloud | A hydrocarbon where 40% or more of the fluid volume vaporizes at pumping temperature and atmospheric pressure as noted on pump data sheet. |
| Pumps handling fluids with acute toxicity risks | Respiratory exposure class R1 and class R2 as noted on pump data sheet. |

Table B: Pump Monitoring Instrumentation Requirements

| Pump Type | Instrument Location | Bearing Type | Accelerometer at Each Bearing Housing | Thermocouple or RTD at Each Bearing | Proximity Probes, Two at Each Bearing |
|-----------|---------------------------|---|---------------------------------------|-------------------------------------|---------------------------------------|
| BB1 – BB5 | DE & NDE Bearing Housings | RE | X | X | |
| | DE & NDE Bearing Housings | Hydrodynamic Radial / RE Thrust | X ⁽²⁾ | X ⁽¹⁾ | X ⁽²⁾ |
| | DE & NDE Bearing Housings | Hydrodynamic Radial / Hydrodynamic Thrust | | X ⁽¹⁾ | X |
| OH2, OH3 | Bearing Housing | RE | X | X | |
| OH4, OH5 | Top Motor Bearing | RE | X | X | |

| Pump Type | Instrument Location | Bearing Type | Accelerometer at Each Bearing Housing | Thermocouple or RTD at Each Bearing | Proximity Probes, Two at Each Bearing |
|--------------------------------|---|--------------------|---------------------------------------|-------------------------------------|---------------------------------------|
| OH6 | Gearbox Casing | RE & Hydrodynamic | X ⁽⁴⁾ | | |
| VS1 – VS7 | Top Motor Bearing | RE | X ⁽⁵⁾ | X | |
| | Bottom Motor Bearing | RE | X ⁽³⁾⁽⁵⁾ | X | |
| | Thrust Bearing (if equipped) | RE | X | X | |
| General Purpose Steam Turbines | DE & NDE Bearing Housings | RE or Hydrodynamic | X ⁽²⁾ | X ⁽¹⁾ | X ⁽²⁾ |
| Motors > 150 kW (200 hp) | DE & NDE Bearing Housings | RE or Hydrodynamic | X ⁽²⁾ | X ⁽¹⁾ | X ⁽²⁾ |
| Gearbox (GP) | Coupling End Bearing Housings | RE or Hydrodynamic | X | X ⁽¹⁾ | |
| | Blind End Bearing Housings | RE or Hydrodynamic | | X ⁽¹⁾ | |
| | Thrust Bearing | Hydrodynamic | | X ⁽¹⁾ | |
| Legend: | DE = Drive End NDE = Non-Drive End RE = Rolling Element or Ball Bearing | | | | |
| Notes: | <p>(1) Hydrodynamic bearings shall be provided with embedded thermocouples or RTD.</p> <p>Rolling Element bearing shall be provided with spring-loaded thermocouples or RTD when nd_m exceeds limits 350,000.</p> <p>(2) Replace accelerometer with proximity probes for pumps and drivers at or over 1.1 MW (1,500 hp).</p> <p>(3) Locate accelerometer and thermocouple or RTD in the thrust pot, if pump is equipped with thrust bearing.</p> <p>(4) For this pump type (OH6) the accelerometer(s) shall be located in the gearbox casing instead of the bearing housing.</p> <p>(5) Locate accelerometer and thermocouple or RTD in the wet zone of the pump casing. If Vendor has no experience with this location, then Vendor and Purchaser shall agree on the location of the instruments to facilitate early detection of failure and minimize damage to pump components.</p> | | | | |

5.2.6 Instrumentation—Vibration, Position and Temperature Detectors

Vibration and temperature instrumentation shall be compatible with the monitoring system specified by Purchaser. Vibration and temperature instrumentation and on-skid wiring shall be provided by Equipment Vendor.

NOTE: Vendor to provide optional quote for EHM panel (BN 3500 or equivalent for applicable Vibration

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and temperature monitoring. Vendor to provide all the sensors pre-wired to Junction box at skid. Instrument cabling from skid to EHM panel (installed in RIE) will be by others.

Kindly Note that:

- If no trip action then EHM can be: Orbit DCM
- If there's trip, then EHM can be: Orbit 60/BN 3500 or VC8000 system

5.2.7 Instrumentation—Vibration, Position and Temperature Detectors

The accelerometers shall be mounted in the H or X locations specified for the different pump types in API STD 610-12, Figure 32 "Locations for Taking Vibration Readings on OH and BB Type Pumps" through Figure 34 "Locations for Taking Vibration Readings on Vertical In-line (OH3) and High-speed Integrally Geared (OH6) Pumps." For vertical pumps, the location shall be at the most sensitive radial location, which is typically 90 degrees from the piping.

5.2.8 Instrument Design Specifications

5.2.8.1 Level Instruments

a. General

- i. GWR is the preferred level measurement, if suitable for the process.
- ii. Level and interface instruments shall be directly connected to vessels or standpipes and shall not be connected to process lines.
- iii. Piping from vessel to standpipe or level instruments shall not have traps or pockets.
- iv. Piping from level gauges and external displacer type level instruments shall be self-draining into a vessel or standpipe.
- v. External standpipes shall not be used for services with process temperatures below -40°C (-40°F). Level instruments for services with process temperatures below -40°C (-40°F) shall be individually connected directly to the vessel and shall require Purchaser acceptance.
- vi. There shall be a block valve between the vessel connection and the level instrument unless the instrument is designed to be mounted inside the vessel. Externally mounted instruments are preferred over internally mounted instruments. Purchaser acceptance is required for installations where the instrument is mounted inside the vessel.
- vii. Level transmitters and level gauges shall be piped so that they can be independently isolated for maintenance (i.e., do not install with only a single valve that will disable both the transmitter and the gauge).
- viii. Differences in specific gravity between the vessel contents and the external level piping or sealing fluids shall be taken into consideration for calibration of the level instrument.
- ix. Pressure/temperature rating of level instruments, switches, and gauges shall be equal to or greater than the pressure/temperature rating of the vessel to which they are connected.
- x. Insertion type level instruments shall be equipped with blowout prevention devices, such as a mechanical stops or safety chains. Insertion type instruments that are installed in a toxic or flammable service shall be equipped with seals (e.g., packing glands) that are fire-safe (e.g., graphite) or include a secondary seal to prevent process fluid release in the event of a fire.
- xi. Variation in fluid properties (e.g., specific gravity, density) during start-up, shutdown, and special operations (e.g., reduced rates) shall be considered and fully addressed during

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instrument selection. If the variation in fluid properties is too large to be covered by a single technology, then diversity in technology shall be employed to cover the entire range of operation. Instrument specification sheets shall include a range of values, not just conditions for normal operation.

- xii. Transmitters in hydrogen service and subject to hydrogen permeation shall require gold-plated diaphragms.
- b. Differential Pressure Level Measurement
- i. The diaphragm seal fluid, seal leg fluid, and purge fluid of differential pressure level instruments shall be compatible with the process fluid and ambient temperature extremes, and process/pressure vacuum conditions.
 - ii. For levels greater than 10 feet, the Rosemount Electronic Remote System may be used with Purchaser approval.
 - iii. Installation of level transmitter remote diaphragm seals shall comply with the following:
 - Transmitters shall be mounted at or below the high-pressure nozzle (vessel lower nozzle), below lowest anticipated operating liquid level.
 - Provide a bleed ring between the block valve and the diaphragm seal.
 - Capillary tubing shall be of sufficient length to account for routing requirements, shall be armored, and shall be furnished in manufacturer's standard lengths.
 - Capillary tubing seal legs shall be mechanically protected and adequately supported.
 - Excess capillary tubing shall be coiled at the receiving device.
 - Capillary lines shall be routed away and/or insulated if they pass by steam or high temperature heat transfer media jackets on a vessel or other high temperature sources.
 - If the level measurement system is not a tuned system, capillary length of both seal legs shall be identical on differential pressure transmitter remote seals.
- c. Level Gauges
- i. Magnetic level gauges are preferred for hazardous liquid applications. Flat glass reflex type may be used for all other applications. Pad type reflex welded-in gauge glass is acceptable for lube and hydraulic reservoir applications.
 - ii. Gauges shall have vent and drain valves.
 - iii. Installation shall include provisions for isolating in the gauge to allow for cleaning.
 - iv. Tubular glass gauges shall not be allowed.
 - v. For reflex glass gauges and transparent glass gauges, tempered Borosilicate, Pyrex ® or equal glass shall be used in applications at or below 232°C (450°F). Purchaser acceptance is required for service between 450°F and 600°F.
 - vi. Transparent glass gauges shall require Purchaser acceptance.

5.2.8.2 Pressure Instrument

- a. General
- i. Pressure measurement points for gas or vapor service shall meet the following criteria:
 - Use top or side taps.

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- Mount transmitters above the pressure taps and slope impulse lines downward to the root valve one inch per foot.
 - ii. Pressure measurement points for liquid and condensing service shall meet the following criteria:
 - Use side taps.
 - Mount transmitters below the pressure taps and slope impulse lines upward to the root valve one inch per foot.
 - iii. Pressure instruments shall have diaphragm seals if used in viscous fluids, slurries, or corrosive applications for fluids not compatible with measuring element material.
 - iv. Pressure transmitters and liquid filled pressure gauges shall have integral pulsation dampeners in oscillating services.
 - v. Instruments shall have over-range protection to the maximum pressure to which they may be exposed. Instruments exposed to vacuum shall have under-range protection to full vacuum.
- b. Pressure Gauges
- i. Nominal diameter shall be 4 1/2 in externally threaded connection of 1/2 inch MNPT with wrench flats, stainless steel Bourdon tube and socket, unless the process conditions dictate otherwise. The case shall be solid front, weatherproof, with blowout backs or disks, stainless steel or phenolic. A visible stop pin at the six o'clock position shall be provided. Gauge window shall be double strength, shatter resistant safety glass. The window shall be gasketed on the bezel side by means of a resilient gasket and held in place from the case side by means of a threaded retainer ring. Siphons shall be provided as required by application.
 - ii. When measuring pulsating pressure, suitable dampening methods shall be employed (glycerin/silicon oil filled gauges, dampening devices etc.). Fluorolube shall be used on the following services: chlorine, nitric acid, or hydrogen peroxide.
 - iii. Pressure gauges shall have a nominal working pressure is between 30% and 70% of scale range. Ensure the maximum working pressure does not exceed the scale range. Pressure gauges shall have an over-range capability of at least 150% maximum scale without loss of calibration.
 - iv. Pneumatic instruments shall have manufacturer's standard integral pressure gauges provided on local controllers and valve positioners.
 - A stop pin shall be provided on all pneumatic receiver gauges at the zero pressure indication.
 - Receiver gauges are designed to measure pneumatic signals (e.g., from 3 to 15 psi) and present the pressure in engineering units. This design creates a unique hazard if receiver gauges are directly connected to the process. Receiver gauges shall be uniquely and distinctly identified (e.g., unique color, tubing size and thread, tagged or placarded, or similar method).
 - v. Gauges shall be designed to pass the vibration test (I-2.6) and the fatigue test (I-2.4) specified in ASME B40.100, Mandatory Appendix I "Test Procedures Used to Measure New Gauge Performance." A statistically meaningful percentage of all gauges sold shall be sampled to give a confidence factor of at least 90%.

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5.2.8.3 Temperature Instruments

- a. General
 - i. Use of temperature switches shall not be allowed.
 - ii. Temperature elements shall be provided as complete assemblies, including element, thermowell, and termination head. All process measuring temperature elements shall be wired to a 4-20mA transmitter.
 - iii. Thermocouples and Resistance Temperature Detectors (RTDs) shall be stainless steel (or Inconel) sheathed, mineral-insulated construction, as a minimum.
 - iv. Thermowells are required for all temperature-measuring devices used in flammable, toxic, or otherwise hazardous pressurized or vacuum systems. Thermowells are not required for temperature measurement of equipment, such as reactor shell skin, machinery bearings, or motor windings, where there is no risk to personnel from the process fluid during removal of the measuring element, or where radial thermocouples are used. Where a thermowell is not used, a permanent label shall be affixed to the primary element, indicating that there is no thermowell.
 - v. A dual temperature element shall not be used to provide separate signals to different instruments or redundant inputs to a logic control system.
 - vi. Thermocouple and RTD termination heads shall be copper free cast aluminum and weatherproof to a minimum NEMA 4X per NEMA 25 and NEMA 7 or 9 per NEMA 250, if explosion proof is required. Heads shall have a minimum of three terminals for thermocouples and four for RTDs and have 3/4-inch NPT conduit connections.
 - vii. Establish upscale or downscale burnout requirement.
- b. Thermocouple types shall be ungrounded Type K. Duplex thermocouples, if used, shall both be terminated in the head.
- c. Process temperature and machinery bearing and motor winding temperature RTDs shall be 3 or 4wire construction. RTD's shall have a platinum sensor of 100 ohms at 0°C with a temperature coefficient of 0.00385 ohms/ohm/°C.
- d. Use of filled thermal system instruments shall require Purchaser acceptance.
- e. Thermowells
 - i. Thermowells shall not be located between suction screens and inlets of pumps.
 - ii. Construction of thermowells shall be of stainless steel material, 316 minimum, except where process conditions require other alloys; be fabricated from solid barstock; have a bore diameter of 0.26 in for thermocouples and RTD sensors; have process connections per Table 2 in Paragraph 4.2.3. The body and flange shall be of the same material.
 - iii. Where practical, thermowell shall be installed in a piping elbow pointed toward the flow. Thermowell shall not be installed in location where stagnation of the flow stream is possible.
 - iv. Thermowell vendor shall check the design of each thermowell using the calculations for frequency limit, dynamic stress limit, static stress limit, and hydrostatic pressure limit, described in ASME PTC 19.3 TW, to prevent thermowell failure Calculations that result in thermowell failure shall be repeated with a wider base diameter and/or a shorter thermowell unsupported length. Where the thermowell has a low fluid velocity (i.e., less than 0.64 m/s]

[2.1 ft/s), no calculations except for hydrostatic pressure limit shall be required. Where process conditions change in lines with existing thermowells, ASME PTC 19.3 TW calculations shall be checked again.

- v. The use of velocity collars to meet ASME PTC 19.3 TW requirements shall be prohibited.
 - vi. All thermowells shall be pressure tested and certified to confirm their pressure rating by Manufacturer/Vendor. Alternatively, if external testing is not readily available, then the thermowell may be installed prior to pressure testing of the associated piping and thereby tested with the piping to meet ASME standards.
 - vii. Thermowells shall have ratings above the design pressure of the associated piping based on the thermowell flange rating, under the requirements of ASME B31.3 or ASME B31.8, as applicable.
- f. Local temperature indicators shall be bimetallic every angle type thermometer with 5 inch dial.

5.2.8.4 Piping And Tubing Requirements

- a. General
 - i. Instruments that require a process tap shall have primary block valve in accordance with Table mentioned below:
 - ii. Process-connected instruments that are not line-mounted shall have secondary isolating valve and bleeder or valve manifold at the instrument.
 - iii. Threaded joints in instrument air service shall be made up using Teflon® dispersion sealant.
 - iv. Avoid pocketing piping and tubing.
- b. Process Connections
 - i. Process instrument piping and connections shall be made with stainless steel pipe or stainless steel tubing to meet service conditions.
 - ii. Process gas or liquid sensing lines shall not be piped or tubed beyond the physical limits of the Packaged Equipment.
 - iii. Instrument process connections shall comply with Table and ASME B31.

TABLE
INSTRUMENT CONNECTIONS TO PIPING, VESSELS, AND EQUIPMENT

| TYPE OF INSTRUMENT | CONNECTION | | |
|--|--|----------------------|----------------|
| | THREADED (Note 2) | WELDED | FLANGED |
| Thermowells: (Note 3) | N/A | N/A | 2 inch Minimum |
| Pressure: | 3/4 inch or 1 inch | 3/4 inch | 1 inch |
| Flow, Orifice with Flange taps: (Note 1) | 1/2 inch (Class 600 pipe and under) 3/4 inch (Class 900 pipe and over) | 1/2 inch 3/4 inch | |

| | | | |
|-----------------------|----------|--|--------------------|
| Level: | | | |
| Differential | 3/4 inch | | 1 inch |
| Internal Displacement | | | 4 inch |
| External Displacement | | | 2 inch |
| Probe | 1 inch | | 1 inch |
| Magnetic Level Gauge | | | 2 inch |
| Gauge Glass | 3/4 inch | | 2 inch |
| Bubbler | | | 2 inch |
| Diaphragm Seals | 3/4 inch | | 1-1/2 in. or 3 in. |

Notes:

1. Instrument connections on orifice with flange taps shall be threaded, or socket welded.
 2. Instrument connections on piping shall be minimum 3/4 inch threaded or welded.
 3. 2" flanged thermowell connections shall be used. Other connections sizes or types shall require Purchaser acceptance.
- c. Purging of Process Connections
- i. If required to prevent plugging, freezing, or corrosion, process connections may be purged.
 - ii. Purge fluid shall be compatible with the process fluid and shall require Purchaser acceptance.
- d. Tubing
- i. Tubing shall be installed in a manner that allows for calibration of instruments and removal of adjacent instruments, equipment, and tubing.
 - ii. Tubes and tube bundles that handle process fluids shall not be installed in channel or cable trays that contain instrument or electrical cables.
 - iii. In general Process and pneumatic tubing shall be seamless per ASTM A269, 316L fully annealed stainless steel [Imperial or Metric].
 - iv. Process and pneumatic tube fittings shall be 316 stainless steel, flareless double ferrule compression type.
 - v. Pneumatic tubing shall be 3/8" minimum and process impulse lines 1/2" minimum.
- e. Instrument Piping and Tubing Supports
- Design and installation of the supports shall:
- i. Avoid strain on equipment, piping connections, and instruments.
 - ii. Allow the flexibility required to accommodate thermal expansion or contraction of piping or equipment.
 - iii. Consider vibration of the process piping or equipment to which an instrument is connected. Welding onto the process or utility piping is never allowed.
 - iv. Do not use process or utility piping to support tubes, tube bundles, or associated support channels and trays.

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- v. Tubing in raceways (e.g., on angle, channel, and in cable trays) shall be firmly attached to the support at intervals not exceeding 1.8 m (6 feet).
- vi. Bare metal tubing shall be attached to structural angle, channel, and cable trays with stainless steel straps or clamps. Stainless steel tubing shall not be routed near or supported by galvanized materials. A suitable fireproof galvanic barrier shall be provided to prevent the stainless steel tubing from contacting any galvanizing.
- vii. Tube bundles shall be secured with stainless steel metal straps and clamps or plastic tie-down straps. Tube bundle plastic tie-down straps shall be ultraviolet resistant, and of suitable material for the ambient conditions.

5.2.8.5 Wiring Methods

- a. Wiring shall be separated by voltage level and application as follows and run in separate raceway/conduit:
 - i. AC power and control (600 volts and lower)
 - ii. DC power and control
 - iii. Intrinsically safe electronic signal wiring
 - iv. Non- intrinsically safe electronic signal wiring, including thermocouple and RTD signals
 - v. Communications
 - vi. Class 2 and Class 3 power-limited circuits per NEC Article 725.
- b. Wire Marking - Instrument and control wiring shall be identified by legible markings at the terminals. Each end of every wire shall be provided with a heat-shrinkable or equivalent sleeve-type wire marker in accordance with the related electrical and instrument drawings. Use of wrap around adhesive, clip-on type or handwritten wire markers is not acceptable.
- c. 'Wire Tagging Philosophy : Labels used for Instrument to JB wiring shall be Reverse tagging Philosophy. Wire labels for Loops should have tag name and location of where the other end of the wire is terminated)

For eg : Wire for loop XOMXX. Is laid from JB-1 to JB-2 and is terminated on Terminal strip A, terminals 1-2 in JB-1 and is terminated on terminal strip B, terminal 1-2 in JB2.

Wire Tag in JB-1 would be XOMXX JB-2 TB1-2 and on other JB-2 the tag would be XOMXX JB-1 TB1-2.

Supplier to confirm compliance to follow same for pre wired wiring (if any).

- d. Wire Connections and terminals
 - i. The electrical and instrument items shall be physically mounted and completely wired by vendor. Vendor shall provide smart junction box(es) with identified terminal blocks for interconnecting field wiring between package units and wiring to locations outside the package. All such terminals shall be grouped, preferably at a single location, enclosed in a manner suitable to the environment and the electrical area classification, and arranged for easy accessibility. Conduit coming from above shall be routed for bottom or side entry into enclosures. Installation drawings provided by vendor shall clearly identify which wiring/cables are to be installed during field erection.
 - ii. Terminal blocks shall be of thermoplastic, non-corrosive, moisture-resistant material with anticorrosive plated terminals. Support material shall be cadmium-plated or stainless steel

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screws and channels. Termination assemblies shall be equipped with standard screw-type terminal connectors.

- iii. Stranded conductors #8 AWG and smaller shall have compression type pin, fork or ring type crimp terminators depending on the type of connection. Solid conductors do not require terminators.
 - iv. Wiring connections shall be wired to terminal blocks. Not more than two connections shall be allowed at each terminal point.
 - v. Terminals for power distribution and for connection of alarm and shutdown systems shall be fused type.
 - vi. Terminals for thermocouple connections shall be used only when intermediate connections cannot be avoided. Thermocouple terminals shall be of the proper thermocouple material.
 - vii. Each terminal strip shall be tagged, and each terminal shall be tagged. A minimum of 20-percent spare terminals shall be provided in each terminal enclosure.
- e. Raceways/Conduit Systems
- i. All wiring and cabling shall be installed in raceway/conduit with termination fittings accepted for the location. Vendor shall furnish and install necessary support material and accessories required including the complete raceway system.
 - ii. Raceway for armored cable applications shall be HDG channel or angle.
 - iii. All conduits shall be hot-dipped galvanized rigid steel meeting the requirements of ANSI C80.1 or rigid aluminum whichever is more suitable for the atmosphere in which installed.
 - iv. Conduit size and fill shall be in accordance with the NEC. The minimum size conduit for general use shall be 3/4 in.
 - v. Conduit shall be:
 - Adequately supported to prevent applying loads to enclosures or devices.
 - Routed to avoid causing safety hazards (including personnel tripping hazards).
 - Installed to prevent vibration damage to the conduit systems, internal wiring, or conduit supports.
 - Installed with low point drains or a drip loop to prevent water from draining into an instrument or enclosure.
 - vi. Conduit unions and fittings shall be provided to facilitate replacement of instruments and electrical devices.
 - vii. Conduit fittings and junction boxes shall be installed with cover openings in the vertical plane. Access for removal of covers shall not be blocked.
 - viii. Conduit fittings and support hardware shall be of compatible material that will not result in galvanic corrosion.
 - ix. Electrically conducting anti-seize compounds shall be applied at threaded joints on conduit and fittings.
 - x. PTFE compounds or other similar insulating anti-seize materials shall not be used.
 - xi. Conduits shall be terminated with flexible metallic conduit at instrument or end device, except

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when entering a junction box or control panel.

- xii. Liquid-tight, flexible metallic conduit with accepted fittings shall be used in all areas at connections where vibration, movement or adjustments are likely to occur; this type of conduit shall not be used in Class I, Division 1 [or Zone 1] hazardous (classified) locations.
 - xiii. Flexible metallic conduits shall be specified and installed to meet the NEC Article 348.
 - xiv. All flexible, liquid-tight metallic conduit connections shall have bonding conductors.
 - xv. Conduit seals shall not be poured by vendor. Vendor shall provide the seals for pouring by others at site per NEC Article 501.
 - xvi. Each raceway/conduit system shall be designed to prevent accumulation of moisture inside the raceway/conduit. Breathers shall be provided at the high points of outdoor raceway/conduit systems.
 - xvii. Raceways in panels and cabinets shall be designed for 50% spare capacity.
- f. Enclosures / Junction Boxes
- i. Each device, or instrument enclosure shall be suitable for the expected environmental conditions and shall be of a type permitted under the hazardous area classification specified for the intended equipment location. Enclosures shall be provided with purge systems in accordance with NFPA 496 "Pressurized Enclosures" type Z classification, if required to meet the area classification.
 - ii. Enclosures for control panels, control boards, or electronic equipment shall be in accordance with NEC. The enclosures shall be rated for NEMA Type 12 per NEMA 250, for indoor use, and NEMA4X Type 4 per NEMA 250, for outdoor use is required as a minimum.
 - iii. Sunshades shall be used for Honeywell Smart Junction boxes. Instrument air purges shall not be used.
- g. Wire and Cable
- i. All wire and cable shall comply with the requirements established for such materials and construction by NEC and Insulated Cable Engineers Association (ICEA) where applicable.
 - ii. Cable insulation shall be selected to withstand the area operating temperature.
 - iii. All wiring shall be continuous from terminal to terminal. No taps or splices will be permitted.
 - iv. Separation of intrinsically safe signal cables and non-intrinsically safe signal cables inside the panel shall meet requirements of NFPA 70 Section 504.30.
 - v. Power Supply Wiring - Power supply, alarm and shutdown, and general-purpose electric wiring for circuits not exceeding 600 V shall be stranded-copper type, minimum size No.14 AWG and Insulated with a 75/90°C insulation system.
 - vi. Intrinsically safe circuits and thermocouple wiring circuits shall be type PLTC/IITC rated 300 V (Min), installed in conduit or 600 V rated armored MC cable installed in raceways.
 - vii. Wiring for 4 to 20 mA analog signals shall be shielded and twisted pairs, minimum size No. 16 AWG for single pairs. The wiring for control or alarm circuits shall be No. 18 AWG multiconductor cable with an overall shield. Thermocouple wiring shall be shielded and twisted pairs No. 16 AWG minimum size. RTD wiring shall be shielded No. 16 AWG stranded copper triad.
 - viii. 4-20 mA instrument signal wiring and shields shall be floated at the device and grounded at

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the marshalling termination point. Intrinsically safe circuits, when specified, shall comply with the requirements of UL 913 and have a blue outer jacket.

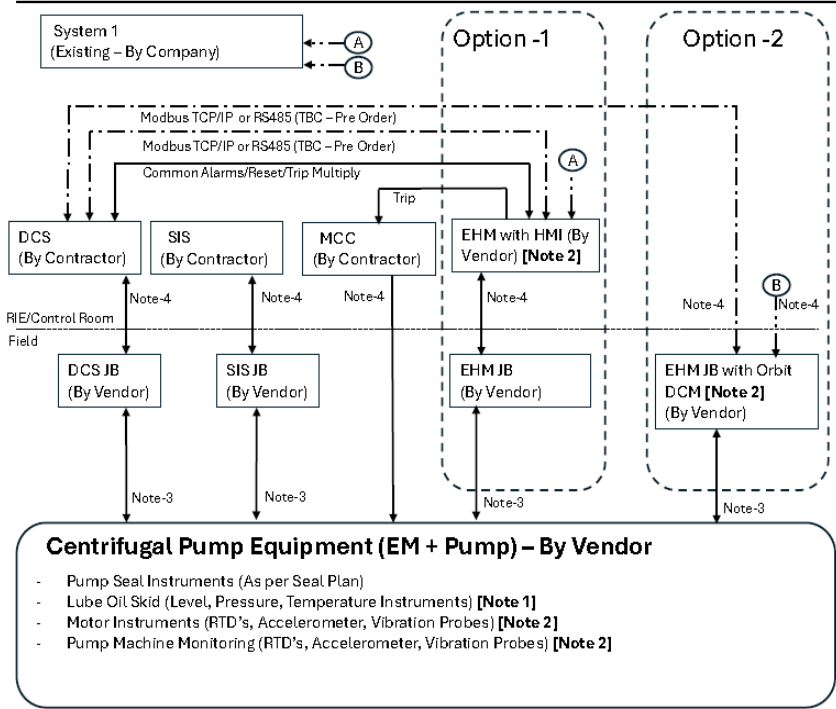
- ix. All interconnecting wiring between vendor-provided instruments and the Packaged Equipment mounted junction boxes and control panels shall be provided and installed by vendor.
- x. In junction boxes, each individual pair and all pairs from the overall cable require permanent tags, affixed to pairs (both sides of terminal strips).
- xi. When interconnecting wiring by others is required between the Packaged Equipment components/skids, the vendor shall provide junction boxes on each component/skid with wires terminated and tagged for interface wiring by others.
- xii. Instrument wire/cable shall be run in raceway, or conduit.
- xiii. Wiring from junction boxes to individual instruments shall be shielded twisted pair or triad No. 16 AWG minimum.
- xiv. Instrument signal (4-20 mA) wiring from junction box to junction box or control panel shall be No.18 AWG minimum, twisted pairs in multi-pair cables with overall shield and drain wire.
- xv. Installation drawings provided by the vendor shall clearly identify which wiring/cables are to be installed during field erection.
- xvi. In junction boxes, each individual pair shield shall be terminated to a dedicated terminal.
- xvii. Control and Instrument Cable - Control cable shall be color-coded and shall be jacketed type ITC wiring, or 600-V rated polyethylene insulated wiring with clear nylon cover over the insulation and polyvinyl chloride (PVC) jacket.
- xviii. Color coding shall be in accordance NFPA 79/UL508A.

5.2.9 Instrumentation: JB's are required for mechanical seal instruments, all instruments within the package shall be pre-wired to a Junction box.

Package Vendor to terminate Instruments to skid mounted Junction box. Cable/ cable trays/ cable glands and Junction Box to be provided by package Vendor.

5.2.10 Vendor to follow below basic I&C block diagram for centrifugal pump package:

BASIC I&C BLOCK DIAGRAM – CENTRIFUGAL PUMP



NOTES :

1. Lube Oil Skid as applicable based on OEM recommendation
2. Equipment Health Monitoring System based on OEM recommendation.

EHM system Model:

- Option 1 - If Trip Action : Orbit 60/BN3500/VC8000 system (with Dual Relay Card for Trip Activation)
- Option 2 - If No Trip action : Orbit DCM

OEM to propose either Option 1 or Option 2 for EHM system of respective pump based on Equipment Trip requirement. In case of Option 2, OEM to verify and confirm suitability for Orbit DCM mounting near equipment for specified Hazardous Area and a need of Additional power Supply Conversion Unit within EHM JB.

3. Field wiring From Equipment to Junction Box by Vendor.
4. Wiring between Field and Control Room/RIE by Contractor.

ABBREVIATIONS :

- EHM : Equipment Health Monitoring
- DCS : Distributed Control System
- SIS : Safety Instrumented System
- EM : Electric Motor
- OEM : Original Equipment Manufacturer
- RIE : Remote Instrument Enclosure
- MCC : Motor Control Center
- TBC : To be Confirmed (Pre Order)

LEGENDS :

- Conventional Hardwired
- Modbus TCP/IP or RS485
- BN Proprietary Protocol – for System 1

5.2.11 Electrical Consumer Motors Terminal Boxes.

5.2.12 Earthing system pads (or) lugs at skid battery limit at grade level.

5.3 Electrical

5.3.1 ExxonMobil has frame agreement for LV motors with ABB and frame agreement is available with Siemens and ABB for MV motors till 1500 HP. All Motors till 1500 HP shall be sourced in line with ExxonMobil frame agreement.

However, below standards shall be followed.

| | |
|--------------------------------|--|
| Motor Specifications/Standards | LV motors shall be as per Frame Agreement or meet IEEE 841. API 541 (for critical motors only). |
| Exxon Specification for motors | Unspare medium-voltage motors and medium-voltage motors larger than 1500 hp purchased without using frame agreements shall be according to Exxon specification. Vendors proposed not in the frame agreement shall be subject for Owner's approval. |
| Space heaters | Motors 100HP and larger. |

| | |
|-------------------------|--|
| Control Station | Local Control stations shall be opposite side of main terminal box |
| RTDs | RTDs shall be provided for motors rated 1500HP & above. One RTD per bearing & two per winding will be integrally provided for motor protection. |
| Differential Protection | Except for VFD applications, motors designed for operation at medium-voltage and supplied by switchgear breakers will be furnished with self-balancing differential protection as follows: a) Induction motors 2500 hp and above. b) Synchronous Motors (0.8 pf) 2500HP & above. c) Synchronous motors (1.0 pf) 3000 hp and above. Required CT will be provided by Motor vendor in terminal box. |
| Surge Protection | Motors having rating 3000 HP and above will be provided with surge capacitors and gapless lightning arrestors mounted in motor terminal box. |
| Insulation | As per NEMA MG1. Motors will be Class B temperature rise provided with Class F insulation. |

5.3.2 Motor Control Station (Applicable for motor greater than 100 HP)

- i. Control station enclosures shall be suitable for the environmental conditions encountered.
- ii. Control stations for single phase or three phase motors controlled by magnetic motor controllers shall be start and stop and shall have provisions for locking the stop in the open position.
- iii. Consideration should be given to having control station wired back to a field remote I/O box where start/stop signals can be routed to the DCS via fiber. Control station with features like start, stop push button & HOA switch as per P&ID, E&I interface document.
- iv. When remote start/stop signals to motor controllers originate in a digital instrument or programmable controller system, contractor shall standardize on a single type of contact provided to the motor control circuit by the remote system. Proposals must be approved by the Owner's Engineer.
- v. Control stations shall be push-button operated. Control station type and design shall conform to plant standard design outlined above.
- vi. Guards: Control stations shall be guarded against accidental operation, either through design or by field-mounted guards. Non-actuation when a push-button is depressed flush with the surrounding ring constitutes adequate guarding. Except in control rooms, guarding shall not prevent intentional operation with gloved hand.
- vii. Emergency stop control stations on control house panels or similar panels shall meet the following:
 - a. Guards shall cover the operating button or arm.

- b. Control shall be of the maintained contact type.
 - viii. Control wiring shall run directly from the control station to the motor controller. Wiring shall not be routed through the motor location.
 - ix. Motor space heaters when furnished shall be controlled by an auxiliary contact of the motor controller. Heaters shall be automatically deenergized when the motor is running and automatically energized when the motor is not running. The auxiliary contact shall remain closed or be automatically bypassed when the starting device is in the test or withdrawn position. A manually operated disconnect switch shall be provided adjacent to the motor to deenergize the space heaters.
- 5.3.3 Pilot lights shall be cluster LEDs unless specified otherwise.

6. EQUIPMENT LAYOUT AND DELIVERY CONDITIONS

6.1 Equipment Layout

The main and auxiliary equipment should be so arranged within the area that enough space is available around each equipment for ease of operation and routine maintenance.

6.2 Shop assembly and delivery condition

- 6.2.1 All skid mounted units and packages shall be supplied by VENDOR completely assembled, wired, cabled, mounted with all on-skid interconnecting piping, wiring, cabling, junction box, cable trays, painting and insulation.
- 6.2.2 VENDOR shall advise if any component shall be dismantled and shipped loose due to transportation constraints.
- 6.2.3 All interconnecting prefabricated piping shall be properly packed with identification, to facilitate easy erection at installation site.
- 6.2.4 Any loose components supplied by VENDOR shall be clearly tagged, labelled and identified. Bolt torque values of any loose supplied equipment or components which shall be bolted on site shall be indicated on the relevant assembly or general arrangement drawing.

7. HEALTH, SAFETY AND ENVIRONMENT

7.1 General Safety requirements

- 7.1.1 All controls shall operate in a fail-safe mode.
- 7.1.2 All electrical equipment and instruments shall meet the requirement for the specified area classification in which they are installed.

7.2 Environmental data

- 7.2.1 Meteorological data- All design calculations shall assume the following meteorological information.

| | |
|-------------------------------|----|
| Dry Bulb, Maximum Design, °F | 95 |
| Wet Bulb, Maximum Design, °F | 81 |
| Machinery, Maximum Design, °F | 96 |
| Machinery, Minimum Design, °F | 32 |

| | | | | | | | | |
|--|--|----|----|----|----|----|---|----|
| Average Winter Dry Bulb, °F | 32 | | | | | | | |
| Impact Testing, CET, °F, new equipment | 10 | | | | | | | |
| CET, °F, historical (for assessing MDMT/MSOT existing equipment) | 32 | | | | | | | |
| Recorded Temperatures, Dry Bulb, °F | | | | | | | | |
| Maximum Extreme, °F | 108 | | | | | | | |
| 1 Percent | 96 | | | | | | | |
| 2-1/2 Percent | 94 | | | | | | | |
| 5 percent | 92 | | | | | | | |
| 97-1/2 Percent | 33 | | | | | | | |
| 99 Percent | 29 | | | | | | | |
| Minimum Extreme, °F | 5 | | | | | | | |
| Winterizing Area Classification | Zone C (Instrumentation) Zone B (All Other Equipment) | | | | | | | |
| Frost Depth | 0 | | | | | | | |
| Wind | | | | | | | | |
| Mean wind speed, mph | 10 | | | | | | | |
| Direction From: | N | NE | E | SE | S | SW | W | NW |
| % of time: | 11 | 5 | 12 | 13 | 41 | 7 | 6 | 6 |

7.2.2 Civil/structural design calculations shall assume the following meteorological data:

| | |
|--|-----|
| Wind loads calculated based on ASCE 7-16 | |
| Basic Wind Speed at 33 feet above ground (V) for Risk Category III and IV, mph | 150 |
| Basic Wind Speed at 33 feet above ground (V) for Risk Category II, mph | 140 |
| Other wind load design criteria | |
| Exposure Category | C |

| | |
|--|----------------|
| 'K _d ' Directionality Factor | Per ASCE 7 |
| Seismic Design per ASCE 7-16 | |
| Short period (0.2 s) spectral response, S _s | 6.9%g (0.069g) |
| 1.0 sec spectral response, S ₁ | 4.0%g (0.040g) |
| Importance Factor, I | 1.25 |
| Site (soil) Class | D |
| Precipitation | |
| Storm Water Design Loading Inches/Hour (10-year storm, 60 min. duration) | 3.44 |
| Maximum Precipitation, Inches/24 Hours (10-year storm, 24 hour duration) | 9.24 |
| Maximum Precipitation, Inches/24 Hours (25-year storm, 24 hour duration) | 12.3 |
| Average Annual Precipitation, Inches/Year | 64.73 |
| Precipitation Frequency (1 mm or more) Days/Year | 104 |

- 7.2.3 All equipment shall be capable of performing reliably in the ambient environment.
- 7.2.4 The expected life of the package is 20 years using standard design and material and the package shall be designed with an on-stream factor of not less than 8000 hours per year.
- 7.2.5 Design life shall be considered for continuous operation independently of the supply of stand-by equipment.

7.3 Hazardous area classification

- 7.3.1 The pumps shall be designed for outdoor installation.
- 7.3.2 All electrical items shall be as per hazardous area classifications indicated in the respective pump mechanical data sheets and with the requirements specified in this specification.
- 7.3.3 Instrumentation and their installation shall comply with the Electrical Hazardous Area Classification in which it is located. The minimum rating of instruments shall be Class 1 Division 2 Groups B, C & D and temperature Class T3.

7.4 Noise/Acoustic Requirements

- 7.4.1 As a basic requirement, the sound pressure level (L_p, re 20 x 10⁻⁶ Pa) for complete equipment train (Pump + Motor + Gearbox if any), shall not exceed 85 dBA at any locations at (Three) 3 ft from equipment surface.
- 7.4.2 Noise level for each piece of equipment should also not exceed 80 dBA. The VENDOR shall guarantee the required sound level is not exceeded. The sound level shall be reported in the loaded condition for the specified design.
- 7.4.3 Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort by the

Company / Contractor and the Vendor. The vendor shall include in the proposal a completed Noise Data Sheet indicating expected sound pressure levels for the pump package as a single noise source and for major noise generating components. Reference location for pump skid noise data shall be 1000 mm (3 ft) from skid edge. In addition, the Vendor shall provide expected sound power data. Sound power levels shall be supplied in the completed noise data sheet for the pump package as a single source and for the major noise generating components.

- 7.4.4 For exceeding the specified noise limit, Vendor shall recommend abatement option, and this shall be quoted as option. Vendor shall specifically state the type of noise treatment and/or steps that will be performed in the event of a noise level exceeding the permitted level. The procedure shall be specifically stated in the submittals. All the necessary noise model/calculations must be performed and submitted for Contractor / Owner review and approval.

8. UTILITY DATA AND B/L CONDITION

8.1 Steam

Steam system shall be assumed to operate at the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve.

| System | Pressure, PSIG | | Temperature, °F | |
|--------|----------------|------------|-----------------|------------|
| | Consumption | Production | Consumption | Production |
| 600# | 615 | 630 | 600 | 725 |
| 150# | 145 | 155 | 400 | 450 |
| 20# | 20 | 25 | 260 | 260 |

Design conditions of all steam system equipment shall be

| System | Pressure, PSIG | Temperature, °F |
|--------|----------------|-----------------|
| 600# | 615 | 725 |
| 150# | 145 | 450 |
| 20# | 20 | 260 |

8.2 Water

Water systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve.

| System | Pressure, PSIG | Temperature, °F |
|----------------------|----------------|-----------------|
| Cooling Water Supply | 65 | 87 |
| Cooling Water Return | 35 | 130 |

Design conditions of all water system equipment shall be

| System | Pressure, PSIG | Temperature, °F |
|----------------------|----------------|-----------------|
| Cooling Water Supply | 150 | 150 |
| Cooling Water Return | 150 | 150 |

8.3 Nitrogen, Air, and oil mist systems

Nitrogen, air, and oil mist systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, PSIG | Temperature, °F |
|-------------------------------------|----------------|-----------------|
| Industrial (Utility/Plant/Yard) Air | 90 | 90 |
| Instrument Air | 80 | 90 |
| Nitrogen | 2000 | Ambient |
| Oil Mist | 0.50 | Ambient |

Design conditions of nitrogen, air, and oil mist systems equipment shall be:

| System | Pressure, PSIG | Temperature, °F |
|-------------------------------------|----------------|-----------------|
| Industrial (Utility/Plant/Yard) Air | 150 | 150 |
| Instrument Air | 150 | 150 |
| Nitrogen | 275 | 140 |
| Oil Mist | 150 | 150 |

9. BASIC DESIGN

9.1 Centrifugal Pumps

- 9.1.1 Pumps shall be designed as per JIP 33 (IOGP S-615), API 610 standard & this specification. The complete Centrifugal pump package shall operate continuously at operating conditions specified in the mechanical data sheets.
- 9.1.2 Vertical in-line pumps (Type OH3) for services greater than 227 m³/hr (1,000 gpm), 152 m (500 ft), or 150 °C (300 °F), or requiring drivers over 112 kW (150 hp) shall not be used without Owner's Engineer approval.
- 9.1.3 Integrally geared vertical pumps (Type OH6) for flows greater than 91 m³/hr (400 gpm), and heads greater than 457 m (1,500 ft), with temperature and power limits being the same, shall not be used without Owner's Engineer approval.
- 9.1.4 The pump head curves shall be continuously rising from the rated point to the shutoff. Low-capacity, high-head pumps may be exempt from this requirement with Owner's Engineer approval.
- 9.1.5 the head values of the pumps shall be equal (±1%) at all points on the curve from rated point to shutoff. For high-energy pumps that are not tested at shutoff, criteria shall apply from the rated point to MCSF.
- 9.1.6 The pump head at shutoff shall not exceed 120% of the head at the rated point without Owner's Engineer approval. Shut off head calculated at maximum suction pressure shall be less than the downstream design pressure inclusive of all positive tolerance.

The pump head at shutoff shall not exceed the system design pressure;

9.1.7 Staggered vane impeller designs shall be provided for double suction impellers that develop greater than 200 m (650 ft) of head and absorb more than 225 kW (200 hp).

9.1.8 Application of pump cooling water shall be as follows:

- a. Pumps with wet sump bearing lubrication and pumping temperatures under 200 °C (400 °F), or pumps with pure oil mist bearing lubrication and pumping temperatures under 370 °C (700 °F), shall be designed to operate continuously without the use of cooling water. Bearing oil temperatures shall not exceed those of specified in API 610 Clause 6.10.2.7 and shall take no credit for motor cooling air. Cooling water may be used for cooling seal flush liquid to assure proper mechanical seal operation.
- b. Pumps with pressurized lubrication or pumping temperatures over 200 °C (400 °F) may utilize cooling water only where required for cooling of bearing oil, seal chambers, or seal flush liquid. Oil mist lubricated pumps with pumping temperatures over 370 °C (700 °F) shall be furnished with purged oil mist and wet sump lubrication. Pumps with wet sump lubrication and pumping temperatures over 200 °C (400 °F) shall be furnished with cooling coils or bearing housing water jackets. Cooling coil or water jacket connections shall be plugged unless cooling is required.

9.1.9 Pump and auxiliaries shall be winterized for the climatic zone as specified below:

| Scope | Climatic Zone Classification | Temperature Condition |
|---------------------|------------------------------|---|
| Instrumentation | C | The lowest mean daily temperature is below 30 deg F for more than 24 hours but is above 0 deg F |
| All other equipment | B | The lowest mean daily temperature is below 30 deg F for no more than 24 consecutive hours |

Pumps and auxiliaries shall be winterized for the climatic zone specified per GP 03-09-01D.

Instrumentation and Associated Piping:

Instruments and instrument piping shall be winterized in accordance with Table 1: Winterizing Against Ambient Temperature for Instruments. The instrument mechanism and indicator portions (e.g., an electronic capsule) of the transmitters shall be kept within Manufacturer's recommended temperature rating.

| Table 1: Winterizing Against Ambient Temperature for Instruments Type of Fluid | Direct-Connected Pressure and Differential Pressure Instruments | Pressure Gauges | Externally Mounted Level Instruments and Gauge Glasses |
|--|--|---|--|
| Water | Heat trace and insulate lead lines and instruments, including first process isolation valve(s) | Heat trace and insulate lead lines and instruments, including first process isolation valve | Heat trace and insulate vessel connections and chamber, including first process isolation valve(s) |
| Liquid (mixture) that could result in water accumulation in lead lines | | | |

| Table 1: Winterizing Against Ambient Temperature for Instruments Type of Fluid | Direct-Connected Pressure and Differential Pressure Instruments | Pressure Gauges | Externally Mounted Level Instruments and Gauge Glasses |
|--|--|--|--|
| Liquid that forms ice or hydrates due to pressure reduction of moisture-bearing gases | | | |
| Liquid with a pour point or freezing point above the lowest ambient temperature | | | |
| Liquid that has high viscosity at the lowest ambient temperature | Use diaphragm seal, heat trace, and insulate lead lines and instruments, including first process isolation valve | Use diaphragm seal, heat trace, and insulate lead lines and instruments, including first process isolation valve | Use diaphragm seal, heat trace, and insulate lead lines and instruments, including first process isolation valve |
| Steam | Heat trace and insulate lead lines and instruments, including first process isolation valve(s) | Insulate lead lines, including first process isolation valve, and use a siphon | N/A |
| Vapor, which could condense at operating pressure and at ambient temperature conditions | Insulate or heat trace and insulate lead lines and instruments, including first process isolation valve(s) | Insulate lead lines, including first process isolation valve | Insulate or heat trace and insulate vessel connections and chamber, including first process isolation valve(s) |
| Corrosive liquid formed by condensation | Use diaphragm seal, liquid purge, or heat trace and insulate, including first process isolation valve(s) | Use a diaphragm seal | Use liquid purge or select corrosion-resistant metallurgy |
| Notes: | | | |
| (1) All valve and/or instrument manifold handles should not be insulated and should be left exposed to allow for proper operability. | | | |

- a. Instrument piping shall not be winterized with an antifreeze solution, unless approved by Owner.
- b. Protective heating of lead lines shall be designed such that the liquid is not allowed to overheat and boil.
- c. Parallel and/or adjacent lead lines for differential pressure instruments that are heat traced shall use common heating and insulation so that a similar temperature is maintained between the lines.
- d. Electronic instruments vulnerable to damage by freezing shall be installed in heated housings or located in buildings such that the temperature remains within Manufacturers' recommended ranges.

9.1.10 Components and sections of VS, multistage horizontal and double-case pumps, including seal

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chambers that are normally subjected to suction pressure, shall be designed to permit (as a minimum) a hydrostatic test pressure equal to the MAWP of the discharge section of the casing.

9.1.11 If more than 3 mm (1/8 in.) corrosion allowance is required in carbon steel casings, then it shall be specified.

9.1.12 Auxiliary connections to the pressure casing can be terminated in a threaded connection only if required to comply with this technical note.

Plugs requiring removal for maintenance or operation shall not be seal-welded. Plugs not requiring removal shall be seal-welded.

Additionally, welding of all threaded plugs and connections shall be as follows:

a. Connections requiring seal-welding shall be made without the use of sealing compounds or PTFE tape. All cutting oil used shall be removed prior to assembly. After the joint has been properly tightened, the seal-welding shall cover all exposed threads or 6 mm (1/4 in.) minimum.

b. Seal welding shall be done with electrodes not exceeding 3 mm (1/8 in.) in diameter, using amperage in the low range to avoid distortion of the connection or part being welded.

9.1.13 Threaded openings, which are allowed in seal glands, valved casing vents and drains, and in pump casings for some pipeline services (if specified in API 610 and as amended in JIP33 (IOGP S615), Clause 6.4.3.2), shall be plugged. Plugs shall be non-seal-welded, long shank solid round-head bar stock plugs in accordance with ASME B16.11. These plugs shall meet the material requirements of the casing. A lubricant/sealant that is suitable for high temperature duty shall be used to ensure that the threads are vapor tight.

9.1.14 Plastic plugs shall not be permitted, including temporary plugs used for shipping.

9.1.15 Connections for mechanical seal self-flushing lines shall be made on the suction nozzle, the discharge nozzle, both nozzles, or the pump casing, if drilling and tapping of the casing is permitted.

9.1.16 Drain valves are required for pump casings with capacity greater than 1 L (0.26 gal) to permit the casing to be drained to a closed system or container before opening for maintenance.

9.1.17 Vent connections on pumps that are not self-venting and are not specified to be piped back to suction shall be provided with vent valves. All pumps in vacuum service shall have flanged casing vents.

9.1.18 The socket weld or seal weld at the connection of extended body valves to pipe fittings or the pump casing shall have a complete bridge weld from the fitting or casing to the body of the valve.

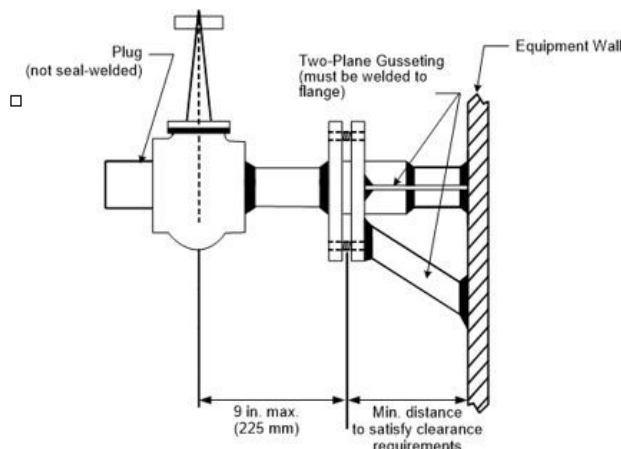
9.1.19 Piping DN 50 (NPS 2) and smaller shall be gusseted into two orthogonal planes to increase the rigidity of the piped connection, in accordance with the following stipulations.

9.1.20 Gusseting material for welded gussets shall be of the same nominal chemistry as the connected parts, except that carbon steel may be used for gusseting P-No. 1, P-No. 3, P-No. 4, and P-No. 5 materials. Connections shall be braced in two planes, as shown in Figure A: Bracing Design for Nozzle and Pressure Casing or Figure B: Bracing Design for Nozzle and Pressure Casing Alternative, with gussets having a minimum thickness of 5 mm (3/16 in.) and a minimum width of 19 mm (3/4 in.).

9.1.21 Valved vent, drain, and auxiliary connections shall be braced per Figure A: Bracing Design for Nozzle

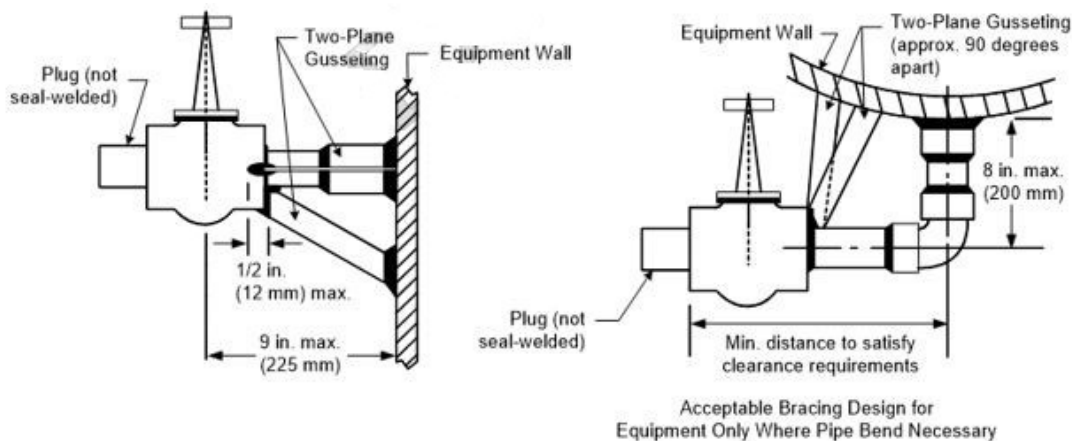
and Pressure Casing or Figure B: Bracing Design for Nozzle and Pressure Casing Alternative.

Figure A: Bracing Design for Nozzle and Pressure Casing



NOTE:
Bracing detail applicable to weld neck or socket welded flange

Figure B: Bracing Design for Nozzle and Pressure Casing Alternative



Acceptable Bracing Design for Equipment Only Where Pipe Bend Necessary

GENERAL NOTE:
Bracing detail applicable to extended body type valve or to compact body valve plus nipple (as illustrated).

- 9.1.22 Gusset attachment welds to a pressure boundary shall be post-weld heat treated whenever PWHT is required in the alloy steel component to which the attachment is to be made. Such attachment welds shall be performed according to ASME B31.3 PWHT criteria for butt welds in alloy steel materials. This requirement shall be met regardless of whether butt welds are used in the assembly.
- 9.1.23 Bracing design for piping connections requiring double block valves or Class 900 or greater valves shall be submitted to Purchaser for approval by Owner's Engineer.
- 9.1.24 For pumps with casings constructed of materials other than steel or alloy steel or for pumps with nozzles larger than DN 400 (NPS 16), allowable nozzle loads shall be submitted for Owner's Engineer approval.
- 9.1.25 Pumps with nozzles DN 400 (NPS 16) and smaller, with casings constructed of steel or alloy steel, and piping configurations that produce loads outside the ranges specified in API 610 and as amended in

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JIP33 (IOGP S615), Table 5 "Nozzle Loadings" shall be capable of satisfactory operation, when subjected to forces and moments according to API 610 and as amended in JIP33 (IOGP S615), Annex F "Criteria for Piping Design," Clause F.1.2.

- 9.1.26 Collets can be used in VS pumps, if there is a second device that restrains the impeller in a direction opposite to the collet.
- 9.1.27 For BB pumps or VS pumps, the shaft shall be full circumference relieved in the plane of the set screw installation a minimum of 1 mm (0.040 in.) diametrically.
- 9.1.28 Integral impeller wear surfaces require approval by Owner's Engineer.
- 9.1.29 If the wear rings have below 400 Brinell hardness numbers, then the stationary wear ring shall always be harder than the rotating wear ring.
- 9.1.30 Nonmetallic wear rings require approval by Owner's Engineer.
- 9.1.31 Mechanical seals and seal systems shall be supplied in accordance with equipment specification for Shaft sealing system for Centrifugal & Rotary pumps, doc no. USBT-000-TE-MR-EQS-0003.
- 9.1.32 Torsional analysis report required when gear box/VFD is applicable. When a torsional analysis is performed, the detailed final report shall be provided for Owner's Engineer approval.
- 9.1.33 "Vibration Limits for Overhung and Between-bearings Pumps" shall also apply to VS pumps as per Table 8 of API 610 and as amended in JIP33 (IOGP S615),
- 9.1.34 The use of oil-lubricated bearings with a nd_m exceeding 350,000 requires Owner's Engineer approval. nd_m is the mean bearing diameter (mm) times the rotational speed (RPM). Pumps with bearings exceeding this nd_m limit shall be provided with EHM per Table C: Pump Monitoring Instrumentation Requirements.
- 9.1.35 Cages for angular contact thrust bearings shall be of machined bronze or machined brass.
- 9.1.36 For services with essentially unidirectional thrust loading, Vendor shall advise when other than a 40 degree (e.g., 15 or 30 degree) angular contact thrust bearing should be used for the normally unloaded bearing to prevent ball skidding.
- 9.1.37 Material for cooling coils shall be austenitic stainless steel unless the plant cooling water system uses sea or saltwater or the cooling water's chloride content is greater than 50 ppm. In these instances, Owner's Engineer shall specify the required coil material.
- 9.1.38 Permanent markings (i.e., cast, stamped, or stamped SS tag affixed with bolts or screws) shall be used to readily identify all oil mist IN, VENT, and DRAIN connections.
- 9.1.39 For pumps in services with process operating temperatures above 300 °C (570 °F), heat sink type flingers and fan cooling shall also be provided. Any additional features to reduce heating of the bearing races by heat transfer shall be noted in the proposal. Typical features also include directional oil mist re-classifiers.
- 9.1.40 For pumps in services with process operating temperatures above 370 °C (700 °F), oil (sump) cooling with heat sink type flingers and fan cooling shall be provided. Any additional features to reduce heating of the bearing races by heat transfer shall be noted in the proposal. Typical features include the following:
 - a. Stainless steel shafts having low thermal conductivity
 - b. Thermal barriers
- 9.1.41 Materials for pump pressure-containing and pressure-retaining casings shall be in accordance to the

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following:

- a. Pressure casing parts for pumps in hydrocarbon or hazardous services and double-casing pumps shall not be cast iron.
- 9.1.42 12% chrome castings shall be according to ASTM A 487/A 487M, Grade CA6NM, Class B.
 - 9.1.43 Monel (Ni-Cu alloy) castings for general service shall be according to ASTM A 494/A 494M, Grade M-30C or M35-1, and shall be tested for weldability according to ASTM A 494/A 494M S.22.
 - 9.1.44 Pumps that may be steamed out shall be specified on the pump data sheet. Gaskets and O-rings used in pumps that may be steamed out shall be suitable for exposure to steam at 200 °C (400 °F); otherwise Owner's Engineer approval is required.
 - 9.1.45 Mill test reports of chemical composition and mechanical properties of castings shall be submitted per Pressure Casting Quality and Inspection doc no. GP 18-03-04D.
 - 9.1.46 Materials resistant to sulfide stress corrosion cracking shall be used for streams that contain hydrogen sulfide (H₂S) even in trace amounts.
 - 9.1.47 For Downstream applications, materials exposed to a sour environment as defined by NACE MR0103/ISO 17945 shall conform to that standard and the requirements as below.
 - a. When an HIC-resistant steel plate is specified by Owner's Engineer for pressure vessels or longitudinally welded pipe for wet H₂S or HF service, it shall be tested in accordance with NACE TM0284, using Solution A.
 - b. The requirement for testing may be waived if vendor can demonstrate to the satisfaction of Owner's Engineer that their product will meet the test requirements. This demonstration shall be based on past production test records of similar material and shall require Owner's Engineer approval. The acceptance criteria shall be as follows:
 - i. CLR < 10% for each of the three sections from each coupon.
 - ii. One set of three specimens shall be tested from each thickness of plate from each heat in the as-received or PWHT condition.
 - c. Unless otherwise specified, in wet H₂S or HF service, the CS plate and strip used for vessels that are not fully lined shall be supplied in the normalized condition and shall be subjected to PWHT. The PWHT procedure outlined in the following industry standards shall be followed:
 - i. ASME/BPVC SEC VIII-1, UW-40 "Procedure for Post-Weld Heat Treatment" and UW-49 "Check for Post-Weld Heat Treatment Practice".
 - ii. ASME/BPVC SEC VIII-1, UHA-32 "Requirements for Post-Weld Heat Treatment" (the notes in Table UHA-32 "Post weld Heat Treatment Requirements for High Alloy Steels" shall not apply).
 - iii. ASME/BPVC SEC VIII-1, UCS-56 "Requirements for Post-Weld Heat Treatment" (the notes in Table UCS-56 "Post weld Heat Treatment Requirements for Carbon and Low Alloy Steels" shall not apply).
- All welds, regardless of type or size, shall be subjected to PWHT at a minimum temperature of 620 °C (1,150 °F). External attachments or seal-welded-threaded connections on P-1 Group 1 and Group 2 materials are exempted from this requirement and do not require PWHT.
- d. Uncoated or unlined carbon and low-alloy steel vessels in wet H₂S or HF service shall be examined as follows:

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- i. All Category A, Category B, and Category C welds as defined in ASME/BPVC SEC VIII-1, Paragraph UW-3 "Welded Joint Category " shall be inspected by one of the following methods:
 - 1) 100% RT with acceptance criteria as defined in ASME/BPVC SEC VIII-1, Paragraph UW-51 "Radiographic Examination of Welded Joints."
 - 2) 100% UT with acceptance criteria as defined in ASME/BPVC SEC VIII-1, Paragraph UW-53 "Ultrasonic Examination of Welded Joints."
 - ii. All Category D welds (nozzle to shell attachments) shall be inspected by one of the following methods:
 - 1) Progressive MT of every 6 mm ($\frac{1}{4}$ in.) of weld buildup, using the AC yoke technique with test methods and acceptance criteria as defined in ASME/BPVC SEC VIII-1, Mandatory Appendix 6 "Methods for Magnetic Particle Examination (MT)." Where applicable, the backside of the root pass shall be examined after being prepared for welding.
 - 2) 100% UT of nozzle to shell welds with acceptance criteria as defined in ASME/BPVC SEC VIII-1, Paragraph UW-53 "Ultrasonic Examination of Welded Joints."
 - iii. Subsequent to PWHT, the inner (wetted) surface of all welds shall be inspected by one of the following methods:
 - 1) WFMT with testing methods and acceptance criteria as defined in ASME/BPVC SEC VIII-1, Mandatory Appendix 6 "Methods for Magnetic Particle Examination (MT)." The surface shall be prepared by abrasive blasting to a commercial blast quality. Alternatively, flapper wheels or sanding discs (no coarser than 40 grit [425 μ average]) may be used.
 - 2) 100% UT of welds not accessible from the ID with acceptance criteria as defined in ASME/BPVC SEC VIII-1, Paragraph UW-53 "Ultrasonic Examination of Welded Joints."
 - e. PWHT is required for all longitudinally welded carbon and low-alloy ferritic steel pipes exposed to wet H₂S or HF service regardless of the pipe thickness. The minimum PWHT temperature shall be per ASME B31.3 for the material used, but not less than 620 °C (1,150 °F). For CS piping exposed to wet H₂S or HF service, the following types of welds are exempt from the special PWHT requirements of this paragraph unless required by the applicable code:
 - i. Multi pass girth welds in seamless piping, welded from the outside surface only.
 - ii. External attachment, when the WM does not come in contact with the service.
 - iii. Multi pass seal and socket welds.
 - iv. Multi pass welds for set on branch connections (e.g., ASME B31.3, Figure 328.4.4 Sketch [a] "Preparation for Branch Connections" Sketch [a]) or set in branch connections (e.g., ASME B31.3, Figure 328.4.4 Sketch [c] "Preparation for Branch Connections"), provided all welding is performed from the outside.
 - f. For CS piping in HF or wet H₂S service only, welds shall be exempted from the special PWHT requirements, provided that the hardness measurement does not exceed 200 BHN.
- 9.1.48 Casting repair procedures shall be submitted for Owner's Engineer review and approval whenever repairs are required that meet any of the following criteria. Defect charts shall be submitted for review prior to the start of repairs. The following repair castings shall be inspected according to Pressure

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Casting Quality and Inspection doc no. GP 18-03-04D:

- a. Repairs required after final heat treatment.
- b. Repairs made due to the inability of the pump to pass hydrostatic testing.
- c. Repairs that exceed 6,500 mm² (10 in.²).
- d. Repairs that result in a repair cavity that exceeds 20% of the casting wall thickness or 25 mm (1 in.), whichever is less.

9.1.49 Welding shall be per General Welding Requirements doc no. GP 18-07-01D.

9.1.50 PWHT of carbon and ferritic alloy steel pressure-containing components exposed to a process containing H₂S that are welded, or weld repaired shall be in accordance to the following requirements:

- a. The PWHT procedure outlined in ASME/BPVC SEC VIII D1, Paragraph UW-40 "Procedures for Post weld Heat Treatment," Paragraph UW-49 "Check of Post weld Heat Treatment Practice," Paragraph UHA-32 "Requirements for Post weld Heat Treatment," and Paragraph UCS-56 "Requirements for Post weld Heat Treatment for Carbon and Low Alloy Steels" shall be followed, except that the notes in ASME/BPVC SEC VIII D1, Tables UHA-32 "Post weld Heat Treatment Requirements for High Alloy Steels" and Paragraph UCS-56 "Requirements for Post weld Heat Treatment" do not apply.
- b. All welds regardless of type or size that are exposed to wet H₂S shall require PWHT at a minimum temperature of 620 °C (1,150 °F). External attachments or seal-welded threaded connections on P-No. 1 Group 1 and 2 materials do not require PWHT.

9.1.51 Pumps specified as handling alkaline solutions shall have PWHT according to this specification.

9.1.52 Impact requirements shall be according to this specification for the specified CET.

9.2 Purchaser Technical Requirements

9.2.1 Pump casing drain valves shall be provided. Drain valve shall be threaded and plugged (downstream).

9.2.2 Pump casing vent valve shall be provided for not self-venting pumps and pumps in vacuum service (flanged).

9.2.3 When pump type is BB or VS, the shaft shall be full circumference stress relieved in the plane of the set screw installation a minimum of 1 mm (0.040 in.) diametrically.

9.2.4 Pump bearing housing shall include a sight glass and an oil sump collection container (water trap).

9.2.5 Electric motor drivers shall be sized for:

- a. Operation over the entire head-capacity curve for pumps in parallel with auto-start operation, firewater pumps, and boiler feedwater pumps.
- b. The peak power required during the vacuum pull-down period for pumps in vacuum service.

9.2.6 Coupling guards shall not be constructed of non-metallic materials. Coupling guards shall not be removable without suitable tools.

9.2.7 Shaft guards shall be guarded 360 degrees. Shaft guards shall permit emission monitoring per US EPA Method 21 without removal of the guard.

9.2.8 Tabs for alignment screws shall be removable in the field. Jackscrews shall be plated for corrosion resistance.

9.2.9 All pumps shall receive a hydrostatic test and a performance test.

- 9.2.10 An NPSH Test shall be performed on pumps where the NPSH required differs from the specified available NPSH by 1 m (3 ft) or less.
- 9.2.11 Mechanical seal flushing liquid coolers shall be hydrostatically tested on the process side to, at least, the same pressure as the pump casing.
- 9.2.12 Seal chamber pressure shall be measured at each point during the pump performance test.
- 9.2.13 Vertical pumps shall be supplied with flanged column pipes.
- 9.2.14 For vertical pumps, Vendor shall assemble and dowel the motor or gear to the pump in its shop to confirm repeatable unit fit-up and shaft mating.
- 9.2.15 For hot pumps, the efficiency and power curves shall include the effect of increased clearances.
- 9.2.16 Suction specific speed for integrally geared vertical high-speed pumps shall not exceed 22,000.

9.3 Drivers & Gear box

- 9.3.1 Electric motor drivers shall be per clause no. of 5.3 of this specification.
- 9.3.2 Unless otherwise specified, Gears shall be supplied as per equipment specification for General purpose Gear Unit, document no. USBT-000-TE-MR-EQS-0011.
- 9.3.3 Power transmissions shall have a power rating at least equal to the driver power rating.
Variable speed transmissions shall not be used without approval by Owner's Engineer.
- 9.3.4 All power transmission components, such as gears, couplings, shafts, etc., shall be capable of transmitting the maximum torque developed by the driver, or that portion of the maximum driver torque transmitted through them. Minimum transient torque to be used for power transmission component design shall be in accordance with Table 2: Minimum Transient Torques.
- 9.3.5 All power transmission components, such as gears, couplings, shafts, etc., shall be capable of transmitting the maximum torque developed by the driver, or that portion of the maximum driver torque transmitted through them. Minimum transient torque to be used for power transmission component design shall be in accordance with Table 2: Minimum Transient Torques.

Table 2: Minimum Transient Torques

| Application | Transient Torque (% of Driver Torque at 1.0 Service Factor) |
|-------------------------|--|
| Electric Motor Drivers: | |
| Induction Type | 400% |
| Synchronous Type | 500% |

9.4 Coupling and Coupling Guard

- 9.4.1 Couplings shall be flexible type (disc type) with stainless steel discs. and designed as per API 610 and as amended in JIP33 (IOGP S-615) as a minimum.
- 9.4.2 The minimum coupling service factor shall be 1.5.
- 9.4.3 All areas with access to rotating parts shall be guarded at 360 degrees. Equipment guards shall meet the requirements of ANSI B11/STD B11.19 and BSI BS EN ISO 14120, as applicable for the intended location of use, or similar local regulations. Guards shall also permit emission monitoring per U.S. EPA

Method 21 without removal of the guard.

- 9.4.4 The coupling guards shall be fabricated from non-sparking material and be constructed of steel, brass, aluminum, or austenitic stainless-steel materials, as suitable.
- 9.4.5 Guards shall not be removable without the use of suitable tools.
- 9.4.6 Coupling and belt guards in hazardous areas shall be constructed entirely of spark-resistant metallic materials.
- 9.4.7 All areas with access to rotating parts, including seal openings with spacers between bearing housings and casings, shall be guarded at 360 degrees. Equipment guards shall meet the requirements of ANSI B11/STD B11.19 and BSI BS EN ISO 14120, as applicable for the intended location of use, or similar local regulations.

- 9.4.8 Guards shall also permit emission monitoring per U.S. EPA Method 21 without removal of the guard.

9.5 Baseplate

- 9.5.1 Unless otherwise specified by Owner's Engineer, a sloped full deck plate, mounted between the side rails, which extends under the pump and drives train components per API 610 and as amended in JIP33 (IOGP S615), Figure 38 "Sloped Full Deck Plate" shall be furnished for horizontal pumps.
- 9.5.2 Additionally, each pad shall be level in all directions within 80 µm/m (0.001 in./ft) of distance between pads.
- 9.5.3 Vendor shall notify Purchaser when it is impractical for grout holes to be accessible for grouting without moving the machinery. In these cases, Owner's Engineer review and approval of the grouting holes location is required.
- 9.5.4 Permanently attached lifting lugs, pad eyes, and trunnions shall pass 100% radiographic or ultrasonic inspection in accordance with AWS D1.1/D1.1M, Section 8 "Inspection".
- 9.5.5 Materials that directly attach to lifting lugs, pad eyes, and trunnions shall pass 100% radiographic or ultrasonic inspection in accordance with AWS D1.1/D1.1M, Section 8 "Inspection".
- 9.5.6 Tabs for alignment screws shall be affixed to the pad without welding so that they are removable in the field. An example would be bolting. Jackscrews shall be plated for corrosion resistance.

9.6 Mechanical Seal and Seal System

- 9.6.1 Mechanical seals shall be designed as per API 682 4th Ed, Shaft Sealing Systems for Centrifugal and Rotary Pumps and in accordance with USBT-000-TE-MR-EQS-0003.
- 9.6.2 Seal flushing where necessary, shall preferably be with the process fluid itself through an appropriate API seal plan for all clean liquids.
- 9.6.3 External seal flushing oil shall be made a requirement only when a self-flushing plan is infeasible.

9.7 Lube Oil System

- 9.7.1 The forced feed external lubrication Oil System shall be in accordance with equipment specification for Lubrication shaft sealing and oil control system and auxiliaries, doc no. USBT-000-TE-MR-EQS-0012.

9.8 Piping

- 9.8.1 Piping and fittings inside Package shall comply with project piping classes, ASME B 31.3.
- 9.8.2 For Class 150 and Class 300: Schedule 160 shall be used for pipe sizes from DN 20 to DN 25 (NPS 3/4 to NPS 1), Schedule 80 shall be used for sizes from DN 40 to DN 50 (NPS 1 1/2 to NPS 2), and Schedule

40 shall be used for sizes DN 80 (NPS 3) and larger.

- 9.8.3 For Class 600: Schedule 160 shall be used for pipe sizes from DN 20 to 50 (NPS ³/₄ to NPS 2) and Schedule 80 shall be used for sizes DN 80 (NPS 3) and larger.
- 9.8.4 Above Class 600, thicker wall pipe may be necessary and Purchaser shall consult Piping General ExxonMobil Material Specifications (GEMS) practices.
- 9.8.5 All orifice plates shall have a tab extending from the union or flange where they are installed to indicate their location. The tab shall be stamped with the orifice size and customer supplied identification number.
- 9.8.6 Threaded vent and drain connections shall be supplied with metal, non-seal-welded round head bar stock plugs per ASME B16.11.
- 9.8.7 Unions shall not be used in Group I (auxiliary process fluid), Group II (steam and air), or Group IV (lubrication and control oil) services.
- 9.8.8 All threaded connections shall be made up without the use of thread compounds or PTFE tape and shall be seal-welded, except for the following:
 - a. Instruments downstream of valved takeoff connections
 - b. Thermowells and other instruments requiring removal for maintenance
 - c. Valve outlets that are plugged or capped
 - d. Seal gland connections
 - e. Tubing fittings
 - f. Auxiliary plug connections requiring removal for maintenance of operation shall not be seal welded.
- 9.8.9 Balance lines that are smaller than 25 mm (1 in.) require approval by Owner's Engineer.
- 9.8.10 Piping supplying external flushing liquid to pump mechanical seals (i.e., API Flush Plans 32 and 54) or wear rings shall be in accordance with USBT-000-TE-MR-EQS-0003.
- 9.8.11 Purchaser and Vendor shall review the measured seal chamber pressure of the pump performance test and shall mutually agree on a suitable flush minimum flow rate, minimum pressure, and temperature.
- 9.8.12 All piping shall be adequately anchored at the pump skid battery limit. Safe isolation with blind flanges shall be included before each terminal point.

9.9 Warm-Up Facilities

- 9.9.1 A warm-up line connected from pump suction to discharge shall be installed per Figure 2: Detail Schematics for Figure 1, Detail A for either of the following conditions:
 - a. If the pumping temperature exceeds 230 °C (450 °F)
 - b. If the ambient temperature may be at, or below, the pour point of the process fluid
- 9.9.2 If specified, then warm-up facilities for dirty and fouling services (e.g., coking and slurry) shall be installed per Figure 2: Detail Schematics for Figure 1:
 - a. The notch for the V-notched valve (flow restrictor) shall be located at the bottom of the gate.
 - b. If a portion of the notch will be blocked (covered up) when the gate is fully closed (gate extending into the body seat), then that shall be taken into account when sizing the notch. This may lead to cut the notch slightly larger to account for some portion of the open area being blocked.

- 9.9.3 Warm-up facilities for clean and non-fouling services shall be per Figure 2: Detail Schematics for Figure 1, Detail A and shall also include the following:
- The drilled check valve shall have the hole sized to provide a flow of 3% to 5% of normal pump flow, but the hole shall not be less than 3 mm ($1/8$ in.) diameter.
 - If a high differential pressure precludes meeting the 3% to 5% flow limitation by means of the drilled check valve detailed above, then, as an alternative to a drilled check valve, a bypass with a flow restrictor is acceptable on pumps with discharge nozzles DN 50 (NPS 2) diameter and larger.
- 9.9.4 A drilled check valve or bypass line per Figure 2: Detail Schematics for Figure 1, Detail A shall be installed when the pump is designed for automatic start-up and when daily mean temperature may fall below the temperature for acceptable process fluid operating viscosity.
- 9.9.5 The warm up orifice plate with flanges, gasket, hardware and check valve shall be in pump vendor scope.

Figure 1: Typical Piping and Valve Arrangement Schematic

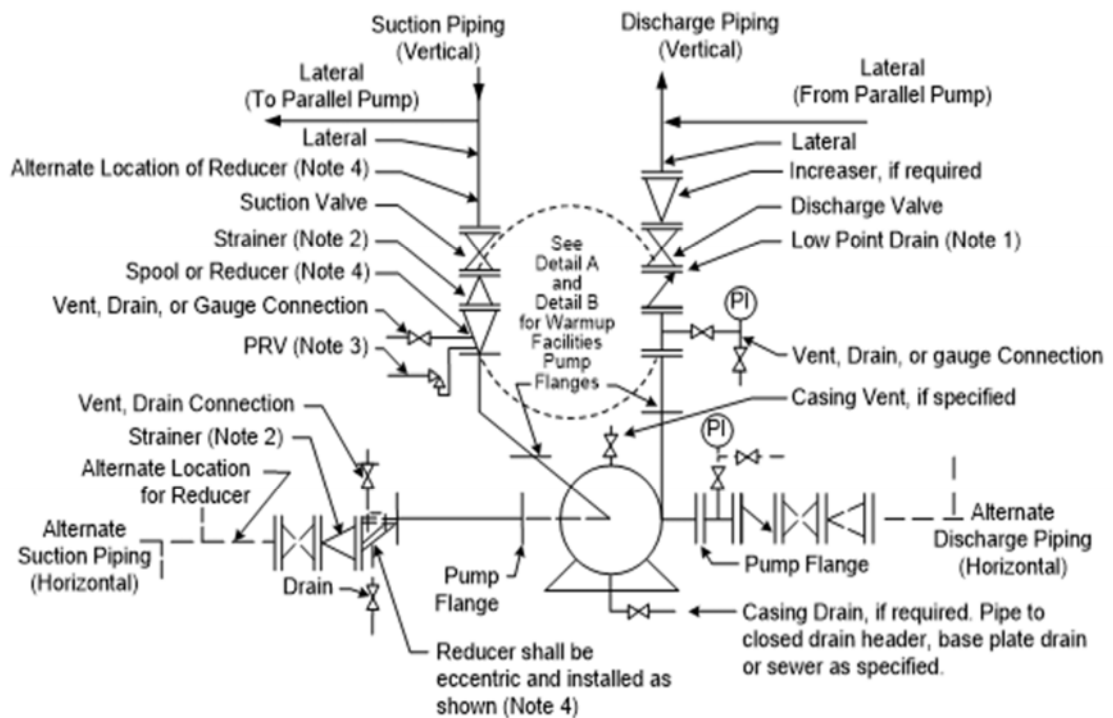


Figure 1 Notes:

- Note (1) A low point drain is not required if the check valve is drilled and a casing drain is provided.
- Note (2) [*] The temporary or permanent strainer location is specified. Alternative locations for the permanent strainer, as required, shall be specified.
- Note (3) The PRV location is specified if required for pump casing or mechanical seal protection.
- Note (4) Reducers shall be located at least 5 pipe diameters away from suction flange to reduce turbulence.

Figure 2: Detail Schematics for Figure 1

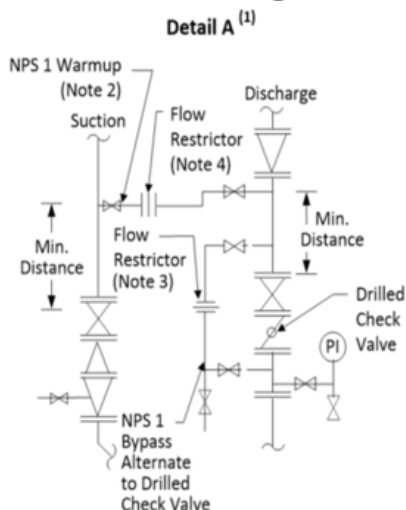


Figure 2 Notes:

Details A:

- (1) Note (1) Line flexibility shall be provided for thermal expansion between pump lines and warmup and bypass lines.
- (2) Note (2) Purpose of warmup line is to keep piping hot, if pump is removed from service, to: a) prevent cooling of line/allow warming of line prior to pump installation to avoid cold springing and b) keep lines from plugging if fluid solidifies at ambient temperature.

Detail A Only:

- (1) Note (3) Flow restrictor shall be sized to provide a flow of 3% to 5% of normal pump flow, but not less than 3 mm (1/8 in.) diameter.
- (2) Note (4) Flow restrictor shall be sized to provide a flow as specified.

Detail B Only:

- (1) Note (5) Lines sized for a maximum velocity of 1.8 m/s (6 ft/sec), but not less than 25 mm (NPS 1).
- (2) Note (6) Flow restrictor shall be a V-notched gate valve with the notch sized to provide a flow of 3% to 5% of normal pump flow, but not less than the equivalent of a 3 mm (1/8 in.) diameter hole. Valve shall be clearly and permanently labeled as having a notched gate.
- (3) Note (7) Flow restrictor shall be a V-notched gate valve sized to provide a flow as specified. Valve shall be clearly and permanently labeled as having a notched gate.

9.10 Materials

9.10.1 As a minimum, Material of construction shall be as per respective mechanical datasheet of pumps. Higher material grades offered by vendor (if any) shall be subject to Purchaser approval.

9.11 Special Tools

9.11.1 The Vendor shall provide any special tools that are required to properly maintain their equipment.

These special tools shall be clearly identified in the Vendor's proposal.

9.12 Nameplates

9.12.1 A stainless-steel nameplate showing, as a minimum, information shall be provided as per API 610.

9.13 Painting

9.13.1 The complete painting cycle of package shall be in accordance with External Paint and Protective coatings doc no. BTDP 19-1-1-1 along with GP 19-01-01D. Surface preparation and painting for the base plate shall be same as the pump.

9.14 Specific Pump Types

9.14.1 For Single-stage Overhung Pumps—Vertical In-Line (Type OH3) Pumps, Proposals to use grease lubricated bearings shall be approved by Owner's Engineer.

9.14.2 For Between-bearings Pumps (Types BB1, BB2, BB3, and BB5)—Pressure Casings, Foot-mounted pumps may be used for nonflammable, nontoxic services below 80 °C (175 °F).

9.14.3 For Between-bearings Pumps (Types BB1, BB2, BB3, and BB5) – Lubrication, Pumps with hydrodynamic thrust bearings or tilting pad type hydrodynamic radial bearings shall be equipped with an external pressurized oil system.

9.14.4 For Between-bearings Pumps (Types BB1, BB2, BB3, and BB5)—Lubrication, Non-shaft-driven horizontal lube oil pumps shall have positive suction heads and suction lines sloped to vent to the reservoir.

9.14.5 Vertically Suspended Pumps (Types VS1 Through VS7)—Pressure Casings, Vertical pumps shall be supplied with flanged column pipes and, depending on the type of pump, either flanged and bolted bowls or a bolted casing assembly. Column and bowl bolting shall be corrosion-resistant for the intended service.

9.14.6 For Vertically Suspended Pumps (Types VS1 Through VS7)—Bushings and Bearings, The use of carbon or PTFE-based guide bushings shall be approved by Owner's Engineer.

9.14.7 For Vertically Suspended Pumps (Types VS1 Through VS7)—Bushings and Bearings, Pump Manufacturer shall specify in the proposal the maximum upthrust and downthrust to be imposed on the motor thrust bearing and shall be responsible for proper sizing of the thrust bearing to accommodate these loads.

9.14.8 For Vertically Suspended Pumps (Types VS1 Through VS7)—Accessories—Drivers, For vertical pumps, Vendor shall assemble and dowel the motor or gear to the pump in its shop to assure repeatable unit fit-up and shaft mating.

10. INSPECTION AND TESTING

10.1 The Vendor shall be responsible for inspection and quality control of the Centrifugal pumps & accessories and, when required, shall provide the necessary inspection and supervision to erect and construct the Centrifugal pump package in accordance with the mechanical datasheet and specifications.

10.2 The Vendor shall refer JIP33 IOGP S-615Q QAP document and project ITP (attached with MR) for the preparation of vendor QAP.

10.3 Inspection shall include verification of the equipment dimensions, compliance with baseplate machining tolerances after all machining steps, examination of test data, and checking preparation for shipment.

10.4 For services with pumping temperatures 260 °C (500 °F) or higher, Inspector shall verify that the internal

clearances conform to those given in API STD 610-12, Clause 6.7.5.

- 10.5 Pressure-containing castings for pumps shall be inspected according to Pressure Casting Quality and Inspection doc no. GP 18-03-04D.
- 10.6 Final acceptance testing of parts requiring magnetic particle, liquid penetrant, radiographic, or ultrasonic examination shall be made after all machining has been completed.
- 10.7 Bearing housings and drained oil shall be inspected by Purchaser's Inspector on a random basis prior to releasing the pump for shipment or after a witnessed performance test. Contamination of any kind of hard particles found in bearing housings or used oil shall result in a failed test, replacement of bearings, and retest prior to shipment.
- 10.8 A witness test, by Purchaser's Inspector, of hardness shall be conducted for 12% chrome CA6NM casings.
- 10.9 If specified, then PMI shall be performed according to Positive Material Identification doc no. GP 18-12-01D.
- 10.10 Vendor shall submit to Purchaser for Owner's Engineer review and comment, detailed procedures for all running tests and all specified optional tests. Purchaser and Vendor shall agree on timing for submittal of detailed procedures before the first scheduled running test.
- 10.11 As a minimum, inspection and testing of all pumps shall be conducted according to Table 3: Pump Testing Procedures.

Table 3: Pump Testing Procedures

| Inspection or Test | Required | Witnessed | Certified Data |
|-------------------------|----------------|-------------------|----------------|
| Hydrostatic Test | Yes | No ⁽⁴⁾ | Yes |
| Performance Test | Yes | No ⁽²⁾ | Yes |
| NPSH Test | ⁽¹⁾ | No ⁽⁵⁾ | Yes |
| Inspection by Purchaser | Yes | — | — |
| Dismantled Inspection | ⁽³⁾ | — | — |

Notes:

- (1) If the NPSH required by the pump differs from the specified available NPSH by 1 m (3 ft) or less, then an NPSH test (see Paragraph 8.3.4.3.1 of API 610) and performance test are required.
- (2) Performance tests shall be witnessed, if either of the following is true:
 - (a) The manufacturing facility has no previous experience with the pump.
 - (b) Manufacturer has made significant changes to standard designs in critical areas, such as hydraulic balance and shaft sealing.
 - (c) The pump is defined as multistage or high energy pump (pumps with heads greater than 200 m [650 ft] per stage and with more than 225 kW [300 HP] per stage).
- (3) Each pump receiving a witnessed performance test shall be dismantled by Manufacturer for inspection by Inspector following the final performance test, according to the guidelines below:
 - (a) Hydrodynamic bearings and housings shall be dismantled.
 - (b) Rolling element bearings and their housings shall only be dismantled, if any of the following occur during test:
 - (i) Oil/bearing temperature rise exceeds 40 °K (70 °R) above the ambient temperature
 - (ii) Unusual noises come from the pump
- (4) Hydrostatic tests shall be witnessed for all high alloy castings (e.g., duplex stainless steels, Incoloy, Inconel, and Monel).

| Inspection or Test | Required | Witnessed | Certified Data |
|--------------------|--|-----------|----------------|
| (5) | If required per Note (1), then the NPSH test shall be witnessed, if the pump is receiving a witnessed performance test per Note (2). | | |

- 10.12 Hydrostatic testing, whether on a component basis or assembled pump, shall be done after all machining and welding (i.e., piping connections, drain, vents, and seal-welding) have been completed and all plugs installed.
- 10.13 Segmented testing of pumps shall require approval by Owner's Engineer.
- 10.14 Mechanical seal flushing liquid coolers shall be hydrostatically tested on the process side to at least the same pressure as the pump casing.
- 10.15 The shutoff head with the negative tolerance allowance included shall not be less than 110% of the head at the rated capacity without Owner's Engineer approval.
- 10.16 The shutoff head with the positive tolerance allowance included shall not exceed 120% of the head at rated capacity without Owner's Engineer approval.
- 10.17 During factory performance tests of variable speed drive pumps, the rated minimum and maximum speed curves shall be verified at five points.
- 10.18 Curves and test data (corrected for speed, specific gravity, and viscosity) shall be submitted after completion of performance testing to Purchaser for Owner's Engineer review and acceptance prior to shipment.
- 10.19 Vendor shall ensure that measured seal chamber pressures (when corrected for rated suction pressure and SG) are consistent with those assumed in designing the mechanical seal. In addition, the suitability of the seal maximum dynamic pressure rating shall be confirmed.
- 10.20 Corrective steps needed to improve seal design or seal chamber operating conditions shall be submitted to Purchaser for Owner's Engineer approval.
- 10.21 If a tight shutoff auxiliary containment seal is used, then the cavity between the main and auxiliary seals shall be vented during testing to confirm acceptable operation of the main seal.
- 10.22 Performance tests of VS1, VS2, VS3, VS4, and VS5 vertical pumps shall be done at the required minimum submergence stated by Vendor.
- 10.23 Performance test of pump shall be done with job seal and job coupling.
- 10.24 Job driver shall be used for Performance test of pump under criticality level 1 rating. If job driver is used for the performance test, then it shall not be operated above nameplate power.
- 10.25 All pumps shall be run on the test stand at the rated flow for at least 1 hour. If it is necessary to dismantle a pump for any correction, such as due to noise, vibration, or leakage, the initial test shall not be acceptable, and the mechanical run test shall be repeated after the correction is made.
- 10.26 NPSH test shall be performed, if the NPSH3 differs from the specified available NPSH by 1 m (3 ft) or less.
- 10.27 A closed loop temperature and pressure control test is required unless suction throttling has been approved by Owner's Engineer.
- 10.28 Sound level tests shall be performed per this specification.
- 10.29 A physical alignment between the pump shaft and the driver shaft shall be performed prior to shipment and reported in the pump maintenance manual.
- 10.30 Painting of unmachined exterior surfaces for corrosive chemical or marine atmospheres will be specified.
- 10.31 The supplier/Sub supplier shall notify company or its designated representative and the assigned

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| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
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Inspector at least 10 working days before items are ready for inspection.

11. PACKING, STORAGE AND TRANSPORTATION

- 11.1 All equipment shall be packed for an outside storage period of at least 12 months unless otherwise specified. Packing shall be suitable for environmental conditions referred in this specification. Any deviation to this clause shall be clearly highlighted by vendor.
- 11.2 All flanged openings shall be provided with bolted blinds with gaskets for transportation. Flanged openings shall be protected with bolted-on wooden outdoor plywood (min. 12 mm thicknesses) or metal covers, using at least three bolts. All the openings shall be plugged & sealed condition during dispatch. Wiring-on covers is not acceptable. After openings have been covered, the joint shall be wrapped with waterproof adhesive tape.
- 11.3 Vendor shall provide special lifting devices such as non-standard slings, turn buckles, lifting beam, spreader bars etc along with their supply.
- 11.4 Spare Rotors of Rotating equipment shall be supplied and stored in metallic containers with N2 purging.
- 11.5 During shipping, vessels and exchangers shall be preserved and/or protected as follows:
 - a) The internals of vessels and heat exchangers shall be drained and dried by circulating warm air, then vessels and heat exchangers shall be internally coated with a suitable preservative.
 - b) All flanged nozzles shall be sealed using gasketed steel blinds. Steel pipe plugs, plastic plugs, or caps shall be used for all threaded connections.
- 11.6 For ocean shipment flanged openings shall be covered with securely taped heavy plastic sheet. All butt weld connections shall be sealed with heavy plastic sheet taped to the nozzle.
- 11.7 Equipment of subassemblies which are susceptible to damage from moisture or water vapor shall be packaged in a container and over packed in a moisture / vapor-proof barrier material Cortec VpCI MilCor plastic wrap with desiccant, or other compatible dehydrating agents. Complete evacuation of air voids shall be accomplished, followed by heat sealing. Bentonite-based desiccants should be used in situations when contact with the item packed is unavoidable. Vapor corrosion inhibitors, VpCI, capsules shall be used. Silica-based desiccant should not be allowed to come in direct contact with the packaged item.
- 11.8 Individual parts and other items like panels shall be enveloped with polyethylene sheets and sealed or shrink-wrapped where practical. Individual instruments shall be preserved by either enclosing the instrument in a sealed heavy-duty VpCI polyethylene bag or shrink wrap or by inserting a VpCI emitter within the instrument housing, replacing the housing cover, and sealing the joint with heavy-duty water-resistant tape. All openings in instrument and electrical equipment shall be plugged or capped. This includes all unused cable entries, process line connections, and pneumatic tubing connections. Plastic plugs are acceptable.
- 11.9 All instrument panels, cabinets, or boxes containing electronic components like relays shall be sealed with heavy-duty polyethylene sheets or shrink-wrapped after the installation of VpCI emitters. The instrument panel front shall be covered with 100 mm (4 in.) thick foam rubber and a 6.35 mm (0.25 in.) thick plywood sheet, attached by straps.
- 11.10 The gauge glasses on skid or equipment-mounted instruments shall be adequately protected or removed.

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| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit Info | 000-General | | | | | | |

- 11.11 Fragile items shall be cushioned within their container to prevent damage from shock, vibration, and rough handling. Finished or critical surfaces shall be protected from abrasion.
- 11.12 All equipment shall be suitably protected against salt water for ocean transport.
- 11.13 All Machined / threaded surfaces shall be protected with suitable rust preventive. Preservative oils and greases shall be compatible with process fluids and service lubricants to minimize the need for their removal and pre-installation/commissioning cleanup. Preservatives detrimental to the process shall not be used.
- 11.14 Equipment supplier shall provide preservation procedures for equipment's and spares listing all the consumables required during detail engineering.
- 11.15 All loose items shall be suitably packaged and marked with identification. All appurtenances susceptible to damage shall be suitably protected.
- 11.16 Spare part shall be packed separately from the main equipment while transportation.
- 11.17 Packing labels shall be placed on each packed and/or over packed package. The label consists of a bar code representing a unique package number which corresponds to a given packing list number. Also on the label shall be the Purchase Order (PO) numbers of the material packed in the package, and the packing list and packing list box number of the packed package. The dimensions of the packing label shall be 3 in. (76.2 mm) high by 4 in. (101.6 mm) wide. All marking shall be stenciled in black waterproof ink, with not less than ½ in. (13 mm) to 1 in. (25 mm) high lettering on two opposite sides of the packaged item(s). Tags and packing labels shall be affixed to remain in place and be clearly visible throughout the storage period to each equipment and stored material, to remain in place and be clearly visible, embossed in stainless steel or engraved plastic and attached to the item using stainless steel straps. Plastic ultraviolet-resistant tie straps are an acceptable alternative to stainless steel and the use of wires, string, paper or cardboard is not acceptable.
- 11.18 Wooden containers (Boxes and crates) shall be constructed to support their own gross weight when suspended by grab hooks at the top or slings around the ends or base.
- 11.19 Vendor shall provide "**Preservation and Protection**" as part of vendor documentation.
- 11.20 Vendor shall provide the recommended inspection protocol (daily, weekly, monthly, 6 months, 1 year, etc) and frequency of renewal of desiccants/anti-rust coatings for the equipment in storage". This document shall be a part of final documentation.

12. PREPARATION FOR SHIPMENT

The VENDOR shall provide its packing and preservation procedure at bid stage for CONTRACTOR review. The packing and preservation shall be suitable for 12 months' outdoor storage. Extend preservation packaging to used where feasible.

13. GUARANTEE AND WARRANTY

13.1 Mechanical Warranty

- 13.1.1 The Vendor shall guarantee the mechanical design of the Centrifugal Pumps when operated under the design conditions specified in the approved Datasheet. This guarantee shall be vendor standard, unless

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otherwise stated by the Purchaser.

13.2 Performance Guarantee

13.2.1 VENDOR shall guarantee and be fully responsible for all performance, engineering, design, fabrication, inspection, testing, cleaning, packing, and supply of the Centrifugal Pumps according to all the attached project specifications, drawings, and stipulated codes & standards.

14. AWP REQUIREMENTS FOR VENDOR WORK PACKAGES

14.1 Introduction to AWP in Baytown GOLD

14.1.1 Advanced Work Packaging (AWP) is a framework, based on the Construction Industries best practices. AWP method flows from Front End Engineering Planning through Commissioning and aligns Engineering & Procurement deliverables with the Construction Sequence to provide a clear Work Front.

14.1.2 This process maximizes productivity in the field, improves quality and safety and improves the schedule by removing roadblocks from the critical path early in the Project Scope of Application.

14.1.3 The implementation of AWP involves identification and delivery of Engineering Work Packages (EWPs) and Procurement Work Packages (PWP) that support the execution of Construction Work Packages (CWPs).

14.1.4 This is expected to develop the foundation to support Work Face Planning (WFP) implementation during Construction with the identification and delivery of Installation Work Packages (IWP).

14.1.5 The advantages of AWP are:

- ✓ Cost avoidance
- ✓ Risk avoidance
- ✓ Reduce Project contingency
- ✓ Increase predictability
- ✓ Increase cost/schedule efficiency
- ✓ Increase overall Project reliability.
- ✓ Improve collaboration among Project resources
- ✓ Better data flow consistency
- ✓ Lower delay accumulation.

14.1.6 In Baytown GOLD Project, ExxonMobil and T.EN will be applying AWP principles on Engineering and Procurement deliverables thereby supporting construction Sequencing to provide a clear Work Front.

14.1.7 The AWP framework for Supply Chain involves the defining and identifying of Procurement work Package (PWP), EWP outlines all material and equipment that needs to be purchased for a given PWP and its corresponding CWP. Ideally there should be a 1:1 relationship between CWPs, EWPs, and PWPs.

14.1.8 For example, every CWP will have minimum of one EWP, and every EWP will have a PWP. There can also be multiple EWP's and PWP's for a single CWP. The CWP cannot be completed until all EWP's and PWP's for that CWP is issued. The PWP should include all materials needed for a CWP, except rental equipment or general consumables (i.e.: generators, cranes, forklifts, gloves, ear protection, drill bits, etc.).

14.1.9 In order to track the PWP, procurement tracks all Purchase orders by PWP Number (an attribute assigned based on CWP), T. EN Engineering tracks the input received (Drawings, Datasheets etc) from vendor and assigns an attribute Vendor Work Package (VWP) identifier.

14.1.10 All these packages information (identifiers) EWP, VWP, PWP and CWP are tracked in level 3 planning

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schedule and their identifiers will be provided by T. EN, which needs to be captured in all vendor deliverables.

14.2 Vendor Work Package (VWP)

14.2.1 The following paragraph will introduce the concept of **Vendor Work package**:

A package of engineering deliverables that contains all the engineering data and drawings produced by vendors and required for a single CWP. As a minimum a VWP must contain:

- a. Engineering vendor drawings
- b. Vendor 3D Model
- c. Vendor BoM (T. EN Excel Format) in addition to pdf format
- d. Vendor Packing list

The planned finish date of a VWP represents the date on which all the vendor drawings and Critical documents are final approved. T.EN will follow this PO based on VWP requirements as a minimum in addition to applicable Material and Supply requisition requirements.

14.3 Vendor Requirements

Vendors should identify an AWP coordinator for ensuring AWP required data are provided. See below the requirements for the deliverables issued by Vendors:

14.3.1 Vendor drawings

- Vendor drawings shall be submitted as per the contract.
- TEN will follow the VEWP/EWP Release Workflow.

14.3.2 Supplying Vendor 3D Models

- Identify Modeling Software
- Software Compatibility:

We require 3D models to be delivered in either the *.nwd (Navisworks) format or a common industry format such as *.ifc, *.stp, *.prt, or *.igs.

➤ **File Size Optimization:**

Please keep file sizes to a minimum by removing unnecessary geometry from the exported model. Ideally, the file size should be under 300 MB.

- **Submission:** Upload your 3D models to the GAIA as per document submission procedure.
- **Format Approval:** If you need to use a format other than those listed above, please obtain approval from the AWP team before submission.

14.4 2D Drawings (PDFs)

14.4.1 2D Drawings

- Only new, revised, or void updates are published every iteration.
- Drawings that have not changed revision do not need to be published.
- Require proper project revision attached to document, i.e. If Drawing-ABC is issued to the project as Rev 1A, then when the associated 2D drawing "Drawing-ABC" is published, then it must be revision 1A.

14.5 3D Model

14.5.1 Review Requirements

- Vendor to identify model review dates for 30/60/90% post PO Issue.
- Will be checks at 30 / 60 / 90 to review the attributes
 - @30 review hierarchy and attribute list
 - @60 Continue review hierarchy and attribute list
 - @90 Validating we have everything required and identify the gaps

14.6 Tagging Procedure:

14.6.1 VENDOR shall Follow unique Tags for all components as shown in the below eg, Steel Tagging Philosophy

Equipment/Structure Tag - Steel Structure - Fireproof - Unique sequence no

| Tag | Member Description | Remarks |
|--------------------------------|---------------------|--------------------------------------|
| EQUIP/STRUCTURE TAG-C-FP-001 | Column | Fireproofed |
| EQUIP/STRUCTURE TAG-CST-FP-001 | Stub | Fireproofed |
| EQUIP/STRUCTURE TAG-GB-FPU-001 | Grid Beam | FPU: Beam Top Flange not Fireproofed |
| EQUIP/STRUCTURE TAG-IB-FPU-001 | Intermediate Beam | FPU: Beam Top Flange not Fireproofed |
| EQUIP/STRUCTURE TAG-PG-FPU-001 | Plate girder | FPU: Beam Top Flange not Fireproofed |
| EQUIP/STRUCTURE TAG-HB-NA-001 | Plan Brace | |
| EQUIP/STRUCTURE TAG-VB-NA-001 | Main Vertical Brace | |
| EQUIP/STRUCTURE TAG-MVB-NA-001 | Misc Vertical brace | |
| EQUIP/STRUCTURE TAG-MR-NA-001 | Monorail | |
| EQUIP/STRUCTURE TAG-HR-NA-001 | Handrail | |
| EQUIP/STRUCTURE TAG-HRR-NA-001 | Removable Handrail | |
| EQUIP/STRUCTURE TAG-GR-NA-001 | Grating | |
| EQUIP/STRUCTURE TAG-GRR-NA-001 | Removable Grating | |
| EQUIP/STRUCTURE TAG-SR-NA-001 | Stringers | |
| EQUIP/STRUCTURE TAG-LD-NA-001 | Ladder | |
| EQUIP/STRUCTURE TAG-CQ-NA-001 | Chequered Plate | |

14.6.2 However if vendor follows different philosophy the same shall be submitted to T.EN.

14.7 Consistency Requirements:

14.7.1 VENDOR will ensure that the tags in the 3D model match exactly what's shown in the engineering drawing.

14.7.2 VENDOR will ensure that 3D Model Object grouping accurately reflects how parts are assembled, including parent and child relationships.

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14.8 3D model Attribute List:

VENDOR shall mandatorily use 3D model attributes as per the attached file (Annexure A), which are minimum requirements. However, vendor shall have additional attributes as per their regular modelling procedure.



VENDOR-3D Model
Attributes.xlsx

14.9 3D model Component Hierarchy:

VENDOR 3D Model Hierarchy will be broken out into constructable elements with independent attributes associated with each one. If there are questions regarding the Hierarchy, please contact the team.

14.10 Vendor BOM

VENDOR shall provide the Data requirement as per the attached file and ensure that details are consistent with all deliverables.



Vendor_BoM_Rev1.
xlsx

VENDOR will provide the packing list (part of BoM) with such details before shipping notice including any ship loose materials.

VENDOR shall ensure **three-way consistency** between their deliverables:

14.10.1 **BOM to Engineering Drawing:** The Bill of Materials (BOM) must clearly identify all components listed in the corresponding Engineering Drawings. Each record of the BOM must be traceable to its corresponding Engineering Drawing.

14.10.2 **BOM to 3D Model:** The BOM grouping needs to accurately reflect how parts are assembled in the 3D Model, including clear parent and child relationships.

14.10.3 **Packing List to BOM:** All packing lists must match the BOM exactly, ensuring all listed parts are included in the shipment.

- VENDOR material descriptions and the Vendor Unique Identifier should be included in the BoMs.
- If VENDOR is detailing the Unique Identifiers further into children, they need to provide this information back to the T.E.N. and Construction Contractor.
- VENDOR will develop children by using the parent tag; Original Unique Identifier - Child.
- All VENDOR must use the Project Procurement templates as per the Contract and deliver data accordingly.
- The above data requirements shall be provided (Excel) along with 3D model (i.e. 4 Weeks after PO).

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- All Vendors must use the Project Vendors Portal to share:
 - a. Packing Lists
 - b. Shipping Release Notices
 - c. Shipping Status Reports
 - d. Inspection Release Notice
 - e. Material Test Certificates (MTR's)
- All VENDOR must use the Project Vendor Portal to share Data and Statuses.

14.11 Packing list

14.11.1 All VENDOR must work out of a unified packing list format attached.



Vendor_PL_Format_Rev1.xlsx

- 14.11.2 VENDOR to include the engineering drawing reference for each item and the PO indication in the packing list.
- 14.11.3 Matching unique identifiers to be applied for both Parent and Child material (so to allow for complete traceability back to the Drawings and 3D Model).
- 14.11.4 VENDOR to provide preliminary packing list in native format (Excel) in 12 weeks after PO placement.
- 14.11.5 VENDOR to provide all packing lists in native format (Excel) in advance of delivery (4 Weeks as a minimum).
- 14.11.6 Every crate should have a packing list on the outside and on the inside accurately reporting the content of the crate.
- 14.11.7 VENDOR will create a detailed Bill of Materials (BOM) ensuring that each Ident Code can be traced back to its corresponding engineering tag.
- 14.11.8 Vendor QA is accountable for the quality of packing list. ExxonMobil/TEN will verify adherence to project quality standards.

14.12 QR Codes

- 14.12.1 All material delivered to site will have QR codes. No material will be delivered at site without QR Codes.
- VENDOR to ship materials with QR code applied.
 - All VENDOR of the BAYTOWN GOLD project will use the same template for all QR coding of material.
 - EXXONMOBIL AND T.E.N. quality inspector will verify to make sure that QR codes are properly installed during inspection.
 - Vendor QA is accountable for the quality of QR Codes. ExxonMobil/TEN will verify adherence to project quality standards.

14.12.2 How to generate QR Codes:

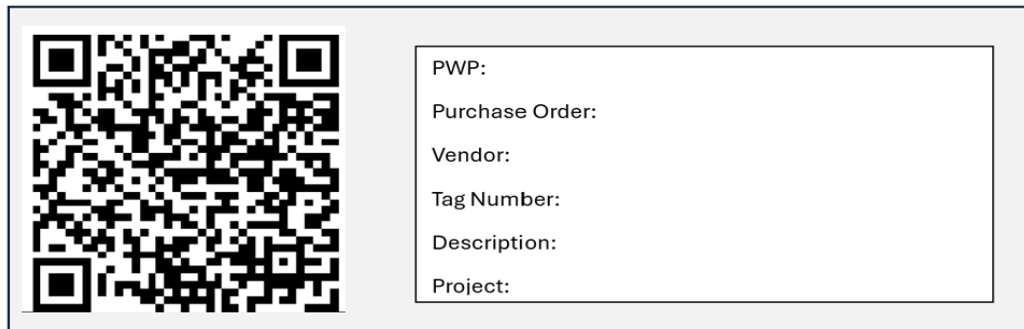
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- VENDOR to provide Vendor BoM along with the 3D Model in 12 weeks after PO placement or at least 8 weeks in advance before shipping the material whichever is the earliest.
- EXXONMOBIL Material Management Database Admin (MMDB) will use Vendor BoM to generate QR Codes based on the project template and sent to vendor via vendor portal. Ideally, each line in Vendor BoM will result in a QR code.

14.12.3 How to print/attach QR codes:

- All QR Code labels should be thermal labels printed on thermal printers to maintain the quality.
- QR Code labels shall be of a minimum of 7cm x 10cm
- QR Code labels shall be physically attached such that it is easy to scan the material for receiving.

Sample of QR Code:



14.12.4 How to apply QR Codes:

- If the shipping crate has:
 - One item
 - QR code should be installed on the Individual item and outside of crate along with packing lists.
 - Multiple ship loose items (1 qty each)
 - QR code should be installed on each ship-loose item and outside of the crate along with packing lists. For example, if there are 5 ship-loose items in a crate, 5 individual QR codes should be installed outside the crate.
 - Multiple ship loose items (1 qty each) plus bulk items
 - QR code should be installed on each ship-loose item, all the bulk-items should be grouped together in a box that should have a QR code installed on it. In addition to the packing lists, the outside of the crate should have the QR code for all the ship-loose items along with QR codes for the bulk items.

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- Bulk items
 - All the bulk items should be grouped together in a box that should have a QR code installed on it. In addition to the packing lists, the outside of the crate should have the QR code for all the bulk items.



Summary:

- Every Component in the model must be linked to an attribute that contains Drawing
- Every Drawing must be linked to a QR Code
- Every Component (Child Tag) must be shipped with a QR Code

APPENDIX 1, LIST OF DEVIATIONS / EXCEPTIONS

List of deviations (exception and addition requested by the Vendor) from Specifications Standards and/or Drawings.

| No. | Spec. No. and Para. No. | Specification Requirement | Vendor Proposed Clarification, Exception & Deviation | Reason |
|-----|-------------------------|---------------------------|--|--------|
| | | | | |

Vendor **NAME** :

Vendor **SIGNATURE** :

APPENDIX 2, CHECKLIST FOR COMPLETENESS OF TECHNICAL REQUIREMENTS.

Vendor shall confirm that their submittals include the following as minimum. In case bids are found incomplete the same can be summarily disqualified for further evaluation. It is in the Vendor's own interest to see that the bids are prepared and submitted in accordance with specified requirements. In case reply is 'NO' Vendor shall furnish reasons for the same.

Vendor to submit all filled-in and stamped checklist's enclosed in this specification.

| S.No. | Document Description | Included (Yes/No) | Remarks |
|-------|--|-------------------|---|
| 1) | Performance data, including: Completed data sheets and performance curve, as applicable for all parts of equipment as listed in MR. | | |
| 2) | Following Electrical documents: <ul style="list-style-type: none"> Electrical MV & LV Motor Data Sheet Electrical MV & LV Motor GA Drawings, Terminal Box drawing Performance curve | | |
| 3) | A Block Diagram showing basic control and protection system | | |
| 4) | Vendor's Statement of Compliance and List of comments and exceptions to applicable specifications | | |
| 5) | Confirmation that total Scope of Work is in accordance with the contract document or else list items excluded from the specified scope of supply / work. Filled in "Checklist: Scope of Supply" attached as Appendix 3 of this specification. | | Vendor to submit the Filled in Appendix 3 – Scope of supply check list. |
| 6) | List of spare parts: - a) Pre-commissioning / commissioning spares b) Capital spare parts | | Separate list to be included for each section. |
| 7) | List of special tools | | To be included in the package basic price. |
| 8) | List of Two Years of Normal Operation with unit prices. | | |
| 9) | Preliminary General Arrangement Drawing showing the dimensions and | | |

| | | | |
|-----|--|--|---|
| | Weight for the Centrifugal Pump Package (including size and weight of heaviest equipment for maintenance) | | |
| 10) | Electrical Consumer List | | |
| 11) | Maintenance frequency and maintenance drawing | | |
| 12) | List of utility consumptions | | |
| 13) | Painting and insulation procedure | | |
| 14) | Schedule for Project Site installation, pre-commissioning and commissioning. | | |
| 15) | Lubricant and chemical requirements for startup and initial operation if any | | |
| 16) | Noise Data sheet | | |
| 17) | Vendor Inspection and Test Plan | | |
| 18) | Manufacturer's catalogues for the offered items | | |
| 19) | Confirmations required with bid as per the Technical Note | | Vendor shall list out all the confirmations as required in this Technical Note. |
| 20) | All filled in, signed and stamped checklists included in this specification shall be included with the Vendor Technical Submittals | | |
| 21) | Detailed offer for Project Site erection activities as per section 10 of this Technical Note. | | |

APPENDIX 3, CHECKLIST FOR SCOPE OF SUPPLY.

Vendor shall furnish all pumps, drivers, auxiliary systems, instruments, controls, and safety devices as per the contract document. Any hardware required over and above what is specified, for safe and satisfactory operation of the equipment package shall be included by the Vendor in his scope. Vendor to indicate Yes/No against each item. Vendor's Scope of Work shall include but not limited to the following for Centrifugal Pumps.

Vendor SHALL FURNISH THIS CHECKLIST DULY FILLED IN.

| SL | Description | Reqd. by Client | Confirmed by Vendor | Remarks |
|-----|---|-----------------|---------------------|--|
| 1 | CENTRIFUGAL PUMPS | (X) | | |
| 1.1 | Centrifugal Pumps (to be confirmed by Vendor) | (X) | | Refer mechanical data sheet, P&ID, this Technical Note and other specifications attached with MR |
| 1.2 | Complete pump assembly as per API 610 and as amended in JIP33 (IOGP S615) | (X) | | Material to be selected as per Table 1 of this Technical Note. |
| 1.3 | Mechanical seal and Seal system (per API 682) | (X) | | |
| 1.4 | Shaft couplings and non-sparking coupling guards | (X) | | |
| 1.5 | Complete lube oil system (per API 614) | (X) | | If required |
| 1.6 | One common fabricated steel baseplate for the pump, motor driver and Lube oil system | (X) | | |
| 1.7 | Balancing line and accessories | (X) | | As applicable |
| 1.8 | Drain & Vent lines with relevant isolating valves and blind flanges, located at skid edge | (X) | | |
| 2 | ELECTRICAL ITEMS | | | |
| 2.1 | Pump motors | (X) | | Suitable for Area Classification as Per respective pump mechanical datasheet. |
| 2.2 | Motor, Attachment/fixing bolts, base plates, anchor bolts, shims, etc | (X) | | |
| 2.3 | Local Control station (Start/ Stop Push Buttons / HOA/Local Remote switch) | (X) | | |

| SL | Description | Reqd. by Client | Confirmed by Vendor | Remarks |
|-----|---|-----------------|---------------------|--|
| 2.4 | All Power & Control Cables from MVLC/LVLC to electrical equipment (other than lighting) | | | By Others |
| 2.6 | All Cable Glands & lugs | (X) | | Vendor to select Glands and Lugs as per provided Cable size. |
| 3 | INSTRUMENTATION | | | |
| 3.1 | All necessary Vibration and Temperature instruments as per Project specifications and Vendor recommendation. | (X) | | |
| 3.2 | All necessary field instruments as per PID and Vendor recommendation. | (X) | | |
| 3.3 | All instruments with necessary tubing, cable and junction box, cable trays, supports etc. up to package B/L | (X) | | |
| 3.4 | Manpower & tool/ tackles for testing, calibration, loop checking & commissioning for all Vendor supplied items | (X) | | |
| 3.5 | Structural steel for erection work, support for instruments | (X) | | |
| 3.6 | Conduits and cable glands | (X) | | |
| 3.7 | Cables trays/ tube trays/ cable duct/ and support up to skid edge. | (X) | | |
| 4 | MISCELLANEOUS | | | |
| 4.1 | All required piping and tubing within the confined of the pumps baseplate, the seal system and oil system baseplate or consoles with connections points placed at the edge of the baseplates. | (X) | | As per PID B/L |
| 4.2 | Acoustic treatment as necessary to meet the specified sound pressure level | (X) | | if necessary |
| 4.3 | Insulation cleats, as necessary for insulation | (X) | | For thermal / Personnel protection, if necessary |
| 4.4 | Certified lifting lugs on skid, lifting devices such as lifting beams/frames, spreader bars, slings and shackles for single lift for installation and maintenance. | (X) | | Lifting lug design calculation to be provided. |
| 4.5 | First fill of lubricant. Endor shall provide complete list of lubricants required. | | | By Others |
| 4.6 | Grout materials | | | Only details by Vendor |

| SL | Description | Reqd. by Client | Confirmed by Vendor | Remarks |
|------|---|-----------------|---------------------|--|
| 4.7 | Installation of Hardware supply & Erection | (X) | | |
| 4.8 | Earthing lugs for all equipment | (X) | | |
| 4.9 | Pipes, tube fittings, conduits, cable glands for electrical items | (X) | | |
| 4.10 | Design and supply of Anchor Bolts | (X) | | |
| 5 | SPARES / TOOLS & TACKLES | | | |
| 5.1 | Erection & Commissioning spares as recommended by the equipment manufacturer | (X) | | |
| 5.2 | Quote for Vendor recommended spares for 2-year normal operation. | (X) | | |
| 5.3 | Special tools and tackles required for erection, Project Site assembly and maintenance of Centrifugal pumps as Recommended by the equipment manufacturer | (X) | | |
| 5.4 | Capital Spares | (X) | | Refer Annex E attached with MR |
| 6 | PARTICIPATION / MEETING | | | |
| 6.1 | Kick Off meeting at CONTRACTOR office | (X) | | Date shall be finalized at the time of award of contract |
| 6.2 | Co-ordination, design and review meetings | (X) | | Timing and frequency shall be decided during KOM. |
| 6.3 | 3D Model / Maintenance review meeting | (X) | | 2 Meetings, at 60% Model review and 90% model Review, one day for each review. |
| 7 | INSPECTION AND TESTING | | | |
| 7.1 | All Inspection and Testing as specified in data sheet, specifications and Inspection and Test Plan for Centrifugal Pumps 1 - Doc no. USBT-000-TE-MR-PLN-0001. | (X) | | |
| 8 | Vendor DATA AND DRAWINGS | | | |
| 8.1 | All data & drawings as required per Vendor data | (X) | | Refer Part-II of |

| SL | Description | Reqd. by Client | Confirmed by Vendor | Remarks |
|--------------|--|-----------------|---------------------|-------------------------------|
| | requirements, data sheets, specifications and referenced codes and standards (Rotating, Static, Electrical, Instrumentation and Piping). | | | SR, 216119C-000-SR-0910-0001. |
| 9 | SCOPE OF SERVICES | | | |
| 9.1 | Supervision services for pre-commissioning and commissioning of Centrifugal Pumps 1 - Multistage. | (X) | | |
| 9.2 | Project Site Assembly, Construction, Erection and mechanical completion of Centrifugal Pumps and its auxiliaries as per this Technical Note | (X) | | |
| 9.3 | Resolving all engineering questions or problems raised by either Contractor or Client | (X) | | |
| 9.4 | Organize Pre-Inspection Meeting in Vendor facilities before beginning of manufacture; | (X) | | |
| 9.5 | Perform workshop inspections and tests of equipment as per the Quality Control Plan (including arrangements of the necessary facilities and consumable for testing) and to solve any issue raised during these activities. | (X) | | |
| 9.6 | Provide Third Party Certification in accordance with Certification Procedure attached to the Material Requisition; | (X) | | |
| 9.7 | Anticipate pre-commissioning and commissioning activities which can be carried out in Vendor facilities (extent of scope to be mutually agreed between Contractor and Vendor | (X) | | |
| NOTES | | | | |
| 1 | Any commissioning spares consumed over and above the quoted spares during commissioning phase shall be supplied without any time/cost implication to the Client. Any left-over spares shall be Client's property. | | | |
| 2 | Vendor shall strictly comply with the Scope of Work including without limitation all technical documents. | | | |

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INSPECTION & TEST PLAN FOR CENTRIFUGAL PUMPS

| ITEM NO. | LEVEL OF INSPECTION |
|---|---------------------|
| HCU1-P800A/B, HCU1-P816A/B, HCU1-P818A/B, HCU1-P819A/B, HCU1-P718A/B, HCU1-P817A/B, PS3-P-393A/B, HCU1-P719A/B, HCU1-P821A/B, HCU1-P820A/B, LTF-P-286A/B, P-XX4 (A/B/C), P-825B | HOLD |

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| 0 | 28-Aug-2024 | IFQ-Issued for Quotation | Amandeep Singh | Dilip Kumar | Subhrajeet Nandi |
| REV. | DATE | STATUS | WRITTEN BY (NAME & SIGN) | CHECKED BY (NAME & SIGN) | APPROVED BY (NAME & SIGN) |
| DOCUMENT REVISIONS | | | | | |

REVISION LOG

| REVISION NO. | SECTION / PAGE NO. | CHANGE DESCRIPTION |
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HOLD STATUS

This revision has the following HOLDS:

| SECTION | PARAGRAPH NO. | DESCRIPTION OF HOLD |
|---------|---------------|---------------------|
| - | - | LEVEL OF INSPECTION |
| | | |

| Inspection Stages/Inspection Levels | | Applicable Documents | Level | | | |
|-------------------------------------|---|---|---------|---------|---------|---|
| | | | 1 | 2 | 3 | 4 |
| | | | ☒ | ☒ | ☒ | ☒ |
| During Design | Vendor Drawings | 216119C-000-SR-0910-0001 | R | R | R | R |
| | Vendor Calculations | 216119C-000-SR-0910-0001 | R | R | R | R |
| | Vendor Inspection ITP and Traveler | 216119C-000-SR-0910-0001 | R | R | R | R |
| | Vendor Procedures Including NDE Procedures | 216119C-000-SR-0910-0001 | R | R | R | R |
| Before Manufacturing | Vendor's Quality Control Manual | Vendor QC Procedure | R | R | R | R |
| | Vendor's Inspection Quality Plan approved prior to fabrication | Vendor's QAP | R | R | R | R |
| | Vendor's subcontracts | Must be submitted for review | R | R | R | R |
| | Procedure for the control and distribution of welding consumables | Vendor QC Procedure | R | R | R | R |
| | Welding Procedures WPS & PQR | ASME SEC IX / Vendor procedure | R | R | R | R |
| | Manufacturing Procedures | JIP33 (S 615) / Vendor procedure | R | R | R | R |
| | Post Weld Heat Treatment Procedure (If applicable) | JIP33 (S 615)/ USBT-000-TE-MR-TCN-0001 | R | R | R | R |
| | Non-destructive test procedures | ASME Sec. V / JIP33 (S 615) | R | R | R | R |
| | Material test certificates /Supplementary tests | JIP33 (S 615)/ USBT-000-TE-MR-TCN-0001 | R | R | R | R |
| | Casting Repair Procedure (Major Defects) | JIP33 (S 615)/ USBT-000-TE-MR-TCN-0001 | R | R | R | R |
| | Pressure Test Procedure | JIP33 (S 615)/ USBT-000-TE-MR-TCN-0001 | R | R | R | R |
| | Positive Material Identification (PMI) Procedures | Vendors Procedure | R | R | R | R |
| | Welder's qualifications | ASME IX | R | R | R | R |
| | Hardness test Procedure | As per applicable specification / Approved procedure/ USBT-000-TE-MR-TCN-0001 | R | R | R | R |
| NDT Personnel qualification | ASME Sec. V / USBT-000-TE-MR-TCN-0001 | R | R | R | R | |
| PIM | As per applicable specification / Approved procedure/ USBT-000-TE-MR-TCN-0001 | H | H | W | - | |
| During Manufacturing | Traceability of materials | Vendor QC Procedure | W | W | W | R |
| | Positive Material Identification (PMI) | Vendors Procedure | W | W | W | R |
| | Pressure castings (Visual / NDE) | USBT-000-TE-MR-TCN-0001 | W | W | W | R |
| | Welding according to applicable WPS, 1st operation each process, if satisfactory, in process thereafter | ASME IX / Vendors Procedure | M/ R | M/ R | M/ R | R |
| | Rotor Balancing | API 610, JIP33 (S 615)/ USBT-000-TE-MR-TCN-0001 | W | W | R | R |

| Inspection Stages/Inspection Levels | | Applicable Documents | Level | | | |
|-------------------------------------|--|---|---------|---------|---------|---|
| | | | 1 | 2 | 3 | 4 |
| | | | ☒ | ☒ | ☒ | ☒ |
| | Mechanical Seal Material conformity | API 682, Vendors approved drawing, USBT-000-TE-MR-EQS-0003 | W | W | R | R |
| | Mechanical Seal Air test | API 682, Vendors approved drawing, USBT-000-TE-MR-EQS-0003 | W | W | R | R |
| | Seal Gland – Hydro test | API 682, Vendors approved drawing, USBT-000-TE-MR-EQS-0003 | W | W | R | R |
| | Coupling Material Compliance | API 671, Vendors approved drawing, USBT-000-TE-MR-EQS-0013 | W | W | R | R |
| | Coupling Balancing | API 671, Vendors approved drawing, USBT-000-TE-MR-EQS-0013 | W | W | R | R |
| | Welding and NDE Maps | ASME V, USBT-000-TE-MR-TCN-0001 | R | R | R | R |
| | Post Weld Heat Treatment (if applicable) | JIP33 (S 615) / USBT-000-TE-MR-TCN-0001 | R/ W | R/ W | R | R |
| | Review of All Radiographic Film | ASME V/ JIP33 (S 615) | R | R | R | R |
| | Hardness test | USBT-000-TE-MR-TCN-0001 | W | W | W | R |
| | Non-destructive testing (UT, MT, LP, Hardness), 1st operation each process, if satisfactory in process thereafter. | ASME V/ Vendors NDE Procedure | W | R/ W | R | R |
| | Nonconformance Reports / Repair Procedures (prior to repair) | JIP33 (S 615), USBT-000-TE-MR-TCN-0001, Approved Procedures | R | R | R | R |
| | Major Repairs (On HOLD until repair procedure is approved by Purchaser) | JIP33 (S 615), USBT-000-TE-MR-TCN-0001, Approved Procedures | W | W | R | R |
| | Inspection of Sub-ordered components | Per approved specification and drawing | W | R/ W | R/ W | R |
| | Supplier / Sub-supplier surveillance (when deemed necessary) | | W | W | W | |
| Final Testing | Hydro test of Lube oil system | USBT-000-TE-MR-TCN-0001, Approved Procedures, USBT-000-TE-MR-EQS-0012 | W | W | W | R |
| | Performance test of Lube oil system | USBT-000-TE-MR-TCN-0001, Approved Procedures, USBT-000-TE-MR-EQS-0012 | W | W | R | R |
| | Mechanical Run Test | JIP33 (S 615), USBT-000-TE-MR-TCN-0001 | H | H | W | R |
| | Performance Test | JIP33 (S 615), USBT-000-TE-MR-TCN-0001 | H | H | W | R |
| | Hydrodynamic bearings inspection | JIP33 (S 615), USBT-000-TE-MR-TCN-0001 | W | W | W | R |
| | NPSH Test (If applicable) | JIP33 (S 615), USBT-000-TE-MR-TCN-0001 | H | H | W | R |
| | Hydrostatic Test of pump parts / system | JIP33 (S 615), USBT-000-TE-MR-TCN-0001 | W | W | W | R |
| | Test of Electric Motors (Routine test with vibration records) | As per XOM Frame Agreement | W | W | W | R |

| Inspection Stages/Inspection Levels | | Applicable Documents | Level | | | |
|-------------------------------------|--|--|-------|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| | | | ☒ | ☒ | ☒ | ☒ |
| | Sound Level Test measurement during running or performance tests | Approved data sheet | W | W | W | R |
| | Dismantle (Strip) test-applicable only if Performance / Mechanical Run test fails (**) | Approved Data Sheet / drawings | H | H | W | R |
| | Dimensional check, Final Inspection | Approved GAD / USBT-000-TE-MR-TCN-0001 | W | W | W | R |
| | Surface preparation & painting | JIP33 (S 615), USBT-000-TE-MR-TCN-0001 | W | W | M | R |
| | Nameplates and tagging | Per approved drawings | W | W | R | R |
| | Marking & preservation (Preparation for Shipment) | JIP33 (S 615), USBT-000-TE-MR-TCN-0001 | W | W | W | R |
| Dispatch Documents | Inspection Release | Technip Inspection Release Certificate (IRC) | H | H | H | R |
| | Release for shipment | Technip Procurement Authorization | H | H | H | R |
| | Review of Manufacturer Data Book prior to submittal | 216119C-000-ITP-0910-0001 | H | H | H | R |

(**)

Each pump receiving a witnessed performance test shall be dismantled by Manufacturer for inspection by Inspector following the final performance test, according to the guidelines below:

- a. Hydrodynamic bearings and housing shall be dismantled.
- b. Rolling element bearings and their housings shall only be dismantled, if any of the following occur during test:
 - Oil/bearing temperature rise exceeds 40 °K (70 °R) above the ambient temperature
 - Unusual noises come from the pump

| HORIZONTAL INDUCTION MOTOR above 1500 HP and less than 3000 HP Inspection Stages/Inspection Levels | | Applicable Documents | Level | | | |
|---|--|------------------------------------|-------|---|-----|---|
| | | | 1 | 2 | 3 | 4 |
| | | | ☒ | ☒ | ☒ | ☒ |
| Before Manufacturing | Vendor's Quality Plan | Vendor QC Procedure | R | R | R | R |
| | Pre-Inspection Meeting (PIM) | | W | W | W/R | R |
| | Material Test Certificates | Applicable specifications | R | R | R | R |
| | Test Procedures | API 541, Applicable specifications | R | R | R | R |
| During Manufacturing | Rotor Balancing | API 541, Applicable specifications | W | W | W/R | R |
| | Stator Immersion Test | API 541, Applicable specifications | W | W | W/R | R |
| | Supplier / Sub-supplier surveillance (when deemed necessary) | | W | W | W | R |
| | Stator Inspection Prior to VPI (for motors above 13.2 KV) | Vendor QC Procedure | W | W | W | R |
| | Sealed winding immersion test | Vendor QC Procedure | W | W | W/R | R |
| Control & Final Tests | Surge Comparison Test | API 541, Applicable specifications | W | W | W | R |
| | Running Test with coupling half | API 541, Applicable specifications | W | W | R | R |
| | Complete Test | API 541, Applicable specifications | H | H | H | R |
| | DC High Potential Test | API 541, Applicable specifications | H | H | H | R |
| | Visual Examination | | W | W | W | R |
| | Vibration Test | API 541, Applicable specifications | W | W | W/R | R |
| | Routine Tests | API 541, Applicable specifications | H | H | H | R |
| | Type Tests | API 541, Applicable specifications | H | H | H | R |
| Documents | Manufacturing Data Book | | H | H | H | R |
| | | | | | | |

| GEAR BOX (As applicable) Inspection Stages/Inspection Levels | | Applicable Documents | Level | | | |
|---|---|--|-------|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| | | | ☒ | ☒ | ☒ | ☒ |
| Before Manufacturing | Vendor's Quality Plan | Vendor QC Procedure | R | R | R | R |
| | Material Test Certificates | Applicable specifications | R | R | R | R |
| | Casting Repair Procedure (minor defect) | Applicable specifications | R | R | R | R |
| | Welding Procedures WPS & PQR | ASME IX, Applicable specifications | R | R | R | R |
| | Test Procedures | API 677, USBT-000-TE-MR-EQS-0011 | R | R | R | R |
| During Manufacturing | NDT on Rough Material | ASME VIII Div 1, ASME V, Applicable specifications | R | R | R | R |
| | Balancing / Run out (Shaft, Pinion, Wheels)/ De-magnetization | API 677, USBT-000-TE-MR-EQS-0011 | R | R | R | R |
| | Hardness Wheels / Pinions | API 677, USBT-000-TE-MR-EQS-0011 | R | R | R | R |
| | Supplier / Sub-supplier surveillance (when deemed necessary) | | W | W | W | |
| Control & Final Tests | Mechanical Running Tests | API 677, USBT-000-TE-MR-EQS-0011 | W | W | W | R |
| | Painting | Applicable specifications | R | R | R | R |
| | Final Inspection / Conformity of Complete unit | API 677, USBT-000-TE-MR-EQS-0011 | W | W | W | R |
| | | | | | | |
| Documents | Manufacturing Data Book | | H | H | H | R |
| | | | | | | |
| | | | | | | |

| LUBE OIL SYSTEM (As applicable) Inspection Stages/Inspection Levels | | Applicable Documents | Level | | | |
|--|--|--|-------|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| | | | ☒ | ☒ | ☒ | ☒ |
| Before Manufacturing | Vendor's Quality Plan | Vendor QC Procedure | R | R | R | R |
| | Material Test Certificates | Applicable specifications | R | R | R | R |
| | Review of Sub orders | Applicable specifications | R | R | R | R |
| | Welding Procedures WPS & PQR | ASME IX, Applicable specifications | R | R | R | R |
| | Test Procedures | API 614, USBT-000-TE-MR-TCN-0001, Approved Procedures, USBT-000-TE-MR-EQS-0012 | R | R | R | R |
| During Manufacturing | NDT on Piping | ASME VIII Div 1, ASME V, Applicable specifications | R | R | R | R |
| | Positive Material Identification | Applicable Specifications | R | R | R | R |
| | Piping Hydrostatic Test | API 614, USBT-000-TE-MR-TCN-0001, Approved Procedures, USBT-000-TE-MR-EQS-0012 | R | R | R | R |
| | Supplier / Sub-supplier surveillance (when deemed necessary) | | W | W | W | |
| Control & Final Tests | Mechanical Running Tests | API 614, USBT-000-TE-MR-TCN-0001, Approved Procedures, USBT-000-TE-MR-EQS-0012 | W | W | W | R |
| | Hydrostatic Test of assembled system | API 614, USBT-000-TE-MR-TCN-0001, Approved Procedures, USBT-000-TE-MR-EQS-0012 | W | W | W | R |
| | Cleanliness prior to shipment | API 614, USBT-000-TE-MR-TCN-0001, Approved Procedures, USBT-000-TE-MR-EQS-0012 | W | W | W | R |
| | Operational Tests | API 614 | W | W | W | R |
| | Painting / Preservation | Applicable specifications | R | R | R | R |
| | Final Inspection / Conformity of Complete unit | API 614, Applicable specifications | W | W | W | R |
| Documents | Manufacturing Data Book | | H | H | H | R |
| | | | | | | |
| | | | | | | |

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| Exxon Doc. No. | NA | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit Info | 000-General | | | | | | |

1. GENERAL DEFINITIONS

- a) Inspection Policy –Technip Energies inspection policy provides for surveillance of a Vendor in which random audits and inspections are performed throughout their organization to ensure compliance with purchase order requirements.
- b) Levels of Inspection – Inspection activities shall be based on Hold/Witness/Review points specified in the Inspection and Test Plan (ITP) and confirmed at the Pre-Inspection Meeting. Technip Energies Inspection will be based on critical ratings and corresponding levels of inspection. Levels of inspection are defined as follows:
- | | |
|-------------|---|
| Level No. 1 | Consists of a Pre-Inspection Meeting to establish hold points and weekly or bi-weekly in-process surveillance visits. When required by the Project and Manager of Inspection this level could consist of resident inspection. |
| Level No. 2 | Consists of a Pre-Inspection Meeting to establish hold points and the specified in-process surveillance visits designated in the Inspection and Test Plan. In-process visits can be weekly or bi-weekly as designated by project. |
| Level No. 3 | Consists of in-process visits as designated by the Inspection and Test Plan followed by Final Inspection or Final Inspection only at the Vendor's facility. |
| Level No. 4 | Consists of a Final Inspection upon arrival at the jobsite. No visit to the Vendor's facility will be made. |
- c) Extent of Inspection – The extent of surveillance inspection activities is defined as follows:
- | | |
|----------------|--|
| Hold Point (H) | Mandatory witness of testing or inspection activities by a Technip Energies inspector. The Inspector shall be notified at least ten (10) working days in advance and must be present during the specified activity. |
| Witness (W) | Optional witness of testing or inspection activities by a Technip Energies inspector. The Vendor must notify the Inspector at least ten (10) working days in advance. If the Inspector does not elect to be present, the Vendor may proceed with the intended activity, provided controls under agreed with Technip Energies test reports are made available for the Inspector's review later. |
| Monitor (M) | Indicates that the assigned Inspector or Project Personnel will observe the fabrication process at any given time. |
| Review (R) | Acceptance of documentation such as reports, procedures, and qualification records by Technip Energies. Documents identified on the Scope of Supply shall be submitted for review. Other applicable documents will be reviewed at the Vendor facility by a Technip Energies Inspector. |
- d) Pre-Inspection Meeting – A Pre-Inspection Meeting is a review with the Vendor, prior to the start of fabrication, to ensure understanding of purchase order requirements, including project specifications, applicable codes and all applicable inspection requirements.

2. INSPECTION AND TEST PLANS

Inspection and Test plan which identify the level of inspection and intended extend of inspection shall be prepared by Technip and forwarded to the Vendor for information.

3. VENDOR QUALITY CONTROL PLAN

The Vendor shall develop an internal Quality Control Plan for each item of equipment. The Supplier Quality Control Plan shall define, in a chronological manner, the Fabrication operations and corresponding inspection/testing activities as required by the code(s) of construction, the Purchase Order, and the Vendor's own quality procedures. The Vendor shall also incorporate into their Quality Control Plan the Technip Energies inspection activities defined in this Technip Energies Inspection and Test Plan.

- a) The Vendor Quality Control Plan shall be submitted to Technip Energies for review prior to scheduling the Pre-Inspection Meeting. Note, a Pre-Inspection Meeting shall not be held until the Vendor Quality Control Plan has been reviewed by the purchaser.

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| Exxon Doc. No. | NA | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit Info | 000-General | | | | | | |

- b) The Vendor Quality Control Plan will be discussed in detail in the Pre-Inspection Meeting. Outstanding comments and modifications to the Vendor's Quality Control Plan shall be finalized at the Pre-Inspection Meeting.
- c) The Vendor Quality Control Plan shall be revised in accordance with agreements set forth in the Pre-Inspection Meeting and submitted to Technip Energies for final approval.

4. GENERAL NOTES

- a) All goods to be delivered under this Purchase Order are subject to inspection, except where waived in writing by Purchaser.
- b) The Vendor shall make every effort to store the goods subject to inspection indoors or under cover with safe condition and in such a way that inspection can be performed easily and quickly.
- c) All goods shall be free from slag, dirt, loose scale or any other foreign material.
- d) Purchaser's Inspectors, and/or Purchaser's nominated inspection authority and Purchaser's Client Inspectors reserve the right to reject any goods that are not acceptable for quality of workmanship, or which fail to comply with the specifications and other requirements contained in the purchase order.
- e) Purchaser's Inspectors, and/or Purchaser's nominated inspection authority and Purchaser's Client Inspectors have the right, on their own judgment, to use any additional testing and/or inspection method when defects are found.
- f) The Vendor shall ensure that all documents as listed in the Scope of Supply are available during final inspection. These documents shall be reviewed, signed, stamped or initialed by the Purchaser's Inspector and submitted to Technip Energies as part of the "Final Data Package." Those not signed, stamped, or initialed by the Purchaser's Inspector will be rejected and returned to the Vendor to obtain the required approval from the Purchaser's Inspector and/or Purchaser's nominated inspection authority.
- g) The Vendor shall incorporate requirements from the Scope of Supply and Inspection and Test Plan, if applicable, in all Purchase Orders issued to his Sub-Vendors.
- h) When Technip Energies is performing an actual inspection, Vendor must obtain a "Final Inspection Notification" form signed off by Technip Energies' Inspector before contacting Technip Energies' Home Office Purchasing Department to obtain authorization to ship. Inspection records shall be submitted to Technip before the equipment and materials are shipped. Inspection Release Certificate (IRC) shall be issued only after satisfactory review. Further, for items noted by Technip Energies' inspector as status "2" (i.e., minor defects), the form shall additionally be signed by the Vendor confirming that the defects have been remedied and the form shall be returned to Technip Energies' Home Office Purchasing Department requesting authorization to ship.
- i) For any specific inspection requirements, refer to requisition and/or specification.
- j) Procedures shall clearly reflect application to the specific component types being fabricated. The Technip Energies Purchase Order Number and revision level shall be indicated on each cover sheet of the procedure. The Vendor's document numbering system shall include, but not limited to the following: document number, page numbers, revision number, cloud marks surrounding revisions, and sample exhibits.
- k) A copy of Safety Data Sheets (SDS) must accompany all applicable shipments. Vendors shall appropriately identify all materials requiring SDS in order to facilitate acceptance at construction site.
- l) On each visit, the Inspector shall verify that drawings and other documents are to the current revisions.
- m) For boiler and vessel code equipment, the Vendor shall submit a Non-Conformance Report (NCR) and a repair procedure for a code related repair for approval by Technip Energies. The Vendor shall not proceed with the repair until Technip Energies has approved the repair procedure and given directions as to the testing and inspection requirements.
- n) Vendor, Vendors, sub-Vendors, contractors and Vendors shall execute the work in accordance with their quality management systems, accredited in accordance with standards such as ISO 9001, ASME, or quality program approved by Technip Energies. This requirement, including this sentence, must be included in any sub-tier order or contract.
- o) Project specification shall be applied with all other code, approved drawing and procedure.
- p) Stockist certificates are not acceptable unless they are accompanied by copies of the original work's certificates.

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| Exxon Doc. No. | NA | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit Info | 000-General | | | | | | |

All certificates shall be in the English Language or include an English translation. All data shall be shown in metric Units. The certificates shall be complete, unambiguous, clearly legible, and suitable for subsequent photocopying.

Quality Requirements for Centrifugal Pumps (API)

Revision history

| VERSION | DATE | PURPOSE |
|---------|--------------|----------------|
| 2.0 | January 2023 | Second Edition |
| 1.0 | January 2019 | First Edition |

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This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

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Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

This second edition cancels and replaces the first edition published in January 2019.

Due to technical writing requirements leading to extensive changes, this second edition should be treated as a new document.

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Introduction

The purpose of this quality requirements specification (QRS) is to specify quality management requirements and the proposed extent of purchaser intervention activities for the procurement of centrifugal pumps in accordance with IOGP S-615 for application in the petroleum and natural gas industries.

Purchaser intervention activities are identified through the selection of one of four conformity assessment system (CAS) levels based on a risk and criticality assessment. The applicable CAS level is specified by the purchaser in the procurement data sheet or purchase order.

This QRS shall be used in conjunction with the specification (IOGP S-615), the procurement data sheet (IOGP S-615D) and the information requirements specification (IOGP S-615L) which together comprise the full set of specification documents. The introduction section in the specification provides further information on the purpose of each of these documents and the order of precedence for their use.



**JIP33 Specification for Procurement Documents
Quality Requirements Specification**

1 Scope

To specify quality management requirements for the supply of centrifugal pumps to IOGP S-615 including:

- a) supplier quality management system requirements;
- b) purchaser conformity assessment (surveillance and inspection) activities;
- c) traceability requirements.

2 Normative references

For the purpose of this document, the documents referenced in IOGP S-615 and those listed below, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

IOGP S-615, *Supplementary Specification to API Standard 610 for Centrifugal Pumps*

ISO 9001, *Quality management systems — Requirements*

ISO 29001, *Petroleum, petrochemical and natural gas industries — Sector-specific quality management systems — Requirements for product and service supply organizations*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in IOGP S-615 and ISO 9000 (normative to ISO 9001), and the following shall apply.

3.1

conformity assessment

demonstration that specified requirements are fulfilled

Note 1 to entry: Conformity assessment (or assessment) includes but is not limited to review, inspection, verification and validation activities.

Note 2 to entry: Assessment activities may be undertaken at a supplier/sub-supplier's premises, virtually by video link, desktop sharing, etc. or by review of information.

3.2

conformity assessment system

CAS

system that provides different levels of purchaser interventions to assess and verify supplier conformance to specified requirements

Note 1 to entry: CAS A applies to the highest risk and associated extent of verification. CAS D is the lowest.

3.3

hold point

H

<conformity assessment> point in the chain of activities beyond which an activity shall not proceed without the approval of the purchaser or purchaser's representative

3.4 witness point W

<conformity assessment> point in the chain of activities that the supplier shall notify the purchaser or purchaser's representative before proceeding

Note 1 to entry: The operation or process may proceed without witness if the purchaser does not attend after the agreed notice period.

3.5 surveillance S

<conformity assessment> observation, monitoring or review by the purchaser or purchaser's representative of an activity, operation, process, product or associated information

3.6 review R

<conformity assessment> review of the supplier's information to verify conformance to requirements

4 Symbols and abbreviations

For purposes of this document, the following symbols and abbreviations apply.

| | |
|-----|--|
| CAS | conformity assessment system |
| IRS | information requirements specification |
| QMS | quality management system |
| QRS | quality requirements specification (this document) |

5 Quality requirements

5.1 Quality management system

The vendor shall operate and maintain a quality management system (QMS) that conforms with ISO 9001, ISO 29001, API Specification Q1 or an equivalent quality management system standard.

5.2 Conformity assessment system (CAS)

5.2.1

The conformity assessment system (CAS) provides different levels of assessment of the vendor control activities. The CAS level is defined by the purchaser, using a risk-based approach, and included in the purchase order/contract. The defined CAS level may be adjusted by the purchaser during manufacture based on vendor performance and re-assessment of risk.

NOTE For industrial proven solutions, CAS level D is specified unless risk assessment indicates that a more stringent CAS level is required.

5.2.2

Quality plans and inspection and test plans shall include provision for purchaser intervention activities based on the CAS level selected in the procurement data sheet or purchase order. See Annex A.

5.2.3

Vendor performance in meeting the requirements may be routinely assessed during execution of the scope and where appropriate, corrective action requested and conformity assessment activities increased or decreased consistent with criticality and risk.

6 Certification and traceability

Where material certification and traceability requirements are not specified in the parent standard or supplementary specification, material certification and traceability shall be maintained in accordance with Annex B.

7 Evidence — conformance records

Documents and information shall be provided for in accordance with the associated IRS.

Annex A (normative)

Purchaser conformity assessment requirements

This annex defines four conformity assessment systems (CAS) or levels of purchaser assessment.

| | PURCHASER ASSESSMENT ACTIVITIES | CAS | | | |
|----------|---|-----|---|---|---|
| | | A | B | C | D |
| 1 | Operational planning and control activities | | | | |
| 1.1 | Kick-off, pre-production and pre-inspection meeting (IOGP S-615, 8.1.5) | H | W | W | - |
| 2 | Design and development activities | | | | |
| 2.1 | No activities applicable for purchaser intervention | - | - | - | - |
| 3 | Control of external supply | | | | |
| 3.1 | No activities applicable for purchaser intervention | - | - | - | - |
| 4 | Production and service provision | | | | |
| 4.1 | Material certification and traceability as specified (IOGP S-615, 6.12.1.8, 6.12.3.4, 6.12.4.3, Table H.2, Table H.3, Table H.4) | W | R | R | R |
| 4.2 | Surfaces of castings inspection as specified (IOGP S-615, 6.12.2.1) | W | S | - | - |
| 4.3 | Fabrication | | | | |
| 4.3.1 | Baseplate flatness and coplanarity of baseplate equipment mounting pads inspection (IOGP S-615, 7.4.8, 9.3.8.3.1) | W | R | R | - |
| 4.3.2 | Lifting lugs verification (IOGP S-615, 7.4.18, 8.4.5) | W | R | R | R |
| 4.4 | Inspection, testing and verification activities | | | | |
| 4.4.1 | Inspector verification of materials as specified, production weld process controls and non-destructive examinations (IOGP S-615, 6.12.2, 6.12.3, 8.2.2.7, 6.4.3.10, 6.6.15.1, 7.4.18.3, 8.2.2, 9.3.2.5, 9.3.2.6, Table 11, Table 14, Table 15) | S | S | S | - |
| 4.4.2 | Inspection of major weld repairs as specified (IOGP S-615, 6.12.2.3, 6.12.2.4, 6.12.2.5) | H | W | R | - |
| 4.4.3 | Pressure casing and auxiliary process-liquid piping inspection as specified, including welded and bolted connections associated with the casing and process fluids (IOGP S-615, 7.6.2, 8.2.2.3, 8.2.2.6, Table 14) | W | S | R | - |
| 4.4.4 | Non-destructive examinations of component parts if specified (IOGP S-615, 6.12.3, 6.4.3.10, 8.2.1.3, 8.2.2.1, 8.2.2, 9.3.2.5, 9.3.2.6, Table 14, Table 15) | W | R | R | - |
| 4.4.5 | Positive material identification as specified (IOGP S-615, 8.2.2.8) | W | S | R | - |
| 4.4.6 | Wear rings and running clearance verification (IOGP S-615, 6.7.5, Table 6) | W | S | S | - |
| 4.4.7 | Heat treatment (IOGP S-615, 6.12.2, 6.12.3, 6.4.3.10, Table 11) | S | S | S | - |
| 4.4.8 | Hardness testing as specified (IOGP S-615, 8.2.2.7, 6.4.3.10) | W | S | R | - |

| | PURCHASER ASSESSMENT ACTIVITIES <i>(continued)</i> | CAS | | | |
|----------|--|-----|---|---|---|
| | | A | B | C | D |
| 4.4.9 | Shaft and rotors (IOGP S-615 6.6, 7.1.8, 9.2.2.4, 9.3.12.2, 9.3.3.1, Table 17) | W | R | - | - |
| 4.4.10 | Rotating component balancing as specified (IOGP S-615, 8.3.3.8, 6.12.1.10, 6.12.1.11, 6.9.3, 7.2.2, 9.1.3.6, 9.2.4.2, Table 19) | W | R | - | - |
| 4.4.11 | Cleanliness check prior to final assembly if specified (IOGP S-615, 8.2.2.6) | W | S | S | - |
| 4.4.12 | Verify installed instrumentation calibration and installation to applicable standards (IOGO S-615, 7.5.1, 7.5.2) | W | S | R | R |
| 4.4.13 | 'Ex' verification of equipment and assemblies for compliance with the specified hazardous area classification (IOGP S-615, 6.10.2.9, 6.1.29, 7.1.6, 7.3.2.1, 7.3.2.2, 7.3.3.3, 7.3.3.4) | W | S | S | S |
| 4.4.14 | Hydrostatic testing activities (IOGP S-615, 8.3.2) | H | W | W | R |
| 4.4.15 | Performance and mechanical run testing as specified (IOGP S-615, 6.1.22, 6.10.2.7, 8.3.3, 8.3.4.2.2, 8.3.4.3.7, 8.3.4.7.3, C.4.1, C.4.2, C.4.3, Table 16, Table 8, Table 9) | H | W | W | R |
| 4.4.16 | Net positive suction head required or minimum submergence testing if specified (IOGP S-615, 6.1.22, 9.3.9.1, 6.10.2.7, 8.3.1, 8.3.4) | H | W | W | R |
| 4.4.17 | Sound level testing if specified (IOGP S-615, 8.3.4) | H | W | R | R |
| 4.4.18 | Complete unit testing if specified (IOGP S-615, 6.1.22, 6.10.2.7, 9.3.9.1, 8.3.1.4, 8.3.1.5, 8.3.4.1, 8.3.4.4.1, 8.3.4.4.2) | H | H | W | R |
| 4.4.19 | Auxiliary equipment testing if and as specified (IOGP S-615, 8.3.4.1, 8.3.4.6) | H | W | R | R |
| 4.4.20 | Bearing housing resonance test if specified (IOGP S-615, 8.3.4.1, 8.3.4.7) | H | W | R | R |
| 4.4.21 | Nozzle force and moments testing if specified (IOGP S-615, 7.4.23, 7.4.24, 8.3.4.1, Table 13) | H | W | R | R |
| 4.4.22 | Structural resonance test if specified (IOGP S-615, 8.3.4.1, 9.3.9.2) | H | W | R | R |
| 4.4.23 | Disassembly after testing if specified (IOGP S-615, 8.3.3.9, 8.3.4.1, 9.3.3.1) | H | W | S | R |
| 4.4.24 | Hydrodynamic bearing inspection after testing if specified (IOGP S-615, 9.2.7.4, 8.3.4.1) | H | W | S | - |
| 4.4.25 | Surface preparation and painting as specified (IOGP S-615, 9.3.8.3.2, 7.4.16, 8.2.1.2, 8.4.3.4) | H | W | R | - |
| 5 | Release of product or service | | | | |
| 5.1 | Verify conformance to the purchase order including as applicable | | | | |
| 5.1.1 | Complete skid overall dimensions including holding down bolt hole and connection locations (IOGP S-615, 8.1.5) | H | W | W | W |
| 5.1.2 | Couplings and guards inspection (IOGP S-615, 7.2, 7.3.2, 7.3.3, 9.3.8.2.1) | H | W | W | W |
| 5.1.3 | Pump nameplate and rotation arrows inspection. Review photograph for CAS C and CAS D. (IOGP S-615, 6.13) | H | W | R | R |

| | PURCHASER ASSESSMENT ACTIVITIES <i>(continued)</i> | CAS | | | |
|---|---|-----|---|---|---|
| | | A | B | C | D |
| 5.2 | Loose ship items, spares and special tools inspections as applicable (IOGP S-615, 7.7.1, 7.7.2) | H | W | W | R |
| 5.3 | Preparation of preservation, packing and storage as specified (IOGP S-615, 8.4) | H | W | S | - |
| 5.4 | Release of equipment (IOGP S-615, 6.12.3.3, 7.1.8, 7.5.2.2, 7.6.2.4, 6.4.3.5, 6.8.12, 7.4.25.3, 8.1.5, 8.4.14) | H | H | H | H |
| Key H: Hold point W: Witness point R: Review S: Surveillance | | | | | |

Annex B (normative)

Certification and traceability requirements

| Item | | Certificate type | Traceability level | Additional requirements |
|---|--|------------------|--------------------|--|
| Centrifugal pump | Metallic components as per Annex H or as specified. Minimum: pressure casing (including bolting), auxiliary process fluid piping (including all pressure containing components such as fittings, valve bodies), impeller; shaft, sleeve, seal gland plate. | 3.1 | Level II | NACE MR0175 (all parts) or NACE MR0103 if and as specified. Type 3.2 Certification is applicable as per the design requirements. |
| | Metallic components as per Annex H or as specified. Minimum: wear rings, throttle bushings, diffusers. | 2.2 | Level II | NACE MR0175 (all parts) or NACE MR0103 if and as specified. Type 3.1 Certification is applicable as per the design requirements. |
| | Non-metallic components as per Annex H or as specified. Minimum: wear parts. | 2.2 | Level II | Type 3.1 Certification is applicable as per the design requirements. |
| <p>NOTE 1 Certificates Inspection certificates shall be provided in accordance with ISO 10474 or EN 10204.</p> <p>NOTE 2 Traceability A. Level I — Full traceability — Material is uniquely identified and its history tracked from manufacture through stockists (where applicable) to the vendor and to actual position on the equipment with specific location defined on a material placement record (the traceability to a specific location only applies to skids / packaged equipment, not to bulks). B. Level II — Type traceability — The vendor maintains a system to identify material throughout manufacture, with traceability to a material certificate. C. Level III — Compliance traceability — The vendor maintains a system of traceability that enables a declaration of compliance to be issued by the vendor.</p> | | | | |

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MECHANICAL DATASHEET FOR CENTRIFUGAL PUMPS HCU1-P821 A/B

THIS DOCUMENT IS UNCONTROLLED WHEN REPRODUCED

| | | | | | |
|--------------------|-------------|--------------------------|---|---|--|
| | | | | | |
| | | | | | |
| | | | | | |
| 1 | 23-Sep-2024 | IFQ-Issued for Quotation | Amandeep Singh | Subhrajeet Nandi | Subhrajeet Nandi |
| 0 | 17-Sep-2024 | IFQ-Issued for Quotation | Amandeep Singh | Dilip Kumar | Subhrajeet Nandi |
| B | 02-Sep-2024 | IFR-Re-Issued for Review | Amandeep Singh | Subhrajeet Nandi | Subhrajeet Nandi |
| A | 22-Aug-2024 | IFR-Issued for Review | Amandeep Singh | Dilip Kumar | Subhrajeet Nandi |
| REV. | DATE | STATUS | WRITTEN BY (NAME & SIGN) | CHECKED BY (NAME & SIGN) | APPROVED BY (NAME & SIGN) |
| DOCUMENT REVISIONS | | | | | |

REVISION LOG

| REVISION NO. | SECTION / PAGE NO. | CHANGE DESCRIPTION |
|--------------|--------------------|--|
| A | - | MECHANICAL DATASHEET (MDS) IS PREPARED BASED ON PDS DOC NO. USBT-032-TE-PX-DDS-0037 REV A. |
| B | | RE-ISSUED AFTER INCORPORATING TYPICAL COMMENTS FROM XOM |
| B | | MOC UPDATED BASED ON XOM COMMENTS |
| 0 | - | MECHANICAL DATASHEET (MDS) IS PREPARED BASED ON PDS DOC NO. USBT-032-TE-PX-DDS-0037 REV 0. |
| 1 | - | CHANGE IN PUMP TYPE (LOW FLOW HIGH HEAD) |
| | | |
| | | |
| | | |
| | | |

HOLD STATUS

This revision has the following HOLDS:

| SECTION | PARAGRAPH NO. | DESCRIPTION OF HOLD |
|---------|---------------|---------------------|
| | | |



**CENTRIFUGAL PUMP
DATASHEET
(API 610-12th Ed.)
US CUSTOMARY
D811 SOUR WATER PUMPS
(HCU1-P821 A/B)**

| | | | | | | | | | | | | | |
|----------------|--------------------------|------|-----|----------|----|------|------|-----------|------|-----|---|------|--------|
| Doc. No. | 216119C | Unit | 032 | Doc.Type | SP | Code | 0910 | Serial N° | 0004 | Rev | 1 | Page | 3 of 9 |
| Exxon Doc. No. | USBT-032-TE-MR-DDS-0004 | | | | | | | | | | | | |
| Client | ExxonMobil | | | | | | | | | | | | |
| Project | BAYTOWN GOLD | | | | | | | | | | | | |
| Location | Baytown, Texas | | | | | | | | | | | | |
| Unit Info | 032 - Hydrocracking Unit | | | | | | | | | | | | |

GENERAL

| | | | | |
|---|------|--|---|-----|
| 1 | Note | APPLICABLE TO: PROPOSAL | APPLICABLE NATIONAL / INTERNATIONAL STANDARD : API-610 | Rev |
| 2 | | CLIENT ExxonMobil | UNIT 032 - Hydrocracking Unit | |
| 3 | | SITE Baytown, TX | SERVICE Sour Water | |
| 4 | | NO. REQ Two (1W+1S) PUMP SIZE _____ | TYPE Centrifugal (Note 18) No. STAGES _____ (Note 18) | |
| 5 | | MANUFACTURER _____ | MODEL _____ SERIAL NO. _____ | |
| 6 | | EQUIPMENT NUMBER HCU1-P821 A/B | | |

LIQUID CHARACTERISTICS

| | Units | @ RATED TEMP | @ MAXIMUM TEMP | @ MINIMUM TEMP | Alternate LIQUID |
|--------------------------------|--------------|-----------------------------|----------------------|----------------|------------------|
| LIQUID TYPE OR NAME : | | Sour Water (Note 28) | | | |
| 10 PUMPING TEMPERATURE : | °F | 130.6 | (Note 13, 30) | | |
| 12 VAPOR PRESSURE : | psia | 2.32 | | | |
| 13 RELATIVE DENSITY (3.1.53) : | | 0.999 | (Note 25, 31) | | |
| 14 SPECIFIC HEAT : | Btu/(lbm-°F) | | | | |
| 15 VISCOSITY : | cP | 0.51 | (Note 29) | | |

OPERATING CONDITIONS (6.1.3)

| | Units | Rated | Normal | Alt Condition 1 <i>Min</i> | Alt Condition 2 <i>{Name 2}</i> | Alt Condition 3 <i>{Name 3}</i> | Alt Condition 4 <i>{Name 4}</i> |
|---------------------------------|-------|---------------|-----------------|-------------------------------|------------------------------------|------------------------------------|------------------------------------|
| 20 NPSHA Datum: | | | | | | | |
| 21 PUMPING TEMPERATURE : | °F | 130.6 | | | (Note 13, 30) | | |
| 22 FLOW : | gpm | 57.0 | 52.0 | 26.0 | (Note 10, 11) | | |
| 23 DISCHARGE PRESSURE (6.3.2) : | psig | 1571.8 | | | | | |
| 24 SUCTION PRESSURE : | psig | 1.2 | | | (Note 22) | | |
| 25 DIFFERENTIAL PRESSURE : | psi | 1570.6 | | | | | |
| 26 DIFFERENTIAL HEAD : | ft | 3627.8 | | | | | |
| 27 NPSHA : | ft | 28.2 | (Note 9) | | | | |
| 28 HYDRAULIC POWER : | HP | 52.26 | | | | | |

| | | | |
|--|---|---|-------------------------|
| 30 SERVICE (CONTINUOUS/INTERMITTENT) : | CONTINUOUS | INSTALLATION LOCATION : | OUTDOOR (Note 1) |
| 31 * IF INTERMITTENT, NO. OF STARTS : | | IF INDOOR, TEMPERATURE: MAX: _____ °F MIN: _____ °F | |
| 32 PUMPS OPERATE IN: | ALONE | ELECTRIC AREA CLASSIFICATION (6.1.29): | HAZARDOUS |
| 33 CORROSION DUE TO : (6.12.1.9) | YES | DIVISION 2 CLASS I | |
| 34 EROSION DUE TO : (6.12.1.9) | NA | GROUP D | |
| 35 H2S CONCENTRATION (ppm) : (6.12.1.13) | 21.2 | TEMP CLASS T3 | |
| 36 CHLORIDE CONCENTRATION (ppm) : | NA | PUMP VALVE START POSITION : | Close Valve |
| 37 PARTICULATE SIZE (DIA IN MICRONS) | NA | | |
| 38 PARTICULATE CONCENTRATION (ppm) | NA | | |
| 39 CORROSION ALLOWANCE (6.3.10) : | NA | | |
| 40 DESIGN NOTES: | Electric driver shall be suitable for MV power supply. Electrical power supply: Voltage / Frequency / Phase : 2300 V / 60 Hz / 3 | | |

PERFORMANCE

DRIVER (7.1) (Note 24, 31)

| PERFORMANCE | DRIVER (7.1) (Note 24, 31) |
|---|---|
| 46 PROPOSAL CURVE NO. _____ RPM _____ | DRIVER TYPE Electrical Motor |
| 47 IMPELLER DIA: RATED _____ MAX. _____ MIN. _____ in | GEAR NO |
| 48 RATED POWER : _____ HP EFFICIENCY _____ (%) | VARIABLE SPEED REQUIRED NO |
| 49 RATED CURVE BEP FLOW (at rated impeller diameter) (6.1.16) : _____ gpm | SOURCE OF VARIABLE SPEED _____ |
| 50 MIN FLOW : THERMAL _____ gpm STABLE _____ gpm | MANUFACTURER _____ |
| 51 PREFERRED OPERATING REGION (6.1.16) _____ to _____ gpm | NAMEPLATE POWER : _____ HP |
| 52 ALLOWABLE OPERATING REGION (6.9.4.1) _____ to _____ gpm | NOMINAL RPM _____ |
| 53 MAX HEAD @ RATED IMPELLER _____ ft | RATED LOAD RPM _____ |
| 54 MAX POWER @ RATED IMPELLER _____ HP | FRAME _____ |
| 55 NPSH3 AT RATED FLOW (6.1.9) : _____ ft | ORIENTATION _____ |
| 56 CENTERLINE OF PUMP TO NPSHA DATUM _____ ft | LUBRICATION _____ |
| 57 NPSH MARGIN AT RATED FLOW (6.1.10) : _____ ft | BEARING TYPE _____ |
| 58 SPECIFIC SPEED (6.1.17) _____ gpm,rpm,ft | RADIAL _____ |
| 59 SUCTION SPECIFIC SPEED LIMIT (6.1.11) _____ gpm,rpm,ft (Note 27) | THRUST _____ |
| 60 SUCTION SPECIFIC SPEED (6.1.11) _____ gpm,rpm,ft | STARTING METHOD Direct On Line (DOL) |
| 61 MAX. ALLOWABLE SOUND PRESSURE LEVEL (6.1.19) _____ (dBA) | DRIVER DATASHEET NUMBER _____ |
| 62 ESTIMATED MAX. SOUND PRESSURE LEVEL _____ (dBA) | DRIVE DESIGN STANDARD _____ |
| 63 MAX. ALLOWABLE SOUND POWER LEVEL (6.1.19) (Note 5) 85 (dB) | |
| 64 ESTIMATED MAX SOUND POWER LEVEL _____ (dB) | |
| 65 | |



CENTRIFUGAL PUMP DATASHEET
(API 610-12th Ed.)
US CUSTOMARY
D811 SOUR WATER PUMPS
(HCU1-P821 A/B)

| | | | | | | | | | | | | | |
|------------|--------------------------|------|-----|----------|----|------|------|-----------|------|-----|---|------|--------|
| Project N° | 216119C | Unit | 032 | Doc.Type | SP | Code | 0910 | Serial N° | 0004 | Rev | 1 | Page | 4 of 9 |
| Doc. No. | Exxon | | | | | | | | | | | | |
| Doc. No. | USBT-032-TE-MR-DDS-0004 | | | | | | | | | | | | |
| Client | ExxonMobil | | | | | | | | | | | | |
| Project | BAYTOWN GOLD | | | | | | | | | | | | |
| Location | Baytown, Texas | | | | | | | | | | | | |
| Unit Info | 032 - Hydrocracking Unit | | | | | | | | | | | | |

| 1 | Note | CONSTRUCTION | | | | | | | | | | | Rev |
|----|------|---|------|-----------|--------|----------|--------|-----------------|---|--|-------------------|------------------------|-----|
| 2 | | API PUMP TYPE (Table 1): | | (Note 18) | | | | | CASING MOUNTING (6.3.14, 9.3.8.3): | | CENTERLINE | | B |
| 3 | | | | | | | | | CASING TYPE: | | | | |
| 4 | | NOZZLE CONNECTIONS (6.4.2): | | | | | | | OH3 BACK-PULLOUT LIFTING DEVICE REQ'D. (9.1.2.6) | | | | |
| 5 | | | | | | | | | CASING PRESSURE RATING: (Note 7, 13) | | | | |
| 6 | | SUCTION | Size | Facing | Rating | Position | | | MAWP (6.3.6): | | psig @ | | °F |
| 7 | | DISCHARGE | | RF | 1500 | | | | HYDROTEST (8.3.2.2): | | psig @ | | °F |
| 8 | | PRESSURE CASING AUX. CONNECTIONS: (6.4.3) | | | | | | | WETTING AGENT REQUIRED FOR HYDROTEST (8.3.2.7): | | | | |
| 9 | | | No. | Size | Type | Facing | Rating | Posn. | HYDROTEST OH PUMP AS ASSEMBLY (8.3.2.14): | | | | |
| 10 | | BALANCE/LEAK OFF | | | | | | | SUCTION PRESS. REGIONS DESIGNED FOR MAWP (6.3.8): | | | | |
| 11 | | DRAIN | | | | | | | ROTOR: | | | | |
| 12 | | VENT | | | | | | | SHAFT FLEXIBILITY INDEX (SFI) (9.1.1.3) | | | | |
| 13 | | PRESSURE GAGE | | | | | | | FIRST CRITICAL SPEED WET (MULTISTAGE PUMPS ONLY) | | | | |
| 14 | | TEMP GAGE | | | | | | | COMPONENT BALANCE TO ISO 1940-1, G1 (6.9.3.4): | | | YES | |
| 15 | | WARM-UP LINE | | | | | | | SHRINK-FIT-LIMITED MOVEMENT IMPELLERS (9.2.2.3) | | | | |
| 16 | | | | | | | | | ROTATION (VIEWED FROM COUPLING END): | | | | |
| 17 | | DRAIN VALVE SUPPLIED BY (7.6.2.5) | | | | | | SUPPLIER | IMPELLERS INDIVIDUALLY SECURED (6.6.3): | | | | |
| 18 | | DRAINS MANIFOLDED (7.6.2.5) | | | | | | YES | COUPLING: (7.2) | | | | |
| 19 | | VENT VALVE SUPPLIED BY | | | | | | | MANUFACTURER | | | | |
| 20 | | VENTS MANIFOLDED | | | | | | | MODEL | | | | |
| 21 | | THREADED CONS FOR PIPELINE SERVICE & < 55°C (6.4.3.2) | | | | | | | RATING (HP / 100 RPM) | | | | |
| 22 | | SPECIAL FITTINGS FOR TRANSITIONING (6.4.3.3) | | | | | | | SPACER LENGTH (7.2.2.d) | | | | in |
| 23 | | CYLINDRICAL THREADS REQUIRED (6.4.3.2) | | | | | | | SERVICE FACTOR (7.2.3) | | | 1.5 min | |
| 24 | | MACHINED AND STUDDED AUX CONNECTIONS (6.4.3.6) | | | | | | | RIGID-TYPE | | | | |
| 25 | | ROUTE DRAIN TO SKID EDGE | | | | | | YES | COUPLING WITH HYDRAULIC FIT (7.2.9) | | | | |
| 26 | | | | | | | | | COUPLING WITH PROPRIETARY CLAMPING DEVICE (7.2.10) | | | | |
| 27 | | | | | | | | | COUPLING IN COMPLIANCE WITH (7.2.4)(7.2.2.f) | | | API 610 | B |
| 28 | | MATERIAL (6.12.1.1) | | | | | | | GUARDS (7.3) | | | | |
| 29 | | ANNEX H CLASS | | S-6 | (NACE) | | | | COUPLING AND SHAFT GUARD STANDARD (7.3) | | | ISO 14120 | |
| 30 | | MINIMUM DESIGN METAL TEMPERATURE (6.12.4.1) | | | | 10 | | °F | IGNITION HAZARD ASSESSMENT PER ISO 80079-36 (7.3.2.2; 7.3.3.4) | | | | |
| 31 | | MAXIMUM ALLOWABLE TEMPERATURE (3.1.19) | | | | | | °F | COUPLING GUARD MATERIAL (7.3.2.1; 7.3.3.3): | | | | |
| 32 | | REDUCED-HARDNESS MATERIALS REQ'D (6.12.1.14) | | | | | | YES | SHAFT GUARD MATERIAL (7.3.2.1; 7.3.3.3): | | | | |
| 33 | | APPLICABLE HARDNESS STANDARD (6.12.1.14) | | | | | | NACE MR0103 | SPARK RESISTANT MATERIAL REQUIRED (7.3.2.1): | | | YES | |
| 34 | | BARREL: | | | | | | | | | | | |
| 35 | | CASE: | | | | | | | | | | | |
| 36 | | DIFFUSERS | | | | | | | | | | | |
| 37 | | IMPELLER: | | | | | | | | | | | |
| 38 | | IMPELLER WEAR RING: | | | | | | | | | | | |
| 39 | | CASE WEAR RING: | | | | | | | | | | | |
| 40 | | SHAFT: | | | | | | | | | | | |
| 41 | | BOWL (IF VS-TYPE) | | | | | | | | | | | |
| 42 | | | | | | | | | | | | | |
| 43 | | | | | | | | | | | | | |
| 44 | | BEARINGS AND BEARING HOUSINGS (6.10.1) | | | | | | | BASEPLATE | | | | |
| 45 | | BEARING (TYPE / NUMBER): | | | | | | | API BASEPLATE NUMBER (ANNEX D): | | | | |
| 46 | | RADIAL | | | | | | | IF NON-STD BASEPLATE DIMENSIONS (LxW) (in²): | | | | |
| 47 | | THRUST | | | | | | | BASEPLATE CONSTRUCTION (7.4) | | | TOP DECKING | |
| 48 | | REVIEW AND APPROVE THRUST BEARING SIZE : (9.2.5.2.6) | | | | | | | BASEPLATE DRAINAGE (7.4.1) | | | SLOPED FULL DECK PLATE | |
| 49 | | LUBRICATION (6.11.3) (9.3.12.4) : (Note 6, 33) | | | | | | | MOUNTING: | | | GROUTED | |
| 50 | | PRESSURE LUBE SYSTEM TO API-614, CHAPTER: | | | | | | N/A | NON-GROUT CONSTRUCTION (7.4.1.e): | | | NOT REQUIRED | |
| 51 | | API 614 DATASHEETS ATTACHED (9.2.6.4) | | | | | | | SUPPLIED WITH: | | | | YES |
| 52 | | PRESSURIZED LUBE OIL SYSTEM MOUNTED ON BASEPLATE: | | | | | | | ● GROUT AND VENT HOLES | | | | YES |
| 53 | | LOCATION OF PRESSURIZED LUBE OIL SYSTEM: | | | | | | | ● DRAIN CONNECTION | | | | YES |
| 54 | | INTERCONNECTING PIPING PROVIDED BY | | | | | | | DEMONSTRATE BASEPLATE PAD FLATNESS (7.4.9) | | | | YES |
| 55 | | OIL VISC. ISO GRADE | | | | | | VG | PROVIDE SPACER PLATE UNDER ALL EQUIPMENT FEET (7.4.10) | | | | YES |
| 56 | | VENT-TO-HOUSING CONSTANT LEVEL OILER (6.10.2.4): | | | | | | (Note 6, 33) | BOLT OH 3/4/5 PUMP TO PAD / FOUNDATION : | | | | B |
| 57 | | OIL MIST PROVISIONS (6.11.3) | | | | | | PURE MIST | PROVIDE SOLEPLATE FOR OH 3/4/5 PUMPS (9.1.2): | | | | |
| 58 | | GREASE LUBRICATION (6.11.4) | | | | | | NO | | | | | |



**CENTRIFUGAL PUMP
DATASHEET
(API 610-12th Ed.)
US CUSTOMARY
D811 SOUR WATER PUMPS
(HCU1-P821 A/B)**

| | | | | | | | |
|----------------|--------------------------|------|----------|------|-----------|-----|--------|
| Doc. No. | Project N° | Unit | Doc.Type | Code | Serial N° | Rev | Page |
| Exxon Doc. No. | 216119C | 032 | SP | 0910 | 0004 | 1 | 5 of 9 |
| Client | USBT-032-TE-MR-DDS-0004 | | | | | | |
| Project | ExxonMobil | | | | | | |
| Location | BAYTOWN GOLD | | | | | | |
| Unit Info | Baytown, Texas | | | | | | |
| | 032 - Hydrocracking Unit | | | | | | |


| 1 | Note | INSTRUMENTATION (Note 14) | SEAL SUPPORT SYSTEM MOUNTING | Rev |
|----|------|---|--|-------------------------------|
| 2 | | INSTRUMENTATION PER API-670 (7.5.2) | MOUNTED ON PUMP BASEPLATE (7.6.1.4) | YES |
| 3 | | ACCELEROMETERS (7.5.2.1) | LOCATION ON OR OFF BASEPLATE (7.4.6): | |
| 4 | | NUMBER OF ACCELEROMETERS | INTERCONNECTING PIPING BY | Supplier |
| 5 | | MOUNTING LOCATION: _____ | | |
| 6 | | PROVISION FOR MTG ONLY (6.10.2.13) | | |
| 7 | | FLAT SURFACE REQUIRED (6.10.2.14) | | |
| 8 | | | MECHANICAL SEAL (6.8) (Note 8, 32) | |
| 9 | | VIBRATION PROBES (7.5.2.2) | API 682 DATASHEET ATTACHED: | YES |
| 10 | | VIBRATION PROBES REQUIRED (7.5.2.2) | ADDITIONAL CENTRAL FLUSH PORT (6.8.9) | |
| 11 | | NUMBER PER RADIAL BEARING | HEATING JACKET REQ'D. (6.8.11) | |
| 12 | | NUMBER PER AXIAL BEARING | | |
| 13 | | THREADED PROVISION FOR MTG ONLY (6.10.2.13; 6.6.12) | HEATING AND COOLING (6.1.23-6.1.27) | |
| 14 | | FLAT SURFACE PROVISION ONLY (6.10.2.14) | COOLING REQ'D | |
| 15 | | MONITORS AND CABLES SUPPLIED BY (7.5.2.4) | COOLING WATER PIPING PLAN (7.6.3.1) | |
| 16 | | | COOLING WATER PIPING | |
| 17 | | TEMPERATURE DETECTORS (7.5.2.3) | FITTINGS | |
| 18 | | TEMP. PROBES REQUIRED (7.5.2.3) | COOLING WATER PIPING MATERIALS | |
| 19 | | PROVISIONS FOR MOUNTING ONLY (6.10.2.2) | COOLING WATER REQUIREMENTS: | SUPPLY PRESSURE _____ psig |
| 20 | | RADIAL BEARING TEMP. | | BEARING HOUSING _____ gpm |
| 21 | | NUMBER PER RADIAL BEARING | | HEAT EXCHANGER _____ gpm |
| 22 | | THRUST BEARING TEMP. | | TOTAL COOLING WATER _____ gpm |
| 23 | | NUMBER PER THRUST BEARING ACTIVE SIDE | HEATING MEDIUM | |
| 24 | | NUMBER PER THRUST BEARING INACTIVE SIDE | HEATING PIPING | |
| 25 | | TEMP. GAUGES (WITH THERMOWELLS) (9.1.3.5) | | |
| 26 | | TEMP. GAUGE LOCATION _____ | PIPING & APPURTENANCES | |
| 27 | | SUPPLY UPPER/LOWER CASING RTD'S FOR WARMUP | TAG ALL ORIFICES (7.6.2.4) | |
| 28 | | | SOCKET WELD UNION ON 1st SEAL GLAND NIPPLE (7.6.2.8) | |
| 29 | | PRESSURE GAUGE TYPE _____ | MANIFOLD AUX PIPING SYSTEMS AT SKID EDGE (7.6.1.6) | |
| 30 | | PRESSURE GAUGE LOCATION _____ | | |
| 31 | | | | |
| 32 | | | | |
| 33 | | PRESSURE VESSEL DESIGN CODE REFERENCES | | |
| 34 | | THESE REFERENCES SHALL BE PROVIDED BY THE MANUFACTURER | | |
| 35 | | CASTING FACTORS USED IN DESIGN (PER TABLE 4) | | |
| 36 | | SOURCE OF MATERIAL PROPERTIES (6.3.5) | | |
| 37 | | | | |
| 38 | | WELDING AND REPAIRS (6.12.3.1) | | |
| 39 | | THESE REFERENCES SHALL BE PROVIDED BY THE PURCHASER. (DEFAULT TO TABLE 11 IF NO PURCHASER PREFERENCE IS STATED) | | |
| 40 | | ALTERNATIVE WELDING CODES AND STANDARDS | | |
| 41 | | WELDING REQUIREMENT (APPLICABLE CODE OR STANDARD) | | |
| 42 | | ALTERNATIVE WELDER/OPERATOR QUALIFICATION STANDARD | | |
| 43 | | ALTERNATIVE WELDING PROCEDURE QUALIFICATION STANDARD | | |
| 44 | | NON-PRESSURE RETAINING STRUCTURAL WELDING STANDARD (BASEPLATES OR SUPPORTS) | | |
| 45 | | STANDARD FOR MAGNETIC PARTICLE OR LIQUID PENETRANT EXAMINATION (PLATE EDGES) | | |
| 46 | | STANDARD FOR POSTWELD HEAT TREATMENT | | |
| 47 | | STANDARD FOR POSTWELD HEAT TREATMENT OF CASING FABRICATION WELDS | | |
| 48 | | | | |
| 49 | | MATERIAL INSPECTION | | |
| 50 | | THESE REFERENCES SHALL BE PROVIDED BY THE PURCHASER | | |
| 51 | | DEFAULT TO TABLE 14 YES TABLE 14 INSPECTION CLASS: II | | |
| 52 | | ALTERNATIVE MATERIAL INSPECTIONS AND ACCEPTANCE CRITERIA (SEE TABLE 15, 8.2.2.5) | | |
| 53 | | | | |
| 54 | | TYPE OF INSPECTION | METHOD | FOR FABRICATIONS |
| 55 | | RADIOGRAPHY | | |
| 56 | | ULTRASONIC INSPECTION | | |
| 57 | | MAGNETIC PARTICLE INSPECTION | | |
| 58 | | LIQUID PENETRANT INSPECTION | | |
| 59 | | VISUAL INSPECTION (all surfaces) | | |
| 60 | | | | |



CENTRIFUGAL PUMP DATASHEET
(API 610-12th Ed.)
US CUSTOMARY
D811 SOUR WATER PUMPS
(HCU1-P821 A/B)

| | | | | | | | | | | | | | |
|----------------|--------------------------|------|-----|----------|----|------|------|-----------|------|-----|---|------|--------|
| Doc. No. | 216119C | Unit | 032 | Doc.Type | SP | Code | 0910 | Serial N° | 0004 | Rev | 1 | Page | 6 of 9 |
| Exxon Doc. No. | USBT-032-TE-MR-DDS-0004 | | | | | | | | | | | | |
| Client | ExxonMobil | | | | | | | | | | | | |
| Project | BAYTOWN GOLD | | | | | | | | | | | | |
| Location | Baytown, Texas | | | | | | | | | | | | |
| Unit Info | 032 - Hydrocracking Unit | | | | | | | | | | | | |

| 1 | Note | SURFACE PREPARATION, PAINT & SPARES | | | | | | TEST (Note 17) | | | | Rev | |
|----|--|-------------------------------------|------|--------|------|------|-------|---|-----------------------|--|--|-----|---------|
| 2 | MANUFACTURER'S STANDARD (8.4.3.4) | | | | | | | SHOP INSPECTION (8.1.1.1) | | | | | YES |
| 3 | OTHER (SEE BELOW) | | | | | | | PERF. CURVE & DATA APPROVAL REQ'D PRIOR TO SHIPMENT (8.3.3.4.6) : | | | | | YES |
| 4 | SPECIFICATION NO. | BTDP 19-1-1-1 & GP 19-01-01D | | | | | | TEST WITH SUBSTITUTE SEAL (8.3.3.3.1) | | | | | |
| 5 | PUMP: | | | | | | | MATERIAL CERTIFICATION REQUIRED (6.12.1.8): | CASING | | | | YES |
| 6 | PUMP SURFACE PREPARATION | | | | | | | | IMPELLER | | | | YES |
| 7 | PRIMER | | | | | | | | SHAFT | | | | YES |
| 8 | FINISH COAT | | | | | | | | OTHER | | | | |
| 9 | BASEPLATE: | | | | | | | CASTING REPAIR WELD PROCEDURE APPROVAL REQD (6.12.2.5): | | | | | YES |
| 10 | SURFACE PREPARATION | | | | | | | INSPECTION REQUIRED FOR CONNECTION WELDS (6.12.3.4) | | | | | |
| 11 | PRIMER: | | | | | | | | MAG PARTICLE | | | | YES |
| 12 | FINISH COAT | | | | | | | | RADIOGRAPHY | | | | NO |
| 13 | UNDERSIDE | | | | | | | | LIQUID PENETRANT | | | | YES |
| 14 | | | | | | | | | ULTRASONIC | | | | NO |
| 15 | SHIPMENT: (8.4) | | | | | | | HARDNESS TEST REQUIRED (6.12.1.14; 8.2.2.7) | | | | | |
| 16 | EXPORT BOXING REQUIRED | | | | | | | ADDITIONAL SUBSURFACE EXAMINATION (6.12.1.6) (8.2.1.3) | | | | | |
| 17 | PREPARE FOR OUTDOOR STORAGE (NUMBER OF MONTHS) : | 12 | | | | | | FOR: | | | | | |
| 18 | | | | | | | | METHOD: | | | | | |
| 19 | SPARE ROTOR ASSEMBLY PACKAGED FOR: | | | | | | | PMI TESTING REQUIRED (8.2.2.8) | | | | | YES |
| 20 | ROTOR STORAGE ORIENTATION (9.2.8.2) | | | | | | | COMPONENTS TO BE TESTED : | | | | | |
| 21 | SHIPPING & STORAGE CONTAINER SUITABLE FOR | | | | | | | RESIDUAL UNBALANCE TEST (J.4.1.2) | | | | | YES |
| 22 | VERTICAL STORAGE (9.2.8.3) : | | | | | | | NOTIFICATION OF SUCCESSFUL PERFORMANCE TEST (8.1.1.3) (8.3.3.4.6) | | | | | YES |
| 23 | N2 PURGE REQUIRED (9.2.8.4) : | | | | | | | BASEPLATE (NOZZLE LOAD) TEST (7.4.24) | | | | | |
| 24 | | | | | | | | HYDROSTATIC TEST (8.3.2) | | | | | |
| 25 | SPARE PARTS (10.3.4.2) | | | | | | | HYDROSTATIC TEST OF BOWLS & COLUMN (9.3.13.1) | | | | | |
| 26 | START-UP | | | | | | | PERFORMANCE TEST (8.3.3) (Note 16) | | | | | WIT |
| 27 | NORMAL MAINTENANCE | | | | | | | RETEST ON SEAL LEAKAGE (8.3.3.3.2) | | | | | OBSERVE |
| 28 | | | | | | | | TEST DATA POINTS TO (8.3.3.4) | | | | | |
| 29 | | | | | | | | ALTERNATE TEST TOLERANCES PER (8.3.3.5) | | | | | |
| 30 | | MASSES ib | | | | | | NPSH (8.3.4.3) | | | | | WIT |
| 31 | | ITEM No | PUMP | DRIVER | GEAR | BASE | TOTAL | NPSH BASED ON 1ST STG ONLY ALLOWED (8.3.4.3.2) | | | | | N/A |
| 32 | | | | | | | 0 | TEST NPSHA LIMITED TO 110% SITE NPSHA (8.3.3.7) | | | | | N/A |
| 33 | | | | | | | 0 | RETEST REQUIRED AFTER FINAL HEAD ADJUSTMENT (8.3.3.8.2) | | | | | |
| 34 | | | | | | | 0 | COMPLETE UNIT TEST (8.3.4.4.1) (Note 26) | | | | | |
| 35 | | | | | | | | SOUND LEVEL TEST (8.3.4.5) | | | | | WIT |
| 36 | | OTHER PURCHASER REQUIREMENTS | | | | | | CLEANLINESS PRIOR TO FINAL ASSEMBLY (8.2.2.6) | | | | | OBSERVE |
| 37 | COORDINATION MEETING REQUIRED | | | | | | | LOCATION OF CLEANLINESS INSPECTION: | | | | | |
| 38 | MAXIMUM DISCHARGE PRESSURE TO INCLUDE (6.3.2) | | | | | | | CHECK FOR CO-PLANAR MOUNTING PAD FLATNESS (7.4.8) | | | | | |
| 39 | MAX RELATIVE DENSITY | | | | | | | MECHANICAL RUN TEST UNTIL OIL TEMP STABLE (8.3.4.2.1) | | | | | |
| 40 | OPERATION TO TRIP SPEED | | | | | | | 4 HR. MECH RUN AFTER OIL TEMP STABLE (8.3.4.2.2) (Note 16) | | | | | WIT |
| 41 | MAX DIA. IMPELLERS AND/OR NO OF STAGES | | | | | | | BRG HSG RESONANCE TEST (8.3.4.7) | | | | | |
| 42 | CONNECTION DESIGN APPROVAL (9.2.1.4) | | | | | | | STRUCTURAL RESONANCE TEST (9.3.9.2) | | | | | |
| 43 | TORSIONAL ANALYSIS / REPORT (6.9.2) | | | | | | | REMOVE / INSPECT HYDRODYNAMIC BEARINGS AFTER TEST (9.2.7.4) | | | | | |
| 44 | PROGRESS REPORTS (L.3.3) | | | | | | | AUXILIARY EQUIPMENT TEST (8.3.4.6) | | | | | |
| 45 | OUTLINE OF PROCEDURES USED FOR OPTIONAL TESTS (L.2.5) | | | | | | | EQUIPMENT TO BE INCLUDED IN AUXILLIARY TESTS : | | | | | |
| 46 | ADDITIONAL DATA REQUIRING 20 YEARS RETENTION (8.2.1.1) | | | | | | | LOCATION OF AUXILIARY EQUIPMENT TEST : | | | | | |
| 47 | LATERAL ANALYSIS REQUIRED (9.2.4.1.2) | | | | | | | | | | | | |
| 48 | ROTOR DYNAMIC BALANCE TO 4W/N (6.9.3.5) | | | | | | | IMPACT TEST (6.12.4.3) | PER EN 13445 | | | | |
| 49 | VFD STEADY STATE FORCED RESPONSE ANALYSIS (6.9.2.3) | | | | | | | | PER ASME SECTION VIII | | | | |
| 50 | TRANSIENT FORCED RESPONSE (6.9.2.4) | | | | | | | CASING DISASSEMBLY AFTER TEST (8.3.3.9) | | | | | |
| 51 | BEARING LIFE CALCULATIONS REQUIRED (6.10.1.11) | | | | | | | SPARE PARTS TEST (8.3.4.8) | | | | | |
| 52 | CASING RETIREMENT THICKNESS DRAWING [L.3.6.1 cc) 7) xiii]] | | | | | | | | | | | | |
| 53 | CONNECTION BOLTING (7.6.1.7) | | | | | | | | | | | | |
| 54 | VENDOR TO KEEP REPAIR AND HT RCDS (8.2.1.1.c) | | | | | | | | | | | | YES |
| 55 | VENDOR SUBMIT TEST PROCEDURES (8.3.1.1) | | | | | | | | | | | | YES |
| 56 | SUBMIT INSPECTION CHECK LIST (8.1.5) | | | | | | | | | | | | YES |
| 57 | ACOUSTIC ANALYSIS OF CROSSOVER PASSAGE (BB3, BB5)(9.2.1.5) | | | | | | | | | | | | |
| 58 | API-691 DOCUMENTATION REQUIRED (6.1.3.1) | | | | | | | | | | | | |
| 59 | | | | | | | | | | | | | |

|  | | CENTRIFUGAL PUMP DATASHEET (API 610-12th Ed.) US CUSTOMARY D811 SOUR WATER PUMPS (HCU1-P821 A/B) | | Project N° | Unit | Doc.Type | Code | Serial N° | Rev | Page |
|---|--------|---|--------------------------|------------|------|----------|------|-----------|--------|------|
| | | Doc. No. | 216119C | 032 | SP | 0910 | 0004 | 1 | 7 of 9 | |
| | | Exxon Doc. No. | USBT-032-TE-MR-DDS-0004 | | | | | | | |
| | | Client | ExxonMobil | | | | | | | |
| | | Project | BAYTOWN GOLD | | | | | | | |
| | | Location | Baytown, Texas | | | | | | | |
| | | Unit Info | 032 - Hydrocracking Unit | | | | | | | |
| NOTES | | | | | | | | | | |
| 1 | Note # | | | | | | | | | Rev |
| 2 | 1 | For utility conditions and site data, please refer to Technical Notes For Centrifugal Pumps doc no. USBT-000-TE-MR-TCN-0001. For utility condition at | | | | | | | | |
| 3 | | vendor battery limit, vendor to consider 7.11 psia additional pressure drop to arrive at vendor battery limit pressure (stringent among min/max/nor to | | | | | | | | |
| 4 | | be considered). The pressure drop between the supply header and pump battery limit is 7.11 psia. vendor shall consider the pressure drop while | | | | | | | | |
| 5 | | sizing the equipment. | | | | | | | | |
| 6 | 2 | Vendor to provide utility consumption summary with following minimum data per item: Name of utility, consumption rate/quantity, | | | | | | | | |
| 7 | | intermittent/continuous, frequency if intermittent, and required operating min/max pressure and temperature. | | | | | | | | |
| 8 | 3 | Vendor to provide all the auxiliary instrument and equipment datasheet as applicable. Unit of Measurement shall be in US units. | | | | | | | | |
| 9 | 4 | For mechanical seal/bearing cooling systems, where cooling water is used, maximum pressure drop allowed across supply and return at pump | | | | | | | | |
| 10 | | skid battery limit is 9.95 psia. Vendor shall ensure backflush provision and a bleed point with valve and blind at upstream of isolation valve on | | | | | | | | |
| 11 | | cooling water return line. Cooling water composition is as specified in the Technical Notes For Centrifugal Pumps. | | | | | | | | |
| 12 | 5 | Maximum allowable sound pressure level at 3 ft distance is 85 dBA for the complete train, where that of each component shall be limited to 80 dBA. | | | | | | | | |
| 13 | 6 | To be confirmed by vendor. | | | | | | | | |
| 14 | 7 | Estimated shut off pressure = 2000 psig. Pump head at shutoff shall not exceed the system design pressure. Selected pump shutoff pressure | | | | | | | | |
| 15 | | including API margin shall not exceed estimated shut off pressure specified in the datasheet. | | | | | | | | |
| 16 | 8 | Pump seal plan to be confirmed by vendor based on seal vendor recommendation as per process service. Mechanical seal shall be in compliance | | | | | | | | |
| 17 | | with API 682, 4th Ed. and USBT-000-TE-MR-EQS-0003_Shaft Sealing Systems for Centrifugal and Rotary Pumps. Seal vendor recommendation | | | | | | | | |
| 18 | | shall be part of vendor offer. Preferred mechanical seal vendor for the project is "Flowserve". | | | | | | | | |
| 19 | 9 | The net positive suction head available (NPSHa) shall exceed the net positive suction head required (NPSH3) by at least 3 ft (0.9 m) or a ratio | | | | | | | | 1 |
| 20 | | of 1.2 (whichever yields the higher NPSH margin) at pump rated capacity. From rated operating point up to end of curve, NPSH3 shall not | | | | | | | | |
| 21 | | exceed NPSHa. NPSHa is specified at pump centerline assuming pump centerline is at 3 ft from grade. Vendor shall offer NPSH testing for all pumps. | | | | | | | | |
| 22 | 10 | Pump vendor to advise minimum continuous circulation flow required for the pump. | | | | | | | | |
| 23 | 11 | Indicated flow (Rated / Normal / Minimum) is process required flow and does not include pump Minimum Circulation flow. Vendor shall include | | | | | | | | |
| 24 | | Minimum Circulation flowrate requirement in specified pump rated capacity to arrive at final rated capacity of pump. Rated head shall be | | | | | | | | |
| 25 | | guaranteed without any -ve margin at final rated capacity of pump. | | | | | | | | |
| 26 | 12 | Minimum flow for the pump is 50% of normal flow. | | | | | | | | |
| 27 | 13 | The pump design temperature is 180 deg. F. | | | | | | | | |
| 28 | 14 | Vendor shall follow Equipment Health Monitoring (EHM) as applicable in line with Technical Notes For Centrifugal Pumps. Vendor shall provide Probes, | | | | | | | | |
| 29 | | Probes, Temperature, vibration instrument and wiring upto junction boxes (JBs) including JB's, as applicable. | | | | | | | | |
| 30 | 15 | The pumps shall be designed and supplied as per API 610, 12th edition and JIP 33 S615 and Technical Notes for Centrifugal Pumps doc no. | | | | | | | | |
| 31 | | USBT-000-TE-MR-TCN-0001 | | | | | | | | |
| 32 | 16 | Performance testing and mechanical run test shall be in accordance with Technical Notes For Centrifugal Pumps, API Standard 610 Twelfth Edition. | | | | | | | | |
| 33 | | Performance test & MRT shall be carried out for both working and standby pumps. | | | | | | | | |
| 34 | 17 | For inspection and Test Requirements, please refer Inspection Test Plan for Centrifugal Pumps_216119C-000-ITP-0910-0001. | | | | | | | | |
| 35 | 18 | Vendor to confirm pump type and no. of stage. | | | | | | | | |
| 36 | 19 | All drain piping including seal plan drains shall be routed to the edge of the baseplate. | | | | | | | | |
| 37 | 20 | All utility piping shall be terminated at the edge of baseplate/skid. Further distribution within skid shall be included in vendors scope. | | | | | | | | |
| 38 | 21 | Spare philosophy shall be as per Technical Notes For Centrifugal Pumps. | | | | | | | | |
| 39 | 22 | Suction design pressure = 111.4 psig | | | | | | | | |
| 40 | | Below legend to be followed for the datasheet: - For text in BLACK colour data furnished by purchaser, - For text in BLUE colour data furnished by supplier, - For text in RED colour data furnished by Supplier, wherever not specified by Purchaser | | | | | | | | |
| 41 | 24 | ExxonMobil has frame agreement for LV motors with ABB and frame agreement is available with Siemens and ABB for MV motors till 1500 HP. | | | | | | | | |
| 42 | | All Motors till 1500 HP shall be sourced in line with ExxonMobil frame agreement. | | | | | | | | |
| 43 | 25 | Range of operating fluid density is 63.62 lb/ft3. | | | | | | | | |
| 44 | 26 | Unitization of complete pump package along with driver and other auxiliaries to be carried at pump vendor works. | | | | | | | | |
| 45 | 27 | For suction specific speed kindly refer to clause 9.2.16 of Technical Notes For Centrifugal Pumps. | | | | | | | | 1 |
| 46 | 28 | Below service condition to be considered: | | | | | | | | |
| 47 | | Hazardous / Toxic Service : Yes / Yes | | | | | | | | |
| 48 | 29 | Viscosity of fluid ranges from 0.51 to 0.72 cP | | | | | | | | |
| 49 | 30 | Operating temperature of fluid ranges from 95.64 to 130.57 °F | | | | | | | | |
| 50 | 31 | Vendor shall consider maximum relative density for driver selection. | | | | | | | | |
| 51 | 32 | Respiratory Exposure Hazard Class is R4. Default seal control level shall be Level 2 and corresponding default sealing arrangement is Single | | | | | | | | |
| 52 | | mechanical seal with floating carbon throttle bushing as per Arrangement 1 of API 682 std. Vendor shall provide the seal & seal plan recommendation. | | | | | | | | |
| 53 | | However, final seal type and seal plan shall be subject to purchaser approval. Vendor to fill API 682 datasheet and submit along with their proposal. | | | | | | | | |
| 54 | 33 | Pure oil mist lubrication is preferred lubrication method for pump/motor. Vendor shall offer pump/driver suitably. Necessary provision for oil mist | | | | | | | | |
| 55 | | lubrication in the bearing housing shall be provided by vendor for the pump/motor. Lubrication type shall be decided at a later stage. | | | | | | | | |
| 56 | | | | | | | | | | |
| 57 | | | | | | | | | | |



CENTRIFUGAL PUMP DATASHEET
 (API 610-12th Ed.)
US CUSTOMARY
D811 SOUR WATER PUMPS
 (HCU1-P821 A/B)

| | | | | | | |
|----------------|--------------------------|----------|------|-----------|------|------|
| Project N° | Unit | Doc.Type | Code | Serial N° | Rev | Page |
| Doc. No. | 216119C | 032 | SP | 0910 | 0004 | 1 |
| Exxon Doc. No. | USBT-032-TE-MR-DDS-0004 | | | | | |
| Client | ExxonMobil | | | | | |
| Project | BAYTOWN GOLD | | | | | |
| Location | Baytown, Texas | | | | | |
| Unit Info | 032 - Hydrocracking Unit | | | | | |

| | | | | |
|--|-------------------------|---------|----------|----------|
| Data to be completed by: | Project Phase: | INQUIRY | PROPOSAL | CONTRACT |
| <input type="radio"/> Purchaser | Identification Number: | | | |
| <input type="radio"/> Seal Vendor | Other Identification: | | | |
| <input type="radio"/> Purchaser or Seal Vendor | Date / Revision Number: | / | / | / |
| Optional Features | By: | | | |

| | | |
|---|---|---|
| <p>1 SEAL SPECIFICATION</p> <p>2 Seal Code (Annex D)</p> <p>3 <input type="checkbox"/></p> <p>4 Vendor's Seal Code</p> <p>5 <input type="checkbox"/></p> <p>6 Vendor's Seal Drawing No.</p> <p>7 <input type="checkbox"/></p> <p>8 Vendor</p> <p>9 <input type="checkbox"/> Category 1 (4.1.2)</p> <p>10 <input type="checkbox"/> Category 2</p> <p>11 <input type="checkbox"/> Category 3</p> <p>12 <input type="checkbox"/> Arrangement 1 (4.1.4) piping plans:</p> <p>13 <input type="checkbox"/> 1CW-FX (Cat. 1) 01, 02, 03, 11, 13,</p> <p>14 <input type="checkbox"/> 1CW-FL (Cat. 2&3) 14, 21, 22, 23, 31,</p> <p>15 <input type="checkbox"/> 1CW-FL (Cat. 1) 32, 41, 51, 62, 65A</p> <p>16 <input type="checkbox"/> segm. carb. bush. (Cat. 2&3) (7.1.2.1) 65B, 66A, 66B, 99</p> <p>17 <input type="checkbox"/> Arrangement 2 (4.1.4) piping plans:</p> <p>18 <input type="checkbox"/> 2CW-CW (liquid) 01, 02, 03, 11, 13,</p> <p>19 <input type="checkbox"/> 2CW-CS (gas) 14, 21, 22, 23, 31,</p> <p>20 <input type="checkbox"/> 2NC-CS (gas) 32, 41, 52, 55, 61,</p> <p>21 <input type="checkbox"/> fix carbon throttle 62, 66A, 66B, 71,</p> <p>22 <input type="checkbox"/> bushing (7.2.2.1) 72, 75, 76, 99</p> <p>23 <input type="checkbox"/> Arrangement 3 (4.1.4) piping plans:</p> <p>24 <input type="checkbox"/> 3CW-FB (liquid) 01, 02, 03, 11, 13,</p> <p>25 <input type="checkbox"/> 3CW-BB (liquid) 14, 21, 22, 23, 31,</p> <p>26 <input type="checkbox"/> 3CW-FF (liquid) 32, 53A, 53B, 53C</p> <p>27 <input type="checkbox"/> flush connection 54, 61, 62, 66A,</p> <p>28 <input type="checkbox"/> fix carbon throttle 66B, 74, 99</p> <p>29 <input type="checkbox"/> bushing (7.3.2.2/7.3.2.1)</p> <p>30 <input type="checkbox"/> 3NC-BB (gas)</p> <p>31 <input type="checkbox"/> 3NC-FB (gas)</p> <p>32 <input type="checkbox"/> 3NC-FB (gas)</p> <p>33 <input type="checkbox"/> Type A (4.1.3) inner / outer seal</p> <p>34 <input type="checkbox"/> stationary spring (6.1.1.2)</p> <p>35 <input type="checkbox"/> single spring (6.1.5.1)</p> <p>36 <input type="checkbox"/> Type B (4.1.3)</p> <p>37 <input type="checkbox"/> stationary bellows (6.1.1.2)</p> <p>38 <input type="checkbox"/> Type C (4.1.3)</p> <p>39 <input type="checkbox"/> rotating bellows (6.1.1.3)</p> <p>40 <input type="checkbox"/> Piping Plans prod. - between seals - atm. (Annex G)</p> <p>41 <input type="checkbox"/> Sleeve Shaft Drive</p> <p>42 <input type="checkbox"/> set screws</p> <p>43 <input type="checkbox"/> approval for (6.1.3.14)</p> <p>44 <input type="checkbox"/> ≥ 9 set screws</p> <p>45 <input type="checkbox"/> other, specify</p> <p>46 SEAL PERFORMANCE DATA</p> <p>47 Sealing Pressure Rating</p> <p>48 <input type="checkbox"/> dynamic _____ psi (ga) (3.1.27)</p> <p>49 <input type="checkbox"/> static _____ psi (ga) (3.1.84)</p> <p>50 <input type="checkbox"/> Arr. 3: continous operation @ abnormal barrier pressure condition [7.3.1.2 d]</p> <p>51 Temperature</p> <p>52 <input type="checkbox"/> max. allowable _____ °F (3.1.51)</p> <p>53 <input type="checkbox"/> min. metal design _____ °F (6.1.6.11.1)</p> <p>54 Additional Data for Category 3</p> <p>55 <input type="checkbox"/> generated heat, normal _____ btu/hr</p> <p>56 <input type="checkbox"/> heat soak, normal _____ btu/hr</p> <p>57 <input type="checkbox"/> axial thrust on shaft _____ lbf</p> <p>58 Test of Seal by Pump Manufacturer (10.3.6)</p> <p>59 <input type="checkbox"/> modified seal faces _____ specify faces or seal on page 2 line 54, 55</p> <p>60 <input type="checkbox"/> alternative seal</p> | <p>SEAL MATERIALS</p> <p>Secondary Seals (6.1.6.5)</p> <p><input type="checkbox"/> FKM inner / outer seal</p> <p><input type="checkbox"/> spiral-wound gasket</p> <p><input type="checkbox"/> FFKM</p> <p><input type="checkbox"/> NBR</p> <p>specify:</p> <p><input type="checkbox"/> other @ inner seal</p> <p><input type="checkbox"/> other @ outer seal</p> <p>Seal Faces (6.1.6.2)</p> <p><input type="checkbox"/> Carbon / SiC inner / outer seal</p> <p><input type="checkbox"/> SiC / SiC</p> <p><input type="checkbox"/> SSiC</p> <p><input type="checkbox"/> RBSiC</p> <p>specify:</p> <p><input type="checkbox"/> other @ inner seal</p> <p><input type="checkbox"/> other @ outer seal</p> <p>Metal Bellows (6.1.6.6)</p> <p><input type="checkbox"/> UNS N10276 (Type B) inner / outer seal</p> <p><input type="checkbox"/> UNS N07718 (Type C)</p> <p><input type="checkbox"/> UNS N07718 (Type B)</p> <p><input type="checkbox"/> UNS N08020</p> <p>specify:</p> <p><input type="checkbox"/> other @ inner seal</p> <p><input type="checkbox"/> other @ outer seal</p> <p>Springs (6.1.6.4)</p> <p><input type="checkbox"/> UNS N10276 or N06455 (multiple springs)</p> <p><input type="checkbox"/> UNS S31600 or S31635 (single spring)</p> <p>Metal Parts (6.1.6.3 & 6.1.6.7)</p> <p><input type="checkbox"/> UNS S31600 or S31635</p> <p><input type="checkbox"/> UNS N10276</p> <p><input type="checkbox"/> UNS N08020</p> <p><input type="checkbox"/> other, specify:</p> <p>SEAL CHAMBER DATA</p> <p><input type="checkbox"/> ASME B73.1&2 (Category 1)</p> <p><input type="checkbox"/> cylindrical</p> <p><input type="checkbox"/> tapered</p> <p><input type="checkbox"/> API 610 (Category 2 & 3)</p> <p><input type="checkbox"/> other, specify</p> <p><input type="checkbox"/> bolt on seal chamber (6.1.6.8)</p> <p><input type="checkbox"/> fixed throat bush</p> <p><input type="checkbox"/> floating throat bush</p> <p><input type="checkbox"/> seal chamber vent</p> <p><input type="checkbox"/> heating/cooling jacket</p> <p>PUMP DATA</p> <p><input type="checkbox"/> Manufacturer</p> <p><input type="checkbox"/> model</p> <p><input type="checkbox"/> frame/size</p> <p><input type="checkbox"/> Case Material</p> <p><input type="checkbox"/> Suction Press. (rated) _____ psi (ga)</p> <p><input type="checkbox"/> Discharge Pressure _____ psi (ga)</p> <p><input type="checkbox"/> Seal Chamber Pressure</p> <p>normal _____ psi (ga)</p> <p>minimum _____ psi (ga)</p> <p>maximum _____ psi (ga)</p> <p>static _____ psi (ga)</p> <p><input type="checkbox"/> Shaft Details</p> <p>diameter _____ mm</p> <p>speed _____ rpm</p> <p>horizontal _____</p> <p>vertical _____</p> <p>CW rotation _____</p> <p>CCW rotation _____ respective to driver</p> | <p>FLUID DATA (Pumped Stream, Flush Fluid)</p> <p>Pumped Stream</p> <p><input type="checkbox"/> type or name _____</p> <p><input type="checkbox"/> & concentration (%) _____</p> <p><input type="checkbox"/> dissolved contaminant</p> <p>H₂S _____ ppm</p> <p>wet _____</p> <p>Cl₂ _____ ppm</p> <p>other, specify _____</p> <p>_____ ppm</p> <p><input type="checkbox"/> solid contaminant</p> <p><input type="checkbox"/> concentration _____ (mass fraction)</p> <p><input type="checkbox"/> pumping temperature</p> <p>normal _____ °F</p> <p>max. _____ °F</p> <p>min. _____ °F</p> <p><input type="checkbox"/> specific gravity at indicated temperature</p> <p>@ normal temp. _____ lb/ft³</p> <p>@ max. temp. _____ lb/ft³</p> <p><input type="checkbox"/> absolute vapor pressure at ref. temperature</p> <p>normal temp. _____ psi</p> <p>max. temp. _____ psi</p> <p><input type="checkbox"/> atmosph. boiling point _____ °F</p> <p><input type="checkbox"/> viscosity @ norm. temp. _____ cP (s. line 14)</p> <p><input type="checkbox"/> hazardous</p> <p><input type="checkbox"/> flammable</p> <p><input type="checkbox"/> other, specify _____</p> <p><input type="checkbox"/> fluid solid @ ambient</p> <p><input type="checkbox"/> solidifies @ temp. _____ °F</p> <p><input type="checkbox"/> pour point temp. _____ °F</p> <p><input type="checkbox"/> solidifies under shear</p> <p><input type="checkbox"/> polymerizing agents</p> <p><input type="checkbox"/> name or type _____</p> <p><input type="checkbox"/> polymerize @ temp. _____ °F</p> <p><input type="checkbox"/> plates out/decomposes</p> <p><input type="checkbox"/> @ conditions _____</p> <p><input type="checkbox"/> regulated for fugative or other emissions _____ ppm</p> <p><input type="checkbox"/> special pump cleaning procedures, specify _____</p> <p><input type="checkbox"/> alternate process fluids & concentration, spec. _____</p> <p>Flush Fluid (not required if same as pumped stream)</p> <p><input type="checkbox"/> type or name _____</p> <p><input type="checkbox"/> & concentration (%) _____</p> <p><input type="checkbox"/> seal vendor review _____</p> <p><input type="checkbox"/> fluid temperature:</p> <p>normal _____ °F</p> <p>max. _____ °F</p> <p>min. _____ °F</p> <p><input type="checkbox"/> specific gravity at indicated temperature</p> <p>@ normal temp. _____ lb/ft³</p> <p>@ max. temp. _____ lb/ft³</p> <p><input type="checkbox"/> absolute vapor pressure at ref. temperature</p> <p>normal temp. _____ psi</p> <p>max. temp. _____ psi</p> <p><input type="checkbox"/> atmosph. boiling point _____ °F</p> <p><input type="checkbox"/> viscosity @ norm. temp. _____ cP (s. line 48)</p> <p><input type="checkbox"/> flow rate req'd max. _____ gpm</p> <p>_____ gpm</p> <p>min. _____ gpm</p> <p><input type="checkbox"/> pressure req'd max. _____ psi (ga)</p> <p>min. _____ psi (ga)</p> |
|---|---|---|



**CENTRIFUGAL PUMP
DATASHEET
(API 610-12th Ed.)
US CUSTOMARY
D811 SOUR WATER PUMPS
(HCU1-P821 A/B)**

| | | | | | | |
|----------------|--------------------------|----------|------|-----------|------|--------|
| Project N° | Unit | Doc.Type | Code | Serial N° | Rev | Page |
| Doc. No. | 216119C | 032 | SP | 0910 | 0004 | 1 of 9 |
| Exxon Doc. No. | USBT-032-TE-MR-DDS-0004 | | | | | |
| Client | ExxonMobil | | | | | |
| Project | BAYTOWN GOLD | | | | | |
| Location | Baytown, Texas | | | | | |
| Unit Info | 032 - Hydrocracking Unit | | | | | |

| | | | | |
|---|--------------------------------|----------------|-----------------|-----------------|
| Data to be completed by: <input type="radio"/> Purchaser <input checked="" type="radio"/> Seal Vendor <input type="radio"/> Purchaser or Seal Vendor | Project Phase: | INQUIRY | PROPOSAL | CONTRACT |
| | Identification Number: | | | |
| | Other Identification: | | | |
| | Date / Revision Number: | / / | / / | / / |
| Optional Features | By: | | | |

| | | | | | |
|--|--|--|--|---|--|
| 1 FLUID DATA (Quench, Buffer, Barrier) | | SEAL AUXILIARY SYSTEM (Connection Lines, Components, Instrumentation) | | | |
| Quench Fluid (plan 51, 62) <input type="radio"/> type or name <input type="radio"/> supply temp. max. °F min. °F <input type="checkbox"/> flow rate req'd max. gpm min. gpm | | General <input type="radio"/> joint user/vendor layout (8.1.3) <input type="radio"/> supplier connect. lines <input type="radio"/> support/stand <input type="radio"/> design limits of seal aux. pressure casing (pump) MAWP _____ psi (ga) max. allow. temp. _____ °F (8.1.4) <input checked="" type="checkbox"/> design limits of seal aux. system (Category 1/2/3) MAWP if >20/40 bar _____ psi (ga) max. allow. temp. _____ °F comment <input type="radio"/> optional components press. relief valve _____ MAWP pump casing > in suct. piping of pump _____ MAWP aux. system (9.8.3) therm. relief valves _____ (8.3.7) plan 23,52,53 ext. circul. pump _____ (8.2.24) utility manifold conn. _____ (8.3.5.4) in flush line other, specify _____ | | Barrier & Buffer Reservoirs (plan 52, 53A) <input type="radio"/> supplier/ref. code <input type="checkbox"/> dimensions standard <input checked="" type="checkbox"/> (8.3.6.2.7) alternative <input type="checkbox"/> other <input checked="" type="checkbox"/> capacity 3 U.S. gal d(shaft) ≤ 2.5 inch [8.3.6.2.5 a)] 5 U.S. gal d(shaft) > 2.5 inch other U.S. gal <input checked="" type="checkbox"/> height - seal gland/NLL _____ ft (8.3.6.2.2) <input type="checkbox"/> ASME B31.3 (8.3.6.2.8) <input type="checkbox"/> ASME code stamp | |
| Buffer & Barrier Fluid (liquid/gas) <input type="radio"/> type or name <input type="radio"/> selection: purchaser seal vendor <input type="checkbox"/> review: purchaser seal vendor <input type="checkbox"/> flow rate req'd max. gpm min. gpm <input type="checkbox"/> cooling/heating (+/-) kW <input checked="" type="checkbox"/> supply pressure (< seal ch. press. for plan 52,55,72) max. psi (ga) min. psi (ga) <input type="checkbox"/> fluid operating normal temperature max. °F min. °F <input checked="" type="checkbox"/> specific gravity at indicated temperature @ normal temp. lb/ft³ @ max. temp. lb/ft³ <input checked="" type="checkbox"/> absolute vapor pressure at ref. temperature @ normal temp. psi @ max. temp. psi <input checked="" type="checkbox"/> atmosph. boiling point °F <input type="checkbox"/> viscosity @ norm. temp. cP <input type="checkbox"/> specific heat capacity @ constant pressure for liquid @ normal temp. btu/h.ft.°F | | <input type="radio"/> special requirements special alloys hazardous service other, specify _____ <input checked="" type="checkbox"/> system hold up period _____ days plan 52,53 <input checked="" type="checkbox"/> filling system (8.1.9.5) <input checked="" type="checkbox"/> hot surfaces insulation protection <input type="radio"/> pipe taper threads (8.2.13) ASME B1.20.1 ISO 7 | | Bladder Accumulator (plan 53B) <input type="radio"/> supplier/ref. code <input checked="" type="checkbox"/> nomin. size 5 U.S. gal d(shaft) ≤ 2.5 inch 9 U.S. gal d(shaft) > 2.5 inch designed U.S. gal (Table 9) Piston Accumulator (plan 53C) <input type="radio"/> supplier/ref. code <input type="checkbox"/> pressure ratio <input checked="" type="checkbox"/> barrier liquid volume (U.S. gal) (8.3.6.4.2) min/max 0.05/0.7 d(shaft) ≤ 2.5 inch min/max 0.09/1.28 d(shaft) > 2.5 inch | |
| SITE & UTILITIES <input type="radio"/> control voltage V <input type="radio"/> frequency Hertz <input type="radio"/> phase <input type="radio"/> electrical area CL GR DIV <input type="radio"/> ambient temp. max. °F min. °F (Design) <input type="radio"/> cooling water <input checked="" type="radio"/> other cooling liquid <input type="checkbox"/> supply temperature °F <input checked="" type="checkbox"/> flow rate gpm <input type="checkbox"/> Cl ₂ content ppm <input type="checkbox"/> pressure normal design psi (ga) <input type="radio"/> ATEX group cat. EC Directive 94/9/EC T class | | Connection Lines <input type="radio"/> tubing (8.2.8, Table 6) <input type="radio"/> piping (8.2.9, Table 5) <input type="checkbox"/> schedule <input type="radio"/> size 1/2 inch d(shaft) ≤ 2.5 inch 3/4 inch d(shaft) > 2.5 inch other inch <input type="checkbox"/> heat tracing (8.2.23) Cooler (plan 21, 22, 23, 41, 53B, 53C) <input type="radio"/> supplier/ref. code <input type="radio"/> ASME B31.3 (8.3.2.1.2) <input checked="" type="checkbox"/> water cooler (8.3.2.2) <input type="checkbox"/> pipe, galvanized CS (8.2.21) <input checked="" type="checkbox"/> air cooler <input type="checkbox"/> natural air draft (8.3.2.3.1) <input checked="" type="checkbox"/> forced air draft (8.3.2.3.2) <input checked="" type="checkbox"/> w. high temp. alarm Cyclone Separator <input type="radio"/> supplier/ref. code | | External Seal Flush Systems (plan 54 and 55) <input type="radio"/> supplier/ref. code Collect. Reservoir for liquid leakage (plan 65, 75) <input type="radio"/> supplier/ref. code Barrier/Buffer Gas Supply System (plan 72, 74) <input type="radio"/> supplier/ref. code <input checked="" type="checkbox"/> press. control valves (9.9) <input checked="" type="checkbox"/> press. amplifier (9.10) | |
| INSPECTION & TESTING Test at Pump Manufacturer - Seal Specific. <input checked="" type="checkbox"/> modified seal faces <input checked="" type="checkbox"/> alternative seal Miscellaneous <input type="checkbox"/> opt. seal qual. testing (10.3.2.1.2) <input type="checkbox"/> hardness test, for <input type="checkbox"/> purchaser participation <input type="checkbox"/> inspector's checklist (Annex H) | | Welded Designs <input type="radio"/> purchaser approval for welded connections (6.1.6.10.5) <input type="radio"/> 100% inspection of all welds, method: <input type="checkbox"/> magnetic particle <input type="checkbox"/> liquid penetrant <input type="checkbox"/> radiographic <input type="checkbox"/> ultrasonic | | INSTRUMENTATION (see also Annex G) <input type="radio"/> design temp. > 212 °F °F (9.1.7) <input type="radio"/> IEC 604529.dsgn. IP65 <input type="radio"/> NEMA 250, encl. Type 4 (9.1.2) Units (press., temp., level, flow) Temp.-Indicator f. p. plan <input type="radio"/> bi-metallic <input type="radio"/> liquid filled (9.2.1) option for piping plan 32, 53B, 53C Pressure-Instruments <input type="radio"/> gauges for piping plan <input type="checkbox"/> oil filled gauges (9.4.3) <input type="radio"/> transmitter for p. plan <input type="checkbox"/> switches for p. plan <input type="radio"/> set press. min. psi (ga) max. psi (ga) Level-Instruments (plan 52, 53A, 75) <input type="radio"/> rfl. indicator weld pad (9.6.1) <input type="checkbox"/> removable (9.6.2) <input type="radio"/> transmitter hydrostatic (9.5.3) <input type="checkbox"/> capac. ultrasonic <input type="checkbox"/> switches (9.5.1.8) <input type="radio"/> set points high low Flow-Instruments <input type="radio"/> flow indicator f. p. plan e.g. in cooling water outlet line (8.2.22) or plan 32 <input type="radio"/> flow meter for p. plan <input type="radio"/> transmitter for p. plan <input type="checkbox"/> switches for p. plan | |
| NOTES <input type="radio"/> purchaser <input type="checkbox"/> seal vendor | | | | | |

Baytown Area Facilities - Local Design Requirements

GP 99-01-03D

Scope

0-1

This document provides standards and information that is specifically relevant to new or modified facility design at the Baytown Refinery (BTRF), Baytown Chemicals Plant (BTCP), Baytown Olefins Plant (BOP), and Mont Belvieu Polypropylene Plant (MBPP). Alongside other internal standards, it is considered for inclusion during the Standards Application Strategy and Design Philosophy development for projects following EMCAPS (see EMCAPS 7.2 and 7.8).

0-2

Everything contained in this standard meets the following criteria:

- Eligibility Test: (Must answer YES to all)
 - Must relate to facilities design
 - Must be specific
 - Must be incremental to global standards
 - Not subject to frequent update (frequent = at least annually)
- Justification Test: (Must answer YES to at least one)
 - Utility/Meteorological/Geotechnical Information Needed for Design
 - Local regulation/code references or links
 - Local visual cue standards that impact safety (e.g. wiring color schemes, PSV/Car Seal Paint Colors)
 - Emergency response design considerations
 - Mitigates a Category 1 or 2 SHE Risk or Category 1 Financial/Business Risk that is specific to the site
 - Returns a 6:1 B/C or 200% DCF for Operability/Maintainability Items

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0-3

All Site Standards Purpose Codes share common definitions with the Global Practices Purpose Codes.

0-4

Site drawing standards are detailed in the local Coordination Procedure.

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1. References

1.1. Required References

1.1-1

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.2. Additional References

1.2-1

[*] This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.3. Frequently Referenced Local Regulations

1.3-1

33 Code of Federal Regulations Part 154 – Facilities Transferring Oil or Hazardous Material in Bulk

1.3-2

Code of Ordinances, Baytown, Texas; Chapter 34 "Environment," Article VII "Noise," Division 1 "Generally"

1.3-3

Texas Administration Code – Texas Commission on Environmental Quality Requirements in 30 TAC 290.44 and 30 TAC 290.47(f) and TAC Chapters 55, 60, and 65.

1.3-4

Texas Boiler Safety Law (Texas Health and Safety Code, Chapter 755); Texas Department of Licensing and Regulation (TDLR) Enabling Law (Texas Occupations Code, Chapter 51)

1.3-5

Texas Engineering and Land Surveying Practice Acts and Rules Concerning Practice and Licensure

1.3-6

Texas Administrative Code Title 25, Section 289 (25 TAC 289): Radiation Control

2. Acronyms and Definitions

3. Existing Facility Information

3.1. Baytown Primary Utility Systems Conditions

3.1.1. Baytown Dock Facilities

3.1.1-1

[S] Design pressure of all dock piping shall be limited to 220 psig.

3.1.2. BTRF Primary Utility Systems Conditions

3.1.2-1

[O] [R] Steam system shall be assumed to operate at the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | | Temperature, °F | |
|--------|----------------|------------|-----------------|------------|
| | Consumption | Production | Consumption | Production |
| 600# | 615 | 630 | 600 | 725 |
| 150# | 145 | 155 | 400 | 450 |
| 20# | 20 | 25 | 260 | 260 |

3.1.2-2

[S] Design conditions of all steam system equipment shall be:

| System | Pressure, psig | Temperature, °F |
|--------|----------------|-----------------|
| 600# | 700 | 750 |
| 150# | 185 | 450 |
| 20# | 50 | 450 |

3.1.2-3

[O] [R] Steam condensate system shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|-------------------|----------------|-----------------|
| 600# Condensate | 615 | 495 |
| 150# Condensate | 145 | 400 |
| 20# Condensate | 20 | 260 |
| Condensate Return | 125 | 200 |

3.1.2-4

[S] Design conditions of all steam condensate equipment shall be:

| System | Pressure, psig | Temperature, °F |
|--------|----------------|-----------------|
| 600# | 700 | 750 |
| 150# | 185 | 450 |
| 20# | 50 | 450 |

| | | |
|-------------------|-----|-----|
| Condensate Return | 175 | 450 |
|-------------------|-----|-----|

3.1.2-5

[O] [R] Water systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|--------------------------------------|----------------|-----------------|
| Industrial (Utility) | 50 | Ambient |
| Domestic (Potable) | 50 | Ambient |
| Firewater | 110 | Ambient |
| Cooling Water Supply | 65 | 87 |
| Cooling Water Return | 35 | 130 |
| 600# High Pressure Boiler Feed Water | 1000 | 260 |
| Demineralized | 160 | Ambient |

3.1.2-6

[S] Design conditions of all water system equipment shall be:

| System | Pressure, psig | Temperature, °F |
|--------------------------------------|----------------|-----------------|
| Industrial (Utility) | 150 | 150 |
| Domestic (Potable) | 125 | 100 |
| Firewater (Above-ground) | 170 | 140 |
| Firewater (Underground) | 170 | 100 |
| Cooling Water Supply | 150 | 150 |
| Cooling Water Return | 150 | 150 |
| 600# High Pressure Boiler Feed Water | 1250 | 350 |
| Demineralized | 250 | 150 |

3.1.2-7

[O] [R] Fuel Systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|-------------------------|----------------|-----------------|
| Fuel Gas (Blend Gas) | 55 | 90 |
| Natural Gas / Pilot Gas | 200 | 90 |
| LBG (Low BTU Gas) | 15 | 100 |

3.1.2-8

[S] Design conditions of all Fuel Systems equipment shall be:

| System | Pressure, psig | Temperature, °F |
|-------------------------|----------------|-----------------|
| Fuel Gas (Blend Gas) | 150 | 180 |
| Natural Gas / Pilot Gas | 250 | 150 |
| LBG (Low BTU Gas) | 29 | 150 |

3.1.2-9

[O] [R] Nitrogen, air, and oil mist systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|-------------------------------------|----------------|-----------------|
| Industrial (Utility/Plant/Yard) Air | 90 | 90 |
| Instrument Air | 80 | 90 |
| Nitrogen | 200 | Ambient |
| Oil Mist | 0.50 | Ambient |

3.1.2-10

[S] Design conditions of nitrogen, air, and oil mist systems equipment shall be:

| System | Pressure, psig | Temperature, °F |
|-------------------------------------|----------------|-----------------|
| Industrial (Utility/Plant/Yard) Air | 150 | 150 |
| Instrument Air | 150 | 150 |
| Nitrogen | 275 | 140 |
| Oil Mist | 150 | 150 |

3.1.2-11

[R] Control valve actuators shall be sized based on the following air system nominal pressures listed for the sites:

| System | Pressure, psig |
|--|----------------|
| BTRF (exc. DCU) control valve actuator air | 40 |
| DCU control valve actuator air | 60 |

3.1.3. BTCP Primary Utility Systems Conditions

3.1.3-1

[O] [R] Steam system shall be assumed to operate at the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | | Temperature, °F | |
|---------|----------------|------------|-----------------|------------|
| | Consumption | Production | Consumption | Production |
| 600# | 600 | 635 | 675 | 700 |
| 150# | 145 | 155 | 365 | 450 |
| PAU 50# | 43 | 50 | 281 | 281 |
| 20# | 20 | 25 | 260 | 260 |
| PAU 12# | 9 | 14 | 240 | 250 |

3.1.3-2

[S] Design conditions of all steam system equipment shall be:

| System | Pressure, psig | Temperature, °F |
|---------|----------------|-----------------|
| 600# | 700 | 750 |
| 150# | 170 | 500 |
| PAU 50# | 150 | 450 |
| 20# | 150 | 450 |
| PAU 12# | 150 | 350 |

3.1.3-3

[O] [R] Steam condensate system shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|-------------------|----------------|-----------------|
| Condensate Return | 75 | 260 |

3.1.3-4

[S] Design conditions of all steam condensate equipment shall be:

| | | |
|-------------------------|-----|-----|
| Steam Condensate Return | 165 | 450 |
|-------------------------|-----|-----|

3.1.3-5

[O] [R] Water systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|-----------------------------|----------------|-----------------|
| Industrial (Utility) | 40-60 | Ambient |
| Domestic (Potable) | 50 | Ambient |
| Firewater | 110 | Ambient |
| Cooling Water Supply, CT-18 | 70 | 90 |
| Cooling Water Supply, CT-70 | 60 | 90 |
| Cooling Water Supply, CT-17 | 60 | 90 |
| Cooling Water Return, CT-18 | 20 | 107 |
| Cooling Water Return, CT-70 | 20 | 112 |
| Cooling Water Return, CT-17 | 20 | 110 |
| Demineralized | 150 | Ambient |

3.1.3-6

[S] Design conditions of all water system equipment shall be:

| System | Pressure, psig | Temperature, °F |
|-----------------------------|----------------|-----------------|
| Industrial (Utility) | 150 | 150 |
| Domestic (Potable) | 125 | 100 |
| Firewater (Above-ground) | 170 | 140 |
| Firewater (Underground) | 170 | 100 |
| Cooling Water Supply, CT-18 | 125 | 130 |
| Cooling Water Supply, CT-70 | 125 | 130 |
| Cooling Water Supply, CT-17 | 125 | 130 |
| Cooling Water Return, CT-18 | 125 | 150 |
| Cooling Water Return, CT-70 | 125 | 150 |
| Cooling Water Return, CT-17 | 125 | 150 |
| Demineralized | 250 | 150 |

3.1.3-7

[O] [R] Fuel Systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|--------|----------------|-----------------|
|--------|----------------|-----------------|

| | | |
|-------------------------|-----|---------|
| Fuel Gas (Blend Gas) | 55 | 90 |
| Natural Gas / Pilot Gas | 200 | 90 |
| Natural Gas – 380# | 380 | Ambient |

3.1.3-8

[S] Design conditions of all Fuel Systems equipment shall be:

| System | Pressure, psig | Temperature, °F |
|----------------------|----------------|-----------------|
| Fuel Gas (Blend Gas) | 150 | 180 |
| Natural Gas | 275 | 140 |
| Natural Gas – 380# | 430 | 150 |

3.1.3-9

[O] [R] Nitrogen and air systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|-------------------------------------|----------------|-----------------|
| Industrial (Utility/Plant/Yard) Air | 89 | 90 |
| Instrument Air | 89 | 90 |
| Nitrogen | 140 | Ambient |

3.1.3-10

[S] Design conditions of nitrogen and air systems equipment shall be:

| System | Pressure, psig | Temperature, °F |
|-------------------------------------|----------------|-----------------|
| Industrial (Utility/Plant/Yard) Air | 150 | 150 |
| Instrument Air | 150 | 150 |
| Nitrogen | 275 | 140 |

3.1.3-11

[R] Control valve actuators shall be sized based on the following air system nominal pressures listed for the sites:

| System | Pressure, psig |
|---|----------------|
| BTCP (exc. BAPP) control valve actuator air | 60 |
| BAPP control valve actuator air | 40 |

3.1.4. BOP Primary Utility Systems Conditions

3.1.4-1

[O] [R] Steam system shall be assumed to operate at the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|--------|----------------|-----------------|
| 1500# | 1500 | 925 |
| 660# | 660 | 730 |
| 225# | 225 | 530 |
| 50# | 50 | 400 |

3.1.4-2

[S] Design conditions of all steam system equipment shall be:

| System | Pressure, psig | Temperature, °F |
|--------|----------------|-----------------|
| 1500# | 1615 | 940 |
| 660# | 730 | 800 |
| 225# | 275 | 650 |
| 50# | 75 | 550 |

3.1.4-3

[O] [R] Steam condensate system shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|-------------------------------|----------------|-----------------|
| 50# Condensate | 50 | 298 |
| Atmospheric Condensate Return | 15 | 125 |
| Suspect Condensate Return | 18 | 255 |

3.1.4-4

[S] Design conditions of all steam condensate equipment shall be:

| System | Pressure, psig | Temperature, °F |
|-------------------------------|----------------|-----------------|
| 50# Condensate | 75 | 550 |
| Atmospheric Condensate Return | 90 | 350 |
| Suspect Condensate Return | 27 | 300 |

3.1.4-5

[O] [R] Water systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|---------------------------------|----------------|-----------------|
| Industrial | 130 | Ambient |
| Domestic | 40 | Ambient |
| Firewater | 125 | Ambient |
| Cooling Water Supply | 85 | 90 |
| Cooling Water Return | 30 | 130 |
| High Pressure Boiler Feed Water | 2000 | 270 |
| Low Pressure Boiler Feed Water | 280 | 270 |
| Demineralized | 160 | Ambient |

3.1.4-6

[S] Design conditions of all water system equipment shall be:

| System | Pressure, psig | Temperature, °F |
|---------------------------------|----------------|-----------------|
| Industrial | 170 | 150 |
| Domestic | 125 | 150 |
| Firewater (Above-ground) | 150 | 150 |
| Firewater (Underground) | 150 | 100 |
| Cooling Water Supply | 150 | 150 |
| Cooling Water Return | 150 | 150 |
| High Pressure Boiler Feed Water | 3038 | 400 |
| Low Pressure Boiler Feed Water | 420 | 400 |
| Demineralized | 190 | 140 |

3.1.4-7

[O] [R] Fuel Systems and other hydrocarbon systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|----------------------------|----------------|-----------------|
| SC Tar | 310 | 355 |
| Low Sulfur Fuel Oil (LSFO) | 390 | 190 |

| | | |
|-----------------------------------|-----|---------|
| Natural Gas | 350 | Ambient |
| WLD Header to ZD-02 Blowdown Drum | 5 | Ambient |

3.1.4-8

[S] Design conditions of all Fuel Systems other hydrocarbon systems equipment shall be:

| System | Pressure, psig | Temperature, °F |
|-----------------------------------|----------------|-----------------|
| SC Tar | 420 | 385 |
| Low Sulfur Fuel Oil (LSFO) | 430 | 350 |
| Natural Gas | 500 | 150 |
| WLD Header to ZD-02 Blowdown Drum | 625 | 188 |

3.1.4-9

[O] [R] Nitrogen and Air Systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|----------------|----------------|-----------------|
| Instrument Air | 110 | Ambient |
| Utility Air | 120 | Ambient |
| Nitrogen | 157 | Ambient |

3.1.4-10

[S] Design conditions of all Nitrogen and Air Systems equipment shall be:

| System | Pressure, psig | Temperature, °F |
|----------------|----------------|-----------------|
| Instrument Air | 150 | 150 |
| Utility Air | 150 | 150 |
| Nitrogen | 250 | 140 |

3.1.4-11

[R] Control valve actuators shall be sized based on the following air system nominal pressure:

| System | Pressure, psig |
|--------------------------------|----------------|
| BOP control valve actuator air | 60 |

3.1.5. Mont Belvieu Primary Utility Systems Conditions**3.1.5-1**

[O] [R] Steam system shall be assumed to operate at the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|------------|----------------|-----------------|
| 50# Steam | 50 | 298 |
| 75# Steam | 75 | 320 |
| 250# Steam | 250 | 407 |
| 500# Steam | 535 | 476 |

3.1.5-2

[S] Design conditions of all steam system equipment shall be:

| System | Pressure, psig | Temperature, °F |
|------------|----------------|-----------------|
| 50# Steam | 85 | 328 |
| 75# Steam | 100 | 338 |
| 250# Steam | 300 | 422 |
| 500# Steam | 619 | 493 |

3.1.5-3

[O] [R] Steam condensate system shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|---------------|----------------|-----------------|
| Condensate LP | 20 | 260 |
| Condensate HP | 75 | 320 |

3.1.5-4

[S] Design conditions of all steam condensate equipment shall be:

| System | Pressure, psig | Temperature, °F |
|---------------|----------------|-----------------|
| Condensate LP | 75 | 320 |
| Condensate HP | 125 | 355 |

3.1.5-5

[O] [R] Water systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|---------------|----------------|-----------------|
| Firewater | 125 | Ambient |
| Cooling Water | 60 | 90 |

| | | |
|---------------|----|---------|
| Potable Water | 90 | Ambient |
|---------------|----|---------|

3.1.5-6

[S] Design conditions of all water system equipment shall be:

| System | Pressure, psig | Temperature, °F |
|---------------|----------------|-----------------|
| Firewater | 218 | 150 |
| Cooling Water | 80 | 150 |
| Potable Water | 113 | 150 |

3.1.5-7

[O] [R] Fuel Systems and other hydrocarbon systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|-------------------------|----------------|-----------------|
| Natural Gas South Plant | 125 | 90 |
| Natural Gas North Plant | 70 | 90 |

3.1.5-8

[S] Design conditions of all Fuel Systems other hydrocarbon systems equipment shall be:

| System | Pressure, psig | Temperature, °F |
|-------------------------|----------------|-----------------|
| Natural Gas South Plant | 150 | 150 |
| Natural Gas North Plant | 100 | 150 |

3.1.5-9

[O] [R] Nitrogen and Air Systems shall be assumed to have the following conditions at the consumer utilization point, at grade, and upstream of any throttling valve:

| System | Pressure, psig | Temperature, °F |
|-------------------|----------------|-----------------|
| Air – North Plant | 80 | Ambient |
| Air – South Plant | 60 | Ambient |
| Nitrogen | 100 | Ambient |

3.1.5-10

[S] Design conditions of all Nitrogen and Air Systems equipment shall be:

| System | Pressure, psig | Temperature, °F |
|----------|----------------|-----------------|
| Air | 165 | 150 |
| Nitrogen | 138 | 150 |

3.2. Meteorological Data

3.2-1

[S][O][R] All design calculations shall assume the following meteorological information:

| | |
|--|--|
| Dry Bulb, Maximum Design, °F | 95 |
| Wet Bulb, Maximum Design, °F | 81 |
| Machinery, Maximum Design, °F | 96 |
| Machinery, Minimum Design, °F | 32 |
| Average Winter Dry Bulb, °F | 32 |
| Impact Testing, CET, °F, new equipment | 10 |
| CET, °F, historical (for assessing MDMT/MSOT existing equipment) | 32 |
| Recorded Temperatures, Dry Bulb, °F | |
| Maximum Extreme, °F | 108 |
| 1 Percent | 96 |
| 2-1/2 Percent | 94 |
| 5 percent | 92 |
| 97-1/2 Percent | 33 |
| 99 Percent | 29 |
| Minimum Extreme, °F | 5 |
| Winterizing Area Classification | Zone C (Instrumentation) Zone B (All Other Equipment) |
| Frost Depth | 0 |

| | | | | | | | | |
|----------------------|----|----|----|----|----|----|---|----|
| Wind | | | | | | | | |
| Mean wind speed, mph | | | | | | 10 | | |
| Direction From: | N | NE | E | SE | S | SW | W | NW |
| % of time: | 11 | 5 | 12 | 13 | 41 | 7 | 6 | 6 |

3.2-2

[S] [O] [R] Civil/structural design calculations shall assume the following meteorological data:

| Wind loads calculated based on ASCE 7-16 | |
|--|--------------------|
| Basic Wind Speed at 33 feet above ground (V) for Risk Category III and IV, mph | 150 |
| Basic Wind Speed at 33 feet above ground (V) for Risk Category II, mph | 140 |
| Wind loads calculated based on ASCE 7-05 | |
| Basic Wind Speed at 33 feet above ground (V), mph | 115 (BTCX & BOP) |
| | 110 (Mont Belvieu) |
| Importance Factor for Wind Load Calculations (Occupancy Category III) | 1.15 |
| Importance Factor for Wind Load Calculations (Occupancy Category II) | 1.00 |
| Other wind load design criteria | |
| Exposure Category | C |
| 'K _d ' Directionality Factor | Per ASCE 7 |
| Seismic Design per ASCE 7-16 | |
| Short period (0.2 s) spectral response, S _s | 6.9%g (0.069g) |
| 1.0 sec spectral response, S ₁ | 4.0%g (0.040g) |
| Importance Factor, I | 1.25 |
| Site (soil) Class | D |
| Seismic Design per ASCE 7-05 | |
| Short period (0.2 s) spectral response, S _s | 8.9%g (0.089g) |
| 1.0 sec spectral response, S ₁ | 3.7%g (0.037g) |
| Importance Factor, I | 1.25 |
| Site (soil) Class | D |
| Ground Snow Load and Ice Load per ASCE 7 | |
| Snow load, psf | 0 |
| Frost depth, ft. | 0 |
| Ice thickness, in. (5 F concurrent temp., 40 mph 3-sec gust wind speed) | 0 |
| Precipitation | |

| | |
|--|-------|
| Storm Water Design Loading Inches/Hour (10 year storm, 60 min. duration) | 3.44 |
| Maximum Precipitation, Inches/24 Hours (10 year storm, 24 hour duration) | 9.24 |
| Maximum Precipitation, Inches/24 Hours (25 year storm, 24 hour duration) | 12.3 |
| Average Annual Precipitation, Inches/Year | 64.73 |
| Precipitation Frequency (1 mm or more) Days/Year | 104 |

3.3. Electrical System Information

3.3-1

[C] [M] [O] For BTRF and BTCP, preferred system voltages are:

| | Requirements |
|---------------|---|
| <i>Motors</i> | |
| < 1 HP | 120V or 240V, single phase |
| 1 - 150 HP | 480V |
| > 150 HP | 2400V/4160V (radial/spot), 4160V (sec. selective) |

| <i>Other Loads</i> | Voltage | Phase |
|--------------------|------------|-------|
| Welding Outlets | 480 | 3 |
| Lights | 120 or 240 | 1 |
| Instruments | 120 | 1 |

| <i>Load</i> | Minimum Power | Primary/Secondary voltage ratings |
|---------------------------------------|---------------|--|
| Medium-voltage substation transformer | 5000 kVA | 13,800/4160 OR 13,800/2400 Delta-Y resistance grounds |
| Low-voltage substation transformers | 1000 kVA | - |

3.3-2

[C] [M] [O] For BOP and MBPP, preferred system voltages are:

| | Voltage | Phase |
|-------------------------------|---------|-------|
| Drivers | | |
| 1 HP and smaller | 120/240 | 1 |
| 0.25 HP – 200 HP | 480 | 3 |
| 150 HP – 7500 HP | 4160 | 3 |
| 4000 HP – 12000 HP and larger | 13800 | 3 |

| <i>Other Loads</i> | Voltage | |
|--------------------------------|---------|---|
| Welding Outlets | 480 | 3 |
| Unit Floodlights/Street Lights | 480 | 1 |
| Instruments | 120 | 1 |

| <i>Other Loads</i> | Minimum Power |
|-------------------------------------|---------------|
| Low-voltage substation transformers | 1000 kVA |

4. Piping Design

4.1. Piping Paint Color Schemes

4.1-1

[S] The following equipment color code for piping shall be maintained:

Table 1: Color Coding and Decals for Piping

| SERVICE | BTRF, BTCP & MBPP | | BOP COLORS |
|----------------------------|-------------------------|------------------------------------|---------------|
| | COLORS & IDENTIFICATION | | PIPE |
| | PIPE | DECALS | |
| Industrial (Utility) Air | Safety Green | White Letters on Green Background | Dark Green |
| Industrial (Utility) Water | Safety Blue | White Letters on Blue Background | Dark Blue |
| Nitrogen | Safety Yellow | Black Letters on Yellow Background | Safety Orange |
| Steam | Black | White Letters on Black Background | Red |

| | | | |
|-----------------------------|--------|--|------|
| H2S-Bearing (Acid Gas) | -- | Black Lettering on Safety Yellow Background on Safety Orange Jacketing | Pink |
| Oxygen (> 35% O2 by volume) | Yellow | -- | -- |
| Potable Water | Blue | White on Blue | -- |

5. Civil Design

5.1. Sewer Design

5.1-1

[S] [E] Sewer seals shall be at manhole inlets, consistent with existing plant/unit sealing methods.

6. Heat Exchangers

6.1. Heat Exchanger Design

6.1-1

[C] Shell and tube heat exchanger dimensions and weights shall be limited to maximum bundle weight of 50 short tons (100,000 lbs).

7. Electrical

7.1. Equipment Design

7.1-1

[S] All field instrument wiring terminating at the BOP Control Center requires current limiting barriers at termination rack for each loop.

7.1-2

[C] [R] For new substations at BTRF and BTCP, remote terminal units (RTU's) shall provide monitoring and control capabilities from the Utilities Control Center (UCC).

7.1-3

[S] Grounding of medium-voltage and low-voltage substation transformers shall be low-resistance and high-resistance, respectively.

7.1-4

[R] Remote trip and close via the RTU shall use auxiliary relays protected with a 3 amp fuse.

7.1-5

[M] Flooded cell lead acid batteries shall be used.

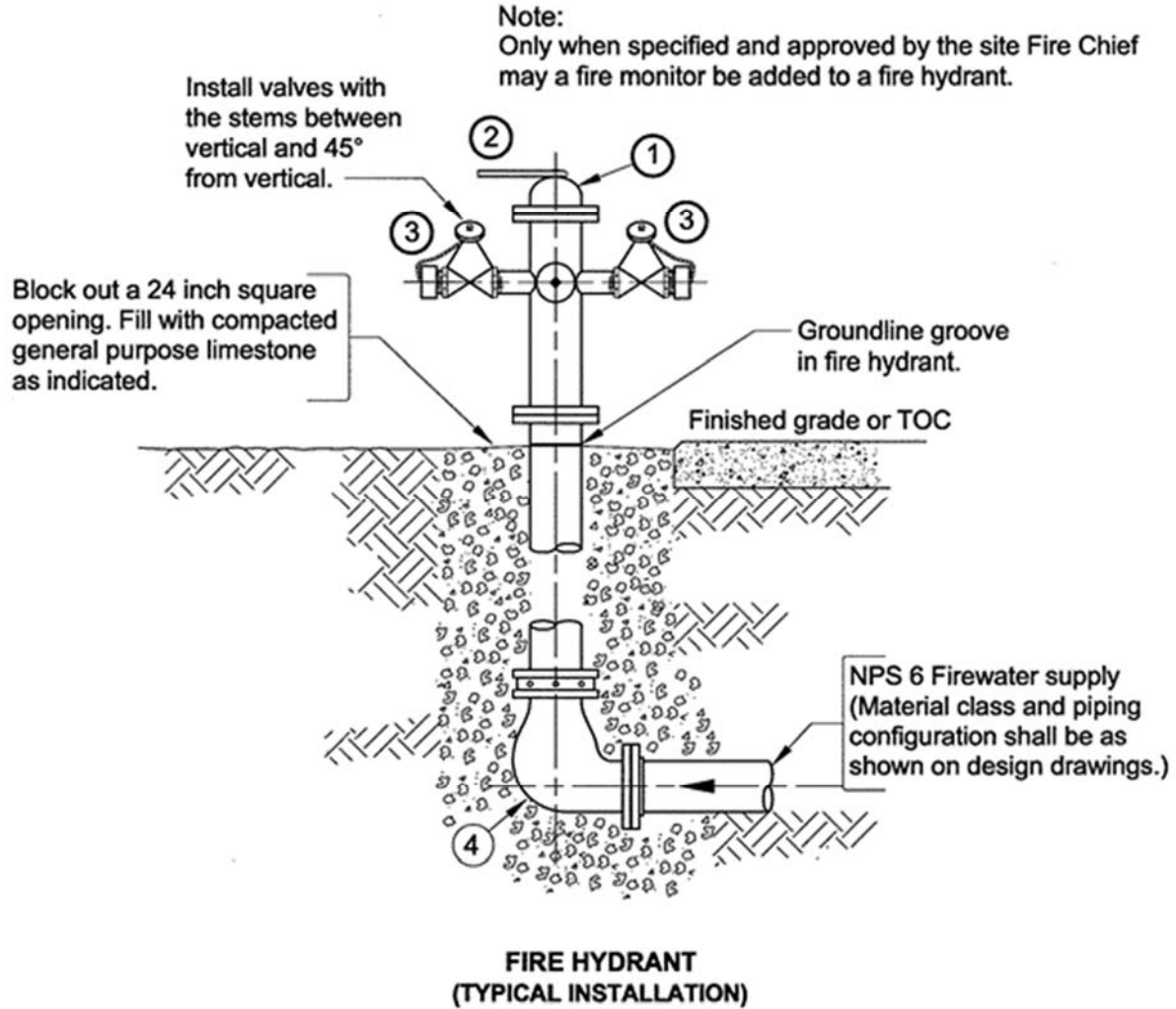
8. Safety Facilities

8.1. Safety Critical Equipment

8.1-1

[S] If specifying Fire Water systems at BTRF and BTCP, then all hydrants shall be configured per Figure 1, including corresponding Bill of Materials.

Figure 1: BTRF & BTCP Fire Hydrant Configuration



| Item | Description |
|------|-------------|
|------|-------------|

| | |
|---|--|
| ① | <p>Hydrant, Fire; 6-inch valve opening; 200 psi CWP; cast iron upper barrel, ductile iron lower barrel; rubber main valve; cast iron lower valve plate; solid flange 3-1/2 inches above ground line groove; NPS 6, Class 125, flanged, cast iron base, inlet; 1 inch bronze, square operating nut; open left; two 2-1/2 inch bronze hose nozzles with NYCFD male threads; one 4-1/2 inch, bronze, "Steamer", pumper nozzle, threaded National Standard with cast iron cap and steel chain tying cap to barrel; all nozzles with Amlock® connections into body of hydrant; specify 2-1/2 inch outlet nozzles to be with or without cap and chain; corrosion resistant nuts and bolts; seat and barrel tested at 400 psi; AWWA C502, UL 246, and FM 1510; American Flow Control hydrant, American-Darling Model 6"-B84B-BB or an equal approved by Owner's Site Fire Chief.</p> <p>Material Number 93001682X.</p> |
| ② | <p>Wrench, Operating; wrench for 1-inch square nut.</p> |
| ③ | <p>Gate Valve; NPS 2-1/2", Class 300, threaded ends; FNPT x MNYFD, with cap and chain; finished cast brass body; non-rising stem; solid wedge; tapered seats; red, iron handwheel; polished chrome trim; FM approved and UL listed; for use with fire hydrants and monitors; metal tagged with BTRF valve code <u>BTV910</u>; Badger-Powhatan P/N 19-281-00007. MMN 99018117X</p> |
| ④ | <p>Base Elbow; NPS 6; Class 125, flanged; cast iron, furnished with item 1.</p> |

8.1-2

[S] If specifying Fire Water systems at BOP, then fire water manifolds shall be used instead of hydrants.

8.1-3

[S] The following color code shall be maintained:

Table 2: Color Coding and Decals for Safety and Fire Protection

| EQUIPMENT / ITEM | BTRF, BTCP & MBPP COLOR ID | BOP COLOR ID |
|---|---|---|
| Fire Hydrants, Fire Monitors, Fire Hose Reels, Aboveground Fire Water Piping (including exposed portions of underground valves but excluding sprinkler system piping beyond the deluge valve), Deluge Manifolds and Background where Fire Extinguishers are mounted | Safety Red | Safety Red |
| Mobile Fire-Fighting Equipment | Safety Red | Safety Red |
| Scott Air Paks and Background where mounted | Safety Yellow | Safety Yellow |
| First Aid and Safety Equipment Cabinets, Safety Equipment Centers | Green Markings on White Background | Green |
| CSO Valves Upstream of Safety Shower Eye/Face Wash Stations and System Block Valves at Battery Limits | Red | N/A |
| Foam Equipment and Piping – Tanks | Red | Red |
| Foam Equipment and Piping – Dock Area | Yellow | Red |
| Sewer Vents (above ground portions) | Safety Yellow | Safety Yellow |
| Safety Relief Valves and the CSO Isolation Valves Associated with Safety Relief Systems (i.e. those valves located in pressure relieving paths and sensing lines to rated relief valves.) | Safety Red | Safety Yellow |
| Safety Critical Car Seal Valves | Safety Red | Safety Yellow |
| Uninterruptible Steam Tracing (UST) Isolation Valves | Safety Red | N/A |
| Operational Car Seal Open Valves (OCSO) and Operational Car Seal Closed Valves (OCSC) | Blue | Magenta Purple |
| Bonnets and Vents of Bellows Safety Relief Valves | Safety Yellow | Safety Red |
| Environmental Car Seal Open Valves (ECSO) and Environmental Car Seal Closed Valves (ECSC) | Green | Black |
| Battery Limit Block Valves (BLBV) | Green - KRYLON #2012, Clover/Safety Green | Green - KRYLON #2012, Clover/Safety Green |
| Process Sewer Covers | N/A | Red |
| Contaminated Sewer Covers | N/A | Yellow |

| | | |
|---|---------------|--------------------------------------|
| Goose Creek/Rain Water Covers | N/A | Blue |
| Vacuum Breakers, Pressure Vents | Red | White |
| Manhole Covers, Hatches and Emergency Vents | N/A | White |
| Flare Stacks | N/A | International Orange and White Bands |
| Fixed Ladders | Safety Yellow | Safety Yellow |

Record of Change

9-1

| Version 1.0 | | |
|-------------|--------|------------------|
| Location | Action | Description |
| | | Initial Publish. |

Purpose Code Definitions

10-1

| Code | Description |
|---|---|
| * | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |
| A | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| C | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| CS | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| E | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| I | Obsolete as per 2019 CIG - Assigned to paragraphs that provide only clarifying information, such as Scope statements, definitions of terms, etc. |
| M | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| O | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| R | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| S | Assigned to paragraphs that contain design, fabrication and construction requirements that, if not met, can directly result in or significantly increase the risks of either: <ol style="list-style-type: none"> 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). Safety designation shall not be applied to paragraphs with Risk Matrix Category 4 when the incident probability and risk can be determined by the appropriate SME. |
| Purpose Code Hierarchy: Purpose Codes assigned to a numbered item apply to all associated subitems. Purpose codes assigned to an individual subitem apply only to that subitem. | |

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SHAFT-SEALING SYSTEMS FOR CENTRIFUGAL AND ROTARY PUMPS

THIS DOCUMENT IS UNCONTROLLED WHEN REPRODUCED

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REVISION LOG

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| A | - | IFR-ISSUED FOR REVIEW |
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HOLD STATUS

This revision has the following HOLDS:

| SECTION | PARAGRAPH NO. | DESCRIPTION OF HOLD |
|---------|---------------|---------------------|
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1. INTRODUCTION

1.1 Project Overview

"ExxonMobil Corporation ("COMPANY") has awarded a CONTRACT to Technip Energies India ("CONTRACTOR") for performing the FEED and EP work for reconfiguring COMPANY's BAYTOWN refinery to produce a more resilient product slate, while enabling future GHG emission reductions.

The project includes scope in three major areas of the refinery: the Hydrocracking Unit (HCU-1), the Raffinate Hydro-Conversion Unit (RHC) and Offsites and Utilities.

The project will convert the HCU-1 to a lubes hydrocracker, using light Virgin Gas Oil (VGO) streams as charge to be cracked into diesel and additional feed from HCU-1 will be supplied to the RHC to produce the light-neutral grades".

2. REFERENCES

2.1 Required References

[*] This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced Specifications may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

2.1.1 References

| Reference | Reference Title |
|-------------------------|---|
| JIP33 (IOGP S-615) | Supplementary Specification to API Standard 610 for Centrifugal Pumps |
| USBT-000-TE-MR-TCN-0001 | Technical Notes for Centrifugal Pumps |
| GP 03-12-01D | Valve Selection |
| GP 18-07-01D | Welding Procedures |
| GP 18-10-01D | Additional Requirements for Materials |

2.1.2 Industry Standards

| Industry Standard Number | Industry Standard Title |
|--------------------------|--|
| API STD 682-4 | Pumps - Shaft Sealing Systems for Centrifugal and Rotary Pumps, Fourth Edition |
| ASME B16.11 | Forged Fittings, Socket-Welding and Threaded |
| ASME B31.3 | Process Piping |

| Industry Standard Number | Industry Standard Title |
|--------------------------|---|
| NACE MR0103/ISO 17945 | Petroleum, Petrochemical, and Natural Gas Industries - Metallic Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments |

2.2 Acronyms and Definitions

2.2.1 Acronyms

| Acronym | Description |
|------------|--|
| CET | Critical Exposure Temperature |
| EEE HLA | Emissions, Equipment, Exposure High Level Alarm |
| HLL (HIL) | High Liquid (Interface) Level, which corresponds to the LAH (High Level Alarm) |
| IH | Industrial Hygiene |
| LLA | Low Level Alarm |
| LLL (LIL) | Low Liquid (Interface) Level, which corresponds to the LAL (Low Level Alarm) |
| MAWP | Maximum Allowable Working Pressure |
| NLL (NIL) | Normal Liquid (Interface) Level |
| NPT | National Pipe Thread |
| PWHT | Post Weld Heat Treatment |

2.3 REQUIREMENT DESIGNATION

Certain paragraph/s are preceded by bracketed uppercase letter. Below is the meaning of each designation.

| Acronym | Definition |
|---------|--|
| [S] | 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). |
| [O] | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform |

| | |
|------|--|
| | satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| [A] | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| [E] | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| [R] | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| [M] | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| [C] | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| [CS] | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| [*] | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |

3. REVISIONS TO API STANDARD 682-4TH EDITION

- 3-1** API STD 682-4 (API Standard) shall be used as modified by this Specification, unless superseded by more stringent local regulations. This Specification is intended to supplement the API Standard and not replace it. All headings and paragraph or clause numbers contained herein correspond to those in the API standard. Sections not modified shall be followed as written in the API Standard.
- 3-2** Specific definitions of the terms "new," "addition," "substitution," and "deletion" are shown directly below:
- i. "New"—New clause that does not currently appear in the API standard. Text in this specification is accompanied by a clause number not currently existing in the API standard.
 - ii. "Addition"—Text added to a clause already in the API standard, but not overwriting any of the text currently in the API standard. Text in this specification does not modify or overwrite the API standard text in any way. The reader shall read and follow both the API standard text and this specification clause text.
 - iii. "Substitution"—Text wholly replaces the text currently in the API standard. Text in this specification is wholly taking the place of the API standard text. The reader shall ignore the API standard text and only follow the clause text of this specification.
 - iv. "Modification" – Specific revisions have been made to the text currently in the API standard.

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- v. "Deletion"—Wholly deletes the text currently in the API standard. Text in this specification is stating that the API standard text shall not be followed.
- vi. "Decision" – Text in this specification makes a decision that was required.

MODIFICATIONS TO SECTION 1: SCOPE

1.a. Addition: Scope

- a. **[R]** For seals and sealing systems rated over 34.5 barg (500 psig), sealing liquids above 260 °C (500 °F) or below 0 °C (32 °F) or with a balance diameter ≥ 100 mm (4.0 in.), and all dual seals, regardless of service, Vendor proposals shall include an experience list demonstrating experience for the proposed seal and sealing system.
- b. **[R]** Vendor shall have manufactured at the proposed point of manufacture at least two seals and sealing systems of comparable: tangential speed, pressure, temperature, and fluid properties; and operating satisfactorily for at least 1 year.

1.b. Addition: Scope

[R] If qualification requirements prevent application of the latest technology, Vendor may submit an alternative proposal, specifically identifying the undemonstrated features and stating the advantages.

MODIFICATIONS TO SECTION 4: SEALING SYSTEMS

4.1.2. Addition: Seal Categories

[C] Seals shall be Category 2.

4.3. Addition: Specifying and/or Purchasing a Sealing System

[E] Purchaser shall ensure that seal selections have been made using site-specific EEE and IH reviews, and that seal selections have been approved by Site Environmental Engineer. Owner's Engineer shall approve seal selection.

MODIFICATIONS TO SECTION 6: DESIGN REQUIREMENTS

6.1.2.8. Addition: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate

[A][R] Pressurized dual seals (including liquid or gas barrier fluid) that cannot be operated at rated barrier pressure with atmospheric pressure in the pump due to distortion or yielding of the seal cartridge, which supports the inner seal stationary face, shall be approved by Owner's Engineer.

6.1.2.9. Addition: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate

[R] Operation of a pressurized dual seal (Arrangement 3) with rated barrier fluid pressure and ambient pressure in the pump shall be considered when determining stress levels. Seals that can operate in this manner without impairing life or reliability are preferred.

6.1.2.14. Addition: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate

[A][O][R] Where special provisions are proposed to be added to the pump or seal (e.g., floating throat bushings, coolers, or hydro-padded faces) to meet the specified conditions, the special provisions shall be submitted for approval by Owner's Engineer.

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6.1.2.16 Addition: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate

[O] It is the responsibility of the seal manufacturer to determine when vent and drain holes are required if throat bushings are being used.

6.1.2.17. Addition: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate

- a. [R] Mechanical seal gland plates shall be furnished with a 13 mm (1/2 in.) NPT connection to permit measurement of seal chamber pressure during the pump performance test, when such a connection is not provided on the pump casing. A seal chamber external vent connection may be used for this purpose.
- b. [A][R] When a pressure measurement port is provided in the gland, it shall be directed to an area of the seal chamber not used for distribution of flush fluid. When inclusion of this second port restricts the flow area for flush distribution or may otherwise negatively impact seal face cooling or flushing, the design shall be submitted for approval by Owner's Engineer.

6.1.2.18.1. Substitution: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate—Connection Points and Plugs

[E] Plastic plugs are not permitted, including temporary plugs used for shipping.

6.1.2.18.2. Substitution: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate—Connection Points and Plugs

[M] Metal plugs of the same material as the gland, or with superior corrosion resistance for the intended service, shall be furnished to plug all unused openings in the gland plate. The metal plugs shall be solid round-head plugs furnished in accordance with the dimensional requirements of ASME B16.11.

6.1.2.20.b. Addition: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate

[O][R] For vertical pumps utilizing any Piping Plan other than 02, 23, 53, or 54, the specified port to vent the inner seal chamber shall be used to connect a Piping Plan 13 flush. The orifice shall be sized to allow free removal of vapor without significantly affecting seal chamber pressure.

6.1.2.20.g. Addition: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate

[R] For Arrangement 1 seals with stationary flexible elements, the flush inlet arrangement shall be designed to avoid erosion of the stationary seal elements by ensuring that a jet of flush liquid is not directed on these components.

6.1.2.24 Decision: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate

[*] [A] Pumps in hot duties where the fluid will solidify if not kept at pumping temperature (i.e. Sulphur) may require heating jackets to be specified. This requirement shall be reviewed and agreed upon between the pump manufacturer and Purchaser pre-order to clarify the most appropriate design option.

6.1.2.25 Decision: Common Design Requirements (All Categories)—Seal Chamber and Gland Plate

[*] [A] Purchaser to be advised if tap and port connections typically on the gland plate will be in pump manufacturer's scope (i.e. on pump cover) because of space restrictions.

6.1.6.1.4. New: Common Design Requirements (All Categories)—Materials

[*][R] Purchaser shall specify if seals are in wet hydrogen sulfide (H₂S) service. When specified, reduced-hardness materials shall be supplied in accordance with NACE MR0103/ISO 17945 and the requirements of GP 18-10-01D.

6.1.6.5.5. New: Common Design Requirements (All Categories)—Seal Faces—Secondary Seals

[M][R] Secondary sealing element selection (e.g., for elastomers and gaskets) shall be based on the maximum temperature specified.

6.1.6.10.1. Addition: Common Design Requirements (All Categories)—Materials—Welding

[R] Welding of pressure-containing parts, excluding metal bellows, shall comply with GP 18-07-01D.

6.1.6.11.4. Substitution: Common Design Requirements (All Categories)—Materials—Low Temperature Service

Impact test requirements shall be as per below.

[S] This Section covers impact testing requirements for pressure vessels, piping, and machinery. Impact requirements shall be based on the CET established by Owner's Engineer.

[R] Steel pressure containing machinery components such as compressor and pump casings, including cast, forged, or welded nozzles, shall meet the requirements in Table 1: Impact Requirements for Machinery.

Table 1: Impact Requirements for Machinery

| CET, °F (°C) | Maximum Casing Working Pressure, psi (bar) | Impact Requirement ⁽¹⁾ |
|---|--|--------------------------------------|
| CET < -20 °F (-29 °C) | All | 15/12 ⁽¹⁾ ft-lb (20/16 J) |
| 60 °F (16 °C) > CET ≥ -20 °F (-29 °C) | > 1000 psi (69 bar) | 15/12 ⁽¹⁾ ft-lb (20/16 J) |
| 60 °F (16 °C) > CET ≥ -20 °F (-29 °C) | ≤ 1000 psi (69 bar) | None |
| CET ≥ 60 °F (16 °C) | All | None |
| <p>Note:</p> <p>(1) In the notation such as 15/12, the first number is the maximum average energy of three specimens while the second number is the minimum for one specimen in the impact determination.</p> | | |

[C] For carbon steel and low alloy steel, no impact tests are required if the maximum casing working pressure generates a stress less than 25% of the minimum specified yield stress for the casing material, as determined by Manufacturer, for the casing design.

[*] For pressure containing components of (ductile) cast iron, (duplex) stainless steel, and nickel alloys, Owner's Engineer shall specify the impact test requirements.

6.2.2.2.1. Addition: Design Requirements (Category-Specific)—Category 2 Seals—Seal Chamber and Gland Plate (Category 2)

[R] A distributed flush system shall be provided for Category 2, Arrangement 1 and Arrangement 2 seals, except for service temperatures over 176 °C (350 °F) or when Piping Plan 13 and Piping Plan 23 are specified. The seal flush arrangement shall be located to maximize the uniformity and degree of cooling of the seal faces. For multipoint systems, ports having a minimum diameter of 3.2 mm (1/8 in.) shall be used.

MODIFICATIONS TO SECTION 7: SPECIFIC SEAL CONFIGURATIONS

7.2.1.3. Addition: Arrangement 2 Seals—General

[R] Arrangement 2 seals shall not be used for pumping temperatures above 176 °C (350 °F) unless a cool flush is used such as Piping Plan 21, Piping Plan 23, or Piping Plan 32.

MODIFICATIONS TO SECTION 8: ACCESSORIES

8.1.2. Addition: General

The following installation details shall be used with the flush plans indicated:

- [R]** For Piping Plan 52, Piping Plan 75 or Piping Plan 76 the vent connection to vapor collection system shall be connected to the collection header according to Figure 2: Reservoir Vent Connections.
- [*][R]** When specified for Piping Plan 53A, Piping Plan 53B, or Piping Plan 53C, a pressure relief valve shall be installed just downstream of the makeup barrier fluid block valve.
- [R]** Piping Plan 75 shall be used with Arrangement 2 seals that utilize a dry containment seal, whenever 100% of the pumped fluid does not vaporize at atmospheric pressure and minimum ambient temperature. The collection reservoir vent connection shall be connected to the collection header according to Figure 2: Reservoir Vent Connections. Valves shall be braced per Paragraph 8.2.6 . The line from the seal drain to the collection reservoir shall be 13 mm (1/2 in.) Schedule 160 pipe and shall slope a minimum of 42 mm/m (1/2 in./ft). If leakage can solidify at minimum ambient temperature, then the drain line and reservoir shall be heat traced and insulated.
- [R]** Piping Plan 76 shall be used with Arrangement 2 seals that utilize a dry containment seal, only when 100% of the pumped fluid vaporizes at atmospheric pressure and minimum ambient temperature. The vent connection shall be connected to the collection header according to Figure 2: Reservoir Vent Connections.
- [*]** Owner shall specify when the optional reservoir vent connection is permissible for Figure 2: Reservoir Vent Connections.

8.1.6. Addition: General

[O] Filling systems supplied by Seal Vendor for Arrangement 2 seals shall be designed such that the reverse pressure capability of the seal is not exceeded when filling the reservoir.

8.1.12. Addition: General

[R] Vents from Piping Plan 75 and Piping Plan 76 shall be connected to a collection system with operating pressures that do not exceed the design pressure of the seal (consideration should be given to normal operating pressures and extended periods of higher pressure such as flaring during plant startup or shutdown).

8.2.1. Addition: Piping for Seal Auxiliary Systems

[R] Auxiliary process piping or tubing made of 300 series stainless steel shall be provided with a minimum corrosion allowance of 0.25 mm (0.01 in.).

8.2.4. Addition: Piping for Seal Auxiliary Systems

[R] Barrier and buffer fluid lines shall not include elbows.

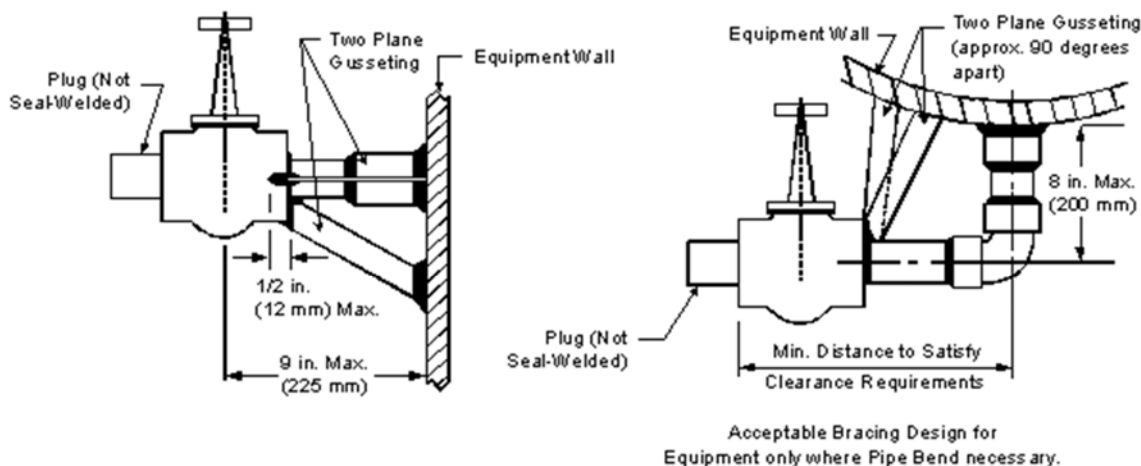
8.2.6. New: Piping for Seal Auxiliary Systems

Valved piping vent and drain connections less than DN 50 (NPS 2) that connect to pipe/vessels two or more NPS sizes larger (e.g., seal pots) shall be braced as follows:

- [S]** Valved piping vent and drain connections shall be braced as shown in Figure 1: Bracing Design.
- [A]** Proposals to use clamped or bolted bracing designs shall be submitted to Purchaser for Owner's Engineer approval.
- [A]** Bracing design for piping connections requiring double block valves shall be submitted to Purchaser for Owner's Engineer approval.
- [R]** Bracing shall have a minimum thickness of 5 mm (3/16 in.) and a minimum width of 19 mm (3/4 in.).

- e. [R] Bracing material for welded bracing shall be of the same nominal chemistry as the connected parts, except that carbon steel may be used for bracing P-1, P-3, P-4, and P-5 materials.
- f. [R] Bracing attachment welds to a pressure boundary shall PWHT whenever PWHT is required on the alloy steel component to which the attachment is to be made. Such attachment welds shall be performed according to ASME B31.3 PWHT criteria for butt welds in alloy steel materials. This requirement shall be met regardless of whether butt welds are used in the assembly.

Figure 1: Bracing Design



GENERAL NOTE:

Bracing detail applicable to extended body type valve, or compact body valve plus nipple (as illustrated).

8.2.7. Addition: Piping for Seal Auxiliary Systems

- a. [M] Auxiliary piping for seal flush systems larger than DN 25 (NPS 1) shall be seamless steel piping.
- b. [M] Auxiliary piping for seal flush systems for sizes DN 25 (NPS 1) and smaller shall be as follows:
 - i. [R] Flush Piping Plans shall use a minimum of 20 mm (3/4 in.) diameter, 2 mm (0.065 in.) wall thickness seamless tubing meeting the requirements of API STD 682-4, Table 4 "Minimum Requirements for Auxiliary Piping" when pressure loss shall be minimized. A 1/2 NPT connection to the seal gland may be used if a 3/4 NPT connection is not possible due to space constraints. Examples include Piping Plans 23, 52, or 53.
 - ii. Flush Piping Plans may use a minimum of 12 mm (1/2 in.) diameter, 2 mm (0.065 in.) wall thickness seamless tubing, meeting the requirements of API STD 682-4, Table 4 "Minimum Requirements for Auxiliary Piping" when there is a flow restriction orifice. Tubing shall be connected to the seal gland from the flanged connection on the pump casing with paddle-type orifice plate. If Piping Plan includes a vent valve, then it shall be attached to seamless steel piping before transitioning to tubing. Examples are Piping Plan 11, Piping Plan 13, Piping Plan 14, and Piping Plan 21.
 - iii. Flush Piping Plans supplied from an external process source shall use seamless piping per API STD 682-4, Table 4 "Minimum Requirements for Auxiliary Piping" up to 300 mm (12 in.) from the seal gland where it shall transition to seamless tubing per paragraph 8.2.7.b.ii. above. Examples are Piping Plan 32, Piping Plan 54 and Piping Plan 62.
 - iv. [C] Flush Piping Plan 54 that utilizes a separate seal oil skid shall use seamless tubing per paragraph 8.2.7.b.i. on the skid. Seamless tubing per paragraph 8.2.7.b. ii. may be used between the seal skid and seal gland provided valves and instruments are well-supported by structural steel.

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- v. Flush Piping Plan 72 and Piping Plan 74 shall use seamless tubing per paragraph 8.2.7.b. ii. from the seal gas panel to the seal gland. Tubing on the gas panel may be 6 mm (1/4 in.) diameter, provided it is secured to a metal plate.

8.2.8. Substitution: Piping for Seal Auxiliary Systems

Lines connecting the barrier/buffer fluid system to the mechanical seal shall be tubing in accordance with Paragraph 8.2.7.

Table 4. Addition: Minimum Requirements for Auxiliary Piping

[M] Solid round-head plugs with the dimensional requirements of ASME B16.11 shall be utilized per Paragraph 6.1.2.18.2.

8.2.9. Substitution: Piping for Seal Auxiliary Systems

Steel piping shall be in accordance with Paragraph 8.2.7.

8.2.11. Addition: Piping for Seal Auxiliary Systems

- a. **[M]** Unions shall not be used in any hydrocarbon (i.e., including lubricating oil) or steam services.
- b. **[R]** The centerline radius of pipe bends shall be a minimum of five times the nominal pipe diameter.

8.2.19. Addition: Piping for Seal Auxiliary Systems

[M][O][R] Plugs in threaded connections that do not require later removal shall be seal welded. Seal welding of all threaded plugs and connections shall be as follows:

- a. Connections requiring seal welding shall be made without the use of sealing compounds or tape. All cutting oil shall be removed prior to assembly. After the joint has been tightened to full-thread engagement, the seal welding shall cover all exposed threads or 6 mm (1/4 in.) minimum.
- b. Seal welding shall be done with electrodes not to exceed 3.2 mm (1/8 in.) in diameter, using an amperage in the low range to avoid distortion of the connection or the part being welded. If the piping requires PWHT following welding, then seal welding shall be given the necessary heat treatment.

8.2.21. Substitution: Piping for Seal Auxiliary Systems

[R] Cooling water tubing smaller than DN 40 (NPS 1-1/2) shall be per API STD 682-4, Table 4 "Minimum Requirements for Auxiliary Piping," Column "Cooling Water, Standard" Piping DN 40 (NPS 1-1/2) and larger shall be per API STD 682-4, Table 4 "Minimum Requirements for Auxiliary Piping," Column "Cooling Water, Optional". Fabricated joints DN 40 (NPS 1-1/2 in.) and larger shall be flanged. Gaskets and flange bolting shall be per API STD 682-4, Table 4 "Minimum Requirements for Auxiliary Piping," Column "Quench".

8.2.22. Substitution: Piping for Seal Auxiliary Systems

[O] Sight flow indicators shall be provided at each cooling water outlet.

8.3.2.1.7. Substitution: Components of Seal Auxiliary Systems—Coolers—General

[M][R] The minimum tubing size shall be 20 mm (3/4 in.) with 1.5 mm (0.065 in.) wall and made of Type 316 stainless steel for freshwater cooling and Monel for salt or brackish water cooling. Vendor shall ensure the tubing material is compatible with the flush and pumped fluids. No tubing connectors, fittings, or seams mounted internal to the reservoir are allowed.

8.3.2.1.13. New: Components of Seal Auxiliary Systems—Coolers—General

[R] Materials for self-flushing liquid coolers shall be per Table 7.1: Cooler Metallurgy.

Table 7.1: Cooler Metallurgy

| Cooling Media | Tube Coil | Casing (or Shell) |
|------------------------|--|-------------------|
| Fresh water | Type 316 stainless steel or Monel | Carbon steel |
| Salt or brackish water | Monel | Carbon steel |
| Air | Type 316 stainless steel with aluminum or stainless-steel fins | — |

8.3.6.1.3. Addition: Components of Seal Auxiliary Systems—Barrier/Buffer Fluid Reservoirs and Accumulators—General

[R] Structural members that are weak in torsion (e.g., I-beams or channels) shall be reinforced with a plate 3.2 mm (1/8 in.) minimum, stitch welded to the member to make a box or rectangular cross-section on at least one side of the member.

8.3.6.1.5. Addition: Components of Seal Auxiliary Systems—Barrier/Buffer Fluid Reservoirs and Accumulators—General

- a. [M][O] Fill, vent, drain, and instrumentation (other than thermowells) connections shall be valved with 19 mm (3/4 NPT) threaded end.
- b. Gate valves shall be in accordance with GP 03-12-01D.
- c. Valved piping connections shall be braced per Paragraph 8.2.6.
- d. Threaded connections shall be plugged per Paragraph 6.1.2.18.2. Plugs not requiring later removal shall be seal welded per Paragraph 8.2.19.

8.3.6.2.1. Addition: Components of Seal Auxiliary Systems—Barrier/Buffer Fluid Reservoirs and Accumulators—Barrier/Buffer Fluid Reservoirs

[M] The barrier/buffer fluid reservoir shall be arranged as shown in API STD 682-4, Annex G, Figure G.35 "Standard External Barrier/Buffer Fluid Reservoir" with the following exceptions:

- a. [C] The barrier/buffer fluid return and supply tubing connections shall be threaded into 19 mm (3/4 NPT) half pipe coupling welded to barrier/fluid reservoir in lieu of flanged connections.
- b. Gate valves with threaded ends coupled to instrument block and bleed valves shall be provided to isolate the pressure transmitter and the differential pressure level transmitter from the barrier/buffer fluid reservoir. Flanges are not required.
- c. Gate valves for vent and fill shall end with a 19 mm (3/4 NPT) connection that is plugged.

8.3.6.2.3. Addition: Components of Seal Auxiliary Systems—Barrier/Buffer Fluid Reservoirs and Accumulators—Barrier/Buffer Fluid Reservoirs

[O] The pressure transmitter shall alarm as follows:

- a. For Arrangement 2 seals, the pressure transmitter shall alarm at 69 kPag (10 psig) and rising.
- b. For Arrangement 3 seals, the pressure transmitter shall alarm at 138 kPa (20 psi) above the maximum seal chamber pressure and falling. Purchaser and Vendor shall review the measured seal chamber pressure from the pump test (see Technical Note for Centrifugal pumps, USBT-000-TE-MR-TCN-0001) to ensure that the recommended barrier pressure setting is at least 207 kPa (30 psi) above the maximum seal chamber pressure.

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8.3.6.2.4. Addition: Components of Seal Auxiliary Systems—Barrier/Buffer Fluid Reservoirs and Accumulators—Barrier/Buffer Fluid Reservoirs

[O] A level transmitter shall be furnished with a LLA and HLA.

8.3.6.2.11. Addition: Components of Seal Auxiliary Systems—Barrier/Buffer Fluid Reservoirs and Accumulators—Barrier/Buffer Fluid Reservoirs

[O] The NLL, LLL, and HLL shall be clearly marked on the level gauge with a tag, engraving, stamping, or other permanent method.

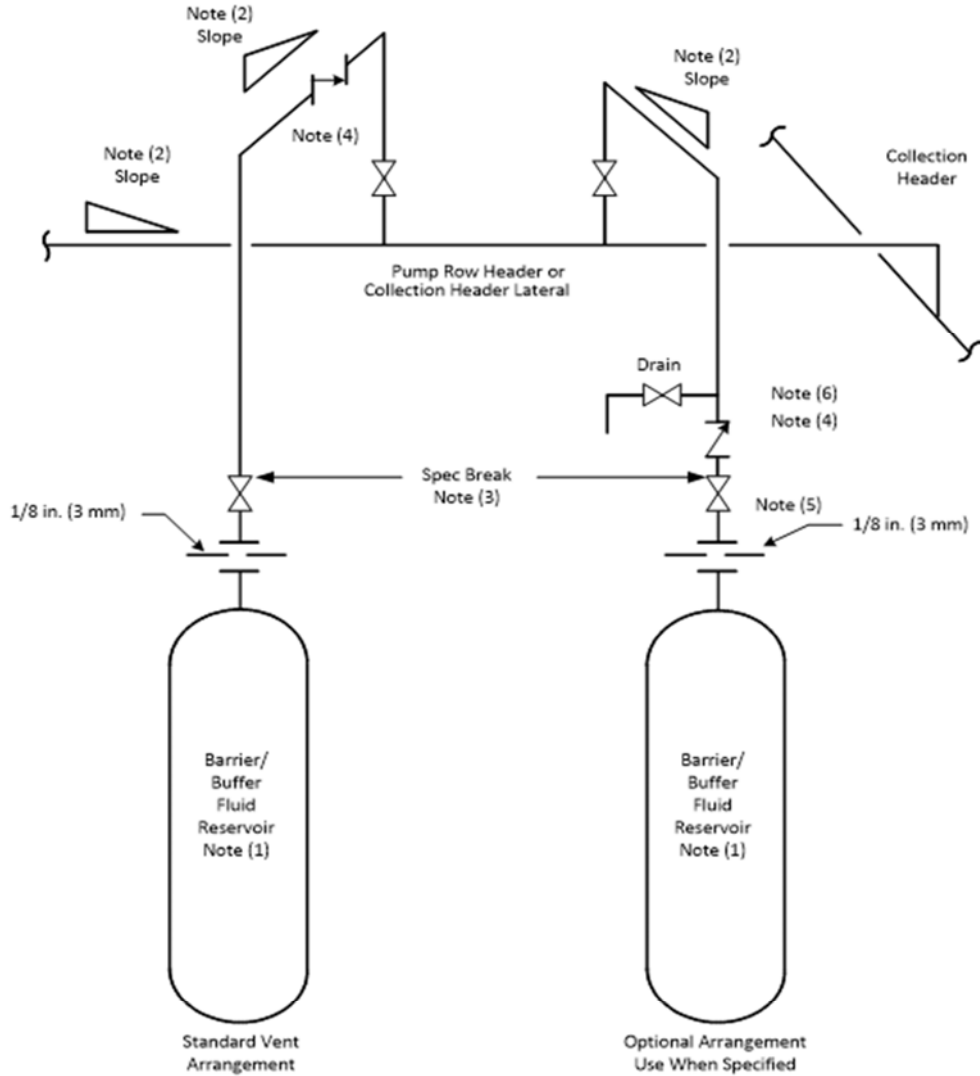
8.3.6.2.14. New: Components of Seal Auxiliary Systems—Barrier/Buffer Fluid Reservoirs and Accumulators—Barrier/Buffer Fluid Reservoirs

- a. [*][O] If valves are specified at the inlet and outlet on the barrier/buffer fluid reservoir, then they shall be gate valves installed in accordance with GP 03-12-01D.
- b. Valved piping connections shall be braced per Paragraph 8.2.6.

8.3.8.1. Addition: Components of Seal Auxiliary Systems—Components for External Seal Flush Systems

- a. [O][R] Purchaser and Vendor shall review the measured seal chamber pressure of the pump performance test (see Technical Note for Centrifugal pumps, USBT-000-TE-MR-TCN-0001) to ensure the external flush supply pressure is at least 172 kPa (25 psi) higher than the maximum seal chamber pressure.
- b. Piping Plan 32 and Piping Plan 54 shall be provided with the following features as a minimum:
 - i. [*][O] Separate hand control valve and flow indicator for flow regulation to each seal chamber. A temperature indicator shall be furnished only when specified by Owner's Engineer.
 - ii. [O] Check valve in each supply lateral downstream from the flow regulation and flow indicating device.
 - iii. [R] Flow indicators shall be rated for the MAWP and temperature of the pump casing per API STD 682-4, Section 8.1.4.

Figure 2: Reservoir Vent Connections



NOTES:

- (1) [R] Each reservoir shall have separate vent to collection system.
- (2) [O] All horizontal runs shall slope toward the collection system a minimum 1/2 in./ft (42 mm/m).
- (3) [O] Valve, orifice flanges, and piping to the reservoir shall have same pressure/temperature rating as reservoir. Piping and components above the valve shall have same ratings as collection system.
- (4) [R] Unless specified otherwise check valves shall be 2 psi back pressure, with spring load installed in most favorable position (horizontal or vertical) for satisfactory operation.
- (5) [O] Distance from reservoir to orifice shall be minimized. Valve shown is within reservoir Vendor scope of supply.
- (6) [R] Distance from check valve to drain connection shall be minimized.

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MODIFICATIONS TO SECTION 9: INSTRUMENTATION

9.1.1. Addition: Instrumentation—General

[*] Unless otherwise specified, instrumentation and installation shall conform to API STD 682-4 as modified by this specification.

9.4.1. Substitution: Pressure Indicators

Pressure gauges shall conform to Technical Note for Centrifugal pumps, USBT-000-TE-MR-TCN-0001.

9.5.1.2 Decision: Instrumentation-Transmitters and Switches-General

[*] [R] Transmitters are required in lieu of all switches.

9.6.1. Addition: Level Indicators

[O][R] All materials for level indicators shall be compatible with the pump and flush fluids.

9.7.2. Addition: Flow Instruments—Flow Meters

[O][R] Materials for flowmeters shall be compatible with the pump and flush fluid and shall have a pressure and temperature rating at least equal to the pump casing.

9.9.f. Addition: Pressure Control Valves

[S] Pressure control valves for Piping Plan 72 shall not be self-venting. Pressure control valves for other Piping Plans shall not be self-venting unless vent is routed to a safe location.

MODIFICATIONS TO ANNEX A: RECOMMENDED SEAL SELECTION PROCEDURE

A.1.2. Addition: Additional Engineering Required

[A] Owner's Engineer shall approve seal selection.

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1. INTRODUCTION

1.1 Project Overview

"ExxonMobil Corporation ("COMPANY") has awarded a CONTRACT to Technip Energies India ("CONTRACTOR") for performing the FEED and EP work for reconfiguring COMPANY's BAYTOWN refinery to produce a more resilient product slate, while enabling future GHG emission reductions.

The project includes scope in three major areas of the refinery: the Hydrocracking Unit (HCU-1), the Raffinate Hydro-Conversion Unit (RHC) and Offsites and Utilities.

The project will convert the HCU-1 to a lubes hydrocracker, using light Virgin Gas Oil (VGO) streams as charge to be cracked into diesel and additional feed from HCU-1 will be supplied to the RHC to produce the light-neutral grades".

2. REFERENCES

2.1 Required References

[*] This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced Specifications may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

2.1.1 Industry Standards

| Industry Standard Number | Industry Standard Title |
|--------------------------|---|
| ANSI B11/STD B11.19 | Performance Requirements for Risk Reduction Measures: Safeguarding and other Means of Reducing Risk |
| API STD 677-4 | General-purpose, Extruder, and Epicyclic Gear Units for Petroleum, Chemical, and Gas Industry Services - Fourth Edition |
| BSI BS EN ISO 14120 | Safety of Machinery - Guards - General Requirements for the Design and Construction of Fixed and Movable Guards |

2.2 REQUIREMENT DESIGNATION

Certain paragraph/s are preceded by bracketed uppercase letter. Below is the meaning of each designation.

| Acronym | Definition |
|---------|--|
| [S] | 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). |
| [O] | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| [A] | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| [E] | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| [R] | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| [M] | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| [C] | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| [CS] | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| [*] | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |

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3. REVISIONS TO API STANDARD 677-4TH EDITION

- 3-1** API STD 677-4 (API Standard) shall be used as modified by this Specification, unless superseded by more stringent local regulations. This Specification is intended to supplement the API Standard and not replace it. All headings and paragraph or clause numbers contained herein correspond to those in the API standard. Sections not modified shall be followed as written in the API Standard.
- 3-2** Specific definitions of the terms "new," "addition," "substitution," and "deletion" are shown directly below:
- i. "New"—New clause that does not currently appear in the API standard. Text in this specification is accompanied by a clause number not currently existing in the API standard.
 - ii. "Addition"—Text added to a clause already in the API standard, but not overwriting any of the text currently in the API standard. Text in this specification does not modify or overwrite the API standard text in any way. The reader shall read and follow both the API standard text and this specification clause text.
 - iii. "Substitution"—Text wholly replaces the text currently in the API standard. Text in this specification is wholly taking the place of the API standard text. The reader shall ignore the API standard text and only follow the clause text of this specification.
 - iv. "Modification" – Specific revisions have been made to the text currently in the API standard.
 - v. "Deletion"—Wholly deletes the text currently in the API standard. Text in this specification is stating that the API standard text shall not be followed.
 - vi. "Decision" – Text in this specification makes a decision that was required.

MODIFICATIONS TO SECTION 6: BASIC DESIGN

6.1.1.1 Addition: General – Equipment Reliability

[R] To be considered field proven, Vendor shall have manufactured at the proposed point of manufacture at least two gear units of comparable: power, speed, pinion speed, gear ratio, and pitch line velocity; and operating satisfactorily for at least 1 year.

6.1.1.2. Addition: General – Equipment Reliability

[R] Vendor shall provide documentation to demonstrate that all equipment proposed qualifies as field proven.

6.1.1.3. Addition: General – Equipment Reliability

- a. **[O] [R]** Alternatively, Supplier may satisfy the experience requirement on an individual component and service condition basis. Experience need not be concentrated in a single gear unit but may exist in several different operating gear units. To qualify, however, each of these gear units shall have at least 1 year of satisfactory operation. Such design shall be subject to review and approval by Company / Contractor.
- b. **[R]** If qualification requirements prevent application of the latest technology, then Vendor may submit an alternative proposal, specifically identifying the undemonstrated features and stating the advantages. Such design shall be subject to review and approval by Company / Contractor.

6.1.12.1 Addition: General

- a. As a basic requirement, the sound pressure level (Lp, re 20 x 10⁻⁶ Pa) for complete equipment train (Pump + Motor + Gearbox if any), shall not exceed 85 dBA at any locations at (Three) 3 ft from equipment surface. The VENDOR shall guarantee the required sound level is not exceeded. The sound level shall be reported in the loaded condition for the specified design.
- b. The sound pressure level of each piece of equipment in the train shall not exceed 80 dBA at any location, 3 ft from equipment surface.

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- c. Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort by the Company / Contractor and the Vendor. The vendor shall include in the proposal a completed Noise Data Sheet indicating expected sound pressure levels for the pump package as a single noise source and for major noise generating components. Reference location for pump skid noise data shall be 1000 mm (3 ft) from skid edge. In addition, the Vendor shall provide expected sound power data. Sound power levels shall be supplied in the completed noise data sheet for the pump package as a single source and for the major noise generating components.
- d. For exceeding the specified noise limit, Vendor shall recommend abatement option, and this shall be quoted as option. Vendor shall specifically state the type of noise treatment and/or steps that will be performed in the event of a noise level exceeding the permitted level. The procedure shall be specifically stated in the submittals. All the necessary noise model/calculations must be performed and submitted for Contractor / Owner review and approval.

6.1.20. Addition: General

- e. [R] Gear units and auxiliaries shall be suitable for outdoor (without a roof) installation.
- f. [*] [R] Gear units and auxiliaries shall be winterized for the climatic zone as per below.

| Scope | Climatic Zone Classification | Temperature Condition |
|---------------------|------------------------------|---|
| Instrumentation | C | The lowest mean daily temperature is below 30 deg F for more than 24 hours but is above 0 deg F |
| All other equipment | B | The lowest mean daily temperature is below 30 deg F for no more than 24 consecutive hours |

Gear units and auxiliaries shall be winterized for the climatic zone specified per GP 03-09-01D.

6.4.1.1.2. Addition: Rating—Gear Rated Power

[R] Specifically for synchronous motor drives and variable frequency induction motor drives, the gear unit, including the gear teeth and bearing metal, shall also be rated to withstand the peak oscillatory torque values predicted by the system transient torsional analysis of the motor starting without incurring fatigue damage or failure.

6.4.2.1. Addition: Rating—Gear Tooth Service Factor

[O] [R] The minimum gear tooth service factor used for both tooth pitting resistance rating and bending strength rating shall be as follows for the following equipment types:

- a. Induction motors, synchronous motors, and variable speed motors shall have a minimum gear tooth service factor of 1.5 when driving the following equipment types:
 - i. Centrifugal pumps

6.4.2.3. New: Rating—Gear Tooth Service Factor

[A] [R] Gears shall also be rated to withstand momentary high torque overloads as specified in Table 2: Minimum Gear Transient Torque Transmission Requirements. The suitability of this rating shall be approved by Purchaser after the final system characteristics are defined.

Table 2: Minimum Gear Transient Torque Transmission Requirements

| Application | Minimum Transient Torque (% of Driver Torque at 1.0 Service Factor) |
|---|---|
| Electric Motor Drivers: Induction Type | 400% |

| Application | Minimum Transient Torque (% of Driver Torque at 1.0 Service Factor) |
|------------------|--|
| Synchronous Type | 500% |

6.5.3.4. Addition: Casings—Piping and Tubing

[R] All internal piping in lube oil service shall be stainless steel.

6.6.1.5. New: Casing Connections—Service and Size Criteria

[*] [R] When specified, the casing shall include provisions to allow inert gas purging of the vapor space.

6.7.1.5. Substitution: Gear Elements—General

[R] Hunting tooth combination is required.

6.9.1.4. Addition: Bearings and Bearing Housings—General

[A] [R] Rolling element bearings with a $d_m N$ number greater than 350,000 mm-RPM shall be approved by Owner's Engineer prior to design finalization.

6.9.6.5.3. Addition: Bearings and Bearing Housings—Bearing Housings

[*] [R] When specified, bearing housings with shaft penetrations shall be provided with isolation seals that provide a positive tight seal to prevent the ingress of atmospheric contaminants.

MODIFICATIONS TO SECTION 7: ACCESSORIES

7.2.3. Addition: Couplings and Guards

[R] The coupling to shaft juncture shall be capable of transmitting the normal and transient torques defined in Paragraph 6.4.2.1. and Paragraph 6.4.2.3.

7.2.6.1. Addition: Couplings and Guards

[S] Guards shall be constructed of sufficient stiffness (rigidity) to withstand a 900 N (200 lbf) static point load in any direction without the guard contacting moving parts.

7.2.6.3. New: Couplings and Guards

[S] All areas with access to rotating parts (including couplings and openings between bearing housings and casings) shall have equipment guards in accordance with ANSI B11/STD B11.19 and BSI BS EN ISO 14120 as applicable for the intended location of use.

7.2.6.4. New: Couplings and Guards

- a. [M] [O] Guards shall be fabricated from solid sheet or plate with no openings.
- b. [M] [O] Guards fabricated from expanded metal or perforated sheets may be used if the size of the openings does not exceed 10 mm (0.375 in.).
- c. [M] Guards shall be constructed of steel, brass, aluminum, or austenitic stainless-steel materials.
- d. [M] [O] Guards of woven wire shall not be used.
- e. [S] Coupling and seal guards in hazardous areas shall be constructed entirely of spark-resistant metallic materials.

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MODIFICATIONS TO SECTION 8: INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT

8.3.3.2. Addition: Testing—Mechanical Running Test

[*] [R] If specified, or for gear units with a rating over 750 kW (1,000 hp), the extended mechanical running test shall be conducted.

8.3.3.9. Addition: Testing—Mechanical Running Test

[R] For gear units with a rating over 750 kW (1,000 hp), all hydrodynamic bearings shall be removed, inspected, and reassembled after the mechanical running test is complete.

8.3.4.2.3. Addition: Testing—Optional Tests—Full-Speed/Full- or Part-Load Test

[*] [R] Unless otherwise specified, vibration limits shall not exceed those specified in API STD 677-4, Section 6.8.7 "Vibration," Paragraph 6.8.7.1 and oil sump and drain temperatures shall not exceed those specified in API STD 677-4, Section 6.10.13 "Lube Oil Temperatures," Paragraph 6.10.13.3.

MODIFICATIONS TO SECTION 11: VENDOR'S DATA

11.2. Substitution: Vendor's Data

Information detailed in API STD 677-4, Annex D "Proposal and Contract Documents and Engineering Design Data" shall be provided.

LUBRICATION SHAFT-SEALING AND OIL-CONTROL SYSTEMS AND AUXILIARIES

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1. INTRODUCTION

1.1 Project Overview

“ExxonMobil Corporation (“COMPANY”) has awarded a CONTRACT to Technip Energies India (“CONTRACTOR”) for performing the FEED and EP work for reconfiguring COMPANY’s BAYTOWN refinery to produce a more resilient product slate, while enabling future GHG emission reductions.

The project includes scope in three major areas of the refinery: the Hydrocracking Unit (HCU-1), the Raffinate Hydro-Conversion Unit (RHC) and Offsites and Utilities.

The project will convert the HCU-1 to a lubes hydrocracker, using light Virgin Gas Oil (VGO) streams as charge to be cracked into diesel and additional feed from HCU-1 will be supplied to the RHC to produce the light-neutral grades”.

2. REFERENCES

2.1 Required References

[*] This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced Specifications may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

2.1.1 References

| Reference | Reference Title |
|-------------------------|---|
| USBT-000-TE-MP-PSP-0005 | Technical Notes for Valves |
| USBT-000-TE-MR-EQS-0016 | Machinery Protection Systems |
| USBT-000-TE-MP-PSP-0002 | Piping Fabrication Shop or Field |
| GP 18-12-01D | Positive Material Identification |
| GP 03-15-01D | Pressure Relief Valves |
| GP 03-09-01D | Winterizing Against Ambient Temperatures |
| GP 18-03-04D | Pressure Casting Quality and Inspection |
| JIP33 (IOGP S-615) | Supplementary Specification to API Standard 610 for Centrifugal Pumps |
| USBT-000-TE-MR-EQS-0005 | Positive Displacement Pumps - Rotary |
| USBT-000-TE-EA-EQS-0005 | Job Specification for Low Voltage AC Induction Motors |
| USBT-000-TE-EA-EQS-0004 | Job Specification for Supply of Medium Voltage Induction motors |

2.1.2 Industry Standards

| Industry Standard Number | Industry Standard Title |
|--------------------------|--|
| API RP 582 | Recommended Practice for Welding Guidelines for the Chemical, Oil, and Gas Industries |
| API STD 614-6 | Lubrication, Shaft-Sealing and Oil-Control Systems and Auxiliaries - Sixth Edition |
| ASME B16.11 | Forged Fittings, Socket-Welding and Threaded |
| ASME B31.3 | Process Piping |
| ASME/BPVC SEC VIII D1 | BPVC Section VIII - Rules for Construction of Pressure Vessels - Division 1 |
| ASTM A 182/A 182M | Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service |
| ASTM A 240/A 240M | Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| ASTM A 789/A 789M | Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service |
| ASTM A 790/A 790M | Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe |
| ASTM A 815/A 815M | Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings |
| ASTM A 487/A 487M | Standard Specification for Steel Castings Suitable for Pressure Service |
| ASTM A 494/A 494M | Standard Specification for Castings, Nickel and Nickel Alloy |
| AWS D1.1/D1.1M | Structural Welding Code - Steel |
| IEC 60529 | Degrees of Protection Provided by Enclosures (IP Code) |
| NEMA 250 | Enclosures for Electrical Equipment (1000 Volts Maximum) |

2.2 Acronyms and Definitions

2.2.1 Acronyms

| Acronym | Description |
|---------|---|
| P&IDs | Piping and Instrumentation Diagrams |
| CET | Critical Exposure Temperature |
| DCS | Distributed Control System |
| GMAW | Gas Metal Arc Welding |
| GTAW | Gas Tungsten Arc Welding |
| HOA | Hand-Off-Auto |
| ISA | The International Society of Automation |
| MAWP | Maximum Allowable Working Pressure |
| NDT | Non-Destructive Testing |
| OEM | Original Equipment Manufacturer |
| PMI | Positive Material Inspection |
| PSV | Pressure Safety Valve |
| PLV | Pressure Limiting Valve |
| PES | Programmable Electronic Systems |
| PLC | Programmable Logic Controller |

2.3 REQUIREMENT DESIGNATION

Certain paragraph/s are preceded by bracketed uppercase letter. Below is the meaning of each designation.

| Acronym | Definition |
|---------|--|
| [S] | 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). |
| [O] | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |

| | |
|------|--|
| [A] | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| [E] | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| [R] | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| [M] | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| [C] | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| [CS] | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| [*] | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |

3. REVISIONS TO API STANDARD 614, SIXTH EDITION: GENERAL REQUIREMENTS

3.1 API STD 614-6 (API Standard) shall be used as modified by this Specification, unless superseded by more stringent local regulations. This Specification is intended to supplement the API Standard and not replace it. All headings and paragraph or clause numbers contained herein correspond to those in the API standard. Sections not modified shall be followed as written in the API Standard.

3.2 Specific definitions of the terms "new," "addition," "substitution," and "deletion" are shown directly below:

- i. "New"—New clause that does not currently appear in the API standard. Text in this specification is accompanied by a clause number not currently existing in the API standard.
- ii. "Addition"—Text added to a clause already in the API standard, but not overwriting any of the text currently in the API standard. Text in this specification does not modify or overwrite the API standard text in any way. The reader shall read and follow both the API standard text and this specification clause text.
- iii. "Substitution"—Text wholly replaces the text currently in the API standard. Text in this specification is wholly taking the place of the API standard text. The reader shall ignore the API standard text and only follow the clause text of this specification.
- iv. "Modification" – Specific revisions have been made to the text currently in the API standard.

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- v. "Deletion"—Wholly deletes the text currently in the API standard. Text in this specification is stating that the API standard text shall not be followed.
- vi. "Decision" – Text in this specification makes a decision that was required.
used without Owner's Engineer approval.

MODIFICATIONS TO SECTION 6: BASIC DESIGN

6.1.3 Substitution: System Design

[R] Vendor shall have manufactured at the proposed point of manufacture at least two oil systems of comparable conditions and operating satisfactorily for at least 1 year.

6.1.3.1 Substitution: System Design

- a. [R] Proposal shall include an experience list demonstrating experience for the proposed oil system.
- b. [R] Alternatively, Vendor may satisfy this experience requirement on an individual component and service condition basis. Experience need not be concentrated in a single oil system, but may exist in several different operating oil systems. To qualify, however, each of these oil systems shall have at least 1 year of satisfactory operation.

6.1.3.2 Addition: System Design

[R] If experience requirements prevent application of the latest technology, then Vendor may submit an alternative proposal, specifically identifying the undemonstrated features and stating the advantages.

6.1.6 Addition: System Design

- a. [R] Equipment and auxiliaries shall be suitable for outdoor installation.
- b. [*] [R] Oil systems shall be winterized as per the climatic zone specified below

| Scope | Climatic Zone Classification | Temperature Condition |
|---------------------|------------------------------|---|
| Instrumentation | C | The lowest mean daily temperature is below 30 deg F for more than 24 hours but is above 0 deg F |
| All other equipment | B | The lowest mean daily temperature is below 30 deg F for no more than 24 consecutive hours |

Oil systems shall be winterized per GP 03-09-01D for the climatic zone specified in the equipment data sheets.

6.2.12 Decision: System Design

- a. As a basic requirement, the sound pressure level (Lp, re 20 x 10⁻⁶ Pa) for complete equipment train (Pump + Motor + Gearbox if any), shall not exceed 85 dBA at any locations at (Three) 3 ft from equipment surface. The VENDOR shall guarantee the required sound level is not exceeded. The sound level shall be reported in the loaded condition for the specified design.
- b. The sound pressure level of each piece of equipment in the train shall not exceed 80 dBA at any location, 3 ft from equipment surface.
- c. Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort by the Company / Contractor and the Vendor. The vendor shall include in the proposal a completed Noise Data Sheet indicating expected sound pressure levels for the pump package as a single noise source and for major noise generating components. Reference location for pump skid noise data shall be 1000 mm (3 ft) from skid edge. In addition, the Vendor shall provide expected sound power data. Sound power levels shall be supplied in the completed noise data sheet for the pump package as a single source and for the major noise generating components.

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- d. For exceeding the specified noise limit, Vendor shall recommend abatement option, and this shall be quoted as option. Vendor shall specifically state the type of noise treatment and/or steps that will be performed in the event of a noise level exceeding the permitted level. The procedure shall be specifically stated in the submittals. All the necessary noise model/calculations must be performed and submitted for Contractor / Owner review and approval.

6.2.8 Substitution: System Selection

[R] Where oil is supplied from a common system to two or more machines (e.g., a compressor, a gear, and a motor), Vendor having unit responsibility of the train shall specify the oil's characteristics on the basis of agreement with all vendors supplying equipment served by the common oil system.

6.2.13 Substitution: System Selection

Oil system layout shall provide the following accessibility features:

- a. **[S]** Manual operation of valve handles shall not require application of force exceeding 38 kg (80 lb).
- b. **[S]** Minimum clearance shall be 80 mm (3 in.) between adjacent valve handles and equipment; and 50 mm (2 in.) between the back of the handle and insulation on the line. Additional clearance shall be provided for wrench-assisted operation of valve handles of ball-and-plug type valves. Use of valve wrenches shall be approved by the Owner's Engineer.
- c. **[M]** Minimum clearance around automated valves shall be 300 mm (12 in.).
- d. **[O]** Valve handles shall be readily accessible and positioned to be within normal reach for operation. Acceptable distance from grade is 150 mm (6 in.) to 1980 mm (6ft-6in.).
- e. **[O]** Valve handles shall be oriented such that they do not turn to restrict the access or walk-through pathway in front of the valve.
- f. **[O]** Valves shall be selected and installed to ensure the consistent operating stereotype of increasing flow when the actuator is turned counter-clockwise, moved from left to right, front to back or upwards.
- g. **[M]** Clearance around and access to components (especially clearance around and access to heat exchangers, filters and hand valves) shall be a minimum of 800 mm (30 in.) wide.
- h. **[O]** Equipment shall be accessible from grade or from a permanent platform. Access to these platforms shall be by permanently installed stairs or ladders.
- i. **[O]** The maximum horizontal reach from a platform or ladder shall not exceed 510 mm (20 in). The maximum overhead grip reach from grade or a platform shall not exceed 1800 mm (6 ft).
- j. **[M]** Strainers, filters, cleaning and flushing connections shall be accessible from grade or platform and with sufficient clearance and lifting devices to facilitate: removal of strainer or filter media, use of rodding-out devices, and connection of hoses for flushing.
- k. **[O]** Minimum vertical clearance between finished grade (or top of floor plate) and the bottom of the low-level piping shall be 150 mm (6 in.).
- l. **[O]** Adequate clearance shall be provided for rodding out of drain valve connections.
- m. **[M]** Layout shall allow sufficient clearance and access to enable removal of equipment with mobile hoisting equipment.
- n. **[O]** Blinds heavier than 50 lb (25 kg) shall be equipped with a lifting handle. Blinds heavier than 100 lbs (50 kg) shall be oriented vertically and equipped for and accessible by a lifting device.
- o. **[M]** When possible, the clearance between the outside surface of any insulation system and adjacent equipment or structural members shall be not < 100 mm (4 in.).
- p. **[M]** Junction box installation shall be with the centerline of the box about 1.2 m (4 ft) above grade or platform. Location of junction boxes shall permit easy access for maintenance.

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6.2.15 Decision: System Selection

[*] [R] All austenitic stainless steel materials of the oil system shall be 316 grade.

6.3.3 Addition: Pressure Design Code

[M] Vessels smaller than the size required for a code stamp per ASME/BPVC SEC VIII D1 shall be manufactured as piping components only; code stamping is not required.

[S] Non-piping vessels shall be designed, fabricated and inspected in accordance with the most stringent of ASME (ASME SEC VIII D1 and ASME SEC VIII D2) and the local legally applicable code. All lube oil system vessels (filters, coolers, accumulators) are not to be code stamped.

6.4.1 Addition: Welding

Welding shall be in accordance with API RP 582.

6.5.2 Substitution: Baseplates

[C] [M] [O] The oil system shall be designed as a single fabricated steel console with all system components and related valves and manifolds on a common baseplate.

6.5.4 Substitution: Baseplates

[M] Non-skid metal decking covering of all walk and work areas shall be provided on the top of the baseplate. Openings in the top of the baseplates are acceptable only if voids are to be filled with grout that has a sand mixture added on top to provide a nonskid surface.

6.5.5 Substitution: Baseplates

[M] Decking surfaces shall be sloped to avoid the collection of liquids.

6.5.6.3 Substitution: Baseplates

[S] The lifting lugs or trunnions that are attached by welding and have continuous welds shall be tested as follows:

- a. Permanently attached lifting lugs, pad eyes and trunnions shall pass 100% radiographic or ultrasonic inspection in accordance with AWS D1.1/D1.1M.
- b. Materials that directly attach to lifting lugs, pad eyes and trunnions shall pass 100% radiographic or ultrasonic inspection in accordance with AWS D1.1/D1.1M.

6.5.7 Substitution: Baseplates

[M] All baseplates shall be provided with at least one opening or hole in each bulkhead section through which grout can be poured and vented, per API STD 614-6, Paragraphs 6.5.7.1 thru 6.5.7.6.

6.5.15 New: Baseplates

[S] Systems and skid designs shall have adequate spacing for safe access to equipment during routine operations and maintenance, as agreed between vendor and purchaser during a 3D model review.

6.6.1.5 Addition: Oil Reservoirs—General

[R] The oil reservoir shall be designed to withstand the negative pressure which may result from the use of an extraction type oil mist eliminator. If impractical, then a vacuum relief device shall be provided.

6.6.1.9 Substitution: Oil Reservoirs—General

[M] For installations other than offshore applications, pumps, heat exchangers, and filters shall not be mounted on top of the reservoir.

6.6.2.10 Substitution: Oil Reservoirs—Oil Connections and Internal Piping

[M] All reservoir pipe connections shall be flanged.

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6.6.3.1 Substitution: Oil Reservoirs—Manway and Drains

[M] [O] The bottom of each reservoir shall be sloped continuously, at least 20 mm/m (1/4 in./ft.) to a low point drain.

6.6.3.3 Substitution: Oil Reservoirs—Manway and Drains

[M] A flanged drain connection (with a valve and a blind flange) at least 50 mm (2 in.) in diameter shall be provided.

6.6.4.3.1 Substitution: Oil Reservoirs—Features

[O] [C] A reflex-type, welding-pad oil level glass (with stainless steel weld pad and carbon steel cover) shall be arranged to cover the span from at least 25 mm (1 in.) above the rundown level to 50 mm (2 in.) below the pump suction-loss level.

6.6.4.5 Substitution: Oil Reservoirs—Features

[O] A fill opening of at least 50 mm (2 in.) in diameter that automatically closes (normally held shut by a spring) shall be provided and shall also be equipped with a stainless steel 20 mesh (or finer) strainer basket that has an open area equal to 200% of the internal pipe area.

6.6.4.6 Decision: Oil Reservoirs-Features

[*] A blind-flanged vent connection at least 50 mm (2 in.) in diameter shall be provided on the reservoir.

6.6.5.13 Substitution: Oil Reservoirs—Extraction and Static Oil Mist Eliminator

[M] Suitable isolation and bypass valves shall be installed to allow for online maintenance of the oil mist eliminator.

6.6.7.4 Substitution: Oil Reservoirs—Capacity and Configuration

[O] [R] The working capacity between the minimum oil level and pump suction loss level in Figure G.1 of API STD 614-6 shall be sufficient for at least 5 minutes of normal flow.

6.6.7.5 Substitution: Oil Reservoirs—Capacity and Configuration

[O] [R] The minimum retention capacity shall be calculated based on 8 minutes of normal oil flow.

6.6.7.11 Substitution: Oil Reservoirs—Capacity and Configuration

[R] A low-level alarm shall be provided per USBT-000-TE-MR-EQS-0016, Table R-10 "Instrumentation for Lube Oil Systems in Critical Service".

6.6.7.12 Substitution: Oil Reservoirs—Capacity and Configuration

[R] The free surface of the oil in the reservoir shall be a minimum of 60 cm² for each liter per minute (0.25 ft.² for each gallon per minute) of normal flow.

6.6.8.2 Addition: Oil Reservoirs—Heating

[O] Unless otherwise specified, heaters shall be electric.

6.6.8.5 Substitution: Oil Reservoirs—Heating

[R] Temperature devices for remote monitoring and control shall be provided per Machinery Protection Systems _USBT-000-TE-MR-EQS-0016, Table R-10 "Instrumentation for Lube Oil Systems in Critical Service".

6.6.8.7 Substitution: Oil Reservoirs—Heating

[M] If electric immersion heaters are specified, then they shall be installed to allow for online removal for maintenance without interrupting operation of the oil system.

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6.6.8.8 Substitution: Oil Reservoirs—Heating

[O] [R] Vendor having unit responsibility shall submit a report for Owner's Engineer review that validates the heater capacity will satisfy the minimum heat-up timing requirements specified in API STD 614-6, Paragraph 6.6.8.2.2.

6.6.10.1 Substitution: Oil Reservoir—Plugged Connections

[O] Each reservoir shall be provided with one threaded and plugged connection above the rundown oil level that is at least 25 mm (1 in.) in diameter.

6.6.13.1 Substitution: Oil Reservoirs—Special Features

[M] [O] If the top of the oil reservoir contains equipment that requires routine access and is higher than 2 m (6 ft), then an accessible ladder with extended handrails shall be provided.

6.6.13.2 Substitution: Oil Reservoirs—Special Features

[S] If the top of the oil reservoir contains equipment that requires routine access and is higher than 2 m (6 ft), then handrails around the perimeter of the reservoir top shall be provided.

6.6.13.3 Substitution: Oil Reservoirs—Special Features

[S] If the top of the oil reservoir contains equipment that requires routine access and is higher than 2 m (6 ft), then non-skid surface decking (checker or diamond plate or hot-dipped galvanized steel grating) shall be provided on the top of the reservoir.

6.7.1.2 Addition: Pumps and Pump Drivers

- a. Centrifugal pumps shall be in accordance with JIP33 S-615 and rotary pumps shall be in accordance with USBT-000-TE-MR-EQS-0005.
- b. [M] Pump casings shall be steel or alloy steel.

6.7.1.3 Substitution: Pumps and Pump Drivers

[R] An electric-motor-driven standby pump, suitable for continuous operation, shall be provided for start-up and/or main-pump failure backup.

6.7.2 Substitution: Pumps and Pump Drivers

[O] [M] Pumps shall be external to the reservoir.

6.7.7 Substitution: Pumps and Pump Drivers

[O] [R] Unless otherwise specified, the main oil pump shall be motor driven and have an electrical feed independent from the source provided for the standby pump.

6.7.12 Addition: Pump and Pump Drivers

[*] Main and standby motor drives shall be in accordance with USBT-000-TE-EA-EQS-0005, USBT-000-TE-EA-EQS-0004, or Standardized Equipment Specifications, as specified.
All Motors shall be sourced in line with Exxon Mobil frame agreement.

6.7.13.d Addition: Pumps and Pump Drivers

[A] [R] Arrangements for booster pumps shall be submitted to Purchaser for approval by Owner's Engineer.

6.7.18 Decision: Pumps and Pump Drivers

[*] [R] Shaft driven pumps shall have check valves and bypasses arranged such that the shaft-driven pump continues to supply pressurized oil during periods of reverse rotation.

6.7.20.1 Substitution: Pumps and Pump Drivers

[M] Oil pump discharge PLVs shall be installed on vendor supplied piping.

6.7.21.1 Addition: Pumps and Pump Drivers

[M] [O] Oil pump discharge PLVs shall be routed back to the oil reservoir through sight flow indicators.

6.7.22.4 Substitution: Pumps and Pump Drivers

[R] Oil pump discharge PLVs shall not be used for continuous pressure regulation.

6.7.22.6 Substitution: Pumps and Pump Drivers

[M] Oil pump discharge PLVs shall be tight shutoff.

6.7.22.7 Substitution: Pumps and Pump Drivers

- a. [O] [M] Manual bypass valves shall be provided around each oil pump discharge PLV.
- b. [O] [R] Manual bypass valves shall be globe valves per API STD 614-6, Annex C schematics.

6.7.23.2 Addition: Pumps and Pump Drivers

[R] Bypass pressure regulating valves shall be located downstream of the oil coolers and upstream of the oil filters.

6.7.27.4 Decision: Pumps and Pump Drivers

[*] [M] Cone strainers (if applicable) shall be installed in spool pieces to minimize piping removed.

6.7.28 Addition: Pumps and Pump Drivers

[M] The design, location, and arrangement of strainers shall permit removal of the internal basket or element without removing the strainer body.

6.7.30 Substitution: Pumps and Pump Drivers

[O] [R] If a permanent strainer is being used, a compound-type pressure gauge shall be installed between the permanent strainer and the pump suction.

6.7.33 Addition: Pumps and Pump Drivers

For centrifugal pumps, coupling guards shall be per JIP33 (IOGP S-615), and for rotary pumps, coupling guards shall be per Positive Displacement Pumps – Rotary_USBT-000-TE-MR-EQS-0005.

6.7.35 Addition: Pumps and Pump Drivers

For centrifugal pumps, couplings shall be per JIP33 (IOGP S-615), and for rotary pumps, couplings shall be per Positive Displacement Pumps – Rotary_USBT-000-TE-MR-EQS-0005.

6.7.41 Addition: Pumps and Pump Drivers

- a. [O] [R] Couplings shall have a minimum continuous torque service factor of 1.5 based on the driver rating including any applicable driver service factor.
- b. [O] [R] Couplings shall have a minimum transient torque service factor as follows for the respective driver application:
 - i. Induction motor driven applications—400% of driver torque at 1.0 service factor.

6.7.45.1 Decision: Pumps and Pump Drivers

[*] [R] For drivers larger than 10 hp, mounting pads shall be provided for each pump and its driver.

6.7.45.5 Decision: Pumps and Pump Drivers

[*] When the drivers weight exceeds 45kg (100 lbs.) transverse and axial-alignment positioning jackscrews shall be provided for all pump drivers.

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6.8.1.2 Substitution: Heat Exchangers - General

[M] [R] Dual liquid-cooled heat exchangers shall be provided and shall be piped in a parallel arrangement using a continuous-flow transfer valve.

6.8.1.7 Addition: Heat Exchangers - General

[S] Vendor shall provide thermal overpressure protection of the water side of the heat exchangers by providing separate thermal relief valves on each heat exchanger.

6.8.1.15 Substitution: Heat Exchangers - General

[R] An oil bypass line around the heat exchangers with a temperature control valve shall be included to regulate the oil supply temperature.

6.8.1.15.3 Substitution: Heat Exchangers - General

[O] [R] The oil bypass valve shall be a flanged and pneumatically operated (air-to-open and fail-close), two port or three port, temperature control valve.

6.8.1.15.5 Decision: Heat Exchangers - General

Internal thermostat-operated three-port valves are not acceptable.

6.8.1.15.6 Substitution: Heat Exchangers - General

[O] The temperature control valve shall be provided with a manual override that permits operation independent of temperature conditions.

6.8.1.16 Substitution: Heat Exchangers - General

[O] Shell-and-tube or plate-frame coolers shall be suitable for use of a 150 °C (300 °F) heating medium.

6.8.1.20 Substitution: Heat Exchangers - General

[M] The heat exchangers shall be fabricated with flanged vent and drain nozzles. Screwed and seal-welded or socket-welded pipe and flange additions to the heat exchangers after certification are not acceptable.

6.8.1.21 Decision: Heat Exchangers - General

When cooler oil drains are required to be manifolded together with the filter clean-side oil drains it will be specified on the mechanical data sheets.

6.8.1.22 Substitution: Heat Exchangers - General

[M] [R] Vents on the oil side shall be routed back to the oil reservoir through sight flow indicators.

6.8.2.4 Substitution: Heat Exchangers - Shell-and-Tube Coolers

[M] [R] Nominal tube outside diameter shall be at least 16 mm (5/8 in.) and nominal tube wall thickness shall be at least 18 BWG [1.245 mm (0.049 in.)].

6.8.4.1 Substitution: Heat Exchangers - Air-cooled Heat Exchangers

[*] [M] [R] Unless otherwise specified by Owner's Engineer, for Downstream applications air-cooled heat exchangers shall not be used for un-spared equipment in critical services.

6.9.1.7 Addition: Filters

[M] [R] Vents shall be taken off the side of the filter housing and shall be located as high on the housing as possible; at a minimum above the top of filter element.

6.9.1.8 Substitution: Filters

[M] All connections on filter housings shall be flanged.

6.9.1.10 Substitution: Filters

[M] The oil filter housings shall be equipped with separate flanged valve vents and clean- and dirty-side flanged valve drain connections.

6.9.1.12 Substitution: Filters

[S] Oil filter housings shall be grounded with electrical grounding bonding cables to the baseplate.

6.9.3 Decision: Filters

[O] Oil from discharge of thermal relief valves shall be routed back to the reservoir.

6.9.6 Substitution: Filters

[M] [O] Filter vents shall be routed back to the oil reservoir through sight flow indicators.

6.9.7.e Substitution: Filters

[M] The maximum number of filter cartridges permitted in one stack is one (i.e., no stacking allowed).

6.9.7.h New: Filters

[R] The filter cartridge shall be retained by an internal hold down mechanism other than the filter housing cover, with stops, to prevent over tightening.

6.9.7.i New: Filters

[R] All inlets to filter housings, including the fill/equalization line or orifice, shall be designed to prevent direct impingement of an oil jet onto the filter element.

6.9.7.j New: Filters

[M] Seals or resilient seats for filter elements shall be part of the filter element, not on the filter housing or head.

6.9.14 Substitution: Filters

[O] [R] One sample point shall be provided for each oil reservoir and one downstream of the lube oil filters.

6.10.2 Substitution: Transfer Valves

[R] Transfer valves shall be two three-way ball valves with resilient seats, tight shutoff and permanently aligned and joined with a single operating lever.

6.10.6 Addition: Transfer Valves

[M] Spectacle blinds shall be provided.

6.11.1 Substitution: Accumulators

[O] [R] An accumulator shall be provided for all oil systems.

6.11.2 Substitution: Accumulators

- a. [C] If the required accumulator capacity is less than 150 L (40 gal), then a bladder-type accumulator per Figure C.18 of API STD 614-6 shall be provided.
- b. [*] [O] If the required accumulator capacity exceeds 150 L (40 gal), then a direct-contacting (bladderless) type accumulator per Figure C.19 of API STD 614-6 shall be provided.

6.11.3 Substitution: Accumulators

[M] [O] If a direct-contact-type accumulator is specified, a manual precharge valve (including check valve) and a 100 mesh stainless steel element Y strainer shall be provided.

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6.11.8 Addition: Accumulators

- a. [R] For systems that have motor driven standby oil pumps, the accumulator shall be designed to maintain lubrication and control oil pressure for a minimum of 5 seconds.

6.11.9 Addition: Accumulators

[R] Accumulator vessels shall be made of austenitic stainless steel.

6.11.20 New: Accumulators

[M] [R] Direct-contact-type accumulators shall be equipped with flanged opening(s) to permit hand cleaning.

6.12.2.6 Substitution: Lube-oil Rundown Tanks

[R] For pressurized rundown tanks, a bypass orifice around the ball float check valve shall be provided per Figure C.16 of API STD 614-6.

MODIFICATIONS TO SECTION 7: PIPING

7.1.1.1 Addition: General

Piping design and joint fabrication, examination, and inspection shall be in accordance with ASME B31.3 and the additional requirements of Piping Fabrication Shop or Field per USBT-000-TE-MP-PSP-0002, 7.1.1.1A and 7.1.1.1B below-

7.1.1.1A

- a. [R] Steel flanges mating to flat-faced cast iron flanges shall be flat faced. Full-faced gaskets shall be used.
- b. [S] Proprietary flanged piping connectors, quick opening closures, or clamps shall not be used without prior approval by Owner's Engineer. Equipment that is provided with a Company-approved quick-opening closure shall incorporate the following additional design features:
 - a) A vent valve that is located such that vent operation shall be outside of the opening path of the quick opening closure or its potential failure path.
 - c. [S] b) A pressure gauge, easily visible from the location of the quick opening closure and vent valve.
- d. [C] Cast iron flanges are permitted only if furnished as integral flanges on cast iron piping or equipment.
- e. [R] Threaded flanges on cast iron or ductile iron pipe shall be of steel.
- f. [R] Aluminum alloy flanges shall be either wrought or forged forms. Casting shall not be used.

7.1.1.1B

- a. [S] This Section covers impact testing requirements for pressure vessels, piping, and machinery. Impact requirements shall be based on the CET established by Owner's Engineer.
- b. [R] Preservation shall be provided for fixed equipment to prevent corrosion and deterioration from the effects of environmental conditions during shipping, storage, and construction.
- c. [A][R] Procedures for protection shall be submitted to Owner's Engineer for review. Procedures shall include protective measures, inspection, maintenance, and removal of preservatives. Selection of preservation methods shall consider their environmental impact during removal or disposal.
- d. [R] If preservatives are removed for inspection or testing at any time prior to commissioning, they shall be reapplied upon completion of the work.
- e. [A][R] Stainless steel surfaces shall be protected against contamination by iron-containing dust and fumes from grinding, welding, wire brushing, and other manufacturing operations. All internal and external surfaces of stainless steel shall be clean and bright. Contaminated surfaces and

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weldments showing heat tints, other than bright and yellow, require pickling and passivation. Other cleaning processes require Owner Engineer approval.

- f. **[R]** Nozzles, manholes, vents, and connection openings on pressure vessels shall be blanked to prevent moisture from entering. A 0.2 in. (5 mm) thick, gasketed steel blind shall be used, held in place by a minimum of four bolts.
- g. **[R]** Threaded openings in equipment shall be closed with threaded stainless steel pipe plugs. Stainless steel equipment or components shall not be exposed to salt water or salt spray. If this occurs, then exposed external surfaces shall be washed with potable water containing less than 250 ppm chloride ions (Cl⁻) and dried.
- h. **[R]** Stainless steel shall not be stored outdoors in direct contact with or within 12 in. (300 mm) of the soil or in contact with porous or moisture retaining supports such as raw wood.
- i. **[R]** During construction, precautions shall be taken to prevent the introduction of water into stainless steel equipment as a result of washing or hydrotesting other connected equipment.

7.1.8.b Addition: General

[A] [R] Flexible piping elements including bellows shall not be used without prior approval of Owner's Engineer.

7.1.8.j New: General

[R] All pressurized piping downstream of oil filters shall be free from internal obstructions and dead legs that could accumulate dirt.

7.1.9 Addition: General

- a. **[A] [M]** Vendor's proposed piping system layout with regard to application of flanges shall not be finalized without Owner's Engineer approval.
- b. **[M]** Blind flanges shall be installed at dead ends of all piping.

7.1.13 Addition: General

[R] Tubing fittings shall have rolled threads.

7.1.15 Addition: General

[R] With the exception of instruments or locations that require disassembly for maintenance, threaded joints shall be seal welded.

7.1.21 Substitution: General

[M] Tubing size shall not exceed DN 25 (1 in.).

7.1.25 Substitution: General

[O] Tapped openings shall be supplied with threaded, non-seal-welded, round-head, solid stainless steel plugs per ASME B16.11.

7.1.27 Addition: General

- a. **[R]** Weld neck flanges shall be used on oil supply piping downstream of the oil filters.
- b. **[C]** For line sizes greater than 25 mm (1 in.) NPS, slip-on flanges may be used upstream of the oil filters and on oil drain lines.

7.1.28 Addition—General

[M] [R] Flanges and valve internals that contain oil shall be made of stainless steel. For steam turbine applications, all valves downstream of oil filters shall be stainless steel.

7.1.30 Substitution: General

[R] Soft-seated and wafer-type check valves shall not be used.

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7.1.37 Substitution: General

[C] Each utility such as air and inert-gas supply, cooling water supply and return lines and others as specified shall be manifolded to a common connection.

7.1.42 New: General

[S] Vents to safe locations shall not be manifolded.

7.1.40 Addition: General

Valves shall be per Technical Notes for Valves_USBT-000-TE-MP-PSP-0005 .

7.2.1.g Addition: Lubricating, Control and Seal Oil Piping

[R] Lube/control oil drain lines shall have a minimum line size of DN 50 (NPS 2).

7.3.3 Addition: Instrument Piping and Tubing

Instrumentation & installation shall conform to requirements specified under instrument section of respective equipment Technical Notes.

7.3.5 Substitution: Instrument Piping and Tubing

[R] Heads of oil-actuated control valves shall be vented back to the oil reservoir through restriction orifices.

7.3.7 Substitution: Instrument Piping and Tubing

[R] Instrument valves for oil and gas service located in sensing lines downstream of a primary service block valve may be bar-stock instrument valves, provided the instrument valves are protected against accidental disassembly. Valves shall be stainless steel with stainless steel shims.

7.3.13 Substitution: Instrument Piping and Tubing

[M] Instrument manifold valves shall be provided.

MODIFICATIONS TO SECTION 8: INSTRUMENTATION, CONTROL AND ELECTRICAL SYSTEMS

8.1.2 Addition: General

Instrumentation & installation shall conform to requirements specified under instrument section of respective equipment Technical Notes.

8.1.4 Substitution: General

[R] Instrument and control terminal boxes shall be Type 316 stainless steel and shall be bottom entry design.

8.1.5 Substitution: General

[R] Outdoor junction boxes or enclosures and shall be weatherproof and watertight to NEMA 4X per NEMA 250 or to IP66 per IEC 60529. Junction boxes shall be approved for the area classification by approving authorities such as British Approvals Service for Electrical Equipment for Flammable Atmospheres (BASEEFA), Factory Mutual (FM), CSA, etc.

8.1.11 New: General

[R] Pneumatic-control valves using instrument air shall have a filter, a pressure-reducing valve, and a pressure gauge to indicate the reduced pressure. A combination filter regulator with gauge may be used. Filter body and regulator valve body (or combined filter-regulator body) shall be of metal construction.

8.2.1.3 Addition: Alarm, Shutdown and Control Systems—General

[O] [R] Unless otherwise specified, isolation valves for shutdown sensing devices shall be provided and car-sealed in the full open position.

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8.2.1.4 Addition: Alarm, Shutdown and Control Systems—General

[O] HOA starting switches shall be provided for all auxiliary motors.

8.2.2.2 Addition: Alarm, Shutdown and Control Systems—Alarm, Shutdown and Trip Systems

[R] Alarms, shutdowns and permissive shall be per Table R-10 of USBT-000-TE-MR-EQS-0016 (Instrumentation for Lube Oil Systems in Critical Service).

8.2.3.1 Addition: Alarm, Shutdown and Control Systems—Alarm and Shutdown Arrangements

Alarm and shutdown arrangements shall be per Machinery Protection Systems_USBT-000-TE-MR-EQS-0016.

8.3.1.7 Addition: Instrumentation—Instrument Installation and Gauge Boards

[O] [R] The DCS or PES shall not be used for oil system pressure or level control. Control of oil system pressure or level shall be via self-regulating instrumentation. Local display of status and monitoring can be done via DCS or PES.

8.3.1.11 Addition: Instrumentation—Instrument Installation and Gauge Boards

[M] [R] Each instrument, switch, and similar device shall have a stainless steel nameplate on or adjacent to the device showing its process identification and services. All plugs and sockets used for instrument connection shall be labeled with the appropriate corresponding instrument identification.

8.3.1.16 New: Instrumentation—Instrument Installation and Gauge Boards

[A] [C] [O] Owner's Engineer shall approve the proposed layout of components and piping prior to Manufacturer of the oil system proceeding with fabrication.

8.3.1.17 New: Instrumentation—Instrument Installation and Gauge Boards

[M] Instruments shall be pre-wired and terminated in a local terminal box.

8.3.9.4.g New: Instrumentation—Oil Sight Flow Indicators

[O] All sight flow indicators shall be provided with positive mechanical flow indication (i.e. paddle wheel, rotating assembly, or any equivalent designs).

8.3.11.11 New: Instrumentation—Pressure-limiting Valves and Pressure Safety Relief Valves

PSVs shall be in accordance to GP 03-15-01D.

8.3.11.12 New: Instrumentation—Pressure-limiting Valves and Pressure Safety Relief Valves

a. [M] Each PSV and PLV shall have isolation valves in the supply and outlet line.

b. [S] Each PSV and PLV supply and outlet line isolation valves shall be car sealed open.

8.3.12.10 New: Instrumentation—Control Valves and Regulators

[M] All control valves shall be supplied with isolation, bleed, and bypass valves allowing uninterrupted operation of the lube oil system should valve replacement become necessary. Bypass valves shall be globe valves per API STD 614-6, Annex C schematics.

8.4.7 Addition: Electrical Systems

[M] [O] Terminal strips shall have block identification markers to indicate polarity, ground connections, and any other pertinent information. Wiring at terminal blocks shall be tagged with permanent sleeve-type tags.

8.4.13 Addition: Electrical Systems

[M] All internal control panel wiring shall be run in plastic wire-way or Company-approved equivalent wire ducting.

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MODIFICATIONS TO SECTION 9: INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

9.1.2 Substitution: General

[A] Purchaser's representative and Vendor's representative shall indicate compliance with the Inspector's checklist by initialing, dating, and submitting the completed checklist to Purchaser before shipment.

9.1.5 Addition: General

[C] An inspection coordination meeting, including Purchaser, Owner's Engineer, and Vendor shall be held to coordinate manufacturing hold points and inspector visits.

9.2.1.3 Substitution: Inspection—General

[R] Non-stainless steel piping spools shall be hydrotested prior to painting.

9.2.2.3.1 Addition: Inspection—Material Inspection of Pressure Vessels and Piping Systems

Material shall have PMI inspection per GP 18-03-04D if it meets the requirements listed in Positive Material Identification (18-03-04D), Section 3 "Specific Applicability."

9.3.2.1 Substitution: Testing—Hydrostatic Test

[R] Pressure-containing parts, including auxiliaries, shall be tested hydrostatically with oil at a minimum of 1.5 times the MAWP unless limited by the hydro test pressure of a component in the system that has been hydro tested to 1.3 times its MAWP.

9.3.2.2 Substitution: Testing—Hydrostatic Test

[R] The assembled and piped oil console or oil console subassemblies (inclusive of all instrument tubing and fittings) shall be hydrostatically tested per Paragraph 9.3.2.1 of this specification. Removal of spools, screens, or the loosening of flanges following a successful hydrotest does not void the original hydrotest.

9.3.2.6.2 Addition: Testing—Hydrostatic Test

[R] If any leaks occur, the test shall not be considered satisfactory until after corrections are made and neither leaks nor seepage is observed.

9.3.3.1 Addition: Testing—Operational Tests

[O] The operational test procedure shall include a marked-up P&ID that indicates the location of temporary jump overs and the test flow and pressure instruments.

9.3.3.4 Substitution: Testing—Operational Tests

[O] The running tests shall be conducted under normal system operating conditions for at least 4 hours, with system parameters recorded at least every 30 minutes. The operational tests may be done concurrently within the 4 hours.

9.3.3.9 Addition: Testing—Operational Tests

[A] The use of alternative drivers shall require Owner's approval.

9.3.3.10.b Addition: Testing—Operational Tests

[R] It shall be demonstrated that each PLV will lift with an accumulation that does not exceed 110% of the system design pressure.

9.3.3.10.c Addition: Testing—Operational Tests

[M] [O] During the operational tests the transfer valves shall be demonstrated to have a tight shutoff.

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9.3.3.10.k New: Testing—Operational Tests

[R] The reservoir shall be drained to the low-level alarm point during the test to verify suction vortexing is not occurring.

9.3.3.10.l New: Testing—Operational Tests

[O] The filter differential pressure shall be measured and recorded at the minimum oil temperature with the normal system flow and pressure.

9.3.3.12 Substitution: Testing—Operational Tests

[M] [O] [R] System cleanliness shall be demonstrated prior to, as well as after the operational testing.

9.4.9 Addition: Preparation for Shipment

[S] Plastic plugs are not permitted, including temporary plugs used for shipping.

9.5.8 Substitution: Preparation for Shipment

[M] One copy of Manufacturer's standard installation instructions shall be packed and shipped with the equipment.

MODIFICATIONS TO SECTION 10: VENDOR'S DATA

10.4.3.2 Substitution: Contract Data—Technical Data

[R] Certified copies of successful test data shall be submitted for Owner's Engineer review and approval prior to shipment of the oil console.

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HOLD STATUS

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1. INTRODUCTION

1.1 Project Overview

“ExxonMobil Corporation (“COMPANY”) has awarded a CONTRACT to Technip Energies India (“CONTRACTOR”) for performing the FEED and EP work for reconfiguring COMPANY’s BAYTOWN refinery to produce a more resilient product slate, while enabling future GHG emission reductions.

The project includes scope in three major areas of the refinery: the Hydrocracking Unit (HCU-1), the Raffinate Hydro-Conversion Unit (RHC) and Offsites and Utilities.

The project will convert the HCU-1 to a lubes hydrocracker, using light Virgin Gas Oil (VGO) streams as charge to be cracked into diesel and additional feed from HCU-1 will be supplied to the RHC to produce the light-neutral grades”.

2. REFERENCES

2.1 Required References

[*] This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced Specifications may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

2.1.1 Industry Standards

| Industry Standard Number | Industry Standard Title |
|--------------------------|---|
| ANSI B11/STD B11.19 | Performance Requirements for Risk Reduction Measures: Safeguarding and other Means of Reducing Risk |
| API STD 671-5 | Special-purpose Couplings for Petroleum, Chemical, and Gas Industry Services - Fifth Edition |
| BSI BS EN ISO 14120 | Safety of Machinery - Guards - General Requirements for the Design and Construction of Fixed and Movable Guards |
| ASME B1.20.2M | Pipe Threads, 60 deg, General Purpose |

2.2 REQUIREMENT DESIGNATION

Certain paragraph/s are preceded by bracketed uppercase letter. Below is the meaning of each designation.

| Acronym | Definition |
|---------|---|
| [S] | <ol style="list-style-type: none"> 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool |

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|------|--|
| | fire effects on surrounding equipment or running pool fires in drainage pathways). |
| [O] | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| [A] | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| [E] | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| [R] | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| [M] | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| [C] | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| [CS] | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| [*] | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |

3. REVISIONS TO API STANDARD 671-5TH EDITION

- 3-1** API STD 671-5 (API Standard) shall be used as modified by this Specification, unless superseded by more stringent local regulations. This Specification is intended to supplement the API Standard and not replace it. All headings and paragraph or clause numbers contained herein correspond to those in the API standard. Sections not modified shall be followed as written in the API Standard.
- 3-2** Specific definitions of the terms "new," "addition," "substitution," and "deletion" are shown directly below:
- i. "New"—New clause that does not currently appear in the API standard. Text in this specification is accompanied by a clause number not currently existing in the API standard.
 - ii. "Addition"—Text added to a clause already in the API standard, but not overwriting any of the text currently in the API standard. Text in this specification does not modify or overwrite the API standard text in any way. The reader shall read and follow both the API standard text and this specification clause text.

- iii. "Substitution"—Text wholly replaces the text currently in the API standard. Text in this specification is wholly taking the place of the API standard text. The reader shall ignore the API standard text and only follow the clause text of this specification.
- iv. "Modification" – Specific revisions have been made to the text currently in the API standard.
- v. "Deletion"—Wholly deletes the text currently in the API standard. Text in this specification is stating that the API standard text shall not be followed.
- vi. "Decision" – Text in this specification makes a decision that was required.

MODIFICATIONS TO SECTION 1: SCOPE

1.a. Addition: Scope

- a. [R] Proposal shall include an experience list demonstrating experience for the proposed coupling.
- b. [R] Vendor shall have manufactured at the proposed point of manufacture at least two couplings of comparable rating (e.g., speed, power, and environmental conditions) and operating satisfactorily for at least 1 year.

1.b. Addition: Scope

[R] If qualification requirements prevent application of the latest technology, Vendor may submit an alternative proposal, specifically identifying the undemonstrated features and stating the advantages.

MODIFICATIONS TO SECTION 5: COUPLING SELECTION

5.1. Addition: Coupling Selection

- a. [M] [R] Couplings shall be a metallic flexible element (disc or diaphragm) non-lubricated type.
- b. [A] Alternative coupling designs may be proposed for use at or below 3,600 rpm when required to increase system torsional damping. Such proposals shall be submitted to the Purchaser for Owner's Engineer approval.

MODIFICATIONS TO SECTION 6: COUPLING DESIGN

6.8. Substitution: Coupling Design

[O] Coupling service factors shall be as specified in Table 1: Minimum Coupling Service Factors and Transient Torques.

Table 1: Minimum Coupling Service Factors and Transient Torques

| Application | Minimum Coupling Service Factor ^{(1) (2)} | Minimum Transient Torque (% of Driver Torque at 1.0 Service Factor) |
|-------------------------|--|---|
| Electric Motor Drivers: | | |
| Induction Type | 1.5 | 400% |
| Synchronous Type | 1.5 | 500% |

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| Location | Baytown, Texas | | | | | | |
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Notes:

(1) Based on max continuous steady-state operation.

(2) For torsional damping and resilient couplings the minimum service factor shall be 3.0.

6.11. Substitution: Coupling Design

[O] If the machine train is driven by an induction motor, then the coupling, coupling to shaft juncture, and the machine shafts shall be able to transmit, without damage, 115% of the maximum transient torque from the torsional analysis; or the transient peak torque listed in Table 1: Minimum Coupling Service Factors and Transient Torques, whichever is greater.

6.14. Substitution: Coupling Design

[O] The service factor for the coupling-to-shaft juncture shall be, at a minimum, 0.25 greater than the minimum coupling service factors for steady-state operation listed in Table 1: Minimum Coupling Service Factors and Transient Torques.

6.19. New: Coupling Design

[R] All bolting requiring a torque in excess of 135 N-m (100 ft-lb) shall be tightened based on elongation of the bolt, not by torque value.

MODIFICATIONS TO SECTION 8: COUPLING REQUIREMENTS

8.1.6. Substitution: Metallic Flexible Element Couplings

[R] For equipment with variable operating speeds, couplings shall incorporate a feature that allows transmission of load for a limited period in the event of a complete flexible element failure.

8.1.7. New: Metallic Flexible Element Couplings

[R] Shims shall be designed and built to ensure that they are positively centered by the adjoining coupling flanges.

8.3.1. New: Spacer

[M] The coupling shall be designed and built to allow easy removal of the spacer without the use of tooling that directly contacts the flexible element surfaces for compressing flexible elements.

8.6.1.2. Addition: Hubs—Removable Hubs

[R] Keyed hubs are acceptable on motor shafts. All other equipment shall have either a keyless hydraulic tapered hub, a straight hydraulic clamped style hub, or an integral shaft end.

8.6.2.1. Substitution: Hubs—Tapered-bore Hubs

[M] Keyless hydraulically fitted hubs shall have the following taper:

- a. For shaft ends of 101.6 mm (4 in.) diameter and less, the coupling taper shall be 1 degree.
- b. For shaft ends greater than 101.6 mm (4 in.) diameter, the coupling taper shall be 1:24.

8.6.2.6. New: Hubs—Tapered-bore Hubs

- a. [R] Shaft end and retaining-nut threads shall be designed and built to withstand at least twice the stress resulting from the force tending to push the hub down the taper, based on the maximum possible hydraulic mounting pressure.
- b. [R] The maximum hydraulic mounting pressure is the maximum rating of the hydraulic pump provided by the party specified in the API STD 671-5 Data Sheet.

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| Project | BAYTOWN GOLD | | | | | | |
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8.6.2.7. New: Hubs—Tapered-bore Hubs

[M] Proposal shall indicate if O-rings will be used on hydraulically mounted hubs.

8.6.2.8. New: Hubs—Tapered-bore Hubs

[R] All O-rings used with hydraulically mounted hubs shall be fitted with a pressure backup ring to prevent O-ring extrusion.

8.6.2.9. New: Hubs—Tapered-bore Hubs

[R] For all tapered-bore hydraulic-mounted hubs greater than 178 mm (7 in.), Vendor shall complete the following:

- a. Provide a finite element analysis that demonstrates that, in both the mounted and dilated condition, there will be no local yielding of the hub or stress concentrations that exceed Vendor's design practices.
- b. Perform mounting and removal of the hub as a witnessed shop inspection point. The procedures and hydraulic tooling used for the test will be those recommended for the specific coupling.

8.12.4 Decision: Dynamics

[*] [R] Delete wording "if specified". The torsional stiffness tolerance range (+/-) shall be indicated on the coupling drawing.

MODIFICATIONS TO SECTION 9: BALANCE

9.1.3. Substitution: Balance—General

[M] [R] Couplings operating at speeds 1,800 rpm or less, shall be balanced by method 1; couplings operating at speeds greater than 1,800 rpm shall be balanced by method 2.

9.2.2.2. Substitution: Method 2—Component Balance with Assembly Check Balance

[R] Couplings balanced to balance method 2 shall be subjected to a repeatability check as described in Paragraph 9.3.9.

9.3.9. Substitution: Balance Criteria—Repeatability Check

- a. [R] For couplings balanced to balance method 2, a repeatability check shall be completed after the assembly check balance to ensure that the requirements of API STD 671-5, Paragraph 9.3.6 "Assembly Check Balance" are achieved.
- b. [R] For the repeatability check, the coupling shall be disassembled to the same extent required for normal field disassembly and remounted on the balance fixture or fixtures. The unbalance of the reassembled coupling shall then be measured on the balancing machine; the residual unbalance, U , expressed in gram-millimeters (ounce-inches), shall not exceed the greatest value determined by Equation (10) to Equation (12) in API STD 671-5.

9.4. Addition: Trim Balance Holes

[M] If the coupling design incorporates trim balance holes, the trim balance holes shall not be used during shop balancing of the coupling.

MODIFICATIONS TO SECTION 10: MATERIALS

10.4. Decision: Materials

[*] [R] When the process includes corrosive agents, the supplier shall provide in the proposal, recommendations and details for protection of the coupling assembly. When 4100 and 4300 Series flexible elements are used, they shall be suitably coated for corrosion resistance.

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| Project | BAYTOWN GOLD | | | | | | |
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10.5. Addition: Materials

[A] [R] For diaphragm type couplings, if Vendor manufacturing experience limits application of corrosion resistant materials, then Vendor shall submit specifications regarding the proposed paint/epoxy coating to Purchaser for Owner's Engineer approval.

10.6. Decision: Materials

[*] [R] Unless otherwise specified on the mechanical data sheets, all other parts not covered under API standard paragraph 10.5, shall preferably be made of corrosion-resistant material or coated with a suitable corrosion-resistant coating.

MODIFICATIONS TO SECTION 11: ACCESSORIES

11.2.1. Addition: Accessories

[M] The following shall be furnished with hydraulically fitted couplings: one complete set of all necessary pump(s), hose and fittings, pressure gauges, instructions for mounting fixture tools, and a recommendation as to the hydraulic fluid required for the installation and removal of hydraulically fitted coupling hubs. The tubing and hose fittings employed shall all be of the same manufacturer.

11.2.3. Decision: Accessories

[*] [M] The coupling supplier shall furnish a 2-piece stop ring to facilitate the installation of the coupling hub on the shaft.

11.2.4. Decision: Accessories

[*] [M] The coupling supplier shall furnish a puller for all keyed-coupling hubs.

11.2.5. Decision: Accessories

[*] [A] [M] When tapered shafts are provided for either the driver and driven equipment, the coupling supplier shall provide a set of matched plug and ring gauges for each shaft end.

11.2.6. Decision: Accessories

[*] [M] A lapping tool set shall be provided by the coupling supplier for each coupling hub assembly and the follows the requirements as stated in this API standard paragraph.

MODIFICATIONS TO SECTION 12: MANUFACTURING QUALITY, INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

12.1.3. Substitution: Manufacturing Quality

[M] [R] Parts of duplicate couplings, except for meshing gear components, shall be manufactured within tolerances that permit interchangeability or replacement of parts in the field with minimal fitting.

12.3.6. Decision: Inspection

[*] [R] Delete wording "if specified". The purchaser's representative and the vendor's representative shall indicate compliance in accordance with an inspector's checklist such as that provided in Annex M by initialing, dating, and submitting the completed checklist to the purchaser before shipment.

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MODIFICATIONS TO ANNEX C: GEAR COUPLINGS

C.1.3. Addition: General

[A] [M] [R] Gear couplings shall not be used without prior written approval by Owner's Engineer.

C.2.2. Substitution: Coupling Selection

[O] Coupling service factors shall be per Table 1: Minimum Coupling Service Factors and Transient Torques.

MODIFICATIONS TO ANNEX D: QUILL-SHAFT COUPLING

D.2.4. Substitution: Coupling Selection and Design

[O] Service factors shall be per Table 1: Minimum Coupling Service Factors and Transient Torques.

MODIFICATIONS TO ANNEX H: COUPLING GUARDS

H.2.1. Addition: General Requirements for All Guards

[M] The driven equipment Vendor shall be responsible for the supply of all coupling guards in the equipment train.

H.2.2. Addition: General Requirements for All Guards

[R] Coupling guards shall be fully enclosed and oil tight.

H.2.4. Addition: General Requirements for All Guards

[M] Removal or partial disassembly of the coupling guard shall permit inspection of the coupling without disassembly of the coupling.

H.2.8. Addition: General Requirements for All Guards

[R] Equipment guards shall meet the requirements of ANSI B11/STD B11.19 and BSI BS EN ISO 14120, as applicable for the intended location of use, or similar local regulations.

H.2.10. Addition: General Requirements for All Guards

[M] [O] Coupling guards in hazardous areas shall be constructed entirely of spark-resistant metallic materials.

H.2.13. Substitution: General Requirements for All Guards

[R] The maximum internal enclosure temperature at the maximum continuous speed shall be calculated based on the maximum ambient temperature and using the surface temperature calculated in API STD 671-5 H.2.12. These calculations shall be provided to Purchaser for Owner's Engineer review.

H.2.17 Substitution: General Requirement for All Guards

[A] [C] Oil spray cooling of coupling guards shall not be used to achieve the required coupling guard temperature without approval from Owner's Engineer.

H.4.1.c Substitution: Fully Enclosed Guards

[*] [R] Coupling guard assembly shall be capable of allowing for axial growth while maintaining a seal. Unless otherwise approved by Owner's Engineer, the sealing for the axial growth shall be provided using a flexible metallic bellows. If Owner's Engineer approves a sliding O-ring design (e.g. a slip joint at one end of the guard with two O-rings), then segmented O-ring seals shall not be used.

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| Location | Baytown, Texas | | | | | | |
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H.4.3. Substitution: Fully Enclosed Guards

[R] Fully enclosed guards shall be oil tight and provided with vent and drain connections. At a minimum, these vent and drain connections shall be DN 50 (NPS 2) (or metric equivalent per ASME B1.20.2M). The drain connection shall be flanged. The connections for coupling guard vent and drain(s) shall be designed and built to accommodate thermal expansion as determined by Vendor with train responsibility.

H.4.5. Addition: Fully Enclosed Guards

[R] Coupling guard vent filters shall be sized for at least the expected air flow required from Coupling Guard Supplier surface temperature calculations. Per Paragraph H.4.3. flanged drain connections, at a minimum, shall be DN 50 (NPS 2).

H.4.8. Substitution: Fully Enclosed Guards

[R] The contract guard shall be used when the contract coupling is factory tested with the driver and driven equipment.

MODIFICATIONS TO ANNEX O: PARTS LISTS AND RECOMMENDED SPARES

O.3.4.7. Addition: Parts Lists and recommended Spares

Vendor to include following spares in their scope, as a minimum:

- a. A full spare coupling with hardware
- b. Shims/Disc packs
- c. Distance piece/hubs

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MACHINERY PROTECTION SYSTEM API STANDARD 670 FIFTH EDITION

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HOLD STATUS

This revision has the following HOLDS:

| SECTION | PARAGRAPH NO. | DESCRIPTION OF HOLD |
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1. INTRODUCTION

1.1 Project Overview

“ExxonMobil Corporation (“COMPANY”) has awarded a CONTRACT to Technip Energies India (“CONTRACTOR”) for performing the FEED and EP work for reconfiguring COMPANY’s BAYTOWN refinery to produce a more resilient product slate, while enabling future GHG emission reductions.

The project includes scope in three major areas of the refinery: the Hydrocracking Unit (HCU-1), the Raffinate Hydro-Conversion Unit (RHC) and Offsites and Utilities.

The project will convert the HCU-1 to a lubes hydrocracker, using light Virgin Gas Oil (VGO) streams as charge to be cracked into diesel and additional feed from HCU-1 will be supplied to the RHC to produce the light-neutral grades”.

2. REFERENCES

2.1 Required References

[*] This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced Specifications may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

2.1.1 References

| Reference | Reference Title |
|-------------------------|---------------------------------|
| USBT-000-TE-IN-SPC-0013 | Package Equipment Specification |

2.1.2 Industry Standards

| Industry Standard Number | Industry Standard Title |
|--------------------------|--|
| API STD 670 | Machinery Protection Systems |
| IEC 61508 | Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems (Active Parts) |

2.2 Acronyms and Definitions

2.2.1 Acronyms

| Acronym | Description |
|---------|-----------------------------|
| AC | Alternating Current |
| CMS | Condition Monitoring System |
| CPU | Central Processing Unit |

| Acronym | Description |
|---------|--|
| DCS | Distributed Control System |
| dP | Differential Pressure |
| EBV | Emergency Block Valve |
| EMS | Equipment Monitoring System |
| EVFD | Engineered Variable Frequency Drive |
| GODS | Governor Overspeed Detection System |
| HAZOP | Hazard and Operability Review |
| HMI | Human-Machine Interface (Monitor, Keyboard, and Mouse or Touch Screen) |
| I/O | Input/Output |
| IODS | Independent Overspeed Detection System |
| KO | Knock-out |
| LAN | Local Area Network |
| LP | Local Panel |
| MMS | Machinery Monitoring System |
| MPS | Machinery Protection System |
| ODS | Overspeed Detection System |
| PCV | Pressure Control Valve |
| PES | Programmable Electronic System |
| PFD | Probability of Failure on Demand |
| PLC | Programmable Logic Controller |
| RIB | Remote Instrument Building |
| RIE | Remote Instrument Enclosure |
| RTD | Resistance-Temperature Detectors |
| SIS | Safety Integrity Level |
| SOV | Solenoid Operated Valve |
| STR | Spurious Trip Rate |
| TEAAC | Totally Enclosed Air-to-Air-Cooled |
| TEWAC | Totally Enclosed Water-Air-Cooled |
| TMR | Triple Modular Redundancy |
| TTV | Turbine Trip and Throttle Valve |

| Acronym | Description |
|---------|------------------------------|
| UPS | Uninterruptible Power Supply |
| VFD | Variable Frequency Drive |
| VIGV | Variable Inlet Guide Vane |

2.2.2 Definitions

| Term | Definition |
|---|---|
| Availability Target | The statistical probability that the protective system is operational and can properly respond to a process demand at some instant in time. The availability target is based on the Probability of Failure on Demand (PFD) as follows: Availability = 1-PFD. |
| Critical Machinery | Any piece of equipment for which a single downtime event results in cost exceeding \$1M. |
| Failure Action | The resulting action of the protective system upon loss of energy (e.g., electrical power, instrument air), or failure of M-out-of-N voting redundant components. There are two possible protective system failure actions: |
| Final Element | A device, such as a valve or motor, used to bring the process to its safe state in response to a signal from the protective system logic. The final element may have devices associated with it, such as solenoid valves, pneumatic components, and actuators. For the steam turbine, the final element is the Turbine Trip and Throttle Valve (TTV) driven by solenoid-operated oil dump valves. |
| Governor Overspeed Detection System (GODS) | Module that is usually part of the Speed Control System, separate from the Independent Overspeed Detection System (IODS) System. |
| Human Machine Interface (HMI) | A system that displays graphics of schematic and textual information to the operator through an electronic display panel (e.g., LCD monitor) and includes provisions for accepting control commands from the operator through a touchscreen, pointing device, or keyboard. |
| Independent Overspeed Detection System (IODS) | Overspeed detection system that is completely independent of the protective system |
| Local Panel (LP) | Local panel for start-up, shutdown, and general maintenance monitoring of a machine. LP may consist of only HMI screens and necessary control functions and may be mounted on compressor deck and/or nearby Remote Instrument Enclosure (RIE). LPs provide mounting for all indicating instruments and controllers for process and auxiliary system variables required by the Operator to place the machine in process service. |

| Term | Definition |
|--|--|
| Logic Solver | A component or group of components that receives inputs from sensors, performs a predetermined decision-making function, causes final elements to assume a protective position, and provides alarms. Technologies used to implement logic include the following: |
| Machinery Monitoring System (MMS) | System for high-speed data collection and correlation. Also called the Equipment Monitoring System (EMS) or Condition Monitoring System (CMS). |
| PES Logic Configurations | The following two PES logic configurations are typically used in Company's protective systems: |
| Probability of Failure on Demand (PFD) | A value that indicates the probability of a protective system failing to respond to an initiating event. |
| Programmable Electronic System (PES) | A type of logic technology (e.g., Microprocessor based devices such as Programmable Logic Controllers [PLCs]). |
| Protective System | A component, group of components, or system that reduces risk by preventing or mitigating the consequences of a hazard. A protective system responds to a process demand and brings a process to its safe state. Such systems may be manually or automatically initiated. These systems are also described as Safety Instrumented Systems (SISs). Systems are designated as 'protective systems' by Safety or Process Specialists. |
| Remote Instrument Enclosure (RIE) | Enclosure that houses control system hardware such as the TMR and Distributed Control System (DCS). RIE is located in the operating unit where the SIS and machinery monitoring and control systems may be located. Also known as Remote Instrument Building (RIB) and Satellite Instrument House (SIH). |
| Trip Valve | The valve that trips the machine by depressurizing the control oil that admits steam to the turbine. |
| Turbine Trip and Throttle Valve (TTV) | Valve that controls introduction of high-pressure steam into the turbine. This valve is controlled by control oil, modulates at start-up, is normally wide open once running at governor speed, and always fails close. |
| V1 and V2 Valves | Valves that control turbine speed. V1 is a steam inlet valve, and V2 is an extraction steam valve. |

2.3 REQUIREMENT DESIGNATION

Certain paragraph/s are preceded by bracketed uppercase letter. Below is the meaning of each designation.

| Acronym | Definition |
|---------|---|
| [S] | 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) |

| | |
|------|--|
| | or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). |
| [O] | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| [A] | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| [E] | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| [R] | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| [M] | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| [C] | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| [CS] | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| [*] | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |

3. REVISIONS TO API STANDARD 670-5TH EDITION

- 3-1** API STD 670-5 (API Standard) shall be used as modified by this Specification, unless superseded by more stringent local regulations. This Specification is intended to supplement the API Standard and not replace it. All headings and paragraph or clause numbers contained herein correspond to those in the API standard. Sections not modified shall be followed as written in the API Standard.
- 3-2** Specific definitions of the terms "new," "addition," "substitution," and "deletion" are shown directly below:

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- i. "New"—New clause that does not currently appear in the API standard. Text in this specification is accompanied by a clause number not currently existing in the API standard.
- ii. "Addition"—Text added to a clause already in the API standard, but not overwriting any of the text currently in the API standard. Text in this specification does not modify or overwrite the API standard text in any way. The reader shall read and follow both the API standard text and this specification clause text.
- iii. "Substitution"—Text wholly replaces the text currently in the API standard. Text in this specification is wholly taking the place of the API standard text. The reader shall ignore the API standard text and only follow the clause text of this specification.
- iv. "Modification" – Specific revisions have been made to the text currently in the API standard.
- v. "Deletion"—Wholly deletes the text currently in the API standard. Text in this specification is stating that the API standard text shall not be followed.
- vi. "Decision" – Text in this specification makes a decision that was required.

MODIFICATIONS TO SECTION 4: GENERAL DESIGN SPECIFICATIONS

4.7.1 Addition: Scope of Supply and Responsibility

[*] Vendor with train responsibility shall be responsible for installation of sensors and signal conditioners (including wiring between sensors and signal conditioners) within the confines of the baseplate for the entire train, as a minimum. If specified, Vendor with train responsibility shall also be responsible for the purchase of monitoring systems and for system design. Unless otherwise specified, vibration sensors, signal conditioners, and monitors shall be procured from the same supplier.

4.9.5 New: System Enclosures and Environmental Requirements

[O] An LP shall be provided for each compressor. The LP shall include the following items as a minimum:

- a. Local stop button.
- b. Local start button for motor drives, located on the opposite side of the motor from the high-voltage terminal box for personnel safety.
- c. Speed indication (for steam turbine drivers). If the LP is not viewable from the TTV, then a second speed indication shall be provided at the TTV.
- d. HMI display.

4.9.6 New: System Enclosures and Environmental Requirements

[O] Outdoor control panel(s) location shall minimize the effects of glare from sunlight on Operator displays. Glare shall be eliminated by using a sun shield, as required.

4.9.7 New: System Enclosures and Environmental Requirements

- a. [O] [R] Control panel(s) location and installation shall be such that it is free of vibration.
- b. [O] [R] Doors on the back of the panel boards, doors on wall-mounted panels, and doors on equipment-facing clearance aisles shall open without obstruction and shall give free access to the interior of the panels.

4.9.8 New: System Enclosures and Environmental Requirements

- a. [M] Sufficient spacing shall be provided between instrument components and terminal strips on control panels and racks to ensure adequate access for maintenance.
- b. [M] Mounting of instruments behind the panel shall allow easy access to each instrument for adjustment in place or for complete removal without obstruction by other instruments or panel structural members.

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4.9.9 New: System Enclosures and Environmental Requirements

[S] Flammable fluids (e.g., hydrocarbons) shall not be piped into control panels. All instrumentation containing hydrocarbons shall be located outside the panel.

4.9.10 New: System Enclosures and Environmental Requirements

[R] Field-mounted instrument panels shall be constructed of stainless steel, unless other materials are required for a hot, humid, or corrosive environment. The thickness shall be consistent with the load requirements, but in no case shall the thickness be less than 3 mm ($1/8$ in.). To avoid sagging and warping, internal bracing shall be provided.

4.9.12 New: System Enclosures and Environmental Requirements

[*] [O] Voltage levels inside instrument panels shall not exceed nominal circuit voltage of 120 VA. Owner's Engineer will specify the specific circuit voltage.

4.10.10 Addition: Power Supplies

[R] The machinery protection monitor system shall be fitted with a minimum of two power supplies, each sized for full load, in a redundant configuration. When available, power supplies shall be fitted with voltage and amperage readings to facilitate load balancing.

4.10.10 New: Power Supplies

- e. [O] [R] Power supply for the PES, field instruments, vibration system, and IODS shall be from redundant UPS power sources.
- f. [R] Loss of power supply redundancy shall be alarmed.
- g. [O] Secondary power supplies shall be grounded. The use of floating power supplies is not allowed.

4.10.12 New: Power Supplies

Design of power source for essential services shall follow USBT-000-TE-MR-TCN-0001.

4.11.1 Addition: Machinery Protection System Features/Functions

[R] PES logic solvers used in Safety System applications shall be manufactured to comply with IEC 61508 by following requirements in USBT-000-TE-MR-TCN-0001 (if any).

4.11.1.c Addition: Machinery Protection System Features/Functions

The instrument, control, and protective systems for critical machinery shall be designed to achieve the following:

- a. The specified availability target (or SIL) as required by USBT-000-TE-MR-TCN-0001 (if any).
- b. [R] STR of no more than 0.028 per year or no less than 35 year MTTF between spurious trips

4.11.3.c Addition: Machinery Protection System Features/Functions

[O] [R] Protective system implementation using TMR or 1-o-o-2D logic shall be implemented such that the CPU and I/O cards can be changed on-line without requiring a machinery shutdown.

4.11.4.a Addition: Machinery Protection System Features/Functions

[R] Vibration channel assignment in a rack shall be distributed such that it avoids common cause trip due to single module failure and online replacement.

4.11.4.c Addition: Machinery Protection System Features/Functions

[R] Redundant protective system sensors shall be equipped as follows:

- a. Separate thermowells for temperature signals.
- b. Pressure instruments shall have individual DN 20 (NPS $3/4$) isolating valves. A common connection with a single DN 20 (NPS $3/4$) isolating valve may be used for clean services if individual secondary (i.e., DN 15 [NPS $1/2$]) isolating valves are provided.

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- c. Pressure instruments shall be installed closed-coupled and be self-draining back to the header or first-out valve.

4.11.4.f Addition: Machinery Protection System Features/Functions

[S] For a PES, an interface shall be provided between the PES and the DCS to allow the DCS to monitor and display all protective system parameters.

4.11.5.a Addition: Machinery Protection System Features/Functions

[R] With the exception of reciprocating compressors and screw compressors incorporating accelerometers, shutdown (i.e., danger) set points do not apply to casing vibration or bearing temperature detection.

4.11.9 New: Machinery Protection System Features/Functions

[A] Annex R (normative) New: Technical Data outlines the recommended level of instrumentation for adequate monitoring and control of designated process equipment. Approval by Owner's Engineer shall be required before design is finalized.

Manufacturer shall inform during bid stage if any additional Instrumentation required as per OEM Standard practice for Machine Safe Operation and control.

4.11.10 New: Machinery Protection System Features/Functions

[*] [R] Purchaser shall specify Manufacturer and model of standard instruments to be supplied by machinery vendors. When possible, these instruments should be the same as used in the rest of the plant.

Instruments shall adhere to the following requirements:

- a. Field Instrumentation, cables and control room equipment shall be in accordance with Package Equipment Specification Document no. "USBT-000-TE-IN-SPC-0013.
- b. Alarms shall be in accordance with below:
 - i. [O/R] Field contacts and relay contacts of alarm systems shall be designed to open to alarm. The alarm loop shall be designed to sound an alarm whenever loss of power or circuit continuity occurs for any component in the loop.
 - ii. [O] All Priority 1, 2, 3, and system alarms shall be logged in the DCS or process control computer to allow for historical event trending where DCS equipment is available.
 - iii. [O] Priority 3 alarms require operator action and should be determined as Priority 3 alarms based on the consequence of no action and available time-to-respond per Table 1-A and Table 1-B (from Section 3.2). These can be designed so that trip point values may be adjusted by the operator. The system must indicate which alarms are not at their design parameter setting and allow for the easy restoration of the design settings. See Section 8 for related alarm management issues.

Table 1-A: Alarm Prioritization Guideline

Guideline Alarm Priority Matrix

| Console Operator Scope of Responsibility | | | | PMT/Business Team | |
|--|------------|--------------|-----------------|-------------------|------------------------|
| Alarm System | | | Alert System | | L4 Notification System |
| Urgency of Response | < 15 mln. | 15 - 45 mln. | > 45 - 120 mln. | 2 hrs - 1 Shift | Beyond 1 Shift |
| High Impact | Priority 1 | Priority 1 | Priority 2 | Alert | Email / Report / etc. |
| Medium Impact | Priority 1 | Priority 2 | Priority 2 | | |
| Low Impact | Priority 2 | Priority 3 | Priority 3 | | |
| Minor Impact | Alert | | | | |

| Alarm System | | | | Alert System | Notification |
|---|--|-------------------------------|-------------------|--|--------------|
| Urgency of Operator Response | < 15 min. | 15 - 45 min. | > 45 - 120 min. | 2 hrs - 1 Shift | > 1 Shift |
| High Consequence (> \$5M) | Priority 1 <small>Automatic Protections Strongly Recommended</small> | 1 | Priority 2 | Primary Console and Field Operator Usage | PMT usage |
| Medium Consequence (\$1M to \$5M) | 1 | 2 | 2 | | |
| Low Consequence (\$50K to \$1M) or > \$1K/min | 2 | Priority 3 3 | 3 | | |
| < \$50K or \$1K/min | | | | | |



Table 1-B: Guideline Definition of Consequences if the Operator Fails to Respond to the Alarm

| Main Impact | Consequences |
|--|---|
| Higher Consequences | |
| Health/Safety Impact | 1. Reasonable potential for serious injury or fatality to process plant personnel or 2. A threat to the health/safety of local community. |
| Public Impact | Significant or visible degree of public disruption. |
| Environmental Impact | 1. Serious Environmental impact. 2. Response team activation. 3. Significant resource commitment to resolution. |
| Equipment Damage | Probable loss of containment (due to fire, explosion, overpressure, etc.), or 1. Probable major damage requiring repair/replacement or inspection prior to continued operation, or 2. Probable lengthy unplanned unit shutdown. |
| Total Financial Impact (direct plus indirect) | Major economic loss (typically greater than 5M US\$). |
| Medium Consequences | |
| Health/Safety Impact | Probable medical treatment to process plant personnel— no impact on the public. |
| Public Impact | 1. Minimal, or 2. Insignificant public impact. |
| Environmental Impact | 1. Moderate/limited response of short duration; or 2. Any reportable release, or 3. Release with no threat to health/safety of local community. |
| Equipment Damage | Probable incremental damage affecting the long-term run life of the equipment. |
| Total Financial Impact (direct plus indirect) | Significant economic loss (typically, from 1M US\$ to 5M US\$). |
| Low Consequences | |
| Health/Safety Impact | No impact on process plant personnel/local community. |
| Public Impact | Minimal—no public impact. |
| Environmental Impact | Minor or no response needed—no reportable release expected. |
| Equipment Damage | None expected |
| Total Financial Impact (direct plus indirect) | Minor economic loss (typically less than 1M US\$ but greater than \$50k or \$1k/minute). |

- iv. [O] Alerts can require operator action and can also lead the operator to a focused monitoring of the process. Alerts can be designed so that trip point values and suppressions may be adjusted by the console operator. See Section 8, below, for related issues.
- v. [O] Alerts should be displayed separately from alarms to allow the console to readily filter out lower priority issues in a notification flood situation.
- vi. [O] Priority 1 and Priority 2 alarms shall be engineered alarms, which require set points being assigned and documented as part of the detailed design.

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- vii. **[O]** Alarm points displayed at multiple operator interfaces (e.g., local control panel, Priority 1 alarm system, DCS video display, etc.) shall have the same tag number/identifier. The DCS tag identifier is preferred.
- viii. **[O]** The minimum required resolution for time stamping alarm events to allow accurate sequence of events determination shall be 1 second. A dedicated sequence of events (SOE) system may be required to provide the required time stamp resolution.
- ix. **[A/O/R]** Temperature, pressure, and level electronic transmitters shall be utilized for Priority 1 alarms.
- x. **[O]** Priority 2 alarms require operator action and should be determined as Priority 2 alarms based on the consequence of no action and available time-to-respond per Table 1 and Table 2 in Attachment 1. These alarms should be designed so that the console operator cannot readily change the alarm trip point. Changes should require an extra action like an alarm card pot adjustment, password, or key-lock authorization. MOC guidelines must be employed to permanently change these alarm trip point settings. The system must indicate which alarms are not at their design parameter setting and allow for the easy restoration of the design settings.
- xi. 3) Short-term consequence definitions for Alerts as follows:
 - a) No SHE or public impact
 - b) No equipment damage expected
 - c) Total financial impact (direct plus indirect) nominally below \$50k or \$1k/minute
 - i) Small sites may need to adjust financial limits based on their business requirements.
 - ii) Financial Consequence is measured by the total loss from an incident, including both direct and business loss.
- xii. Notifications are used to inform non shift members of the Business Team of an abnormal operating condition that can lead to long-term consequences.
- xiii. A pre-alarm indicates that the process has reached the point where one or more protective system sensors are about to cause the protective system to operate unless corrective operator action is taken. A minimum of two separate sensors shall be used, one for the pre-alarm and one for the protective system initiator. Sensors used for pre-alarms may also be used for process control functions. When redundant or multiple voted sensors are used for the protective system, the protective system may generate the pre alarm provided the trip function bypass does not bypass the pre alarm. Pre-alarms should be assigned a priority based on consequence of no action and available time to respond (see the matrix in Table 1). Pre-alarms are not the last line of defense and should not be classified as SHE Critical. Where the pre-alarm is designated Priority 1, a protective system driven VDU may be used for alarm display, provided the alarm generation and alarm status information is available (e.g., on the DCS) if the protective system is disabled or otherwise unavailable.
- xiv. **[O]** Priority 2 and 3 alarms shall be presented on control room video displays associated with the DCS or process control computer systems. These alarms should be delivered to an operating console on an integrated common view display. Generally, these alarms are derived from configured alarm limits on high-level analog signals, DCS calculations, digital contact closures monitored in the DCS, or other auxiliary devices.
- xv. **[O]** Priority 1 and Priority 2 alarm displays should be designed to help the operator respond to the alarm. Alerts should not be presented on the same display with alarms.
- xvi. **[O]** All alerts should be visible and readable from a staffed control console working area.
- xvii. **[O]** When local alarm systems are employed, there shall be a common alarm to the control room. This alarm is meant to alert the control room operator that a local alarm (although acknowledged in the control room) has not yet been locally acknowledged (NYLA). This alarm should reinitiate with subsequent local alarms after the control room alarm is acknowledged.
- xviii. **[O]** Alarm system input shall be provided with an adjustable time delay feature and alarm trip amplifiers shall be provided with an adjustable dead band (0–10%) to reduce nuisance alarms.

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- xix. **[M, O]** Trip amplifiers shall have a readout that may be switched between the measured value and the set point.
- xx. **[O]** Priority 2 and 3 alarms may be generated and monitored by the PCSs. Associated sensors and loop components need not be independent of those used for process control.
- xxi. **[O]** Protective System pre-alarms shall be implemented as follows:
- For Priority 1 pre-alarms, all sensors shall be independent of the protective system with which the pre-alarm is associated. Typically, the process control sensor is used as the pre-alarm loop with a loop current switch used to provide the input to the Priority 1 alarm system.
 - Power for the pre-alarm sensor, trip amplifier, and other loop components shall be taken from one of the following:
 - The DCS loop power. Signal isolators shall be used if the pre-alarm sensor is also to be wired to the protective system.
 - A dedicated alarm system power supply.
 - For Priority 1 pre-alarms, all sensors shall be independent of the trip function, except where redundant or multiple voted sensors are used to initiate the pre-alarm.
- xxii. Alarm system sense voltage shall be 24 VDC unless otherwise specified.
- xxiii. **[R]** The maximum design operating temperature of the electronics shall not be exceeded. Low noise fans/blowers, air conditioners, or solid-state coolers/heaters may be used, if necessary, to maintain equipment within temperature limits. Loss of conditioning device or abnormal equipment temperature shall be alarmed at a continuously manned location.
- xxiv. **[*]** All alarms, including system alarms, shall be prioritized. Key factors in determining alarm priority shall be as follows:
- Time available for operator action
 - Consequence of failure to take corrective action.

4.11.11 New: Machinery Protection System Features/Functions

[O] [R] Upon failure of instrument air or electrical power, regulating devices (including governors) shall fail in a position that ensures safe condition of machine and driver.

4.12.4 New: System Output Relays

- [A] [R]** Electrical relays that are located in environmental conditions where temperature, humidity, or air quality is not controlled shall be hermetically sealed or Company-approved equivalent.

4.12.5 Addition: System Output Relays

[S] Machinery protective systems shall be based on fail-action (de-energize to trip).

4.12.11 Addition: System Output Relays

The design of on-line bypass facilities and associated logic shall be per USBT-000-TE-MR-TCN-0001, with the following additional requirements and clarifications:

- [R]** Voted vibration trips shall be bypassed as one function in the PES.
- [S]** Where multiple trips provide protection against the same hazard (e.g., suction drum level and vibration protecting the machine from liquid carryover damage), provisions shall be included to ensure that those trips cannot be bypassed simultaneously.
- [S]** There shall be no bypass on emergency stop buttons and overspeed protection.
- [R]** There shall be no master bypass.
- [R]** A bypass function shall be provided for each trip initiator function, except for manual shutdown initiators and overspeed protection, to facilitate input testing. The bypass function shall not inhibit the alarm function of a sensor.

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4.13.2 Substitution: Digital Communication Links

The following shall also be available from the digital communications link of API STD 670, Section 4.13 "Digital Communication Links," Paragraph 4.13.1, as a minimum:

- a. Channel status of alarm or no alarm
- b. Alarm storage for storing the time, date, and value.
- c. Channel value
- d. Channel status: armed/disarmed.
- e. Hardware and software diagnostics
- f. Communication link status
- g. Current system time, time stamp, and date of event for all transmitted data
- h. System entry log to include date, time, and record of changes.
- i. Monitor/alarm programming key switch position placed in programming mode.

4.14.1.e Addition: System Wiring and Conduits—General

Signal and power wiring segregation shall be per USBT-000-TE-MR-TCN-0001.

4.14.1 New: System Wiring and Conduits—General

- a. **[M]** The initial run (from machine) of sensor cables shall be run in rigid metal conduit. Flexible conduits shall be considered only if the layout does not permit use of rigid conduits. For example, to facilitate maintenance, the final connection to each conduit box and the signal conditioner enclosure may be flexible conduit.
- b. **[R]** Conduit support shall be provided at approximately 600 mm (2 ft) centers (within the skid area).

4.14.2.5 New: Conduit Runs to Panels

[M] Color-coded wire shall be used for all internal control panel wiring to identify the signal type (e.g., 120 VAC or 240 VAC or 125 VDC power, 120 VAC or 120 VDC control, 24 VAC or 24 VDC control, thermocouple mV signals, RTD, pulse, 4 mA to 20 mA, etc.).

4.14.2.6 New: Conduit Runs to Panels

[M] All internal control panel wiring shall be run in plastic wire-way or Company-approved equivalent wire ducting.

4.14.3 New: Skid-Mounted Junction Boxes

[R] Skid-mounted junction boxes for vibration, displacement, and temperature sensors shall be provided with an anti-wicking design to prevent lube oil (liquid or vapor) from the machine entering the sensor junction box / conduits.

4.15.c Addition: Grounding of the Machinery Protection System

Grounding of instrumentation and junction boxes shall be per USBT-000-TE-MR-TCN-0001.

4.15.i New: Grounding of the Machinery Protection System

[R] Grounding conductors shall be bare, soft copper, solid bar grounding buses. All control panels shall be supplied with one or more isolated copper ground bus bar for instruments, located at the bottom of the panel. All ground bus bars for instruments shall be isolated and have tapped holes with machine screws and washers to terminate cable shield / pair shield drain wires and provide spare connection points.

4.16.3 Addition: System Security, Safeguards, Self-Tests, and Diagnostics

- a. **[S] [M]** Automatic self-testing and system diagnostics shall be incorporated into the PES configuration and shall require no additional application logic.

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- b. **[S] [M]** All self-testing and system diagnostics shall be a proven integral part of the standard system and shall be completely transparent to the user when the application is implemented.
- c. **[S] [M]** The diagnostics and tests shall run periodically (preferably every scan cycle) and shall provide sufficient diagnostic coverage of the protective system function within the logic solver so that during the required operational lifetime of the system, periodic testing of the logic hardware and firmware is not required.
- d. **[S] [M]** Self-testing shall include, as a minimum, the following:
 - a. Error detection in serial and parallel communications.
 - b. An internal watchdog timer to detect halted or looping processor execution.
 - c. A set of instructions executed at each functional cycle to exercise active system components, including the processor.
 - d. A periodic memory check.
 - e. A check of each signal line of a parallel bus before a "read" or "write" operation to an input or output component.
 - f. Detection of the removal of, or any defect in, any logic unit, communication module, processor, I/O module, or power supply.
 - g. Check of the logic solving ability, including a test that exercises active system components, including the processor(s). This test shall be run prior to each logic cycle.
 - h. A set of power-up initialization and communications checks.

4.16.5 New: System Security, Safeguards, Self-Tests, and Diagnostics

- a. **[S]** A test facility shall be provided to initiate the action of each final element.
- b. **[S]** Moving test bypass or test isolation valves to the test position shall trigger a Priority 1 alarm.
- c. **[S]** Test functions shall be interlocked to initiate a test only when all test bypass or isolation valves are in the test position.

4.16.6 New: System Security, Safeguards, Self-Tests, and Diagnostics

Testing and maintenance facilities shall be per USBT-000-TE-MR-TCN-0001.

4.18 New: Manual Shutdowns

4.18.1 New: Manual Shutdowns

- a. **[S]** Manual shutdown capability shall be provided locally at the machine, control house, and at a safe location > 15.3 m (50 ft) from compressor deck.
- b. **[O]** All manual shutdown initiators shall have a protective cover to prevent accidental activation.
- c. **[R]** Manual emergency pushbutton initiators shall be wired with three digital contact signals to the PES to minimize the potential for a single point of failure.

4.18.2 New: Manual Shutdowns

[S] The local manual shutdown button shall be located near the governor end for turbine drives and the opposite side to the terminal box on motor drives.

MODIFICATIONS TO SECTION 5: SENSORS AND TRANSDUCERS

5.1.4.7 Addition: Radial Shaft Vibration, Axial Position, Phase Reference, Speed Sensing, Flow, and Piston Rod Drop Transducers—Oscillator-Demodulators

[O] The oscillator-demodulator (proximitor transducer) shall be isolated from ground in the mounting box.

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5.4 New: Field Installed Instruments

[S] Field instruments shall meet area classification requirements.

MODIFICATIONS TO SECTION 6: SENSOR AND TRANSDUCER ARRANGEMENT

6.1.1 Addition: Locations and Orientation—General

[R] Machinery and machinery systems shall have instrumentation per the applicable table in Annex R (normative) New: Technical Data.

6.1.3.1 Addition: Locations and Orientation—Axial Position Probes

- a. [C] [R] For high-speed, special-purpose gear units, the following shall apply:
 - a. Gear units without thrust bearings may exclude axially oriented probes.
 - b. Gear units with single helical designs shall be provided with two axial probes per gear shaft at each thrust bearing end.
- b. [C] For motors, axially oriented probes may be excluded.

6.1.3.8 New: Locations and Orientation—Axial Position Probes

[O] Probe centerline location shall be a minimum of one probe tip diameter from the shaft lathe center mark and from the shaft edge.

6.1.5.1 Addition: Locations and Orientation—Phase Reference Transducers

- a. [R] Phase reference transducers may be excluded on AC motors 373 kW (500 hp) and smaller.
- b. [R] Phase reference transducers shall be provided on the driven equipment.

6.1.6 Addition: Locations and Orientation—Standard Tachometer Transducers

[O] For special-purpose steam turbines, a speed indicator shall be provided at each of the following locations: the LP, the control house, and near the TTV for easy visibility during start-up.

6.1.9.2.3 Substitution: Locations and Orientation—Bearing Temperature Sensors—Thrust Bearing Sensors

[R] At least two additional temperature sensors shall be provided in the normally inactive thrust bearing, arranged as specified in Annex R (normative) New: Technical Data, when applicable for thrust bearings, and API STD 670, Section 6.1.9.2 "Bearing Temperature Sensors," Paragraph 6.1.9.2.1 and Paragraph 6.1.9.2.2.

6.2.1.1 Addition: Mounting—Probes

[M] [R] All spare probe wiring shall be routed to the same junction box that contains the installed primary probe wiring. Spare wiring shall be terminated on a terminal strip immediately below its primary probe termination. Spare wiring shall not be left coiled in the junction box.

6.2.1.3 Addition: Mounting—Probes

- a. [R] Externally mounted probes shall have double jam nuts on the holder.
- b. [M] Probe gap adjustment shall be possible without removing conduit or junction boxes.
- c. [R] Each jam nut on the probe holder shall have safety wires or lock tabs installed to prevent loosening.

6.2.1.7 New: Mounting—Probes

[R] Probes or probe holders shall not pass through pressurized gas or oil passages, or below oil levels (operating or at rest).

6.2.1.8 New: Mounting—Probes

[R] The probes and signal system shall be explosion proof design.

MODIFICATIONS TO SECTION 7: VIBRATION MONITORING SYSTEMS

7.1.5.a Substitution: General

[R] Fixed time delays for shutdown (danger) relay activation that are field changeable (via controlled access) to require from 1 second to 3 seconds sustained violation. A delay of 3 seconds shall be standard.

7.1.5.c New: General

[S] [R] The time delays on protective trips specified in Table 2: Protective Trip Time Delays shall be used. Times shown are the difference between time of detection and time of action. The [S] portion of this paragraph shall apply only to over-speed trip time delays.

Table 2: Protective Trip Time Delays

| Sensor/Trip Initiator | Time Delay (seconds) | Notes |
|---|---------------------------------------|---|
| Manual Shutdown | 0.5 | 0.5s delay on manual circuit only. |
| Overspeed Detection System (GODS and IODS) | 0.0 | Confirm PES cycle time provides sufficient protection. |
| Lube Oil Pressure, Seal Oil / Gas ΔP Shutdown | 0.5 | 0.5s delay on sensor |
| Suction Drum Level, Seal Oil Level Shutdown | Maximum depends on holdup time | 0.5s delay on sensor |
| Auxiliary Lube Oil / Seal Oil Pump Cut-in | 0.0 | Besides PES logic, transmitter shall also have 0.5 second time delay or buffer. |
| Vibration and Axial Position | 2.0 in vibration monitor; 1 in PES | For triplicated digital inputs to the PES. |
| All Others | 0.5s delay on sensor | — |

7.3.4 New: System Output Relays

- [S] The vibration monitoring system output relays shall be used to provide alarm and shutdown contacts to the PES.
- [R] Shutdown output relay signals from the vibration monitoring system shall connect to the PES via three hardwired connections or relay cards with 2-o-o-3 shutdown voting in the PES.

7.4.3.3 Substitution: Piston Rod Drop Monitoring

[R] The piston rod drop monitor system shall be supplied with one channel per piston rod. For reciprocating compressors in critical service, two channels per piston rod for X-Y measurements shall be provided (see API STD 670, Section 6.1.4 "Piston Rod Drop Probes," Paragraph 6.1.4.7 for detail).

7.4.3.6 Substitution: Piston Rod Drop Monitoring

[R] The piston rod drop monitor's shutdown (danger) function shall not be used. The piston rod drop monitor's alarm (alert) function shall be provided.

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| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
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7.4.4.6 Substitution: Casing Vibration Monitoring

[R] For high-speed special-purpose gearboxes and gearboxes part of a high-speed centrifugal air compressor train, a casing vibration monitor system shall include monitor and display of single-channel acceleration.

7.4.5.4 Substitution: Temperature Monitoring

[R] Unless otherwise specified, bearing temperature monitoring shutdown (danger) function shall not be used. Bearing temperature (danger) function should be alarm only.

7.4.6.1 Substitution: Speed Indicating Tachometer

[O] [R] The speed indicating tachometer shall have the ability to record and store the highest measured rotational speed (rpm), known as peak speed.

7.6 New: Machinery Monitoring System (Condition Monitoring System)

7.6.1 New: Basic Design Requirements

- a. [R] All critical machinery trains shall have an MMS.
- b. [M] The system shall include real-time and historical trending data, accessible via the site LAN.
- c. [M] The system shall collect all available inputs, outputs, and specified calculated data from the PES, as well as data from the vibration monitoring rack. Data from other control and protection boxes shall also be collected.
- d. [O] When MMS is specified, a network connection to the MMS shall be provided on the compressor deck to enable surveillance during start-up and troubleshooting. This network connection shall provide access to the MMS client display and/or the PES and ensure Cyber Security threats are not feasible that would compromise either the PES or MMS systems.

7.6.2 New: Data Storage

[M] The database shall be sized to retain at least 2 years of data defined as follows:

- a. The capture of first-out alarm data shall be provided by the PES and shall be displayed in the DCS and the MMS.
- b. [O] In addition to the vibration signals, parameters listed in Annex R (normative) New: Technical Data with MMS as the display shall be available in the MMS system.
- c. [A] Separate data acquisition PLCs not used by the PES shall require approval by Owner's Engineer.

[R] Single-value analog data (i.e., not vibration wave form data) shall be historized at a minimum fidelity of once per second.

MODIFICATIONS TO SECTION 8: ELECTRONIC OVERSPEED DETECTION SYSTEM

8.1.5 Substitution: General

VFD and EVFD systems shall include an electronic ODS per the following:

- a. [S] For EVFD, if a HAZOP review determines that overspeed protection is required, then a suitably reliable fault-tolerant overspeed trip, independent of the drive controls, shall be provided.
- b. [S] The overspeed trip shall be testable, without requiring a physical overspeed of the machine.
- c. [O] The drive system shall be configured to accept and respond as required to an external overspeed trip command in addition to the independent means of removing power.
- d. [S] Overspeed protection shall immediately shut down the EVFD if the frequency exceeds 105% of input set point or exceeds a preset maximum speed limit.
- e. [S] The overspeed protective system shall have a minimum availability of 98% and its response time shall prevent any damage to the motor or to the driven equipment.

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| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
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- f. [R] Under speed protection shall immediately shut down the EVFD if the output frequency falls below 90% of minimum set point for 20 seconds.

8.3.2 Addition: Segregation

[S] [R] The electronic overspeed detection system shall be dedicated to the overspeed function only. It shall be separate from and independent of all other control and protective systems.

8.3.7 New: Segregation

[R] The communication link between the IODS and the GODS to the MMS shall be for data acquisition only, no action.

8.4.3.7 Addition: Functions—Inputs, Outputs, and Configuration

[S] Any method used to disable the IODS outputs for testing shall not disable the GODS.

8.4.3.11 New: Functions—Inputs, Outputs, and Configuration

[S] The IODS-managed and PES-managed shutdown systems shall include functionality such that an IODS-initiated or PES-initiated shutdown triggers all hydraulic dump SOVs.

8.4.3.12 New: Functions—Inputs, Outputs, and Configuration

Hydraulic dump SOVs shall meet the following requirements:

- [R] SOVs shall be redundant using the two 2-o-o-2 configurations in parallel or a 2-o-o-3 configuration.
- [R] SOVs in series shall be provided with a single manual block valve for on-line instrument testing. The block valve shall be provided with a limit switch to generate a Priority 1 alarm for the closed position.
- [S] The configuration of the block valves and the final element test logic shall not result in defeat of the IODS and the GODS simultaneously.

[R] The IODS and the PES output to the final elements shall be configured with a test method that affects a single output signal, wiring, and final element. This test method applies to SOVs as well as other final elements not related to the TTV.

MODIFICATIONS TO SECTION 9: SURGE DETECTION SYSTEMS

9.2 Addition: Accuracy

[O] [R] V-cone, pitot tubes, and annubars shall not be used for compressor suction flow measurement.

9.3.2 Addition: Segregation

[R] Anti-surge kickback valve actuators shall be pneumatic.

9.3.8 New: Segregation

[M] [O] For new installations, the surge control system shall be incorporated in the PES.

9.4.3.2 Addition: Functions—Inputs, Outputs, and Configuration

[O] [R] If required (e.g., to avoid pulling vacuum in the first stage suction), then a de-energized to action design shall be provided to fully open the anti-surge kickback valve based on 2-o-o-3 voted inputs from pressure transmitters.

9.4.3.6 New: Functions—Inputs, Outputs, and Configuration

- [O] An alarm output shall be generated upon failure of control input signal(s).
- [R] Upon failure of control input signal(s), fallback strategies shall automatically be activated.
- [A] All fallback strategies shall be proven and approved by Owner's Engineer.

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| Exxon Doc. No. | USBT-000-TE-MR-EQS-0016 | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
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9.4.3.7 New: Functions—Inputs, Outputs, and Configuration

[O] Full manual control of the anti-surge kickback valve(s) shall be provided from the DCS.

9.4.3.8 New: Functions—Inputs, Outputs, and Configuration

[O] The control system design for anti-surge kickback valve(s) shall be fail stationary / drift open.

9.4.3.9 New: Functions—Inputs, Outputs, and Configuration

[R] Anti-surge kickback valves for machinery are considered high-performance control valves and shall be designed with the following features:

- a. A smart valve positioner.
- b. Factory acceptance tests and site acceptance tests.
- c. A valve profile that documents its baseline for future maintenance and troubleshooting.
- d. Handled separately and defined as an engineered product as opposed to an off-the-shelf product.
- e. Special attention should be paid to the accuracy of process data in the sizing and selection of these valves. Such attention includes noise prediction and valve characteristic selection.

9.4.3.10 New: Functions—Inputs, Outputs, and Configuration

- a. [O] An alarm output shall be generated upon failure of control input signal(s).
- b. [R] Upon failure of control input signal(s), fallback strategies shall automatically be activated.
- c. [A] All fallback strategies shall be proven and approved by Owner's Engineer.

9.4.4.4 Addition: Functions—Response Time

[O] [R] Anti-surge kickback valve(s) and VIGVs response times shall not exceed 2 seconds to reach full open and 5 seconds to close. Quick exhaust fittings or volume boosters shall be provided to achieve the specified speed of response.

MODIFICATIONS TO SECTION 10: EMERGENCY SHUTDOWN SYSTEMS (ESDS)

10.4.2.2 Addition: ESD Arrangement—Distributed System

[R] Automatic start-up and shutdown systems shall be implemented using the PES logic systems and shall be designed to allow on-line testing of each system component.

10.4.3.2 Addition: ESD Arrangement—Integrated System

[R] Automatic start-up and shutdown systems shall be implemented using the PES logic systems and shall be designed to allow on-line testing of each system component.

10.7.1.1 Substitution: System Inputs—General System Inputs

- [*] i. Radial vibration
- [*] j. Axial position

10.7.1.1 Addition: System Inputs—General System Inputs

- a. [*] l. Suction KO drum level

MODIFICATIONS TO SECTION 12: VENDOR'S DATA

12.1.1 Addition: General—Technical Data

[O] [R] 16 weeks after date of order, Machinery Vendor shall provide the documentation described in API STD 670, Table G.2 "Sample Distribution Record (Schedule)," Item (1) through Item (10) and Item (12).

MODIFICATIONS TO ANNEX

Appendix : Annex R (normative) New: Technical Data

Table R-1: Abbreviations for Function (Table R-3 through Table R-13)

| Abbreviation | Variable Types | Function Codes | | |
|--------------|-------------------------|-------------------------|-----------------------|-------------|
| | | Position 1 | Position 2 | Position 3 |
| A | — | Alarm | Alarm | Alarm |
| B | Burner Flame | — | — | — |
| C | — | Controller or Control | Controller or Control | — |
| (CI) | — | — | Cut In | — |
| (CO) | — | Cut-Out | Cut-Out | Cut-Out |
| D | — | — | — | Dial |
| d | — | Differential | — | — |
| E | — | Element (Primary) | Element (Primary) | — |
| F | Flow | — | — | — |
| G | — | Gauge | — | — |
| H | Hand Actuated | High | High | — |
| I | Current | Indicating or Indicator | Indicating Indicator | or — |
| K | Time / Key-phasor | — | — | — |
| L | Level | Low | Low | — |
| P | Pressure | Phase | — | — |
| R | Remote | Recording Recorder | or — | — |
| S | Speed | Switch | Switch | — |
| T | Temperature | Transmitter | Transmitter | Transmitter |
| (TC) | Thermocouple | — | — | — |
| V | Vibration | — | Valve | Valve |
| W | — | Well | — | — |
| Z | Position (Displacement) | — | — | — |

Table R-2: Typical Instrument Vendor Key (Table R-3 through Table R-13)

| Color | Description |
|-------|-------------|
| | Vendor |
| | Contractor |

Table R-3: Instrumentation for Centrifugal, Axial Compressors in Critical and Very Critical Service

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes | |
|--|---|-----------------------|----------|------------------|--------------|--------------------------------|------------------------|
| Lube Oil | Refer to Table R-10 for Lube Oil Systems | — | — | — | — | — | |
| Seals | Refer to Table R-11 for Seal Oil Systems, Table R-12 or Table R-13 for Dry Gas Seals, as applicable | — | — | — | — | — | |
| Compressor Gas Streams | Suction Knock-out (KO) Drum | LT (three) | LI | HMI | — | — | |
| | | | LHA | HMI | 1-o-o-3 | — | |
| | | | LHH(CO) | — | 2-o-o-3 | Note 2 | |
| | | | LHH(CO)A | HMI | 2-o-o-3 | — | |
| | | LG | LI | Local | — | — | |
| | Each Casing Inlet Line (including each sidestream) | TIT | TI | HMI, Local | — | — | Input to Surge Control |
| | | | THA | HMI | 1-o-o-1 | Note 5, Note 9 | |
| | | TID | PI | Local | — | — | |
| | | PIT | PI | HMI, Local | — | — | Input to Surge Control |
| | | PID | PI | Local | — | — | |
| | Each Casing Discharge Line (including each sidestream) | TIT | TI | HMI, Local | — | — | Input to Surge Control |
| | | | THA | HMI | 1-o-o-1 | — | |
| | | TIT (three) | THH(CO) | — | 2-o-o-3 | Note 2, Note 6 | |
| | | | THH(CO)A | HMI | 2-o-o-3 | — | |
| | | TID | PI | Local | — | — | |
| | | PIT | PI | HMI, Local | — | — | Input to Surge Control |
| | Inlet, Interstage, and Discharge Motor-Operated Valve (MOV) < 50% Open | ZT (one) and ZS (two) | ZI | HMI | — | — | |
| | | | ZLA | HMI | 1-o-o-3 | — | |
| | | | ZLL(CO) | — | 2-o-o-3 | Note 2, Note 8 | |
| | | | ZLL(CO)A | HMI | 2-o-o-3 | — | |
| Total Flow (per section) | FT | FI | HMI, MMS | — | — | Input to Surge Control | |
| Recycle Flow (per section) | FT | FI | HMI, MMS | — | — | Note 7 | |
| Anti-Surge System | ZT | ZI | HMI | — | — | Input to Surge Control, Note 4 | |
| Vibration, Axial Position, and Bearing | Radial Bearing, Each | VE (two) | VI (two) | HMI, MMS | — | — | |
| | | | VHA | HMI, MMS | 1-o-o-4 | — | |
| | | | VHH(CO) | — | 2-o-o-4 | Note 2, Note 10 | |
| | | | VHH(CO)A | HMI, MMS | 2-o-o-4 | — | |
| | | TE (two) | TI | HMI, MMS | — | — | |
| THA | HMI, MMS | | 1-o-o-1 | — | | | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--------|---------------------------------|------------|----------|------------------|--------------|-----------------------|
| | Axial Position | ZE (two) | THHA | HMI, MMS | 1-o-o-1 | — |
| | | | ZI | HMI, MMS | — | — |
| | | | ZHA | HMI, MMS | 1-o-o-1 | — |
| | | | ZHH(CO) | — | 2-o-o-2 | Note 2, Note 11 |
| | | | ZHH(CO)A | HMI, MMS | 2-o-o-2 | — |
| | Thrust Bearing, Active/Inactive | TE (two) | TI | HMI, MMS | — | Two per side, minimum |
| | | | THA | HMI, MMS | 1-o-o-2 | — |
| | | | THHA | HMI, MMS | 1-o-o-2 | — |
| | Phase Angle | VPE | VPI | MMS | — | Note 3 |

Notes:

- (1) HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations shall be determined by Owner's Engineer.
- (2) Connected to driver shutdown (cut-out) system.
- (3) Phase angle transducer shall be supplied on train driver.
- (4) Anti-surge system is not applicable to dry screw compressors.
- (5) Axial compressors shall have a temperature transmitter on the inlet casing and inlet line.
- (6) High-temperature cut-out is only applicable to dry screw compressors.
- (7) If downstream flow measurement is provided in addition to total (machine) flow, then the recycle flow may be calculated instead of being measured directly (as long as satisfactory precision can be achieved). This calculated value shall be displayed within HMI and MMS. If recycle flow is to be used as anti-surge controller input, then measurement shall be direct.
- (8) MOVs, in this context, are taken to be Emergency Motorized Block Valves (EBVs). These MOVs shall be fitted with three independent determinations of valve position to trip the compressor on 2-o-o-3 voted logic when the MOV is < 50% open. The detailed design of the position indicator shall be carefully reviewed to ensure that the instruments are truly independent (e.g., Rotork IQ actuator is supplied with two limit switches and one analog position, but they are all driven off of a single position transducer and, therefore, are not truly independent). The logic should also include a permissive to prevent a start whenever the 2-o-o-3 position logic indicates that the valve is < 50% open. Combinations of limit switches, proximity switches, and analog transmitters may be used.
- (9) Axial and centrifugal compressors operating in parallel shall include a high gas temperature alarm at the inlet of the casing, as close to the inlet flange as possible, to indicate back-flow.
- (10) For rotary compressors, agreement with the Vendor on whether to shutdown in radial vibration or casing acceleration may be needed when the rotors design may limit radial movement during operation. In these cases, radial vibration probes should be used to enhance monitoring. Agreement should be reached during the bid evaluation phase.
- (11) For rotary compressors, rotor spacing constraints may limit the application of the required 2-o-o-2 axial position shutdown configuration. In these cases, a 1-o-o-1 configuration may be acceptable with the Owner's Engineer approval.

Table R-4: Instrumentation for Reciprocating Compressors in Critical Service

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes | | |
|---------------------------------------|---|-----------------------|------------|---------------------------------------|--------------|------------------|---------|---|
| Lubrication | Refer to Table R-10 for Lube Oil Systems | — | — | — | — | Note 4 | | |
| | Cylinder and Packing Lubrication | LT | LI | HMI | — | — | | |
| | | | LLA | HMI | 1-o-o-1 | — | | |
| | | LG | LI | Local | — | — | | |
| | | PIT | PI | HMI, Local | — | Start permissive | | |
| | | | PHA | HMI | 1-o-o-1 | — | | |
| ZS | ZLA | HMI | 1-o-o-1 | Cycle counter indicating loss of flow | | | | |
| Liquid Handling | KO Drum Level | LT (three) | LI | HMI | — | — | | |
| | | | LHA | HMI | 1-o-o-3 | — | | |
| | | | LHH(CO) | — | 2-o-o-3 | Note 2 | | |
| | | | LHH(CO)A | HMI | 2-o-o-3 | — | | |
| | [*] Suction Pulsation Bottle Boot Liquid Level (if specified) | LG | LI | Local | — | — | | |
| | | | LT | LI | HMI | — | — | |
| | | | | LHA | HMI | 1-o-o-1 | — | |
| | | | | LHHA | HMI | 1-o-o-1 | — | |
| Gas Compression | Each Stage Inlet | TIT | TI | HMI, Local | — | — | | |
| | | PIT | PI | HMI, Local | — | — | | |
| | Inlet, Interstage, and Discharge MOV < 50% Open | ZT (one) and ZS (two) | ZI | HMI | — | — | | |
| | | | ZLA | HMI | 1-o-o-3 | — | | |
| | | | ZLL(CO) | — | 2-o-o-3 | Note 2, Note 10 | | |
| | Each Stage Discharge | TIT (three) | ZLL(CO)A | HMI | 2-o-o-3 | — | | |
| | | | TIT | TI | HMI, Local | — | — | |
| | | | PIT | PI | HMI, Local | — | — | |
| | Total Flow (per section) | FT | FI | HMI, MMS | — | — | | |
| | Dynamic Cylinder Pressure, Each End (Head-End/Crank-End) | PT | FT | FI | HMI, MMS | — | — | |
| | Each Cylinder Discharge (Cylinder to Pulsation Bottle) | | | TIT (three) | TI | HMI, Local | — | — |
| | | | | | THA | HMI | 1-o-o-2 | — |
| | | THH(CO) | — | | 2-o-o-3 | Note 2 | | |
| | | THH(CO)A | HMI | | 2-o-o-3 | — | | |
| Differential Pressure (dP) Each Stage | PdIT (three) | TID | TI | Local | — | — | | |
| | | PdI | PI | MMS | — | Note 4 | | |
| | | | PLA | MMS | — | — | | |
| Differential Pressure (dP) Each Stage | PdHA | | PLLA | MMS | — | — | | |
| | | PdI | HMI, Local | — | — | | | |
| Differential Pressure (dP) Each Stage | PdHA | PdHA | HMI | 1-o-o-3 | — | | | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes | | |
|--------------------------------------|-------------------------------------|------------|---|------------------|------------------------|---------------------------|------------|---|
| | | | PdHH(CO) | — | 2-o-o-3 | Note 2 | | |
| | | | PdHH(CO)A | HMI | 2-o-o-3 | — | | |
| | | | PdID | PdI | Local | — | — | |
| | Capacity Control Position Indicator | ZT | ZI | HMI | — | Note 8 | | |
| Vibration and Temperature Monitoring | Valve Temperature, Each Valve Cap | TT | TI | HMI, MMS | — | — | | |
| | | | THA | HMI, MMS | 1-o-o-1 | — | | |
| | Rod Packing, Each Rod | TT | TI | HMI, MMS | — | — | | |
| | | | THA | HMI, MMS | 1-o-o-1 | — | | |
| | Compressor Rod Position, Each Rod | ZT (two) | ZI | MMS | — | Vertical and Horizontal | | |
| | | | ZLA | HMI, MMS | 1-o-o-2 | — | | |
| | Main Bearing, Each | TE (two) | TI | HMI, MMS | — | — | | |
| | | | THA | HMI, MMS | 1-o-o-2 | — | | |
| | | | THHA | HMI, MMS | 1-o-o-2 | — | | |
| | Crankcase Vibration (Velocity) | VE (two) | VI | MMS | — | Horizontal between throws | | |
| | | | VHA | HMI, MMS | 1-o-o-2 | — | | |
| | | | VHH(CO) | — | 2-o-o-2 | Note 2 | | |
| | | | VHH(CO)A | HMI, MMS | 2-o-o-2 | — | | |
| | Crosshead Vibration (Acceleration) | VE (two) | VI | HMI, MMS | — | Vertical over crosshead | | |
| | | | VHA | HMI, MMS | 1-o-o-2 | — | | |
| [*] VHH(CO) | | | — | 2-o-o-2 | Note 2, [*] Note 9 | | | |
| [*] VHH(CO)A | | | HMI, MMS | 2-o-o-2 | — | | | |
| Multi-Event Key Phaser | ZE | ZI | MMS | — | Minimum 13 tooth wheel | | | |
| Flywheel Locking Device | ZS (two) | ZS(CO) | — | 1-o-o-2 | Note 7 | | | |
| | | ZS(CO)A | HMI | 1-o-o-2 | — | | | |
| Cylinder and Packing Cooling System | Tempered Water Tank | LT | LI | HMI | — | — | | |
| | | | LLA | HMI | 1-o-o-1 | — | | |
| | | LG | LI | Local | — | — | | |
| | | | TI | HMI, Local | — | — | | |
| | | | THA | HMI | 1-o-o-1 | — | | |
| | Each Pump Discharge, Main/Standby | PID | PI | Local | — | Note 5 | | |
| | | | Tempered Water Cooler | Inlet | TID | TI | Local | — |
| | | | | Outlet | TIT | TI | HMI, Local | — |
| | | | Tempered Water Supply for Cylinder Jacket Cooling | TIT | TI | HMI, Local | — | — |
| | | | | | TLA | HMI | 1-o-o-1 | — |
| THA | HMI | 1-o-o-1 | | | — | | | |
| PID | PI | Local | — | — | | | | |
| PIT (two) | PI | HMI, Local | — | — | | | | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes | |
|-----------------------------|---|------------|----------|------------------|--------------|-----------------------|---------------|
| | | | PL(CI) | — | 1-o-o-2 | CI standby water pump | |
| | | | PL(CI)A | HMI | 1-o-o-2 | — | |
| | Compressor Cylinder, Each Outlet | TIT | TI | HMI, Local | — | — | |
| | | | TLA | HMI | 1-o-o-1 | — | |
| | | | THA | HMI | 1-o-o-1 | — | |
| | Tempered Water Filter for Packing Coolant | FG | FI | Local | — | Sight Glass | |
| | | | PdIT | PdI | HMI, Local | — | — |
| | | | PdHA | HMI | 1-o-o-1 | — | |
| | Compressor Packing, Each Outlet | PID | PI | Local | — | PI after Filter | |
| | | | TID | TI | Local | — | — |
| Distance Piece / Packing | N2 Supply Header | FG | FI | Local | — | Sight Glass | |
| | | | PdI | PdI | Local | — | Across Filter |
| | | | PIT | PI | HMI, Local | — | — |
| | Packing Purge, Each Rod | TT | PLA | HMI | 1-o-o-1 | — | |
| | | | FI | FI | Local | — | — |
| | | | TID | TI | Local | — | — |
| Packing Vent, Each Cylinder | TT | THA | HMI, MMS | 1-o-o-1 | Note 6 | | |

Notes:

- (1) HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations shall be determined by Owner's Engineer.
- (2) Connected to driver shutdown (cut-out) system.
- (3) Main lube oil pump shall be driven from the crankshaft. Therefore, PT off of main lube oil pump discharge for run indication is not required.
- (4) PT shall be mounted directly on cylinder to measure internal pressure for rod reversal, rod load, and pressure-volume calculations.
- (5) Substation contacts shall be used for standby pump running alarm.
- (6) Thermocouple shall be affixed to packing vent line to indicate leakage on high-temperature alarm.
- (7) The locking device on barring wheel shall be equipped with two independent switches. Normally Open contacts shall be used and shall close when the locking device is engaged. The permissive logic shall prevent the motor from starting whenever 1-o-o-2 contacts are closed.
- (8) Unloader position indicator could be switch, position transducer, or pressure transducer.
- (9) Requirement for crosshead vibration shutdown is Owner's Engineer discretion. Factors for determining include machine size/service and safety/availability risk profiles versus target performance.
- (10) MOVs, in this context, are taken to be EBVs. These MOVs shall be fitted with three independent determinations of valve position to trip the compressor on 2-o-o-3 voted logic when the MOV is < 50% open. The detailed design of the position indicator shall be carefully reviewed to ensure that the instruments are truly independent (e.g., Rotork IQ actuator is supplied with two limit switches and one analog position, but they are all driven off of a single position transducer and, therefore, are not truly independent). The logic should also include a permissive to prevent a start whenever the 2-o-o-3 position logic indicates that the valve is < 50% open. Combinations of limit switches, proximity switches, and analog transmitters may be used.

Table R-5: Instrumentation for Reciprocating Process Compressors in Non-Critical Service

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|---|---|------------|------------|------------------|--------------|---------------------------|
| Lubrication | Frame (Reservoir) | LS | LLA | LP | 1-o-o-1 | — |
| | | LG | LI | Local | — | — |
| | Main Oil Pump (Shaft Driven) | PID | PI | Local | — | — |
| | Standby Oil Pump (Motor Driven) | PID | PI | Local | — | — |
| | | PS | PHA | LP | 1-o-o-1 | Note 3 |
| | Oil Cooler—Inlet | TID | TI | Local | — | — |
| | Oil Cooler—Outlet | TID | TI | Local | — | — |
| | | TIT | TLA | LP | 1-o-o-1 | — |
| | Oil Filter | | THA | LP | 1-o-o-1 | — |
| | | <u>PdI</u> | <u>PdI</u> | Local | — | — |
| | Oil Supply | <u>PdS</u> | PHA | LP | 1-o-o-1 | — |
| | | PID | PI | Local | — | — |
| | Cylinder and Packing Lubrication | PT | PLA | LP | 1-o-o-1 | — |
| | | | PL(CI) | — | 1-o-o-1 | CI standby lube oil pump |
| | | | PL(CI)A | LP | 1-o-o-1 | — |
| | | PLL(CO) | — | 1-o-o-1 | Note 2 | |
| | Suction KO Drum | PT | PLL(CO)A | LP | 1-o-o-1 | — |
| | | | LS | LLA | LP | 1-o-o-1 |
| LG | | | LI | Local | — | — |
| PS | | | PHA | LP | 1-o-o-1 | — |
| PID | | PI | Local | — | — | |
| Liquid Handling | ZS | ZLA | LP | — | — | Cycle counter for FI, FLA |
| | | LT (three) | LI | LP | — | — |
| | | LHA | LP | 1-o-o-3 | — | |
| | | LHH(CO) | — | 2-o-o-3 | Note 2 | |
| | LHH(CO)A | LP | 2-o-o-3 | — | | |
| [*] Suction Pulsation Bottle Boot Liquid Level (if specified) | LG | LI | Local | — | — | |
| | LS | LHA | LP | 1-o-o-1 | — | |
| Gas Compression | Each Stage Inlet | LG | LI | Local | — | — |
| | | LS | LHA | LP | 1-o-o-1 | — |
| | Inlet, Interstage, and Discharge MOV < 50% Open | TIT | TI | LP, Local | — | — |
| | | PIT | PI | LP, Local | — | — |
| | | ZT | ZI | LP | — | — |
| Each Stage dP | ZL(CO) | — | 1-o-o-1 | Note 2 | | |
| | ZL(CO)A | LP | 1-o-o-1 | — | | |
| | <u>PdIT</u> | <u>PdI</u> | Local | — | — | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--|--|--|---------------|------------------|--------------|-----------------------------|
| | | | PdHA | LP | 1-o-o-1 | — |
| | | | [*] PdHH(CO) | — | 1-o-o-1 | Note 2, [*] Note 9 |
| | | | [*] PdHH(CO)A | LP | 1-o-o-1 | — |
| | Each Stage Discharge | TIT | TI | LP, Local | — | — |
| | | PIT | PI | LP, Local | — | — |
| | Total Flow (per section) | FT | FI | LP | — | — |
| | [*] Recycle Flow (per section, if specified) | FT | FI | LP | — | — |
| | Each Cylinder Discharge (Cylinder to Pulsation Bottle) | TID | TI | Local | — | — |
| | | TT | THA | LP | 1-o-o-1 | — |
| | | | THH(CO) | LP | 1-o-o-1 | Note 2 |
| | THH(CO)A | — | 1-o-o-1 | — | | |
| | | Bypass, Unloader, or Capacity Control (indicator position for each unloader) | ZT | ZI | LP | — |
| | Vibration and Temperature Monitoring | [*] Rod Packing, Each Rod (if specified) | TT | TI | LP, MMS | — |
| THA | | | | LP, MMS | 1-o-o-1 | — |
| [*] Rod Drop, Each Rod (if specified) | | ZT | ZI | LP, MMS | — | Single Y probe is an option |
| | | | ZLA | LP, MMS | 1-o-o-1 | — |
| Crankcase Vibration (Velocity) | | VE | VI | MMS | — | Horizontal between throws |
| | | | VHA | LP, MMS | 1-o-o-1 | — |
| | | | VHH(CO) | — | 1-o-o-1 | Note 2 |
| | | | VHH(CO)A | LP, MMS | 1-o-o-1 | — |
| [*] Crosshead Vibration (Acceleration), if specified | | VE | VI | MMS | — | Vertical over crosshead |
| | | | VHA | LP, MMS | 1-o-o-1 | — |
| | | | VHH(CO) | — | 1-o-o-1 | Note 2, Note 7 |
| VHH(CO)A | | LP, MMS | 1-o-o-1 | — | | |
| Multi-Event Key Phaser | | ZE | ZI | MMS | — | Minimum 13 tooth wheel |
| Flywheel Locking Device | ZS | ZS(CO) | — | 1-o-o-1 | Note 4 | |
| | | ZS(CO)A | LP | — | — | |
| Cylinder and Packing Cooling System | Tempered Water Tank | LS | LLA | LP | 1-o-o-1 | — |
| | | LG | LI | Local | — | — |
| | | TID | TI | Local | — | — |
| | Each Pump Discharge, Main/Standby | PID | PI | Local | — | Note 6 |
| | TW Cooler—Inlet | TID | TI | Local | — | — |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--------------------------|---------------------------------------|------------|----------|------------------|--------------|-----------------------|
| | TW Cooler—Outlet | TID | TI | Local | — | — |
| | TW Supply for Cylinder Jacket Cooling | TIT | TLA | LP | 1-o-o-1 | — |
| | | | THA | LP | 1-o-o-1 | — |
| | | PIT | PI | Local | — | — |
| | | | PL(CI) | — | 1-o-o-1 | CI standby water pump |
| | Compressor Cylinder, Each Outlet | TID | TI | Local | — | — |
| | | FG | FI | Local | — | Sight glass |
| | TW Filter for Packing Coolant | PdIS | PdHA | LP | 1-o-o-1 | — |
| | | PID | PI | Local | — | PI after Filter |
| | Compressor Packing, Each Outlet | TID | TI | Local | — | — |
| FG | | FI | Local | — | Sight glass | |
| Distance Piece / Packing | N2 Supply Header | PdI | PdI | Local | — | Across Filter |
| | | PIT | PI | LP, Local | — | — |
| | | | PLA | LP | 1-o-o-1 | — |
| | Packing Purge, Each Rod | FI | FI | Local | — | — |
| | Packing Vent, Each Cylinder | TID | TI | Local | — | — |
| TT | | THA | LP, MMS | 1-o-o-1 | Note 8 | |

Notes:

- (1) LP requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations shall be determined by Owner's Engineer. Likewise, MMS display requirements are Owner's Engineer discretion. For non-critical machines, it is often desirable to avoid expensive MMSs (e.g., Bently Rack with System 1 interface) in favor of simpler forms of data collection (e.g., directly to plant's data historian).
- (2) Connected to driver shutdown (cut-out) system.
- (3) PHA shall be used for standby pump running alarm. Alternatively, substation contacts may be used when specified.
- (4) The locking device on barring wheel shall be equipped with a switch. Normally Open contact shall be used and shall close when the locking device is engaged. The permissive shall prevent the motor from starting whenever contact is closed.
- (5) Unloader position indicator could be switch, position transducer, or pressure transducer.
- (6) Substation contacts shall be used for standby pump running alarm.
- (7) Requirement for crosshead vibration shutdown is Owner's Engineer discretion. Factors for determining include machine size/service and safety/availability risk profiles versus target performance.
- (8) Thermocouple shall be affixed to packing vent line to indicate leakage on high-temperature alarm.
- (9) Requirement for dP cut-out is Owner's Engineer discretion. Factors for determining include machine size/service and safety/availability risk profiles versus target performance.

Table R-6: Instrumentation for Special-Purpose Steam Turbines

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes | |
|---|---------------------------------------|--------------------|------------|------------------|--------------|-------------------------|---|
| Lube Oil | Refer to Table R-10, Lube Oil Systems | — | — | — | — | — | |
| | Control Oil | Control Oil Header | PIT | PI | HMI, Local | — | — |
| PLA | | | HMI | 1-o-o-1 | — | — | |
| PID | | PI | Local | — | — | — | |
| Control Oil Adjacent to Final Element TTV | | PIT (three) | PI | HMI, Local | — | — | — |
| | | PLA | HMI | 1-o-o-3 | — | — | |
| | | [*] PLL(CO) | — | 2-o-o-3 | [*] Note 12 | — | |
| | | [*] PLL(CO)A | HMI | 2-o-o-3 | — | — | |
| PID | PI | Local | — | — | — | | |
| Seal System | Gland Condenser Header | PIT | PI | HMI, Local | — | — | |
| | | PID | PI | Local | — | — | |
| | Sealing Steam | PIT | PI | HMI, Local | — | — | |
| | | PID | PI | Local | — | — | |
| Steam to Ejector | PID | PI | Local | — | — | | |
| Steam Turbine | Inlet Line(s) | PIT | PI | HMI, Local | — | — | |
| | | PID | PI | Local | — | — | |
| | | TIT | TI | HMI, Local | — | — | |
| | | | TLA | HMI | 1-o-o-1 | — | |
| | | TID | TI | Local | — | — | |
| | FT | FI | HMI | — | — | | |
| | TTV | ZT | ZI | HMI | — | Input to Control System | |
| | | ZLA | HMI | 1-o-o-1 | — | | |
| | | ZHA | HMI | 1-o-o-1 | — | | |
| | Trip Solenoid Valves | PID (four) | PI | Local | — | Note 13 | |
| | | ZS (seven) | ZI | HMI, Local | — | Note 5 | |
| | | FG (two) | FI | Local | — | On each drain line | |
| | Admission and Extraction Valves, Each | ZT | ZI | HMI | — | — | |
| | Steam Chest, Each Casing | PIT | PI | HMI, Local | — | Note 4 | |
| | | PID | PI | Local | — | — | |
| | First Stage on Multistage Turbines | PIT | PI | HMI, Local | — | — | |
| | | PID | PI | Local | — | — | |
| | First Stage after Extraction | PIT | PI | HMI, Local | — | — | |
| | | PID | PI | Local | — | — | |
| | Extraction, Each Nozzle | TIT | TI | HMI, Local | — | — | |
| THA | | | HMI | 1-o-o-1 | — | | |
| TID | | TI | Local | — | — | | |
| PIT | | PI | HMI, Local | — | — | | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes | | |
|------------------------------------|------------------------------|---|----------------------|------------------|--------------|---------------------------------|---------|---|
| | | | PLA | HMI | 1-o-o-1 | — | | |
| | | | PHA | HMI | 1-o-o-1 | — | | |
| | | | PID | PI | Local | — | — | |
| | | | FT | FI | HMI | — | — | |
| | | Exhaust | TIT | TI | HMI, Local | — | — | |
| | | | | THA | HMI | 1-o-o-1 | — | |
| | | | TID | TI | Local | — | — | |
| | | | PIT | PI | HMI, Local | — | — | |
| | | | | PLA | HMI | 1-o-o-1 | — | |
| | | | PHA | HMI | 1-o-o-1 | — | | |
| | | Vibration, Axial Position, and Bearing Monitoring | Radial Bearing, Each | VE (two) | VI (two) | HMI, MMS | — | — |
| | | | | | VHA | HMI, MMS | 1-o-o-4 | — |
| VHH(CO) | — | | | | 2-o-o-4 | Note 2 | | |
| VHH(CO)A | HMI, MMS | | | | 2-o-o-4 | — | | |
| TE (two) | TI | | | HMI, MMS | — | — | | |
| | THA | | | HMI, MMS | 1-o-o-2 | — | | |
| Axial Position | ZE (two) | | ZI | HMI, MMS | — | — | | |
| | | | ZHA | HMI, MMS | 1-o-o-1 | — | | |
| | | | ZHH(CO) | HMI, MMS | 2-o-o-2 | Note 2 | | |
| | | | ZHH(CO)A | HMI, MMS | 2-o-o-2 | — | | |
| Thrust Bearing, Active/Inactive | TE (two) | | TI | HMI, MMS | — | two per side minimum | | |
| | | | THA | HMI, MMS | 1-o-o-2 | — | | |
| | | THHA | HMI, MMS | 1-o-o-2 | — | | | |
| Phase Angle | VPE | VPI | MMS | — | Note 3 | | | |
| [*] Torque Coupling (if specified) | TE | TT | MMS | — | Note 7 | | | |
| Turbine Speed System | Electronic Governor (Note 9) | SE (three) | SI | HMI | — | Input to Control System, Note 6 | | |
| | | | SHH(CO) | — | 2-o-o-2 | Note 2, Note 10 | | |
| | | | SHH(CO)A | HMI | 2-o-o-3 | — | | |
| | Tachometers | SE (three) | SI | HMI, MMS | — | — | | |
| | | | SLA | HMI, MMS | 1-o-o-3 | Note 11 | | |
| | | | SLL(CO) | — | 2-o-o-3 | Note 2, Faulty Speed Probes | | |
| | | | SLL(CO)A | HMI | 2-o-o-3 | — | | |
| | | | SHA | HMI, MMS | 1-o-o-3 | — | | |
| SHH(CO) | — | 2-o-o-3 | Note 2, Note 9 | | | | | |
| SHH(CO)A | HMI | 2-o-o-3 | — | | | | | |

Notes:

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--------|---|------------|----------|------------------|--------------|-------|
| (1) | HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations shall be determined by Owner's Engineer. | | | | | |
| (2) | Connected to driver shutdown (cut-out) system that closes both the TTV and governor valve. | | | | | |
| (3) | One phase angle transducer shall be supplied on the turbine shaft. | | | | | |
| (4) | Steam ring pressure measurement applies to single stage turbines only. | | | | | |
| (5) | ZS shall be located on each SOV, each leg isolation valve, and manual trip valve. | | | | | |
| (6) | Three speed indicators shall be provided for CH, for LP, and near TTV for easy visibility during start-up. | | | | | |
| (7) | Torque-measuring coupling is for monitoring the performance of condensing steam turbines. | | | | | |
| (8) | Governor fault alarm shall be displayed in HMI. | | | | | |
| (9) | Over-speed trip system shall display shutdown system fault alarm in HMI. | | | | | |
| (10) | Failure of all governor speed sensors shall shut down the turbine. | | | | | |
| (11) | An alarm should be generated in the HMI when the turning gear is not engaged when turbine is shutdown. | | | | | |
| (12) | The CO is intended to communicate a loss of oil pressure and, therefore, trip of the machine to ensure that the control system properly understands its current state. Moreover, it can be used to indicate a false tripped state or any other failure mode that does not auto-activate the SOVs (e.g., oil swings, loss-of-containment, plugged orifice, etc.). Use of this CO is Owner's Engineer discretion. | | | | | |
| (13) | Pressure gauges are to be located immediately upstream of SOVs for testing purposes. | | | | | |

Table R-7: Instrumentation for High-Speed Centrifugal Air Compressors

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes | |
|---|---------------------------------------|------------|----------|------------------|------------------------|------------------------|------------------------|
| Lube Oil | Refer to Table R-10, Lube Oil Systems | — | — | — | — | — | |
| Compressor Gas Streams | Inlet Filter | PdIT | PdI | HMI, Local | — | — | |
| | | | PdHA | HMI | 1-o-o-1 | — | |
| | First Stage Inlet | TIT | TI | HMI, Local | — | Input to Surge Control | |
| | | | TID | TI | Local | — | |
| | | | PIT | PI | HMI, Local | — | Input to Surge Control |
| | | | PID | PI | Local | — | |
| | Inter-Stage Inlet | TID | TI | Local | — | After intercooler | |
| | | | PID | PI | Local | — | |
| | Last Stage Inlet | TT | TI | HMI | — | — | |
| | | | THA | HMI | 1-o-o-1 | — | |
| | | | TID | TI | Local | — | |
| | | | PID | PI | Local | — | |
| | Inter-Stage Discharge | TID | TI | Local | — | Before intercooler | |
| | | | PID | PI | Local | — | |
| | Last Stage Discharge | TIT | TI | HMI, Local | — | Input to Surge Control | |
| | | | TID | TI | Local | — | |
| | | | PIT | PI | HMI, Local | — | Input to Surge Control |
| | | | PID | PI | Local | — | |
| | Total Flow | FT | FI | HMI, MMS | — | Input to Surge Control | |
| | Vent Flow | FT | FI | HMI, MMS | — | — | |
| Anti-Surge System | ZT | ZI | HMI | — | Input to Surge Control | | |
| Vibration, Axial Position, and Bearing Monitoring | Radial Bearing, Each | VE (two) | VI (two) | HMI, MMS | — | — | |
| | | | VHA | HMI, MMS | 1-o-o-4 | — | |
| | | | VHH(CO) | — | 2-o-o-4 | Note 2 | |
| | | | VHH(CO)A | HMI, MMS | 2-o-o-4 | — | |
| | TE (two) | TI | HMI, MMS | — | — | | |
| | | THA | HMI, MMS | 1-o-o-2 | — | | |
| | | THHA | HMI, MMS | 1-o-o-2 | — | | |
| | | ZI | HMI, MMS | — | — | | |
| Axial Position, Each Shaft with Thrust Bearing | ZE (two) | ZHA | HMI, MMS | 1-o-o-2 | — | | |
| | | ZHH(CO) | — | 2-o-o-2 | Note 2 | | |
| | | ZHH(CO)A | HMI, MMS | 2-o-o-2 | — | | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--------|---------------------------------|--------------|----------|------------------|--------------|-----------------------|
| | Thrust Bearing, Active/Inactive | TE (two) | TI (two) | HMI, MMS | — | Two per side, minimum |
| | | | THA | HMI, MMS | 1-o-o-2 | — |
| | | | THHA | HMI, MMS | 1-o-o-2 | — |
| | Gearbox Casing Vibration | VE API Shaft | VI | HMI, MMS | — | Note 4 |
| | | | VHA | HMI, MMS | 1-o-o-1 | — |
| | | | VHHA | HMI, MMS | 1-o-o-1 | — |
| | Phase Angle | VPE | VPI | MMS | — | Note 3 |

Notes:

- (1) HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations shall be determined by Owner's Engineer.
- (2) Connected to driver shutdown (cut-out) system.
- (3) One phase angle transducer shall be supplied for each different shaft speed of compression train.
- (4) One accelerometer shall be on the gearbox casing near the coupling end radial bearing in the horizontal orientation. Vibration monitor shall provide readout in acceleration.

Table R-8: Instrumentation for Motors in Critical Service

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|---|--|--------------------------------|----------|------------------|------------------------|----------------|
| Lube Oil | Refer to Table R-10, Lube Oil Systems | — | — | — | — | — |
| Motor in Critical Service > 372 kW (500 hp) | Radial Bearing, Each (Note 5) | VE (two) | VI | HMI, MMS | — | — |
| | | | VHA | HMI, MMS | 1-o-o-4 | — |
| | | | VHH(CO) | HMI, MMS | 2-o-o-4 | Note 2 |
| | | | VHH(CO)A | HMI, MMS | 2-o-o-4 | — |
| | | TE (two) | TI | HMI, MMS | — | — |
| | | | THA | HMI, MMS | 1-o-o-2 | — |
| | | | THHA | HMI, MMS | 1-o-o-2 | — |
| | Phase Angle | VPE | VPI | MMS | — | — |
| | Motor Current, One Phase | IE | II | HMI | — | Note 5 |
| | | | IHA | HMI | 1-o-o-1 | — |
| | Differential Current, Each Phase (>1,864 kW [2,500 hp]) | IdE | II | HMI | — | — |
| | | | IHA | HMI | 1-o-o-1 | — |
| | Motor Winding Temperature, Each Phase | TE (Note 4) API recommended | TI | HMI | — | — |
| | | | THA | HMI | 1-o-o-2 | — |
| | | | THHA | HMI | 1-o-o-2 | — |
| | Motor Cooling Water Flow (Totally Enclosed Water-Air-Cooled [TEWAC] motors only) | FT | FI | HMI | — | — |
| | | | FLA | HMI | 1-o-o-1 | — |
| | | | FLL(CO) | — | 1-o-o-1 | Note 2, Note 6 |
| | | | FLL(CO)A | HMI | 1-o-o-1 | — |
| | Motor Cooling Air Flow (Totally Enclosed Air-to-Air-Cooled [TEAAC] motors with separate motor driven fan only) | IE | II | HMI | — | — |
| | | | IILA | HMI | 1-o-o-1 | — |
| | | | ILL(CO) | — | 1-o-o-1 | Note 2 |
| | | | ILL(CO)A | HMI | 1-o-o-1 | — |
| Motor Air Filter (National Electrical Manufacturers type WPII only) | PdT | PdI | HMI | — | — | |
| | | PdHA | HMI | — | — | |
| Current, Motor Space Heater | IE | II | HMI | — | — | |
| | | IILA | HMI | — | Space heater off alarm | |
| Current, Terminal Box Space Heater | IE | II | HMI | — | — | |
| | | IILA | HMI | — | Space heater off alarm | |

Notes:

- HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations will be determined by Owner's Engineer.
- Connected to driver shutdown (cut-out) system.

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--------|--|------------|----------|------------------|--------------|-------|
| (3) | Motors < 3,728 kW (5,000 hp) shall use two TEs per phase. Larger motors in critical service shall use four TEs per phase: two for HMI and two for electrical relay protection; one is spare in each instance. | | | | | |
| (4) | The following vibration monitoring arrangements shall be applied: two X-Y proximity probes at each radial bearing for motors with up to 6 poles; accelerometer at each bearing in the horizontal direction for motors with 8 to 12 poles; or no vibration monitoring for motors with 14 or more poles. | | | | | |
| (5) | One CT shall be used on any phase for signal to HMI display. This is in addition to one CT per phase located in MCC that is wired to the electrical protection relay. | | | | | |
| (6) | Input signal shall be shared between winding temperature and loss of cooling water flow. | | | | | |

Table R-9: Instrumentation for High-Speed Special-Purpose Gearboxes

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|-------------|---------------------------------------|---|----------|------------------|--------------|-----------------------|
| Lube Oil | Refer to Table R-10, Lube Oil Systems | — | — | — | — | — |
| Gearbox | Radial Bearing, Each | VE (two) | VI (two) | HMI, MMS | — | — |
| | | | VHA | HMI, MMS | 1-o-o-4 | — |
| | | | VHH(CO) | — | 2-o-o-4 | Note 2 |
| | | | VHH(CO)A | HMI, MMS | 2-o-o-4 | — |
| | | TE (two) | TI (one) | HMI, MMS | — | One spare TE |
| | | | THA | HMI, MMS | 1-o-o-2 | — |
| | Axial Position | ZE (two) | ZI | HMI, MMS | — | Note 5 |
| | | | ZHA | HMI, MMS | 1-o-o-2 | — |
| | | | ZHH (CO) | — | 2-o-o-2 | Note 2 |
| | | | ZHH(CO)A | HMI, MMS | 2-o-o-2 | — |
| | Thrust Bearing, Active/Inactive | TE (two) | TI | HMI, MMS | — | Two per side, minimum |
| | | | THA | HMI, MMS | 1-o-o-2 | — |
| | Casing Vibration | VE API STD 670 – Only with Rolling Element <i>brg</i> | VI | HMI, MMS | — | Note 3 |
| | | | VHA | HMI, MMS | 1-o-o-1 | — |
| VHHA | | | HMI, MMS | 1-o-o-1 | — | |
| Phase Angle | VPE (two) | VPI | MMS | — | Note 4 | |

Notes:

- (1) HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations shall be determined by Owner's Engineer.
- (2) Connected to driver shutdown (cut-out) system.
- (3) Vibration shall be provided in units of acceleration.
- (4) One phase angle transducer shall be supplied for each different shaft speed of compression train. Transducer may be mounted on the gear pinion or compressor shaft and on bull gear shaft.
- (5) Instrumentation shall be duplicated for each thrust bearing of single helical gears.

Table R-10: Instrumentation for Lube Oil Systems in Critical Service

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|---|--|---------------|----------|------------------|--------------|--------------------------------|
| Lube Oil Systems | Reservoir | TIT | TI | HMI, Local | — | Note 2 |
| | | | TLA | HMI | 1-o-o-1 | — |
| | | | THA | HMI | 1-o-o-1 | — |
| | | TID | TI | Local | — | — |
| | | LT (two) | LI | HMI | — | — |
| | | | LLA | HMI | 1-o-o-2 | — |
| | | | LHA | HMI | 1-o-o-2 | — |
| | | | LLL(CO) | — | 2-o-o-2 | CO electric heater, Note 2 |
| | | LG | LI | Local | — | — |
| | | Oil Pump—Main | PIT | PI | HMI, Local | — |
| | PHA | | | HMI | 1-o-o-1 | Note 4 |
| | PID (two) | | PI | Local | — | Suction and Discharge |
| | Oil Pump—Standby | PIT | PI | HMI, Local | — | — |
| | | | PHA | HMI | 1-o-o-1 | Note 4 |
| | | PID (two) | PI | Local | — | Suction and Discharge |
| | Oil Coolers—Oil Inlet | TIT | TI | HMI, Local | — | — |
| | | TID | TI | Local | — | — |
| | Oil Coolers—Oil Outlet | TIT (two) | TI | HMI, Local | — | — |
| | | | TLA | HMI | 1-o-o-2 | — |
| | | | THA | HMI | 1-o-o-2 | — |
| | | | TLLA | HMI | 2-o-o-2 | Start permissive, Note 5 |
| | | TID | TI | Local | — | — |
| | Oil Filter | PdI | PdI | Local | — | — |
| | | PdT | PdHA | HMI | 1-o-o-1 | Note 6 |
| | Oil Supply Header—Upstream of Pressure Control Valve (PCV) | PIT (two) | PI | HMI, Local | — | — |
| | | | PLA | HMI | 1-o-o-2 | — |
| | | | PLL(CI) | — | 1-o-o-2 | CI to start aux. lube oil pump |
| | | PID | PI | Local | — | — |
| | Lube Oil Header—Downstream of PCV | PIT (three) | PI | HMI, Local | — | — |
| | | | PLA | HMI | 1-o-o-3 | — |
| | | | PLL(CO) | — | 2-o-o-3 | Note 3 |
| | | PLL(CO) A | HMI | 2-o-o-3 | — | |
| | PID | PI | Local | — | — | |
| [*] Accumulator, Direct Contact Type (if specified) | LT (two) | LI | HMI | — | — | |
| | | LLA | HMI | 1-o-o-2 | — | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--------|---|------------|----------|------------------|--------------|-------------------------------|
| | | | LHA | HMI | 1-o-o-2 | — |
| | | | LLL(CI) | — | 1-o-o-2 | CI closes level control valve |
| | | | LLL(CI)A | HMI | 1-o-o-2 | — |
| | | LG | LI | Local | — | — |
| | | PID | PI | Local | — | PI on charge gas |
| | [*] Pressurized Emergency Rundown Tank (if specified) | FG | FI | Local | — | Sight glass on overhead drain |
| | Lube Oil Drain Header—Bearing Returns | FG | FI | Local | — | Sight glass |
| | | TID | TI | Local | — | — |
| | Coupling Housing Drain | FG | FI | Local | — | Sight glass |

Notes:

- (1) HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations shall be determined by Owner's Engineer.
- (2) Electric oil heater shall be controlled by temperature transmitter mounted in reservoir through PLC with high-temperature cut-out switch internal to heater and low reservoir oil level cut-out through PLC.
- (3) Connected to driver shutdown (cut-out) system.
- (4) Pressure transmitter upstream of pump discharge check valve shall provide auxiliary lube oil pump running alarm through PLC.
- (5) TIT provides a low-temperature permissive to start main driver. It does not trip driver when running.
- (6) A zeroing bypass valve is not permitted in lube, control, or seal oil service.

Table R-11: Instrumentation for Seal Oil Systems in Critical Service

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|---------------------------|---|---------------------|-------------|------------------|--------------------------|-------------------------------|
| Seal Oil Systems | Reservoir | TIT | TI | HMI, Local | — | Note 2 |
| | | | TLA | HMI | 1-o-o-1 | — |
| | | | THA | HMI | 1-o-o-1 | — |
| | | TID | TI | Local | — | — |
| | | LT (two) | LI | HMI | — | — |
| | | | LLA | HMI | 1-o-o-2 | — |
| | | | LHA | HMI | 1-o-o-2 | — |
| | | | LLL(CO) | — | 2-o-o-2 | CO electric heater, Note 2 |
| | | LG | LI | Local | — | — |
| | Oil Pump—Main | PIT | PI | HMI, Local | — | — |
| | | | PHA | HMI | 1-o-o-1 | Note 4 |
| | | PID (two) | PI | Local | — | Suction and Discharge |
| | Oil Pump—Standby | PIT | PI | HMI, Local | — | — |
| | | | PHA | HMI | 1-o-o-1 | Note 4 |
| | | PID (two) | PI | Local | — | Suction and Discharge |
| | Oil Coolers—Oil Inlet | TIT | TI | HMI, Local | — | — |
| | | TID | TI | Local | — | — |
| | Oil Coolers—Oil Outlet | TIT (two) | TI | HMI, Local | — | — |
| | | | TLA | HMI | 1-o-o-2 | — |
| | | | THA | HMI | 1-o-o-2 | — |
| | | TLLA | HMI | 2-o-o-2 | Start permissive, Note 5 | |
| | TID | TI | Local | — | — | |
| | Oil Filter | <u>PdI</u> | <u>PdI</u> | Local | — | — |
| | | <u>PdT</u> | <u>PdHA</u> | HMI | 1-o-o-1 | Note 6 |
| | Head Tank, Each Casing (Oil Film Bushing Seals) | LT (three) | LI | HMI | — | — |
| | | | LLA | HMI | 1-o-o-3 | — |
| | | | LHA | HMI | 1-o-o-3 | — |
| | | | LL(CI) | — | 1-o-o-3 | Start auxiliary seal oil pump |
| | | | LL(CI)A | HMI | 1-o-o-3 | — |
| | | | LLL(CO) | — | 2-o-o-3 | Note 3 |
| | | | LLL(CO)A | HMI | 2-o-o-3 | — |
| | LG | LI | Local | — | — | |
| | DP Control, Each Casing (Mechanical Contact Face Seals) | <u>PdIT</u> (three) | PI | HMI, Local | — | Note 7 |
| PLA | | | HMI | 1-o-o-3 | — | |
| PLL(CO) | | | HMI | 2-o-o-3 | Note 3 | |
| PLL(CO)A | | | HMI | 2-o-o-3 | — | |
| Seals/Buffered Labyrinths | <u>PdIT</u> | <u>PdI</u> | HMI, Local | — | — | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--------|----------------------|------------|-------------|------------------|--------------|-------------|
| | | | <u>PdLA</u> | HMI | 1-o-o-1 | — |
| | | | <u>PdHA</u> | HMI | 1-o-o-1 | — |
| | Atmospheric Drain | TIT | TI | HMI, Local | — | — |
| | | FG | FI | Local | — | Sight glass |
| | Seal Oil Drain Trap | [*] LT | LI | HMI | — | Note 8 |
| | | LG | LI | Local | — | — |

Notes:

- (1) HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations shall be determined by Owner's Engineer.
- (2) Electric oil heater shall be controlled by temperature transmitter mounted in reservoir through PLC with high-temperature cut-out switch internal to heater and low reservoir oil level cut-out through PLC.
- (3) Connected to driver shutdown (cut-out) system.
- (4) Pressure transmitter upstream or pump discharge check valve shall provide auxiliary lube oil pump running alarm through PLC.
- (5) TIT provides a low-temperature permissive to start driver. It does not trip driver when running.
- (6) A zeroing bypass valve is not permitted in lube, control, or seal oil service.
- (7) dP control specifically compares seal oil pressure to reference gas pressure.
- (8) Use of LT will depend on trap design and method of control.

Table R-12: Instrumentation for Dry Gas Seals (Unpressurized Dual Seal with Internal Labyrinth)

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|---|---|-----------------------|------------|------------------|--|---|
| Dry Gas Seals (Unpressurized Dual Seal with Internal Labyrinth) | Primary Seal Gas Filtration/Coalescer | PIT | PI | HMI, Local | — | Upstream of Filter |
| | | PdIT | PdI | HMI, Local | — | — |
| | | | PdHA | HMI | 1-o-o-1 | — |
| | | LIT | LI | HMI, Local | — | Coalescer/ Separator level |
| | LHA | | HMI | 1-o-o-1 | — | |
| | Primary Seal Gas Heater | TIT (each seal inlet) | TI | HMI, Local | — | Note 6, Note 7, Heater outlet common header |
| | | | TLA | HMI | 1-o-o-1 | — |
| | | | THA | HMI | 1-o-o-1 | — |
| | Seal Gas dP Control Option (Inboard and Outboard) | PDIT | PDI | HMI, Local | — | Downstream of PDCV, Note 8 |
| | | | PDLA | HMI | 1-o-o-1 | — |
| | | | PDHA | HMI | 1-o-o-1 | — |
| | | FIT (each seal) | FI | HMI, Local | — | Downstream of PDIT |
| | PIT | PI | HMI, Local | — | Seal reference pressure, Note 8 | |
| | Each Individual Seal Gas Flow Control Option (Inboard and Outboard) | FIT | FI | HMI, Local | — | Downstream of FCV, Note 8 |
| | | | FLA | HMI | 1-o-o-1 | — |
| | | FHA | HMI | 1-o-o-1 | — | |
| | PIT | PI | HMI, Local | — | Located at header when one FCV is used | |
| | Each Individual Seal Secondary Seal Gas Flow (Inboard and Outboard) | FIT | FI | HMI, Local | — | Note 9 |
| | | | FLA | HMI | 1-o-o-1 | — |
| | | | FHA | HMI | 1-o-o-1 | — |
| | | PIT | PI | HMI, Local | — | Downstream of each CV |
| | FIT | FI | HMI, Local | — | Note 5 | |
| | | FLA | HMI | 1-o-o-1 | — | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--|--|--|--------------------|------------------|--------------------|-----------------|
| | Each Individual Seal Primary Seal Leakage (Inboard and Outboard) | PIT ([*] three if CO is specified, else one) | FHA | HMI | 1-o-o-1 | — |
| | | | FHH(CO) | — | 1-o-o-1 | Note 3, Note 10 |
| | | | FHH(CO)A | HMI | 1-o-o-1 | — |
| | | | PI | HMI, Local | — | Note 8 |
| | | | PLA | HMI | 1-o-o-1 | — |
| | | | PHA | HMI | 1-o-o-1 | — |
| | | | [*] PHH(CO) | — | 1-o-o-1 or 2-o-o-3 | Note 3, Note 10 |
| | [*] PHH(CO)A | HMI | 1-o-o-1 or 2-o-o-3 | — | | |
| | Each Individual Seal Secondary Seal Leakage (Inboard and Outboard) | FIT | FI | HMI, Local | — | — |
| | | | FHA | HMI | 1-o-o-1 | — |
| | | | FHH(CO) | — | 1-o-o-1 | Note 3, Note 10 |
| | | | FHH(CO)A | HMI | 1-o-o-1 | — |
| | Secondary Gas/Separation Gas Filtration | PdIT | PdI | HMI, Local | — | — |
| | | | PdHA | HMI | 1-o-o-1 | — |
| PIT | | PI | HMI, Local | — | Upstream of Filter | |
| Each Individual Separation Gas Supply (Inboard and Outboard) | PIT | PI | HMI, Local | — | Note 4 | |
| | | PLA | HMI, Local | 1-o-o-1 | — | |

Notes:

- (1) HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations shall be determined by Owner's Engineer. Local indication by digital display mounted on the transmitter.
- (2) A variable orifice with ΔP measurement may be used, if tamper-proof.
- (3) Connected to driver shutdown (cut-out) system.
- (4) Separation gas pressure shall be used as a lube oil pump start permissive with 30 second timer.
- (5) Overpressure bypass relief device shall be considered in the event of catastrophic primary seal failure. A 2 barg (30 psig) opening spring load check valve maybe used. No such device is needed in the secondary vent.
- (6) If seal gas pre-conditioning heater is used, then temperature measurement may be used as input to heater control.
- (7) Electric heater will have internal switches/instruments for element control and cut-out not shown in this Table.

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| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit Info | 000 - General | | | | | | |

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--------|---|------------|----------|------------------|--------------|-------|
| (8) | <p>For compressors with suction pressure greater or equal to 7 barg (100 psig) the primary seal gas supply control methodology shall be flow control (use a single FCV unless seals are designed to have differing sealing pressures where individual FCV to each seal shall be provided). For compressors with suction pressure less than 7 barg (100 psig) the primary seal gas supply control methodology shall be differential pressure control (use a single PDCV unless suction pressure is 1 barg [15 psig] or less). For compressors with suction pressure of 1 barg (15 psig) or less, more than one dP measurement shall be used to prevent reverse pressurization of inner seal due to increase in flare pressure. In these services, signal from the seal reference pressure (typically balance line), the inboard primary seal vent pressure and the outboard primary seal pressure are used in conjunction with the seal gas supply pressure downstream of the PCV to control primary seal supply pressure. For higher suction pressure services, only the seal reference pressure (typically balance line) is used in conjunction with the seal gas supply pressure downstream of the PCV to control the primary seal gas supply pressure.</p> | | | | | |
| (9) | <p>For equal sealing pressure seals, one common FCV/FC can be used for secondary seal gas flow control. Compare signals from both Inboard and Outboard FTs to control secondary seal gas flow. For differing sealing pressure seals, individual secondary gas FCVs shall be provided for each side (Inboard and Outboard).</p> | | | | | |
| (10) | <p>For Upstream applications and for Downstream toxic or hazardous gas services, automatic shutdown (trip) shall be based on primary seal failure using the following logic: Single parameter PHH (CO): pressure in primary vent on 2-o-o-3 transmitters. The design of the primary vent and secondary seal gas supply piping shall ensure that the trip pressure cannot be attained by the secondary seal gas control valve when in the full open position. For other Downstream services, where there may be unit process safety concerns with automatically tripping the compressor, automatic shutdown (trip) shall be based on failure of both primary and secondary seals using the following logic: Triple parameter voting 2X FHH (CO) and PHH (CO): flow in primary vent (1-o-o-1), pressure in primary vent (1-o-o-1), and flow in secondary vent (1-o-o-1) shall all occur within the same seal to initiate a compressor trip.</p> | | | | | |

Table R-13: Instrumentation for Dry Gas Seals (Pressurized Dual Seal Design)

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--|---|------------|---------------|------------------|--------------------|-----------------------------|
| Dry Gas Seals (Pressurized Dual Seal Design) | Buffer Gas Filtration/Coalescer | PIT | PI | HMI, Local | — | Upstream of Filter |
| | | PdIT | PdI | HMI, Local | — | — |
| | | | PdHA | HMI | 1-o-o-1 | — |
| | | LIT | LI | HMI | — | Coalescer / Separator level |
| | LHA | | HMI | 1-o-o-1 | — | |
| | LG | LI | Local | — | — | |
| | | | | | | |
| | Common Buffer Gas Supply Header | PIT | PI | HMI, Local | — | — |
| | | | PLA | HMI | 1-o-o-1 | — |
| | | | PHA | HMI | 1-o-o-1 | — |
| | Each Individual Buffer Gas dP Control Option (Inboard and Outboard) | PdIT | PdI | HMI, Local | — | Note 2, Note 5 |
| | | | PdLA | HMI | 1-o-o-1 | — |
| | | | PdHA | HMI | 1-o-o-1 | — |
| | Each Individual Buffer Gas Flow Control Option (Inboard and Outboard) | FIT | FI | HMI, Local | — | Note 2, Note 6 |
| | | | FLA | HMI | 1-o-o-1 | — |
| | | | FHA | HMI | 1-o-o-1 | — |
| | Common Seal Gas Supply Header | PIT | PI | HMI, Local | — | — |
| | | | PLA | HMI | 1-o-o-1 | — |
| | | | PHA | HMI | 1-o-o-1 | — |
| | Each Individual Seal Gas Supply (Inboard and Outboard) | PIT | PI | HMI, Local | — | — |
| PdIT ([*] three if CO is specified, else one) | | | PdI | HMI | — | Note 7 |
| | | | PdLA | HMI | 1-o-o-1 | — |
| | | | PdHA | HMI | 1-o-o-1 | — |
| | | | [*] PdLL (CO) | — | 2-o-o-3 | Note 3 |
| [*] PdLL (CO)A | HMI | 2-o-o-3 | — | | | |
| Each Individual Seal Leakage (Inboard and Outboard) | FIT | FI | HMI, Local | — | — | |
| | | FHA | HMI | 1-o-o-1 | — | |
| Separation Gas Filtration (only needed if Seal Gas source is different from Separation Gas source) | PdIT | PdI | HMI, Local | — | — | |
| | | PdHA | HMI | 1-o-o-1 | — | |
| Each Individual Separation Gas Supply (Inboard and Outboard) | PIT | PI | Local | — | Upstream of Filter | |
| | | PLA | HMI | 1-o-o-1 | Note 4 | |

Notes:

- (1) HMI requirements are minimum requirements to be located on either DCS Operator screen or local display. Locations will be determined by Owner's Engineer.

| System | Equipment/Monitoring | Instrument | Function | Display (Note 1) | Voting Logic | Notes |
|--------|--|------------|----------|------------------|--------------|-------|
| (2) | For low pressure services (< 7.0 bar [100 psi]), use <u>dP</u> control. For higher pressure services (> 7.0 bar [100 psi]), use flow control to minimize buffer gas consumption. For higher pressure services (> 7.0 bar [100 psi]), <u>dP</u> control will suffice; however, higher buffer gas consumption will result in less efficient operation. | | | | | |
| (3) | Connected to driver shutdown (cut-out) system. | | | | | |
| (4) | Separation gas pressure signal shall be used as lube oil pump start permissive with 30 second timer. | | | | | |
| (5) | <u>dP</u> to seal reference pressure (typically balance line) shall be used for control of common buffer gas supply PDCV. | | | | | |
| (6) | For equal sealing pressure seals, one common FCV/FC can be used for buffer gas flow control. Compare signals from both Inboard and Outboard FTs to control buffer gas flow. For differing sealing pressure seals, individual buffer gas FCVs shall be provided for each side (Inboard and Outboard). | | | | | |
| (7) | For equal sealing pressure seals, one common PDCV can be used for seal gas flow control. For differing sealing pressure seals, individual seal gas PDCVs shall be provided for each side (Inboard and Outboard). | | | | | |

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HOLD STATUS

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1. INTRODUCTION

1.1 Project Overview

“ExxonMobil Corporation (“COMPANY”) has awarded a CONTRACT to Technip Energies India (“CONTRACTOR”) for performing the FEED and EP work for reconfiguring COMPANY’s BAYTOWN refinery to produce a more resilient product slate, while enabling future GHG emission reductions.

The project includes scope in three major areas of the refinery: the Hydrocracking Unit (HCU-1), the Raffinate Hydro-Conversion Unit (RHC) and Offsites and Utilities.

The project will convert the HCU-1 to a lubes hydrocracker, using light Virgin Gas Oil (VGO) streams as charge to be cracked into diesel and additional feed from HCU-1 will be supplied to the RHC to produce the light-neutral grades”.

2. REFERENCES

2.1 Required References

[*] This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced Specifications may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

2.1.1 References

| Reference | Reference Title |
|-------------------------|---|
| GP 03-12-01D | Valve Selection |
| GP 03-12-09D | General Requirements for Valves |
| GP 03-09-01D | Winterizing Against Ambient Temperatures |
| GP 03-15-01D | Pressure Relief Valves |
| GP 18-07-01D | Welding Procedures |
| GP 18-03-04D | Pressure Casting Quality and Inspection |
| USBT-000-TE-MR-EQS-0003 | Shaft Sealing Systems for Centrifugal and Rotary Pumps |
| USBT-000-TE-MR-EQS-0011 | General Purpose Gear Units |
| USBT-000-TE-EA-EQS-0004 | Job Specification for Supply of Medium Voltage Induction motors |
| USBT-000-TE-EA-EQS-0005 | Job Specification for Low Voltage AC Induction Motors |

2.1.2 Industry Standards

| Industry Standard Number | Industry Standard Title |
|---------------------------|---|
| API STD 676-3 | Positive Displacement Pumps - Rotary - Third Edition, November 2009 |
| ASME B16.11 ASME B31.3 | Forged Fittings, Socket-Welding and Threaded Process Piping |
| ASME/BPVC SEC VIII D1 | BPVC Section VIII - Rules for Construction of Pressure Vessels - Division 1 |
| ASTM A 487/A 487M | Standard Specification for Steel Castings Suitable for Pressure Service |
| ASTM A 494/A 494M | Standard Specification for Castings, Nickel and Nickel Alloy |
| AWS D1.1/D1.1M | Structural Welding Code - Steel |
| B11/STD B11.19 | Performance Requirements for Risks Reduction Measures: Safeguarding and other Means of Reducing Risk |
| BSI BS EN ISO 14120 | Safety of Machinery - Guards - General Requirements for the Design and Construction of Fixed and Movable Guards |
| ISO 3744 | Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane |
| NACE MR0103/ISO 17945 | Petroleum, Petrochemical, and Natural Gas Industries - Metallic Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments |

2.2 Acronyms and Definitions

2.2.1 Acronyms

| Acronym | Description |
|---------|------------------------------------|
| ASD | Adjustable Speed Drives |
| CET | Critical Exposure Temperature |
| FAT | Factory Acceptance Test |
| GVF | Gas Volume Fraction |
| ITP | Inspection Test Plan |
| MAWP | Maximum Allowable Working Pressure |

| Acronym | Description |
|---------|------------------------------------|
| NPSH | Net Positive Suction Head |
| NDT | Non-Destructive Testing |
| NPSHR | Net Positive Suction Head Required |
| OEL | Occupational Exposure Limit |
| OEM | Original Equipment Manufacturer |
| PRV | Pressure Relief Valve |
| PMI | Positive Material Inspection |
| PSV | Pressure Safety Valve |
| PTFE | Polytetrafluoroethylene |
| PWHT | Post Weld Heat Treatment |
| RPM | Revolutions per Minute |
| TLV | Threshold Limit Value |
| SG | Specific Gravity |

2.3 REQUIREMENT DESIGNATION

Certain paragraph/s are preceded by bracketed uppercase letter. Below is the meaning of each designation.

| Acronym | Definition |
|---------|--|
| [S] | 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). |
| [O] | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| [A] | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| [E] | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |

| | |
|------|--|
| [R] | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| [M] | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| [C] | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| [CS] | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| [*] | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |

3. REVISIONS TO API STANDARD 676-3RD EDITION

- 3-1** API STD 676-3 (API Standard) shall be used as modified by this Specification, unless superseded by more stringent local regulations. This Specification is intended to supplement the API Standard and not replace it. All headings and paragraph or clause numbers contained herein correspond to those in the API standard. Sections not modified shall be followed as written in the API Standard.
- 3-2** Specific definitions of the terms "new," "addition," "substitution," and "deletion" are shown directly below:
- i. "New"—New clause that does not currently appear in the API standard. Text in this specification is accompanied by a clause number not currently existing in the API standard.
 - ii. "Addition"—Text added to a clause already in the API standard, but not overwriting any of the text currently in the API standard. Text in this specification does not modify or overwrite the API standard text in any way. The reader shall read and follow both the API standard text and this specification clause text.
 - iii. "Substitution"—Text wholly replaces the text currently in the API standard. Text in this specification is wholly taking the place of the API standard text. The reader shall ignore the API standard text and only follow the clause text of this specification.
 - iv. "Modification" – Specific revisions have been made to the text currently in the API standard.
 - v. "Deletion"—Wholly deletes the text currently in the API standard. Text in this specification is stating that the API standard text shall not be followed.
 - vi. "Decision" – Text in this specification makes a decision that was required.

MODIFICATIONS TO SECTION 1: SCOPE

1.a. Addition: Scope

- a. [R] Proposal shall include an experience list demonstrating experience for the proposed pump.

- b. [R] Vendor shall have manufactured at the proposed point of manufacture at least two pumps of comparable power, speed, pressure, temperature, and flow rate and operating satisfactorily for at least 1 year.

1.b. Addition: Scope

[R] If qualification requirements prevent application of the latest technology, Vendor may submit an alternative proposal, specifically identifying the undemonstrated features and stating the advantages.

MODIFICATIONS TO SECTION 6: BASIC DESIGN

6.1.4. Addition: General

- a. As a basic requirement, the sound pressure level (Lp, re 20 x 10⁻⁶ Pa) for complete equipment train (Pump + Motor + Gearbox if any), shall not exceed 85 dBA at any locations at (Three) 3 ft from equipment surface. The VENDOR shall guarantee the required sound level is not exceeded. The sound level shall be reported in the loaded condition for the specified design.
- b. The sound pressure level of each piece of equipment in the train shall not exceed 80 dBA at any location, 3 ft from equipment surface.
- c. Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort by the Company / Contractor and the Vendor. The vendor shall include in the proposal a completed Noise Data Sheet indicating expected sound pressure levels for the pump package as a single noise source and for major noise generating components. Reference location for pump skid noise data shall be 1000 mm (3 ft) from skid edge. In addition, the Vendor shall provide expected sound power data. Sound power levels shall be supplied in the completed noise data sheet for the pump package as a single source and for the major noise generating components.
- d. For exceeding the specified noise limit, Vendor shall recommend abatement option, and this shall be quoted as option. Vendor shall specifically state the type of noise treatment and/or steps that will be performed in the event of a noise level exceeding the permitted level. The procedure shall be specifically stated in the submittals. All the necessary noise model/calculations must be performed and submitted for Contractor / Owner review and approval.

6.1.13.1. Substitution: General

[O] Vendor shall confirm that Multiphase Pumps (MPPs) are capable of start-up at settle-out and maximum suction pressure.

6.1.14. Substitution: General

- e. [R] Pumps and auxiliaries shall be suitable for outdoor (without a roof) installation.
- f. [R] Pumps and auxiliaries shall be winterized for the climatic zone as specified below.

| Scope | Climatic Zone Classification | Temperature Condition |
|---------------------|------------------------------|---|
| Instrumentation | C | The lowest mean daily temperature is below 30 deg F for more than 24 hours but is above 0 deg F |
| All other equipment | B | The lowest mean daily temperature is below 30 deg F for no more than 24 consecutive hours |

Pumps and auxiliaries shall be winterized for the climatic zone specified per GP 03-09-01D.

6.3.3.2. Substitution: Pressure-Containing and Pressure-Retaining Parts

[S] Suction regions shall be designed for the same MAWP as the discharge section.

6.4.2. Addition: Casing Connections

- a. [M][O] All required vents and drains shall be valved.
- b. Gate valves used for vents and drains shall be per GP 03-12-01D and GP 03-12-09D.

6.4.4.1. Addition: Suction and Discharge Nozzles

[A][R] Owner's Engineer shall approve deviations from flanged nozzles for suction and discharge connections.

6.4.4.2. Addition: Suction and Discharge Nozzles

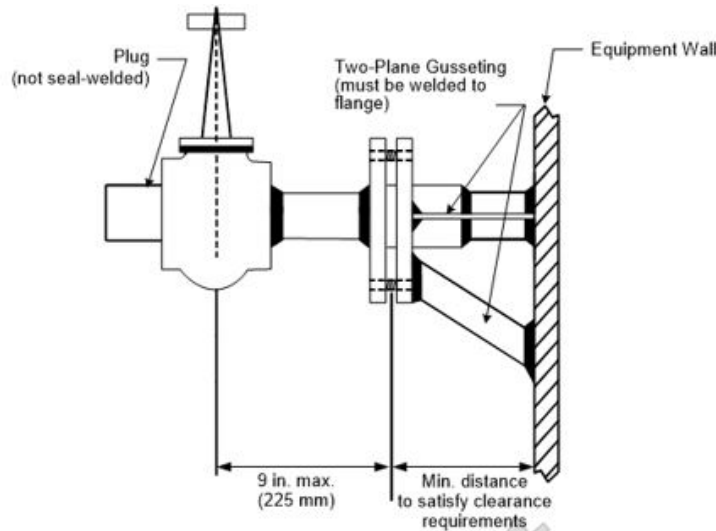
[S] All connections shall be suitable for the pump casing MAWP.

6.5.2. Substitution: Auxiliary Connections

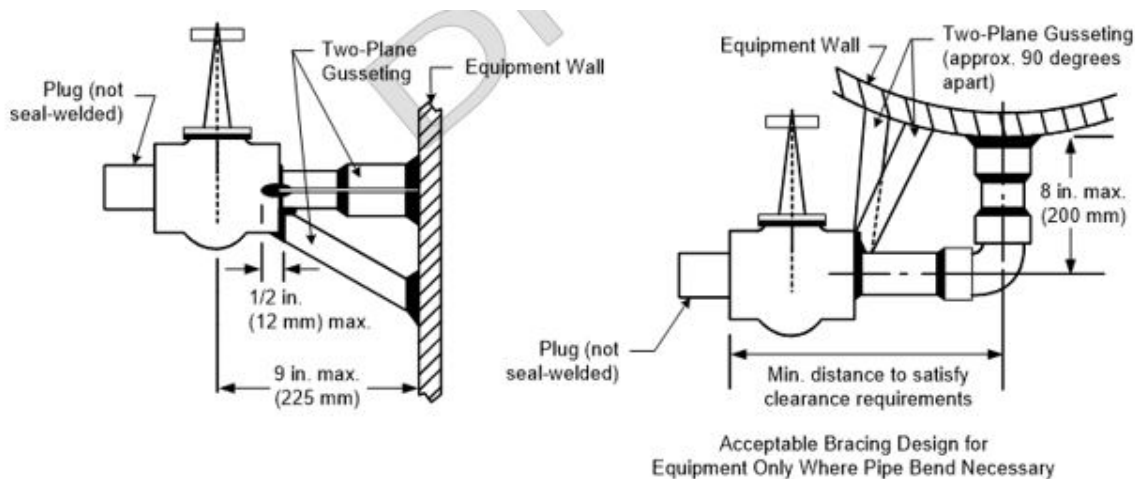
Pressure casing small bore connections less than DN 50 (NPS 2) shall be braced as follows:

- a. [S] Valved vent, drain, and online washing connections to the casing shall be braced as shown in Figure 1: Bracing Detail.
- b. [A] Proposals to use clamped or bolted bracing designs shall be submitted to Purchaser for Owner's Engineer approval.
- c. [A] Bracing design for piping connections requiring double block valves shall be submitted to Purchaser for Owner's Engineer approval.
- d. [R] Bracing shall have a minimum thickness of 5 mm (³/₁₆ in.) and a minimum width of 19 mm (³/₄ in.).
- e. [R] Bracing material for welded bracing shall be of the same nominal chemistry as the connected parts, except that carbon steel may be used for bracing P-1, P-3, P-4, and P-5 materials.
- f. [R] Bracing attachment welds to a pressure boundary shall PWHT whenever PWHT is required on the alloy steel component to which the attachment is to be made. Such attachment welds shall be performed according to ASME B31.3 PWHT criteria for butt welds in alloy steel materials. This requirement shall be met regardless of whether butt welds are used in the assembly.

Figure 1: Bracing Detail



NOTE:
Bracing detail applicable to weld neck or socket welded flange.



GENERAL NOTE:
Bracing detail applicable to extended body type valve or to compact body valve plus nipple (as illustrated).

6.5.3.4. Substitution: Auxiliary Connections

[R] Threaded connections that are essential for maintenance (e.g., venting, draining, disassembly, etc.) shall not be seal welded. For all other threaded connections seal welding shall be as follows:

- Made up without the use of sealing compounds or PTFE tape. All cutting oil used shall be removed prior to assembly. After the joint has been tightened to a full thread engagement, the seal welding shall cover all exposed threads.
- With electrodes not greater than 3.2 mm ($1/8$ in.) in diameter, using amperage in the low range to avoid distortion of the connection or part being welded.

6.5.3.4. Substitution: Auxiliary Connections

[M] Threaded vent and drain connections shall be supplied with metal, non-seal-welded round head plugs per ASME B16.11.

6.8.1.2. Substitution: Rotors

[M] For twin screw pumps, rotor stiffness shall be adequate to prevent contact between the rotor bodies and the casing and between gear-timed rotor bodies at the most unfavorable specified conditions.

6.8.1.10. New: Rotors

[R] Rotors shall not be chrome plated.

6.8.2.5. New: Timing Gears

[R] If a forced-feed lubrication system is supplied, then an independent oil supply line with the specified flow rate shall be provided within the pump casing for timing gear lubrication.

6.9.3. Addition: Mechanical Shaft Seals

Mechanical shaft seals shall be per USBT-30-TE-MR-EQS-0003.

6.10.6. New: Bearings and Bearing Housings

[R] Cages for angular contact thrust bearings shall be of machined bronze or machined brass.

6.12.6.a. Addition: Lubrication

[O][R] For oil-lubricated bearings, each bearing housing shall be furnished with a constant-level oiler.

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| | 216119C | 000 | JSS | 0930 | 0001 | 0 | 11/17 |
| Exxon Doc. No. | USBT-000-TE-MR-EQS-0005 | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit Info | 000-General | | | | | | |

6.12.6.b. Addition: Lubrication

[O][R] A permanent indication of proper oil level shall be accurately located and clearly labeled, on the outside of bearing and timing gear housings, with permanent metal tags, marks inscribed in the casting, or other durable means.

6.13.2.13.1. Substitution: Materials of Construction

[R] For downstream installations, materials exposed to a sour environment as defined by NACE MR0103/ISO 17945 shall conform to below requirements.

- a. **[S]** This Section covers impact testing requirements for pressure vessels, piping, and machinery. Impact requirements shall be based on the CET established by Owner's Engineer.
- b. **[R]** Preservation shall be provided for fixed equipment to prevent corrosion and deterioration from the effects of environmental conditions during shipping, storage, and construction.
- c. **[A][R]** Procedures for protection shall be submitted to Owner's Engineer for review. Procedures shall include protective measures, inspection, maintenance, and removal of preservatives. Selection of preservation methods shall consider their environmental impact during removal or disposal.
- d. **[R]** If preservatives are removed for inspection or testing at any time prior to commissioning, they shall be reapplied upon completion of the work.
- e. **[A][R]** Stainless steel surfaces shall be protected against contamination by iron-containing dust and fumes from grinding, welding, wire brushing, and other manufacturing operations. All internal and external surfaces of stainless steel shall be clean and bright. Contaminated surfaces and weldments showing heat tints, other than bright and yellow, require pickling and passivation. Other cleaning processes require Owner Engineer approval.
- f. **[R]** Nozzles, manholes, vents, and connection openings on pressure vessels shall be blanked to prevent moisture from entering. A 0.2 in. (5 mm) thick, gasketed steel blind shall be used, held in place by a minimum of four bolts.
- g. **[R]** Threaded openings in equipment shall be closed with threaded stainless steel pipe plugs. Stainless steel equipment or components shall not be exposed to salt water or salt spray. If this occurs, then exposed external surfaces shall be washed with potable water containing less than 250 ppm chloride ions (Cl⁻) and dried.
- h. **[R]** Stainless steel shall not be stored outdoors in direct contact with or within 12 in. (300 mm) of the soil or in contact with porous or moisture retaining supports such as raw wood.
- i. **[R]** During construction, precautions shall be taken to prevent the introduction of water into stainless steel equipment as a result of washing or hydrotesting other connected equipment.

6.13.3.4. Addition: Castings

[A][M][R] Casting repairs that meet the following criteria shall not be initiated until the repair procedures have been approved by Owner's Engineer. Defect charts shall be submitted for review prior to start of repairs. The following repair castings shall be inspected per GP 18-03-04D:

- a. Repairs required after final heat treatment.
- b. Repairs made due to the inability of the pump to pass hydrostatic testing.
- c. Repairs that exceed 65 cm² (10 in. ²).
- d. Repairs that result in a repair cavity that exceeds 20% of the casting wall thickness or 25 mm (1 in.), whichever is less.

Mill test reports of chemical composition and mechanical properties of castings shall be submitted as per below table 2.

Table – 2: Castings

| Exam Type ⁽¹⁾ | Exam Frequency (No. of Castings) | Extent of Exam ⁽⁵⁾ | Acceptance Standards |
|--|--|---|---|
| VT | All | 100% | VT-1 |
| MT/PT ⁽⁴⁾ | All | 100% ⁽²⁾ | MT-1 or MT-2 PT-1 or PT-2 ⁽⁴⁾ |
| RT | Initial: F1 Balance: F2 (see below) | Critical areas (see Table 2) | RT-1 or RT-2 ⁽³⁾ |
| Legend: | | | |
| Frequency of Examination: | F1 | Inspect the first casting of each size and ANSI Class rating. | |
| | F2 | Minimum of 10% of the order as selected by the Inspector. | |
| Acceptance Standards: | VT-1 | MSS SP-55 | |
| | MT-1 | ASME SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | |
| | PT-1 | ASME SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | |
| | RT-1 | ASME SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | |
| | MT-2 | ASME B16.34 Mandatory Appendix II, Section II-2.1, "Castings" or MSS SP-53 | |
| | PT-2 | ASME B16.34 Mandatory Appendix III, Section III-2.1, "Castings" or MSS SP-53 Table 1, "Acceptance Standards" | |
| | RT-2 | ASME B16.34 Section 8 "Requirements for Special Class Valves," and Mandatory Appendix I, Section I-2, "Acceptance Standards" or MSS SP-54 | |
| Notes to Table 3: | | | |
| (1) Examination techniques: | | | |
| (a) Visual Examination (VT) per MSS SP-55 . | | | |
| (b) Magnetic Particle Testing (MT), Liquid Penetrant Testing (PT), and Radiographic Testing (RT) per ASME SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings." | | | |
| (c) [A] When approved by Owner's Engineer, Ultrasonic Testing (UT) examination per ASME SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings," may be used in lieu of RT where casting configurations do not allow RT. | | | |
| (2) Including machined gasket surfaces and weld bevels. | | | |
| (3) If a defective casting is found by radiography, then two additional castings of the same material and type shall be examined. If either of these is defective, then all remaining castings of the same material and type shall be examined. | | | |
| (4) PT shall be substituted for MT for all non-magnetic alloys and low-alloy nickel steels. | | | |
| (5) When 100% inspection is specified for critical areas or for the entire casting, it shall mean inspection of all accessible and interpretable areas. | | | |

6.13.3.8. New: Castings

[S] Pressure-containing parts for pumps in hydrocarbon or hazardous services shall be carbon steel or alloy steel.

6.13.5.1. Substitution: Welding

Welding and weld repairs shall be performed in accordance with GP 18-07-01D.

6.13.5.5. New: Welding

[R] Carbon steel and low alloy steel pressure-containing components that can be exposed to aqueous caustic solutions or alkaline solutions (e.g., including amine service, carbonate service) shall receive PWHT in accordance with GP 18-07-01D.

6.13.6.4. Addition: Low-Temperature Service

[S] This Section covers impact testing requirements for pressure vessels, piping, and machinery. Impact requirements shall be based on the CET established by Owner's Engineer.

[R] Steel pressure containing machinery components such as compressor and pump casings, including cast, forged, or welded nozzles, shall meet the requirements in Table 3: Impact Requirements for Machinery.

Table 3: Impact Requirements for Machinery

| CET, °F (°C) | Maximum Casing Working Pressure, psi (bar) | Impact Requirement ⁽¹⁾ |
|---|--|--------------------------------------|
| CET < -20 °F (-29 °C) | All | 15/12 ⁽¹⁾ ft-lb (20/16 J) |
| 60 °F (16 °C) > CET ≥ -20 °F (-29 °C) | > 1000 psi (69 bar) | 15/12 ⁽¹⁾ ft-lb (20/16 J) |
| 60 °F (16 °C) > CET ≥ -20 °F (-29 °C) | ≤ 1000 psi (69 bar) | None |
| CET ≥ 60 °F (16 °C) | All | None |
| Note: | | |
| (1) In the notation such as 15/12, the first number is the minimum average energy of three specimens while the second number is the minimum for one specimen in the impact determination. | | |

[C] For carbon steel and low alloy steel, no impact tests are required if the maximum casing working pressure generates a stress less than 25% of the minimum specified yield stress for the casing material, as determined by Manufacturer, for the casing design.

[*] For pressure containing components of (ductile) cast iron, (duplex) stainless steel, and nickel alloys, Owner's Engineer shall specify the impact test requirements

MODIFICATIONS TO SECTION 7: ACCESSORIES

7.1.1.1. Addition: Drivers—General

[O] Driver shall be sized for pump operation at rated capacity and with a discharge pressure equal to the PRV setting.

7.1.1.5. New: Drivers—General

- [O][R] All torque transmission components (such as gears, couplings, shafts, etc.) shall be capable of transmitting the maximum driver torque transmitted through them.
- [O][R] All torque transmission components (such as gears, couplings, shafts, etc.) shall have a power rating at least equal to the driver nameplate power rating.

7.1.1.6. New: Drivers—General

[O][R] The minimum transient torque service factor for torque transmission components (such as gears, couplings, shafts, etc.) shall be as follows for the respective driver application:

- Induction motor driven applications—400% of Driver Torque at 1.0 Service Factor.
- Synchronous motor driven applications—500% of Driver Torque at 1.0 Service Factor.

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| Exxon Doc. No. | USBT-000-TE-MR-EQS-0005 | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit Info | 000-General | | | | | | |

7.1.2.1.a. Addition: Motors

[*][C] Motors shall be in accordance with per USBT-30-TE-EA-EQS-0004, USBT-30-TE-EA-EQS-0005, or Standardized Equipment Specifications, as specified.

7.1.2.1.b. Addition: Motors

[R] For all operating cases (normal or alternate), motors shall be sized not to operate above a service factor of 1.0.

7.1.4.2. Addition: Gear Units

Gear units shall be per USBT-30-TE-MR-EQS-0011.

7.2.8. Addition: Couplings and Guards

- a. [O][R] The minimum coupling service factor at the driver maximum continuous torque shall be equal to or greater than 1.5.

7.2.15.a. Addition: Couplings and Guards

[S] All areas with access to rotating parts (including couplings and openings between bearing housings and casings) shall have equipment guards in accordance with B11/STD B11.19 and BSI BS EN ISO 14120 as applicable for the intended location of use.

7.2.15.c. Substitution: Couplings and Guards

- a. [M][O] Guards shall be fabricated from solid sheet or plate with no openings.
- b. [M][O] Guards fabricated from expanded metal or perforated sheets may be used if the size of the openings does not exceed 10 mm (0.375 in.).
- c. [M] Guards shall be constructed of steel, brass, aluminum, or austenitic stainless steel materials.
- d. [M][O] Guards of woven wire shall not be used.
- e. [S] Coupling and seal guards in hazardous areas shall be constructed entirely of spark-resistant metallic materials.

7.2.15.d. New: Couplings and Guards

[S] All areas with access to rotating parts between bearing housings and casings shall be guarded over 360 degrees.

7.3.1. Addition: Belt Drives

Belt transmission shall not be used. If approved by Owner's Engineer, the following limitations shall be applied:

- a. [R] Belt and related components (e.g., sheaves) shall have a minimum service factor of 1.5.
- b. [R] Flat belt (non-synchronous) transmissions shall not be used.
- c. [R] V-belts shall be furnished in matched sets. All belts shall be of heavy-duty or premium quality rating with oil-resistant characteristics.
- d. [S] All belts for use in API RP 500 hazardous (classified) location shall be the anti-static conducting type that meets the testing and maximum resistivity requirements of RMA IP-3-3.

7.4.1. Substitution: Baseplates

[R] A baseplate shall be furnished for the pump and driver, and it shall meet the following criteria:

- a. The baseplate shall be a self-supporting single fabricated steel unit (i.e., continuous) constructed of channel side- and cross-member supports.
- b. All equipment supports shall be directly and rigidly attached to the structural steel members of the baseplate by continuous welding.
- c. The steel plate decking shall be 5 mm (³/₁₆ in.) thick at a minimum.

7.4.4. Substitution: Baseplates

[A][M] The mounting plate or plates shall be supplied with horizontal (axial and lateral) jackscrews, the same size or larger than the vertical jackscrews. The lugs holding these jackscrews shall be attached to the mounting plates in such a manner that they do not interfere with the installation of the equipment, jackscrews, or shims and shall be affixed without welding so that they are removable in the field. An example would be bolting. Precautions shall be taken to prevent vertical jackscrews in the equipment feet from marring the shimming surfaces. Alternative methods of lifting equipment for the removal or insertion of shims or for moving equipment horizontally, such as provision for the use of hydraulic jacks, may be proposed for Company approval. Such arrangements should be proposed only for equipment that is too heavy to be lifted or moved horizontally using jackscrews. Jackscrews shall be plated for corrosion resistance.

7.4.10.2. New: Baseplates

- a. **[S]** Permanently attached lifting lugs, pad eyes and trunnions shall pass 100% radiographic or ultrasonic inspection in accordance with AWS D1.1/D1.1M.
- b. **[S]** Materials that directly attach to lifting lugs, pad eyes and trunnions shall pass 100% radiographic or ultrasonic inspection in accordance with AWS D1.1/D1.1M.

7.5.2. Addition: Pressure-Limiting Valves (PLVs)

Relief valves shall meet the requirements defined in **GP 03-15-01D**.

7.7.1. Addition: Auxiliary Piping

[R] Unions shall not be used in Group I (auxiliary process fluid), Group II (steam and air), or Group IV (lubrication and control oil) service.

7.7.4. New: Auxiliary Piping

[S] Piping that supplies external flushing liquid to the pump's mechanical seals shall meet the specified pump casing pressure and temperature ratings.

7.7.5. New: Auxiliary Piping

[R] Auxiliary process piping shall be provided with a minimum corrosion allowance per Table 4: Corrosion Allowance.

Table 4: Corrosion Allowance

| Pipe | Nominal Pipe Size | Minimum Corrosion Allowance | |
|---|-------------------|-----------------------------|------|
| | | in. | mm |
| Carbon and Low Alloy Steels ⁽¹⁾ | All | 0.050 | 1.3 |
| Intermediate Alloy Steels ⁽²⁾ | All | 0.030 | 0.8 |
| High Alloy Steels ⁽³⁾ | All | 0.010 | 0.25 |
| Notes: | | | |
| (1) Includes all steels with an alloy content not exceeding 2 ¹ / ₄ Cr-1 Mo. | | | |
| (2) Includes all steels with an alloy content of 2 ¹ / ₂ to 9% Cr-1 Mo, and 3 ¹ / ₂ to 9 Ni steels. | | | |
| (3) Includes all stainless steels with an alloy content of 12 Cr and greater, Duplex Stainless Steels, Alloy 800, Alloy 825, and Alloy 20. | | | |

7.7.6. New: Auxiliary Piping

[M] All orifice plates shall have a tab extending from the union or flange where they are installed to indicate their location. The tab shall be stamped with the orifice size and customer supplied identification number.

7.8.3. New: Pulsation and Vibration Control Requirements for Multiphase Skids - General

[O] The MPP discharge volutes shall be designed to minimize pressure pulsation throughout the operating range during maximum GVF values.

7.8.4. New: Pulsation and Vibration Control Requirements for Multiphase Skids - General

[R] If pulsation characteristics are unknown, then dynamic pressure measurements shall be taken at the discharge casing connection at various gas volume fractions during the factory acceptance testing.

MODIFICATIONS TO SECTION 8: INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT

8.1.1. Addition: General

[A] [R] Vendor shall develop an Inspection Test Plan (ITP) for approval by Owner's Engineer.

8.2.1.3. Addition: Inspection—General

Pressure-containing castings for pumps shall be inspected per GP 18-03-04D.

8.2.4.2. Addition: Positive Material Identification (PMI)

Material shall have PMI inspection per GP 18-12-01D, if it meets the requirements listed in GP 18-12-01D, Section 3 "Specific Applicability."

8.3.1.1. Addition: Testing—General

[R] As a minimum, inspection and testing of all pumps shall be conducted according to Table 6: Minimum Inspection and Test Requirements.

Table 6: Minimum Inspection and Test Requirements

| Inspection or Test | Required | Witnessed | Certified Data |
|--|----------|-------------------|----------------|
| Hydrostatic Test | Yes | No ⁽⁴⁾ | Yes |
| Performance Test | Yes | No ⁽²⁾ | Yes |
| Net Positive Suction Head (NPSH) Test | (1) | No | Yes |
| Inspection by Purchaser (per GP 20-01-01D) | Yes | — | — |
| Dismantled Inspection | (3) | — | — |

Notes:

- (1) If the NPSH required by the pump differs from the specified available NPSH by 1.0 m (3 ft) or less, then an NPSH test and performance test shall be performed.
- (2) Performance tests shall be witnessed if either of the following apply:
 - a. Manufacturing facility has no previous experience with the pump.
 - b. Manufacturer has made significant changes to standard designs in critical areas such as hydraulic balance and shaft sealing.

| Inspection or Test | Required | Witnessed | Certified Data |
|---|----------|-----------|----------------|
| (3) Pumps receiving a witness performance test shall be dismantled by Manufacturer for inspection by Inspector following the final performance test, according to the guidelines below: | | | |
| a. Hydrodynamic bearings and housings shall be dismantled. | | | |
| b. Rolling element bearings and their housings shall only be dismantled if any of the following occur during test: | | | |
| i. Oil/bearing temperature rise exceeds 40 deg C (100 deg F) above the ambient temperature. | | | |
| ii. Unusual noises coming from the pump. | | | |
| (4) Hydrostatic tests shall be witnessed for all high alloy castings (e.g., Duplex stainless steels, Incoloy, Inconel, and Monel). | | | |

8.3.2.1.2. New: Hydrostatic Testing

[R] Mechanical seal flush coolers shall be hydrostatically tested to at least the same pressure as pump casing.

8.3.2.8. New: Hydrostatic Testing

[R] Hydrostatic testing, whether on a component basis or an assembled pump, shall be completed after all machining and welding (such as piping connections, drain, vents, seal-welding) has been completed and all plugs installed.

8.3.4.4. Substitution: Performance Test

[R] If dismantling is necessary to correct pump deficiencies, then the full performance test shall be repeated from the beginning.

8.3.5.1. Substitution: Mechanical Run Test

[R] The pump shall be mechanically run tested consecutively following the performance test for a minimum of 1 hour or until oil temperatures have stabilized, whichever is greater. This operation shall be performed at the rated flow and rated discharge pressure.

8.3.7.1. Addition: NPIP/NPSH Test

[R] When an NPSH test is required, vacuum tank suppression type testing shall be executed.

8.3.7.3. Addition: Testing—Optional Testing—Sound Level Testing

[E] Sound level test shall be carried out as part of Performance testing & test data shall be submitted to Purchaser.

8.4.1. Substitution: Preparation for Shipment

[R] Equipment shall be prepared for the type of shipment specified. The preparation shall make the equipment suitable for 1 year of outdoor storage from the time of shipment, with no disassembly required before installation, except for inspection of bearings and seals. If storage for a longer period is contemplated, then Purchaser shall consult with Vendor regarding the recommended procedures to be followed.

MODIFICATIONS TO SECTION 9: VENDOR'S DATA

9.2.2.1.b. Addition: Drawings

[R] The proposal shall include cross-sectional dimensioned drawings of the seal chamber, seal, gland, shaft sleeve, and proposed flushing arrangement for the mechanical seal and system furnished.



TECHNIP ENERGIES



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PIPING MANUAL VALVES - TECHNICAL NOTES

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REVISION LOG

| REVISION NO. | SECTION / PAGE NO. | CHANGE DESCRIPTION |
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| 0 | 1.6 / 8 | PURPOSE CODE DEFINATION UPDATED AS PER LATEST GP'S. |
| 0 | 2.1 / 9 | TRIM VALUES CLAUSE ADDED IN PLACE OF TABLE |
| 0 | 2.1.9 / 12 | GEAR OPERATION TABLE UPDATED AS PER LATEST GP'S |
| 0 | 2.4 / 17 | NOTE "C" ADDED AS PER COMMENT |
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HOLD STATUS

This revision has the following HOLDS:

| SECTION | PARAGRAPH NO. | DESCRIPTION OF HOLD |
|---------|---------------|---------------------|
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1. GENERAL

1.1 Scope

This Specification covers the requirements for carbon steel, stainless steel, non-ferrous, lined ferrous, and nonmetallic manually operated valves in the USGC Reconfiguration Project, GOLD Baytown.

Non-manual actuators (i.e., pneumatic, hydraulic, or electric motor actuators) are outside the scope of this specification. Valves covered by the Order are intended for application under the jurisdiction of ASME B31.3 or ASME B31.1.

1.2 Statutory Requirements

The Purchaser and Supplier shall mutually determine the measures that must be taken to comply with all governmental codes, regulations, ordinances, or rules that are applicable to the equipment as the first precedence.

1.3 Units

Metric dimensions shall not be substituted for U.S. Customary units for valves, and vice versa.

1.4 Documents, Codes, and Industry Standards

Codes, Standards, and Specifications referred to herein, or in the valve description, form a part of the requirements of this Specification in the manner and to the extent specified.

DOCUMENTS

| | |
|--------------------------|--|
| USBT-000-TE-MP-PSP-0006, | "Piping Engineering Criteria" |
| USBT-000-TE-MP-PSP-0004, | "Pipe, Fittings, Flanges, Bolting and Gaskets-Technical Notes" |

AMERICAN PETROLEUM INSTITUTE (API)

| | |
|----------|--|
| API 594, | "Check Valves: Flanged, Lug, Wafer and Butt-welding" |
| API 6D, | "Specification for Pipeline & Piping Valve" |
| API 598, | "Valve Inspection and Testing" |
| API 600, | "Bolted Bonnet Steel Gate Valves for Petroleum and Natural Gas Industries" |
| API 602, | "Steel Gate, Globe and Check Valves for Sizes DN 100 and Smaller for the Petroleum and Natural Gas Industries" |
| API 603, | "Corrosion Resistant, Bolted Bonnet Gate Valves-Flanged and Butt-Welding Ends" |
| API 607, | "Fire Test for Soft Seated Quarter Turn Valves" |
| API 608, | "Metal Ball Valves-Flanged, Threaded, and Welding Ends" |
| API 609, | "Butterfly Valves: Double Flanged, Lug-and Wafer-Type" |
| API 622, | "Type Testing of Process Valve Packing for Fugitive Emissions" |
| API 623, | "Steel Globe Valves—Flanged and Butt-welding Ends, Bolted Bonnets" |
| API 624, | "Type Testing of Rising Stem Valves Equipped with Graphite Packing for Fugitive |



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Emissions"
 API 641, "Type Testing of Quarter-turn Valves for Fugitive Emissions"

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BOILER and Pressure Vessel Code
 Section VIII, D1, Mandatory Appendix 7 "Examination of Steel Castings."

- ASME B1.1, "Unified Inch Screw Threads (UN, UNR and UNJ Thread Form)"
- ASME B1.20.1, "Pipe Threads, General Purpose (Inch)"
- ASME B16.5, "Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24"
- ASME B16.10, "Face-To-Face and End-To-End Dimensions of Valves"
- ASME B16.11, "Forged Fittings, Socket-Welding and Threaded."
- ASME B16.25, "Buttwelding Ends."
- ASME B16.34, "Valves - Flanged, Threaded, and Welding End."
- ASME B16.47, "Large Diameter Steel Flanges"
- ASME B31.3, "Process Piping"

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A105/A105M, "Carbon Steel Forgings for Piping Applications"
- ASTM A182/A182M, "Forged or Rolled Alloy and Stainless-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service"
- ASTM A193/A193M, "Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service"
- ASTM A194/A194M, "Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service"
- ASTM A216/A216M, "Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service"
- ASTM A217/A217M, "Steel Castings, Martensitic Stainless and Alloy, for Pressure Containing Parts, Suitable for High Temperature Service"
- ASTM A320/A320M, "Alloy-Steel Bolting Materials for Low-Temperature Service"
- ASTM A350/A350M, "Specification for Forgings, Carbon, and Low-Alloy Steel Requiring Notch Toughness Testing for Piping Components"
- ASTM A351/A351M, "Castings, Austenitic for Pressure-Containing Parts"
- ASTM A352/A352M, "Specification for Castings, Ferritic, and Martensitic for Pressure Containing Parts Suitable for Low-Temperature Service"
- ASTM A370, "Test Methods and Definitions for Mechanical Testing of Steel Products"

CHLORINE INSTITUTE

Pamphlet No. 6, "Piping and Equipment for Use with Dry Chlorine"

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-4.1, "Cleaning Equipment for Oxygen Service"

MANUFACTURER'S STANDARDIZATION SOCIETY (MSS)

MSS SP-6, "Standard Finished for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings"



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MSS SP-25, "Standard Marking System for Valves, Fittings, Flanges and Unions"
MSS SP-134, Valves for Cryogenic Service, including Requirements for Body/Bonnet
Extensions

NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

NACE 0103/ISO17945, "Materials Resistant to Sulfide Stress Cracking in Corrosive
Petroleum Refining Environments"

GLOBAL PRACTICES

GP 03-12-09D, "General requirement of Valves"
GP 03-12-08D, "Block Valve Packing System"
GP 18-03-04D, "Pressure Casting Quality and Inspection"
GP 18-07-01D, "Welding procedures"
GP 18-12-01D, "Positive Material Identification"

1.5 Definitions

1.5.1. [I] General

- a. **"Fire-tested"** means compliance with API 607 unless otherwise specified.
- b. **"Wafer body"** valve describes a valve which is installed between mating pipe flanges and held in place by the compressive force produced by the mating flange bolt forces. The flange bolts are exposed.
- c. **"Lug body"** valve is a "single flange" valve where ALL the flange bolts are covered by the valve body material. The valve is held in place either by the compressive force produced by the mating flange bolt forces (drilled-thru), or by the use of cap screws threaded into the valve body (drilled and tapped).
- d. **"Flanged"** valve is a double flanged valve that is installed in the piping system with two sets of stud bolts. Some flanged valves have a few drilled and tapped holes due to the valve design (e.g., butterfly valves).
- e. **"NACE"** means compliance with the requirements of NACE MR0103/ISO 17945.
- f. **"Port"** refers to the minimum opening through the valve in the full open position.
 - **"Full Port"** ("Full Bore"): The port shall meet the minimum full opening requirements of the design standard or as specified ASME B16.34 Annex A where no port size is defined.
 - **"Standard Port"** and **"Conventional Port"**: Industry terms with varying meanings depending on the design standard. Usually used in conjunction with API 602 valves where a minimum port size is defined but no descriptive term is used. When used with ASME B16.34, API 600 or API 603 valves, these terms mean the port sizes as defined by those standards (i.e., full port per ASME B16.34



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- Annex A).
- "Reduced Port": A port smaller than full port, sometimes defined by the industry standard specified for the valve. For example, API 602 defines port sizes which are reduced port but does not specify a defining term. API 608 lists Full and Reduced Port minimum diameters for each size valve. API 608 Port Terminology has changed as follows:
Full Bore was Full Port
Single Reduced Bore was Regular Port
Double Reduced Bore was Reduced Port
 - "Regular Port": A port smaller than full port, but larger than reduced port, defined by the industry standard specified for the valve. For example, API 608 lists regular port (now single reduced bore) diameters for each size valve.
 - "Venturi": A substantially reduced port valve with a smooth transition from the valve ends to the reduced opening.
- g. **"Dead End Service"**: A valve that shall be suitable for pressurized service during which the downstream piping is removed for equipment maintenance. The valve shall be designed such that no downstream flange is required to be installed during service, and the closure shall be leak tight.
- h. **"Cap Screw"**: A headed bolt designed to secure two components together by engagement in a drilled and tapped hole (similar but not identical to a machine bolt).
- i. **"Cryogenic"**: Austenitic stainless steel valves identified as "Cryogenic" or "impact tested" in the valve description are intended for services -100°F (-73°C) down to -425°F (-254°C).
- j. **Cold Service Temperature**: Service temperatures colder than -50°F (-46°C) down to >-100°F (-73°C).
- k. **Low Temperature**: Service temperatures colder than -20°F (-29°C) down to -50°F (-46°C).

1.6 Purpose Code Definition

This section contains purpose code definition for design requirements that shall be incorporated into Project detailed design by the FEED/EP Contractor. These requirements may affect design, fabrication, construction, commissioning, or any combination.

[*]: Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision.



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- [A]: Assigned to paragraphs that require approval from the Owner's Engineer before the work may proceed or the design is finalized.
- [C]: Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes.
- [E]: Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy
- [I]: Obsolete as per 2019 CIG - Assigned to paragraphs that provide only clarifying information, such as Scope statements, definitions of terms, etc.
- [M]: Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations.
- [O]: Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design, such as during start-ups, process swings, subcomponent malfunction, etc.
- [R]: Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions.
- [S]: Assigned to paragraphs that contain design, fabrication and construction requirements that, if not met, can directly result in or significantly increase the risks of either:
1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or
 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways).

Safety designation shall not be applied to paragraphs with Risk Matrix Category 4 when the incident probability and risk can be determined by the appropriate SME.

2. DESIGN & CONSTRUCTION

2.1 General

2.1.1. [C] Substitutions

When materials cannot be supplied within the specified schedule, the following substitutions are technically acceptable as per below table. All substitutions are subject to prior written approval by the Purchaser.

**TABLE 2
PRE-APPROVED BODY MATERIAL SUBSTITUTIONS**

| Specified Material | Approved Substitution |
|-------------------------|--|
| ASTM A216-WCB | ASTM A105 |
| ASTM A216-WCB | ASTM A216-WCC |
| ASTM A352-LCB | ASTM A352-LCC |
| ASTM A182-F304 | ASTM A182-F316 or F316/316L Dual Stamped |
| ASTM A182-F304 or F304L | ASTM A182-F304L/F304 Dual Stamped |
| ASTM A182-F316 or F316L | ASTM A182-F316L/F316 Dual Stamped |
| ASTM A182-F321 | ASTM A347 or ASTM A347H |
| ASTM A351-CF3 | ASTM A351-CF3M |
| ASTM A351-CF8 | ASTM A351-CF8M |

Substitution of trim shall be as per table 13 CI 6.1.4 of API 602.

2.1.2. Pressure-Temperature Ratings

- a. [R] Valve Pressure-Temperature ratings shall be in accordance with ASME B16.34 or the referenced Code or Standard in the line item description. Pressure/Temperature rating curves or tables shall be submitted for valves with "Manufacturer's Standard" ratings (e.g., utility butterfly valves), and for valves derated from the body rating standard (e.g., resilient seated ball valves). This requirement shall not be interpreted as approval to deviate from the valve specifications.

2.1.3. [M] Valve Lengths

Valve face-to-face or end-to-end dimensions shall be in accordance with ASME B16.10 unless specified otherwise. Buttweld end pressure-seal bonnet valves shall conform to the short pattern dimensions.

2.1.4. [R] End Connections

Unless otherwise specified, end connections shall be in accordance with the following Standards:



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a. Flanged ends:

Flanged ends, including gasket surface finish, shall be in accordance with the following. When not specified by the design standard, gasket surface finish shall be in accordance with MSS SP-6. Unless noted otherwise, flanges shall be integrally cast or forged. Proposals to use welded-on flanges require prior written approval by the Purchaser.

1. ASME B16.5 for NPS 24 and smaller.
 2. Larger than NPS 24: As specified in the line item description (e.g., ASME B16.47 Series A).
 3. ASME B16.5 Class 150 drilling for non-metallic valves (e.g., PVC, CPVC).
 4. Ring joint grooves shall be in accordance with ASME B16.5 and ASME B16.47 as applicable.
- b. Socket-weld ends: ASME B16.11: Socket-weld valves made by drilling threads out of threaded valves are acceptable provided that the resulting socket dimensions and wall thicknesses meet the requirements of ASME B16.11 and ASME B31.3, and that the valves have full warranty.
- c. Threaded ends: ASME B1.20.1.
- d. Butt-weld ends: End preparation shall be in accordance with the specified design standard, and shall match the size and wall thickness or schedule specified in the line item description. Where the end preparation is not defined in the design standard, ASME B16.25, Figure 2a or 3a as applicable shall be followed. Bores shall be in accordance with the line item description. Ends shall be internally machined to match if required.

2.1.5. [R] Valve bodies with tapped bosses

- a. Valve bodies specified with tapped openings shall be bossed, drilled and tapped in accordance with ASME B16.34. Threads shall be internally taper threaded in accordance with ASME B1.20.1.
- b. [E] All threaded openings shall be plugged with solid, round, or square head plugs of wrought material having the same nominal composition as the body. Plugs shall not be made from cast material.

2.1.6. [R] Drilled and Tapped Holes in End Flanges or Lugs

Tapped bolt holes on valve bodies for bolting to external flanges shall be internally threaded in accordance with ASME B1.1. **A complete set of cap screws for all drilled and tapped bolt holes shall be furnished by the valve Supplier, with material as specified in the Order or the valve line item description.** Valves specified as "flanged" or "double flanged" shall be provided with individual end flanges with drilled-through bolt holes. Where it is necessary to drill and tap a few holes due to the valve body design, cap screws shall be provided by the Supplier for the tapped holes. If the cap screw material is not identified in the valve item description, the Supplier shall consult the Purchaser for requirements.

2.1.7. Valve Stems

a. [S] Blow-out Proof Stems

Valve stems and Ball valve/butterfly valve shafts shall be blow-out proof. "Blow-out proof" shall mean that no portion of the stem or shaft can be ejected from the valve due to internal pressure from the following causes: failure of the stem, shaft, stem-to-disc attachment or shaft-to-disc attachment; removal of the stem nut from the yoke; removal of the packing gland; removal of the handle. Valve stems shall be designed such that the weakest link is outside of the pressure boundary.

b. [R] [*] Installation Requirements

Valves with manual actuators shall be designed to be operable in horizontal or vertical lines with the stem in any orientation. Any exceptions to this requirement shall be cause for rejection, unless specifically approved by the Purchaser.

2.1.8. Handwheels

[O] Handwheels, including handwheels on gear actuated valves, shall turn clockwise to close the valve.

2.1.9. Gear Actuators

[O] Gear actuators shall be provided when specified in the line item description. Gear actuators shall be designed to operate with a maximum rim pull of 80 pounds of force under the maximum rated differential pressure across the valve. Gear actuators shall be installed with the handwheel shaft perpendicular to the valve flow path, and shall be rotatable in minimum 90 degree increments. The gear operator selection shall be per Table 3.



TABLE 3
Size and Rating Requirements for Gear Operators per Valve Type

| Valve Type | Pressure Rating | Gear Operator Required | Notes |
|---------------------|-----------------|------------------------|-------|
| Gate | 150 | 16 inches and larger | - |
| | 300 | 12 inches and larger | - |
| | 600 | 10 inches and larger | - |
| | 900 | 8 inches and larger | - |
| | 1500 | 6 inches and larger | - |
| | 2500 | 4 inches and larger | - |
| Globe | 150 | 16 inches and larger | - |
| | 300 | 12 inches and larger | - |
| | 600 | 10 inches and larger | - |
| | 900 | 8 inches and larger | - |
| | 1500 | 6 inches and larger | - |
| | 2500 | 4 inches and larger | - |
| Plug | 150 | 8 inches and larger | - |
| | 300 | 8 inches and larger | - |
| | 600 | 8 inches and larger | - |
| | 900 | 6 inches and larger | - |
| | 1500 | 4 inches and larger | - |
| Ball (Reduced Port) | 150 | 8 inches and larger | - |
| | 300 | 8 inches and larger | - |
| | 600 | 8 inches and larger | - |
| | 900 | 6 inches and larger | - |
| | 1500 | 4 inches and larger | - |
| Ball (Full Port) | 150 | 8 inches and larger | - |
| | 300 | 8 inches and larger | - |
| | 600 | 8 inches and larger | - |
| | 900 | 6 inches and larger | - |
| | 1500 | 4 inches and larger | - |
| Butterfly | 150 | 8 inches and larger | - |
| | 300 | 8 inches and larger | - |
| | 600 | 6 inches and larger | - |



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2.1.10. Pressure-Seal Bonnets

- a. [O] Pressure-seal bonnet valves shall be supplied only when specified in the line item description. "Breech-lock" designs are not acceptable.
- b. [S] Double seated pressure seal valves NPS 2 and larger shall be provided with pressure relief for body cavities per para. 307.2.3 ASME B31.3. Valves shall be identified by permanent markings on the body which indicate the pressure relieving side. The final design shall be approved by the Purchaser.

2.1.11. Chainwheels

- a. [S] Chainwheels shall include a supplementary retention device such as a safety chain or cable. Chain guides shall be included. An anchor point shall be chosen such that the length of the safety chain or cable is minimized, and prevents a separated chainwheel from hanging within 7 ft (2.13 m) of operating level.
- b. [R] Valve Chainwheels shall not be made with cast iron components
- c. [R] When chainwheels are specified, they shall be of the direct mounted adjustable sprocket rim type. Clamp-on type chainwheels for valves greater than NPS 2 (50 mm) are not permitted.

2.2 Requirements by Valve Type

2.2.1. Ball Valves

- a. [S] "Fire-tested" certification. For soft-sealed ball valves, the valve design including the body and bonnet joints, stem seals, and seats shall be certified "fire-tested" for flow in both directions in accordance with API 607. If the valve design has a preferred direction of flow, the manufacturer shall additionally furnish the derated pressures applicable for the operating and the "fire-tested" conditions in the non-preferred direction.
- b. [S] Cryogenic ball valves shall be provided with pressure relief for body cavities.
- c. [S] Ball valves with hollow-ball construction shall not be allowed.
- d. [O] All ball valves shall be equipped with a position indicator to show the relative position of the actuator and the ball closure. The position indicator shall be graduated to indicate the percentage of opening. The design shall be such that the position of the handle/indicator cannot be changed during disassembly and reassembly of the valve.
- e. [S] Valve handles shall be heat resistant and capable of withstanding direct exposure to fire without becoming inoperable.
- f. [I] End connections shall be threaded, socket welding, or flanged as specified in the line item description.
- g. [R] Threaded valves shall have internal taper threads in accordance with ASME B1.20.1.



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- h. [R] [A] Chrome plated balls are not acceptable. The use of other types of metallic plated or coated balls shall be approved by the Purchaser.
- i. [S] Two-piece ball valves with threaded body designs shall have the threaded body joint seal-welded to protect against disassembly under pressure.
- j. [S] [*] All valves (see exception mentioned in above 2.2.1.c) with hollow-ball construction in liquid service shall be provided with pressure relief for the body cavity. Pressure shall relieve to the upstream side of the valve unless otherwise specified. The final design shall be approved by the Owner's Engineer.
- k. Soft seated ball valve shall be supplied with antistatic device and pressure and temperature rating of soft seating material shall be supplied by vendor.

2.2.2. Butterfly Valves

1. [O] All butterfly valves shall be equipped with a position indicator to show the relative position of the actuator and the closure. The position indicator shall be graduated to indicate the percentage of opening. The design shall be such that the position of the handle/indicator cannot be changed during disassembly and reassembly of the valve.
2. [S] "Fire-tested" butterfly valves:
 1. For resilient seated butterfly valves, the valve design, including the seat retainer joints, stem seals, and seats shall be certified "fire-tested" for flow in both directions. If the valve design has a preferred direction of flow, the manufacturer shall additionally furnish the derated pressures applicable for the operating and the "fire-tested" conditions in the non-preferred direction.
 2. Steel seats shall be provided in the butterfly valve body, supplementing the soft seal rings, for protection in case fire destroys the soft seal material. The secondary steel seats shall be designed to protect the soft seals from the throttling effect produced by opening and closing the valve. Seat retainer ring joints and stem seals shall be of a "fire-tested" design that prevents external leakage.
3. [R] High performance butterfly valves shall be in accordance with API 609, Category B for Class 600 and lower, and shall be fully rated for flow in both directions.
4. [S] Lug end (drilled and tapped) butterfly valves shall be suitable for "dead-end" shutoff service at the full rated pressure without a downstream flange installed.

2.2.3. Plug Valves

[S] "Fire-tested" certification: For soft-sealed non-lubricated plug valves specified as fire tested, the body and bonnet joints and stem seals shall be fire-tested **for external leakage** in accordance with API 607. The plug shall be vented to the upstream side; thus the valve will be unidirectional, and shall be marked in accordance with Paragraph 4.4 of this Specification.

2.2.4. Check Valves

[S] Dual Plate Wafer Check valves shall be of the retainerless design unless approved otherwise by the Purchaser. When retainers are approved,



- a. Hinge pin retainer plugs for check valves shall not be made from cast iron or ductile iron.
- b. Threaded retainer plugs for hinge pins on steel or nickel alloy valves shall be seal welded.

2.2.5. Globe Valves

[S] Where globe valves are used in throttling service (e.g., on bypass lines for automated valves), the valve plug shall be body guided in accordance with API STD 623, Section 5.6.3 "Disc."

2.3 [E] Definitions for Stem Packing

| Term | [I] Description |
|--|---|
| Individual Packing Rings | Style A Carbon or graphite wiper rings, having a yarn property carbon assay of 98% minimum, and with corrosion inhibitor applied at the time of manufacture. |
| | Style B Die-formed flexible graphite with corrosion inhibitor; 70-90 lb/ft ³ (1,120–1,440 kg/m ³) nominal die-formed density; used as sealing rings in packing combinations. |
| | Style C Elastomer/plastic packing sealing rings such as polytetrafluoroethylene (PTFE) or polyfluoroethylene (PFE). Material shall be specified in Purchase Order. |
| Packing Types | Type 1 Type 1 packing consists of an all-graphite packing ring arrangement as shown in Figure 1. |
| | Type 2 Type 2 packing consists of an all-elastomer or plastic packing ring arrangement as shown in Figure 2. |
| "Special Packing" (Specified in the valve description) | Low Emissions Packing for Block Valves in toxic services defined as R2 Respiratory Exposure Hazard Class by the Owner. Valves with this packing will undergo mandatory monitoring and maintenance by the Owner. |



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Figure 1: Type 1 Graphite Packing Arrangements

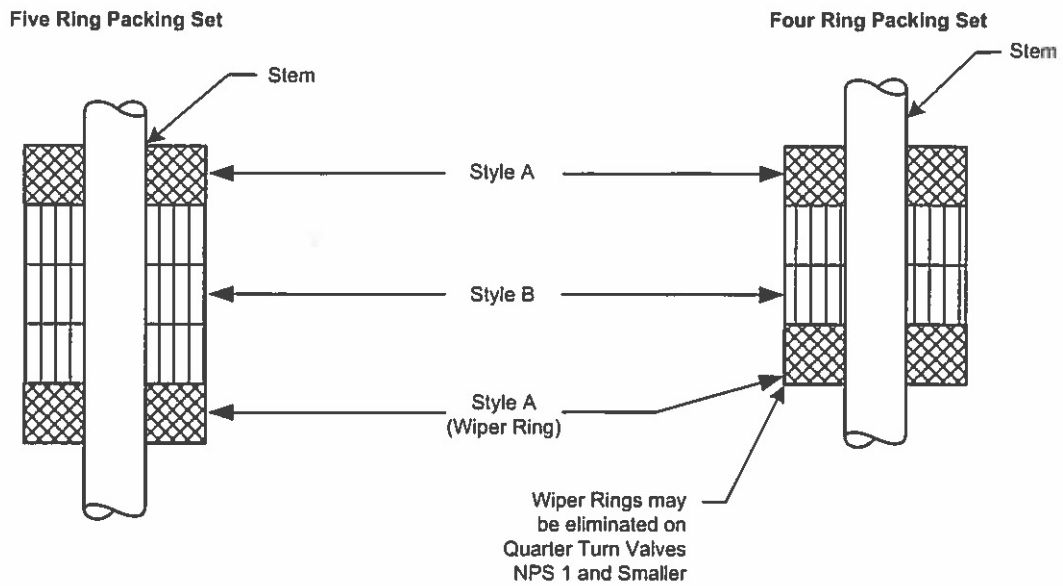
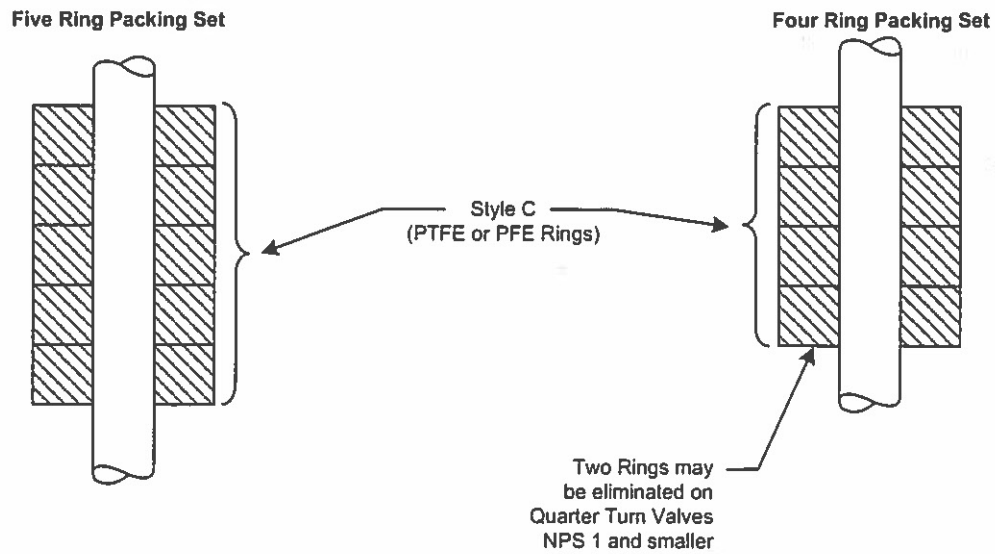


Figure 2: Type 2 Elastomer/Plastic Packing Arrangements





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2.4 Materials of Construction

2.4.1. General

- a. [S] [R] [A] Body and trim materials shall be supplied in accordance with the material standards specified in the valve line item description. When pressure containing parts are specified as forged, substitution of castings is not permitted without the Purchaser's approval.
- b. [S] Aluminum, copper, or copper bearing alloys are not permitted for wetted parts in the material of construction for carbon steel and stainless-steel valves, except that valve shafts made of 17-4Ph stainless steel are acceptable.
- c. Low-melting point alloys, such as aluminum, brass, and bronze, shall not be used unless in Category D fluid service, except that aluminum alloys are permitted in cryogenic services."
- d. [A] [R] The selection of elastomer and/or nonmetallic seal materials shall be done with consideration of all the design conditions (pressure, temperature, chemical environment including corrosion inhibitors, etc.) under which the valve will operate. Additionally, the following apply:
 1. In Class 300 and higher (design pressures > 40 barg [600 psig]), elastomers shall be resistant to explosive decompression as might be caused by high pressure gas, especially in the presence of carbon dioxide.
 2. Elastomer seal materials shall be Anti Explosive Decompression, AED, type in the valves in hydrocarbons service (gas and liquid), and services subject to rapid gas decompression.
- e. [R] Process valves designed with elastomer seals and/or O-rings shall be proven through experience or testing for the service and design conditions (pressure/temperature range) for each type of valve construction offered by Manufacturer. Each seal material and configuration (seal groove size versus seal shape and groove fill) shall be verified for the specified service. When the Manufacturer does not have experience or test data to validate the design, it shall be "type tested" as follows:
 - The valve "type test" shall use the performance method and qualification range as per API SPEC 6A Annex F "Design Validation Procedures." A modified API SPEC 6A Annex F performance test may be acceptable, provided the proposed test procedure is approved by Owner's Engineer prior to use.
 - If the Manufacturer has no previous qualified project experience with the particular



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seal material and/or configuration, it shall be tested.

- If the Manufacturer has made changes to the qualified design of the elastomer seal configuration and/or material (e.g., change in seat, stem or seal design configuration, materials, design parameters, etc.) it shall be retested.
- f. Austenitic stainless steel and nickel alloy valves (body, bonnet, cover, and cap) shall meet the following requirements:
1. Trim including stem and seats, gland assemblies including gland bolting, and trunnion support materials shall be of the same nominal chemistry as the body. Hard facing equal to CoCr-A shall be provided for seating surfaces when specified and is always an acceptable alternative for seating surfaces.
Note: Hard facing (equal to CoCr-A) includes such trademarked materials as Stellite 6, Stoddy 6, and Wallex 6.
 2. Bonnet and cover bolting material for valves NPS 3 (80 mm) and larger shall be specified and shall be of the same material specification as the bolting used for connecting piping.

2.4.2. Stem Packing

1. [E] Packing shall be selected to limit fugitive emissions in compliance with local environmental regulations and shall be tested per API 622.
2. [S] Packing shall be certified **ASBESTOS-FREE**.
3. [E] Packings with flexible graphite for rising, rising- rotating, and rotating stem valves shall be "low-emission" qualified by API 622 and valves with API 624, and API 641, or equivalent. See 3.6 below.
4. [E] Unless otherwise specified all Type 1 graphite packing shall meet the definitions.
 1. Definitions for Type 1, Styles A and B inner deformed rings shall comply with the Definitions Style B and Figure 1.
 2. Top and bottom rings shall comply with the Definitions Style A and Figure 1.
 3. Zinc or Zinc powder shall not be used as a corrosion inhibitor.
 4. Chloride content shall be limited to 200 ppm (parts per million) maximum, and sulfur content shall be limited to 1200 ppm maximum.
5. Elastomer or plastic packing, where specified, shall comply with the Definitions for



Type 2, Style C.

2.4.3. Valve Trim

- a. [I] Trims shall be as specified in the line item description and this specification. Where API trim numbers are specified, trims shall be as defined in API 600 or API 602 for gate, globe and check valves, and in API 594 for wafer check valves.
- b. [I] To meet delivery times, API trim substitutions are permitted as defined in Para. 2.1.1.
- c. [S] Unless specified otherwise, valves specified with body materials ASTM A350-LF2 Cl.1 or A352-LCB/LCC shall be, impact tested at -46°C (-50°F).

2.4.4. Body, Bonnet, and Cover Gaskets

- a. [I] Gaskets shall be in accordance with the standard to which the valve is manufactured unless otherwise specified.
- b. [R] Metallic and nonmetallic bonnet and cover gaskets shall have corrosion resistance equal, at least, to that of the body and bonnet material.
- c. [R] Metal windings of austenitic stainless steel spiral-wound gaskets shall be limited to a maximum hardness of 160 Brinell Hardness Number (BHN).
- d. Ring gaskets for valves with ring-joint bonnets or covers shall have maximum hardness in accordance with the following:
 - 1. Soft iron - 90 HB
 - 2. chrome - 130 HB
 - 3. Austenitic stainless steel - 160 HB
 - 4. Austenitic stainless steel, "L" grade - 130 HB
 - 5. Monel - 125 HB

2.4.5. Body, Bonnet, and Cover Bolting

[R] Bolting shall be supplied as specified in the line item description. Where bolting materials are not specified, the following table applies:

| Valve Body Material | Bolting Materials |
|--|--------------------------|
| Carbon steel, ASTM A105 or A216-WCB | ASTM A193-B7 / A194-2H |
| Carbon steel, NACE, ASTM A105 or A216-WCB | ASTM A193-B7M / A194-2HM |
| LT Carbon steel, ASTM A350-LF2 or A352-LCB/LCC | ASTM A320-L7 / A194-7 |



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| | |
|--|-------------------------------------|
| LT Carbon steel, NACE, ASTM A350-LF2 or A352-LCB/LCC | ASTM A320-L7M / A194-2HM or 7M |
| 1-1/4 Cr-1/2 Mo, ASTM A182-F11 or A217-WC6 | ASTM A193-B16 / A194-7 |
| 2-1/4 Cr-1 Mo, ASTM A182-F22 or A217-WC9 | ASTM A193-B16 / A194-7 |
| 300 Series Stainless Steel, -50 to 1000°F | ASTM A193-B8 Cl 2 / A194-8MA or 8TA |
| 300 Series Stainless Steel, -325 to -51°F | ASTM A320-B8 Cl 2 / A194-8MA or 8TA |

[S] Cadmium - coated bolts and galvanized bolts shall not be used.

3. TESTING AND EXAMINATION

3.1 Pressure Testing and Examination

- 3.1.1. [R] All completed valve assemblies shall meet the pressure test and examination requirements of API 598 unless approved otherwise by the Purchaser. Valves which contain elastomeric O-rings (e.g., Neoprene, Viton, etc.), are provided from stock, and are older than 5 years from the date of manufacture shall be retested.
- 3.1.2. [S] When specified, quarter-turn valves shall additionally be fire tested per API 607. After the design has passed, the valve shall be tagged "Fire-Tested Design." Testing shall be done with the final gear operator installed.
- 3.1.3. [R] All pressure containing welds shall be considered as a part of the valve assembly and shall be subject to all applicable design, fabrication, material, examination, testing, and inspection requirements.
- 3.1.4. [R] The type and/or style of stem packing used during the pressure test shall be the same as that final packing supplied with the valve.
- 3.1.5. Low-pressure seat tests shall be conducted with the air discharge slightly below water to facilitate determination of leakage rates.
- 3.1.6. All valves specified to have double block and bleed capability with body bleeds in the G position per ASME B16.34 shall be tested in accordance with API STD 598 as a "double block and bleed valve." Leakage shall be measured through the open bleed
- 3.1.7. To verify the capability of the metal seat to provide positive shutoff for soft-sealed gate valves, a minimum of 5% (minimum of one valve) of each size in the order, shall be high-pressure closure and low-pressure closure tested per API STD 598 without the soft seal in place. The test valve shall be stroked open and shut at least one time prior to these tests. Leakage shall not exceed rates specified for metal-seated valves.
- 3.1.8. [R] When hydrogen service is specified, low alloy valve castings (P-numbers 3, 4, and 5



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materials) shall be magnetic particle and radiographically examined in accordance with ASME SEC VIII, D1, Mandatory Appendix 7 "Examination of Steel Castings."

[R] Austenitic stainless steel valve castings with a rating of Class 1500 or 2500 shall be liquid penetrant and radiographically examined in accordance with ASME SEC VIII, D1, Mandatory Appendix 7 "Examination of Steel Casting."

3.2 Fire Testing

[S] When specified, fire type testing shall be in accordance with API 607.

3.3 Vacuum Testing

[R] [A] When vacuum service is specified in the line item description, vacuum testing shall be performed in accordance with a procedure approved by the Purchaser.

3.4 Positive Material Identification (PMI)

Alloy and stainless-steel valves shall be positive material identified as per procedure approved by purchaser. PMI shall include 100% of valve bodies, bonnet, flanges, plugs, vent and associated welds

3.5 Impact Testing

- a. [S] Unless specified otherwise, valves specified with body material ASTM A350-LF2 Cl.1 or A352-LCB/LCC, impact tested at -46°C (-50°F).
- b. [S] When "impact tested" or "cryogenic service" is noted in the valve description for austenitic stainless steel cast valves (e.g., ASTM A351) or forged valves (e.g., ASTM A182), the cast valve bodies and any welding to the cast or forged valves shall be impact tested in accordance with the following requirements:
 1. Each heat of ASTM A351 material shall be impact tested in accordance with the methods in ASTM A370. The notched bar impact properties of the material shall be determined by testing a set of three (3) Charpy V-notch specimens for each heat at -196°C (-320°F) or colder. The notched bar impact test specimens shall be machined to the form and dimensions shown in ASTM A370, Standard Full Size Charpy V-notch specimens, Figure 11(a). Each of the three (3) specimens tested in each set shall have a lateral expansion opposite the notch not less than 0.38 mm (0.015 in). When the value of lateral expansion for one specimen of a set is less than 0.38 mm (0.015 in), but not less than 0.25 mm (0.10 in), retests can be done in accordance with ASME Section VIII, Paragraph UHA-51(a)(3).
 2. Any welding shall be in accordance with the following:
 - i. Weld metal deposits for production welds (e.g., welding of extended bonnets), or repair welds shall be impact tested in accordance with Paragraph 323.2.2 and Table 323.2.2 of ASME B31.3 at -196°C (-320°F) or colder. Alternatively, the welding



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procedure qualification shall be qualified at -196°C (-320°F) or colder in accordance with the requirements of Paragraph 323.3 of ASME B31.3. Impact tests that meet the requirements of Table 323.3.1, which are performed as part of the weld procedure qualification, will satisfy all requirements of Paragraph 323.2.2, and need not be repeated for production welds.

- ii. To ensure impact properties of austenitic stainless steel weld consumables used for “cryogenic” valves, each heat, lot or batch of filler metal and filler metal/flux combination to be used in manufacture shall be impact tested at -196°C (-320°F) or colder. Impact testing shall use the methods in ASTM A370 and the acceptance criteria of ASME B31.3, Paragraph 323.5(b).

3.6 [E] Emission Testing

- 3.5.1. Valves shall have low emission packing, packings type tested per API 622, rising stems valves, like gate and globe, type tested in accordance with API 624, and quarter turn valves, like ball, plug and butterfly, type tested per API 641, or equivalent with a maximum leakage rate of 100 ppmv for flexible graphite packing, and 50 ppmv for elastomer/plastic packing as measured in accordance with the U.S. 40 Code of Federal Regulations (CFR) 60 (Method 21) procedures.
- 3.5.2. Valves specified with "**Special Packing**" in the description shall have low emissions flexible graphite packing type tested as above with a maximum leakage rate of 50 ppmv.
- 3.5.3. When specified by Owner's Engineer, a valve packing emission test shall be conducted on the specified type and number of valves. Valve packing emissions testing shall be conducted using the following procedure and acceptance criteria, unless an alternative procedure based on API STD 624, API STD 641, or elements of contained in API STD 622 is agreed to by Owner's Engineer.
 - a. Valve packing emission tests shall be conducted after completion of all required pressure and seat leakage testing per API STD 598 and confirmation that the packing has been installed in accordance with Packing Manufacturer's installation procedures and specifications.
 - b. The packing gland nuts shall be loosened and the valve opened (but not backseated for valves with a backseat feature) or turned 90 degrees open on 1/4 turn valves. The area above and below the stuffing box shall be dried by air blowing, and the stem shall be wiped dry.
 - c. The packing gland nuts shall be tightened to Packing Manufacturer's recommended values and the stem cycled per Manufacturer's instructions. A minimum of one cycle, open to closed to open (but not backseated) is required.
 - d. The valve body shall be pressurized with a light hydrocarbon gas, preferably methane. Alternatively, a gas containing at least 50 wt % hydrocarbons may be used, provided that the gas remains in gaseous form when subjected to the specified



test pressure at 60 °F (15 °C). Test pressure shall be specified with a minimum of 100 psig (690 kPa).

- e. Using a Volatile Organic Compound (VOC) detection instrument, the gland area shall be sniffed for emissions in accordance with 40 CFR 60 (Method 21) procedures
- f. [*] Unless otherwise specified by Owner, acceptance criteria shall be maximum 100 ppmv emissions for valves equipped with Type 1 packing and 50 ppmv for valves equipped with Type 2 packing.

3.7 Cryogenic Testing

[R] Valves in cryogenic service shall be tested in accordance with ISO 28921-1.

3.8 Non-Destructive Testing

A Quality level has been assigned to the Casting Which is as follows:

| Quality Level | Casting Type |
|---------------|---|
| I | <ol style="list-style-type: none"> 1. All alloy steel and stainless steel castings in continuous cyclic hot hydrogen service where the design temperature exceeds the carbon steel curve in API RP 941. 2. All castings in hydrofluoric (HF) acid service. 3. [*] Castings in other services or applications as specified by Owner's Engineer. |
| II | <ol style="list-style-type: none"> 1. All castings in non-cyclic hot hydrogen service where the design temperature exceeds the carbon steel curve in API RP 941. 2. All castings in high-pressure steam and hydrocarbon (Class 1500 and higher) service. 3. [*] Castings in other services or applications as specified by Owner's Engineer |
| III | <ol style="list-style-type: none"> 1. Carbon steel castings in high-pressure hydrogen (Class 600 and higher) service. 2. [*] Castings in other services or applications as specified by Owner's Engineer. |
| IV | <ol style="list-style-type: none"> 1. Hydrocarbon and water services not covered in Quality Levels I–III. 2. All commercial-grade castings. |

Major casting repairs are repairs to defects that meet the following criteria:

- a. Cause a casting to leak during hydrotest.
- b. Result in repair cavities exceeding 20% of the casting wall thickness or 1 in. (25 mm), whichever is less.
- c. Result in a repair area >10 in.² (6500 mm²).

Critical areas are those defined by Owner's Engineer and/or based on the results of examination of initial casting(s), including those listed below:



| Component | Critical Area |
|-----------|---|
| Valves | <ol style="list-style-type: none"> End flange to body transition area Body transition area to the bonnet Small integral nozzle/bleed connections |

Mill test reports of chemical composition and mechanical properties of castings shall be submitted to the Inspector.

[R] For castings requiring Post-Weld Heat Treatment (PWHT) (except carbon steel), final radiographic inspection shall be performed after heat treatment.

[*] [R] Below table specifies the nondestructive examinations and acceptance criteria required for valves. Owner's Engineer may specify additional requirements not listed in table. Purchaser may specify a greater frequency of examination than what is listed in below table.

Required Examinations and Acceptance Criteria for Valves

| Quality Level | Exam Type ⁽¹⁾ | Exam Frequency (No. of Castings) | Extent of Exam ⁽⁵⁾ | Acceptance Standards |
|---------------------------|--------------------------|---|-------------------------------------|--------------------------|
| I | VT | All | 100% | VT-1 |
| | MT/PT ⁽⁴⁾ | All | 100% ⁽²⁾ | MT-1/PT-1 ⁽⁴⁾ |
| | RT | All | 100% | RT-1 |
| II | VT | All | 100% | VT-1 |
| | MT/PT ⁽⁴⁾ | All | 100% ⁽²⁾ | MT-2/PT-2 ⁽⁴⁾ |
| | RT | Initial: F1 Balance: F2 (see below) | Critical areas (see above table) | RT-2 ⁽³⁾ |
| III | VT | All | 100% | VT-1 |
| | MT/PT ⁽⁴⁾ | Initial: F1 Balance: F2 (see below) | Critical areas (see above table) | MT-2/PT-2 ⁽⁴⁾ |
| IV | VT | All | 100% | VT-1 |
| Legend: | | | | |
| Frequency of Examination: | F1 | Inspect the first casting of each size and ANSI Class rating. | | |
| | F2 | Minimum of 10% of the order as selected by the Inspector. | | |
| | VT-1 | <u>MSS SP-55</u> | | |



| Quality Level | Exam Type ⁽¹⁾ | Exam Frequency (No. of Castings) | Extent of Exam ⁽⁵⁾ | Acceptance Standards |
|-----------------------|--------------------------|----------------------------------|--|----------------------|
| Acceptance Standards: | MT-1 | <u>ASME/BPVC SEC VIII D1</u> | Mandatory Appendix 7, "Examination of Steel Castings" | |
| | PT-1 | <u>ASME/BPVC SEC VIII D1</u> | Mandatory Appendix 7, "Examination of Steel Castings" | |
| | RT-1 | <u>ASME/BPVC SEC VIII D1</u> | Mandatory Appendix 7, "Examination of Steel Castings" | |
| | MT-2 | <u>ASME B16.34</u> | Mandatory Appendix II, Section II-2.1, "Castings" | |
| | PT-2 | <u>ASME B16.34</u> | Mandatory Appendix III, Section III-2.1, "Castings" | |
| | RT-2 | <u>ASME B16.34</u> | Section 8 "Requirements for Special Class Valves," and Mandatory Appendix I, Section I-2, "Acceptance Standards" | |

Notes to table: Required Examinations and Acceptance Criteria for Valves:

- (1) Examination techniques:
 - (a) Visual Examination (VT) per MSS SP-55.
 - (b) Magnetic Particle Testing (MT), Liquid Penetrant Testing (PT), and Radiographic Testing (RT) per ASME/BPVC SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings."
 - (c) [A] When approved by Owner's Engineer, Ultrasonic Testing (UT) examination per ASME/BPVC SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings," may be used in lieu of RT where casting configurations do not allow RT.
- (2) Including machined gasket surfaces and weld bevels.
- (3) If a defective casting is found by radiography, then two additional castings of the same material and type shall be examined. If either of these is defective, then all remaining castings of the same material and type shall be examined.
- (4) PT shall be substituted for MT for all non-magnetic alloys and low-alloy nickel steels.
- (5) When 100% inspection is specified for critical areas or for the entire casting, it shall mean inspection of all accessible areas.

4. MARKING AND IDENTIFICATION

- 4.1 [M] All valves shall be marked in accordance with the industry standard to which they are manufactured. However, if no marking criteria exist, MSS SP-25 shall be used as the minimum guideline.
- 4.2 [R] Stamping on all materials shall be with "low-stress" steel stamps having round or "U"



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| 216119C | 000 | JSS | 1300 | 0005 | 0 | 26/28 | |
| Client Doc. No. | USBT-000-TE-MP-PSP-0005 | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit info | 000-General | | | | | | |

shaped cross sections or with "interrupted-dot" die stamps.

4.3 [R] Marking with paint or ink on all austenitic stainless steels, nickel and nickel alloys, shall be in accordance with MSS SP-25 as a minimum.

4.4 [M] Valve Tagging Requirements

4.4.1. The Manufacturer shall attach to each valve a metal nameplate or tag of corrosion resistant metal stamped with characters approximately 5 mm (3/16 in) high with the manufacturer's name and model number, and the size and style of valve. Metal tags, if used, shall have a minimum thickness of No. 20 USS gage (1 mm) and shall be permanently attached by stainless steel wire to the handwheel or yoke, or gland bolting.

4.4.2. In addition, the Supplier shall attach a stainless steel tag with stainless steel wire stamped with the **Purchaser valve tag number** (e.g., GAAAAA), stamped in characters no less than 2 mm (1/16 in) high. Tags for valves with extended stems for underground installation shall include the extension length.

4.4.3. **Soft-seated valves:** Supplier shall tag each socket welded and butt welded valve with the Manufacturer's instructions for installation, welding, and post weld heat treatment (PWHT). Tag shall be corrosion resistant and attached with corrosion resistant metal wire.

4.4.4. Valves specified with drilled and tapped body or bonnet openings (Refer to Paragraph 2.1.5) shall be tagged with securely attached, weather protected instructions for shop or field seal welding of attachments (e.g., nipples and bracing) to the valve.

4.4.5. All valves having a preferred direction of flow shall have their bodies legibly marked with an arrow cast on the valve body or the word "in" or "inlet" cast or stamped on the inlet end of the body to indicate the direction of flow.

4.4.6. Manufacturer's standard soft-sealed valves shall be permanently marked or tagged with the valve temperature pressure rating at 38°C (100°F) and at minimum and maximum rated temperature. For valves with a preferred flow direction, this data shall be given for both the preferred and non-preferred directions.

4.4.7. When check valves are provided with a drilled orifice hole in the plate, the size of the orifice shall be stamped on the body with a low stress stamp near the flow arrow.

5. PROTECTION

Additional protection requirements may apply for items to be exported from the country of



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| Client | USBT-000-TE-MP-PSP-0005 | | | | | | |
| Doc. No. | USBT-000-TE-MP-PSP-0005 | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit info | 000-General | | | | | | |

manufacture.

5.1 Protection

- 5.1.1. [R] Unmachined exterior surfaces of valves shall be painted in accordance with the manufacturer's standard; however, austenitic and non-ferrous surfaces shall not be painted.
- 5.1.2. Machined or threaded exterior surfaces of carbon steel, cast iron, ductile iron, and ferrous alloys with a nominal chemistry of 12 Cr and below shall be protected from corrosion during shipment and subsequent storage by coating with a rust preventive of a type as follows:
 - A. To provide protection during outdoor storage, for a period of 12 months, exposed to a normal industrial environment
 - B. To be removable with mineral spirits or any Stoddard solvent
- 5.1.3. [R] Austenitic stainless steels and high nickel alloy materials shall not be in contact with any substance which contains chlorides including salt water or salt spray .

5.2 Special Cleaning

- 5.2.1. [R] Valves specified for "Oxygen Service" shall be cleaned, labeled, and packaged in accordance with CGA Pamphlet G-4.1 or the Manufacturer's standard if submitted and approved by the Purchaser.
- 5.2.2. [R] Valves specified for "Chlorine Service" shall be cleaned in accordance with the Chlorine Institute Pamphlet No. 6

6. DESPATCH

- 6.1 Valve shall be dry, clean & free from moisture, dirt, and loose foreign materials of any kind.
- 6.2 Compact and extended body gate and globe valves, and soft-sealed wafer-type butterfly valves, shall be in the closed position during shipment and subsequent storage. Other soft-sealed valves shall be shipped in the open position.
- 6.3 Valves, as well as associated operating mechanisms, shall be crated for shipment to protect against internal and external damage.
- 6.4 Valves shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage
- 6.5 Rust preventive used on machined surfaces to be welded shall be easily removable with a



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| 216119C | 000 | JSS | 1300 | 0005 | 0 | 28/28 | |
| Client Doc. No. | USBT-000-TE-MP-PSP-0005 | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit info | 000-General | | | | | | |

petroleum solvent and the same shall not be harmful to welding.

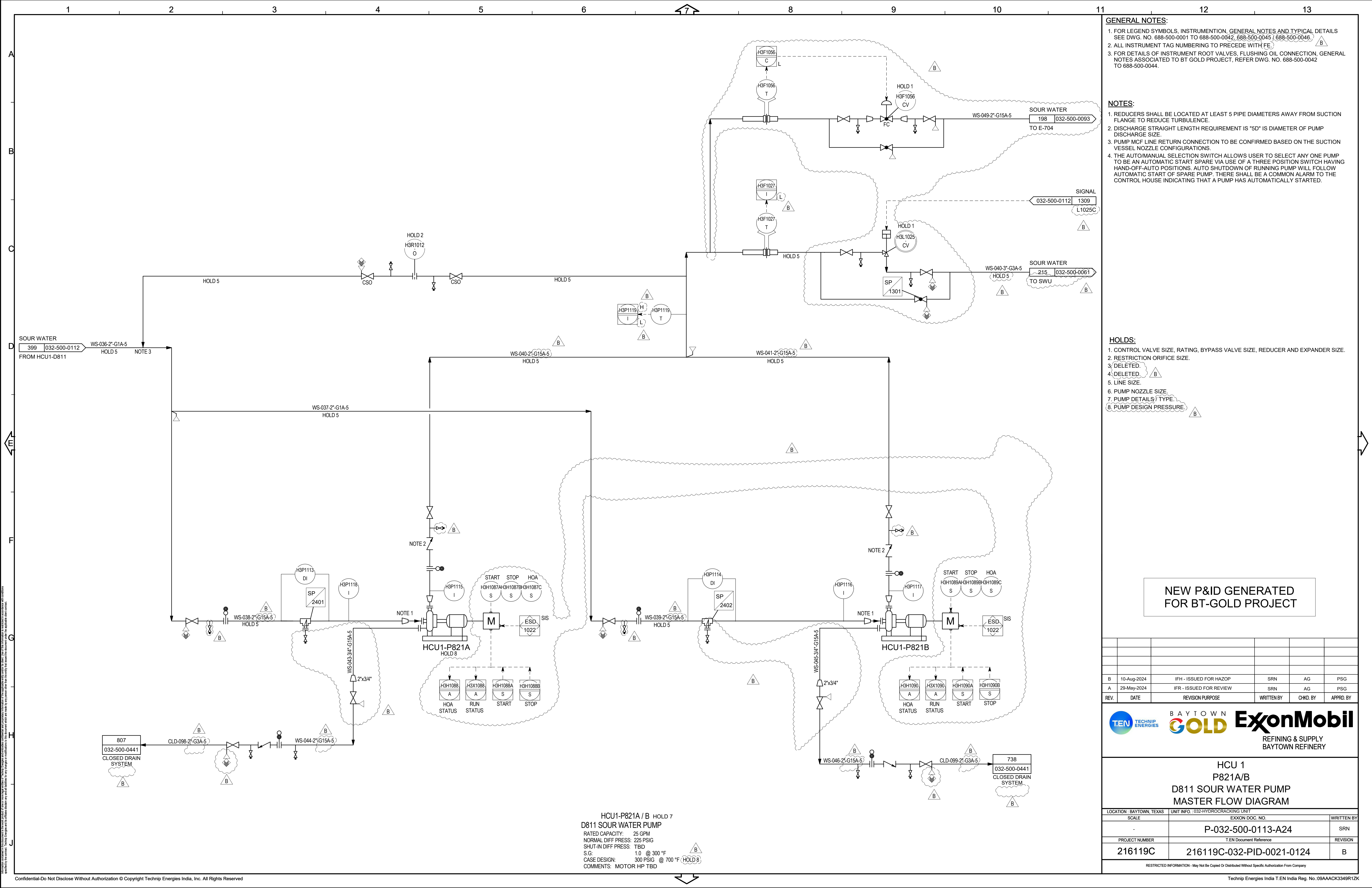
6.6 Each end of valve shall be protected with the following materials:

| | | |
|------------------|---|--------------------------------|
| Flange face | : | Wood, metal, or plastic cover. |
| Beveled end | : | Wood, metal, or plastic cover |
| Plain end | : | Plastic cap |
| SW & Screwed end | : | Plastic cap |

End protectors of wood/plastic to be used on flange faces shall be attached by at least three bolts and shall not be smaller than the outside diameter of the flange. However, plastic caps for SW & SCRD end valves shall be press fit type.

End protectors to be used on beveled end shall be securely and tightly attached.

6.7 For special service valves additional requirement for dispatch shall be as prescribed in data sheet.



GENERAL NOTES:

- FOR LEGEND SYMBOLS, INSTRUMENTATION, GENERAL NOTES AND TYPICAL DETAILS SEE DWG. NO. 688-500-0001 TO 688-500-0042, 688-500-0045 / 688-500-0046.
- ALL INSTRUMENT TAG NUMBERING TO PRECEDE WITH FE.
- FOR DETAILS OF INSTRUMENT ROOT VALVES, FLUSHING OIL CONNECTION, GENERAL NOTES ASSOCIATED TO BT GOLD PROJECT, REFER DWG. NO. 688-500-0042 TO 688-500-0044.

NOTES:

- REDUCERS SHALL BE LOCATED AT LEAST 5 PIPE DIAMETERS AWAY FROM SUCTION FLANGE TO REDUCE TURBULENCE.
- DISCHARGE STRAIGHT LENGTH REQUIREMENT IS "5D" IS DIAMETER OF PUMP DISCHARGE SIZE.
- PUMP MCF LINE RETURN CONNECTION TO BE CONFIRMED BASED ON THE SUCTION VESSEL NOZZLE CONFIGURATIONS.
- THE AUTOMANUAL SELECTION SWITCH ALLOWS USER TO SELECT ANY ONE PUMP TO BE AN AUTOMATIC START SPARE VIA USE OF A THREE POSITION SWITCH HAVING HAND-OFF-AUTO POSITIONS. AUTO SHUTDOWN OF RUNNING PUMP WILL FOLLOW AUTOMATIC START OF SPARE PUMP. THERE SHALL BE A COMMON ALARM TO THE CONTROL HOUSE INDICATING THAT A PUMP HAS AUTOMATICALLY STARTED.

HOLDS:

- CONTROL VALVE SIZE, RATING, BYPASS VALVE SIZE, REDUCER AND EXPANDER SIZE.
- RESTRICTION ORIFICE SIZE.
- DELETED.
- DELETED.
- LINE SIZE.
- PUMP NOZZLE SIZE.
- PUMP DETAILS / TYPE.
- PUMP DESIGN PRESSURE.

NEW P&ID GENERATED FOR BT-GOLD PROJECT

| REV. | DATE | REVISION PURPOSE | WRITTEN BY | CHKD. BY | APPRD. BY |
|------|-------------|-------------------------|------------|----------|-----------|
| B | 10-Aug-2024 | IFH - ISSUED FOR HAZOP | SRN | AG | PSG |
| A | 29-May-2024 | IFR - ISSUED FOR REVIEW | SRN | AG | PSG |

Refining & Supply
 BAYTOWN REFINERY

HCU 1
P821A/B
D811 SOUR WATER PUMP
MASTER FLOW DIAGRAM

| SCALE | EXXON DOC. NO. | WRITTEN BY |
|----------------|---------------------------|------------|
| - | P-032-500-0113-A24 | SRN |
| PROJECT NUMBER | T.EN Document Reference | REVISION |
| 216119C | 216119C-032-PID-0021-0124 | B |

HCU1-P821A / B HOLD 7
D811 SOUR WATER PUMP
 RATED CAPACITY: 25 GPM
 NORMAL DIFF PRESS: 225 PSIG
 SHUT-IN DIFF PRESS: TBD
 S.G.: 1.0 @ 300 °F
 CASE DESIGN: 300 PSIG @ 700 °F (HOLD 8)
 COMMENTS: MOTOR HP TBD

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DATA SHEET FOR LOW VOLTAGE INDUCTION MOTOR

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| B | 20-SEP-2024 | IFR-Issued for Review | S.RAWAT | M.BHATT | T.DEHARIYA |
| A | 27-May-2024 | IFR-Issued for Review | S.RAWAT | M.BHATT | T.DEHARIYA |
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| Doc. No. | Project N° | Unit | Doc. Type | Code | Serial N° | Rev. | Page |
| | 216119C | 000 | SP | 1691 | 0002 | B | 2/4 |
| Exxon Doc. No. | USBT-000-TE-EA-DDS-0009 | | | | | | |
| Client | ExxonMobil | | | | | | |
| Project | BAYTOWN GOLD | | | | | | |
| Location | Baytown, Texas | | | | | | |
| Unit Info | 000-General | | | | | | |



REVISION LOG

| REVISION NO. | SECTION / PAGE NO. | CHANGE DESCRIPTION |
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| B | 3,4 | UPDATED AS PER FRAME AGREEMENT |
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HOLD STATUS

This revision has the following HOLDS:

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| This LV Motor Datasheet is applicable for frame agreement with ABB | | | | | | | |
|--|------|-------|-------------|--|----------|------------|-------------|
| Technical Data Sheet (T160901C01) - Low Voltage AC Motors Up to 200 HP (150 kW) | | | | | | | |
| Specification Sheet for Electric Motors - Customary/Metric Units | | | | | | | |
| Facility Name: Baytown | | | | Purchase Order No.: | | | |
| Location: Texas, US | | | | Requisition No.: | | | |
| Item Name: Low Voltage Induction Motors (Class-1,Div.-2) | | | | ExxonMobil Project No.: USBT-000-TE-EA-DDS-0009 | | | |
| Item No.: | | | | Contractor Project No.: 216119C-000-SP-1691-0002 | | | |
| 1 PURCHASER'S REQUIREMENTS | | | | | | | |
| 2 PLANT IDENTIFICATION: 216119C | | | | SHAFT EXTENSION OR SPECIAL FITTING: <input type="checkbox"/> Yes <input type="checkbox"/> No | | | |
| 3 DRIVEN EQUIPMENT ID: | | | | AREA CLASSIF: Class-1,Div.2_CLASS/DIV __ZONE | | | |
| 4 ADDITIONAL STANDARDS: <input checked="" type="checkbox"/> IEEE 841 <input type="checkbox"/> OTHER | | | | GAS GROUP: B,C,D TEMP. CLASS: T3 | | | |
| 5 SYNCHRONOUS SPEED: _____rpm | | | | MOTOR ENCLOSURE TYPE: <input checked="" type="checkbox"/> TEFC <input type="checkbox"/> EX <input type="checkbox"/> IP _____ | | | |
| 6 RATED OUTPUT: _____hp _____kW | | | | HAZARDOUS AREA CERTIFICATE REQUIRED: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | | |
| 7 RATED VOLTAGE: 460_V <input checked="" type="checkbox"/> 3-PH <input type="checkbox"/> 50 HZ <input checked="" type="checkbox"/> 60 HZ | | | | MOUNTING AS PER: <input checked="" type="checkbox"/> NEMA MG 1 <input type="checkbox"/> IEC 34-7 | | | |
| 8 WINDING CONNECTION: <input type="checkbox"/> WYE <input type="checkbox"/> DELTA <input type="checkbox"/> OTHER | | | | SHAFT HEIGHT: _____ <input checked="" type="checkbox"/> in. NEMA MG <input type="checkbox"/> mm IEC 72.1 | | | |
| 9 STARTING: <input checked="" type="checkbox"/> FVNR <input type="checkbox"/> FVR <input type="checkbox"/> VFD <input type="checkbox"/> OTHER | | | | MAX SOUND PRESS: 80 dBA @ 3 FT | | | |
| 10 BEARING TYPE: _____ | | | | BEARING LUBRICATION METHOD: _____ | | | |
| 11 ROTATION FACING NON-DRIVE END: | | | | SECTIONAL BEARING DRAWING REQUIRED: <input type="checkbox"/> Yes <input type="checkbox"/> No | | | |
| 12 DRIVE: <input type="checkbox"/> DIRECT <input type="checkbox"/> BI <input type="checkbox"/> CW <input type="checkbox"/> CCW <input type="checkbox"/> BELT <input type="checkbox"/> GEAR | | | | LOCATION: <input checked="" type="checkbox"/> OUTDOOR <input type="checkbox"/> INDOOR | | | |
| 13 SPECIAL PAINT OR OTHER FINISH: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | MAX AMBIENT TEMP: 104° F ALTITUDE: 14FT | | | |
| 14 TERMINAL BOX ENTRY DIRECTION: <input type="checkbox"/> TOP <input checked="" type="checkbox"/> BOTTOM <input type="checkbox"/> NDE <input type="checkbox"/> DE | | | | | | | |
| 15 CABLE CABLE BOX | | | | | | | |
| 16 CONNECTION | | TYPE | CROSS SECT. | OVERALL | LOCATION | PROTECTION | ENTRY |
| 17 | | | | | | | |
| 18 SPECIAL REQUIREMENTS | | | | | | | |
| 19 IEEE 841 motors recommended for severe duty applications. Use of IEEE 841 data sheet recommended | | | | | | | |
| 20 Bidder shall also provide the optional price for Bearing Lubrication - Oil mist method. | | | | | | | |
| 21 MANUFACTURER'S DATA | | | | | | | |
| 22 MANUFACTURER: | | | | OUTLINE DRAWING NUMBER: | | | |
| 23 STANDARD: | | | | | | | |
| 24 RATED OUTPUT: _____hp _____kW | | | | MOTORS 125 hp (90 kW) AND LARGER: | | | |
| 25 FULL LOAD SPEED: _____RPM | | | | P.F. AT %LOAD: _____100% _____75% _____50% | | | |
| 26 RATED VOLTAGE: _____V | | | | EFF. AT %LOAD: _____100% _____75% _____50% | | | |
| 27 CURRENT (A): _____FULL LOAD _____NO LOAD | | | | LOCKED ROTOR POWER FACTOR: _____ | | | |
| 28 INSULATION CLASS/TEMP RISE: _____CL _____°C | | | | ALLOWABLE TIME AT LOCKED ROTOR WITH RATED V: _____ | | | |
| 29 LOCKED ROTOR CURRENT (AT RATED V): _____% FL | | | | MOTOR STARTING COLD (AT 40°C AMBIENT): _____sec | | | |
| 30 LOCKED ROTOR TORQUE: _____% FL | | | | MOTOR STARTING HOT (AT 40°C AMBIENT): _____sec | | | |
| 31 PULL-UP/BREAKDOWN TORQUE: _____/ _____%FL | | | | ROTOR INERTIA (WK ²) [GD ²]: _____lb-ft ² , kg-m ² | | | |
| 32 MOTOR WEIGHT: _____lb _____kg | | | | SPACE HEATER: _____VOLTS _____AMPS | | | |
| 33 BEARING RECOMMENDED LUBRICANT: _____ | | | | BEARING MANUFACTURER & NUMBER: _____ | | | |
| 34 | | | | ODE _____ DE _____ | | | |
| 35 NOISE LEVEL: _____dBA @ _____ <input type="checkbox"/> ft <input type="checkbox"/> m | | | | VERTICAL MOTORS-MAXIMUM ALLOWABLE THRUST: | | | |
| 36 MOTOR HAZ. AREA CERT.: _____TYPE _____NO. | | | | UP _____ DOWN _____ | | | |
| Revision Log | | | | | | | |
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| 3 | | | | Dwg. No.: | | | |

| This LV Motor Datasheet is applicable for frame agreement with ABB | |
|---|--|
| Technical Data Sheet (T160901C01) - Low Voltage AC Motors Up to 200 HP (150 kW) | |
| Specification Sheet for Electric Motors - Customary/Metric Units | |
| Facility Name: Baytown | Purchase Order No.: |
| Location: Texas, US | Requisition No.: |
| Item Name: Low Voltage Induction Motors (Class-1,Div.-2) | ExxonMobil Project No.: USBT-000-TE-EA-DDS-0009 |
| Item No.: | Contractor Project No.: 216119C-000-SP-1691-0002 |
| 1 | Motor Features |
| 2 | Basic Features: |
| 3 | Complies with IEEE 841-2009 |
| 4 | 3300 ft (1000 m) Elevation Above Sea Level Altitude |
| 5 | Division 2, Class I, A,B,C,D T3 |
| 6 | Zone 2, Class I, IIA, IIB, IIC T3 |
| 7 | 1.15 Service Factor |
| 8 | +40C Maximum Ambient |
| 9 | -25C Minimum Ambient |
| 10 | Class F Insulation |
| 11 | Class B Temperature Rise |
| 12 | Efficiency - Meets or Exceeds 841-2009 Table 2 & NEMA Premium |
| 13 | |
| 14 | Enclosure/Frame: |
| 15 | TEFC Severe Mill and Chem Duty Enclosure |
| 16 | Conduit box with NPT threaded lead hole |
| 17 | All Cast iron enclosure: Frame, end shields, Conduit box(es), fan covers |
| 18 | Standard Oversized Cast Iron conduit box |
| 19 | Diagonally split, neoprene gasketed rotatable conduit box |
| 20 | Severe Mill and Chem duty paint color system with Blue-Green color |
| 21 | Bi-Directional, Non- sparking Fan |
| 22 | |
| 23 | Hardware: |
| 24 | Stainless steel nameplates |
| 25 | Grounding lug in terminal box |
| 26 | Frame grounding provision |
| 27 | Corrosion resistant hardware |
| 28 | |
| 29 | |
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DATA SHEET FOR MEDIUM VOLTAGE INDUCTION MOTOR - ABB

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| A | 17-Sep-2024 | IFR-Issued for Review | S. SAHU | M.BHATT | T.DEHARIYA |
| REV. | DATE | STATUS | WRITTEN BY (NAME & SIGN) | CHECKED BY (NAME & SIGN) | APPROVED BY (NAME & SIGN) |
| DOCUMENT REVISIONS | | | | | |

REVISION LOG

| REVISION NO. | SECTION / PAGE NO. | CHANGE DESCRIPTION |
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HOLD STATUS

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| SECTION | PARAGRAPH NO. | DESCRIPTION OF HOLD |
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|---|--|--|
| Medium Voltage Induction Motor Frame Agreement - Data Sheets Multi-Country Master Goods & Services Agreement No A2136181 Amendment #004 US Customary Units | User: <u>ExxonMobil</u> Supplier: <u>ABB / Baldor Reliance</u> Site Name & Location: <u>Baytown, Texas</u> Project Name: <u>BAYTOWN GOLD</u> Project No: <u>216119C</u> EPC: - EPC Proj No.: - | |
|---|--|--|

| | |
|------------------|---|
| Purchaser: _____ | ABB / Baldor Reliance Ref No: _____ |
| PO Number: _____ | Rev No: <u>0</u> Date: _____ Applicable to: _____ |
| Qty: _____ | By: _____ Approved: _____ |

KEY: Completed by Purchaser Purchaser or ABB/Baldor

1 Applicable Standards: NEMA API-541, 4th Ed GP 16-09-02 May 2012 Technical Approval from Agreement No A2136181
 2 (Except as modified by this data sheet. When API-541, 4th Ed is specified, this datasheet replaces the API datasheets for this agreement)

3 **Site Conditions:**

4 Ambient temperature: -15 °C to 42.2 °C Altitude: 3300 ft (1000 m) Max Location: Indoor Outdoor With Roof
 5 Seismic Loading IBC Zone: _____ Importance Factor: _____ Onshore Offshore
 6 Exposed to: Dust Corrosive Agents Chemicals: _____
 7 Area Classification: Class: 1 Groups: B,C & D Division 2 Zone _____ Other _____
 8 Temperature Code / Autoignition Temperature: T3 / 200 °C Non-hazardous location

10 **Driven Equipment and Starting Requirements**

11 Load Speed vs Torque and Inertia: Per NEMA MG1 Part 20 (1/2 NEMA Inertia for 2 pole) Per actual load (Include load details)
 12 **Note:** Actual load data is required for 2 pole machines as it can have a significant impact on motor design

13 Starting Load condition: Unloaded (Closed Valve / Damper) Loaded (Open Valve / Damper) Partially Loaded
 14 If NEMA Load curve specified, what is the % load at full speed in starting conditions: _____ % loaded NEMA curve (centrifugal load)
 15 Starting: Direct On Line Min Starting Voltage for DOL Start: 80 % volts
 16 Other Starting Method Details: _____

17 Maximum allowable Locked Rotor Current (% of FL): 650 % Allowable Consecutive Starts 3 Motor at Ambient 2 Motor Above Ambient

19 **Motor Basic Requirements**

20 Nameplate Rating: _____ HP kW _____ RPM (Synchronous) _____ Volts 3 Phase 60 Hertz
 21 Motor Power Source: Sine Wave Power Adjustable Speed Drive (ASD) - Complete details on page 2 lines 20 to 25
 22 Service Factor: 1.0 Insulation: Class F - VPI - Solid Seal Temperature Rise: Class B at Full Load
 23 Connection to Load: Direct Coupled Belted - details _____
 24 Mounting: Horizontal Vertical Foot Mounted Flange Mounted - details _____
 25 Axial thrust / radial load details: _____

26 Enclosure: WP-II Stainless Steel Filters Galvanized Filters Pressure Switch Pressure Gauge
 27 TEFC TEAAC TEAAC Tube Material: Aluminum 300 Series Stainless 316 Series Stainless
 28 TEWAC Tube Material: 90-10 Cu-Ni Other: _____
 29 TEWAC Tube Construction: Single Tube Double Tube Leak Detector
 30 TEWAC Cooling Water: Water / Glycol _____ % Glycol Other Water Conditions / Chemistry (attach details)
 31 TEWAC Other: _____
 32 Other Enclosure: _____

33 Max Sound Pressure Level @ 3 ft (1M), No Load, Full Voltage and Frequency, Sine Wave, Overall Average 82 dBA _____ dBA
 34 Rotor Construction: Fabricated Copper Bar Die Cast Aluminum
 35 **Note:** Per 16-09-02 cast aluminum is acceptable with ExxonMobil approval for 1000HP and below

36 Shaft Material: ABB / Baldor Standard Hot Rolled AISI 4150 Forged AISI 4150 (4150 is required w/ probes, or prov for probes)
 37 Note: Forged AISI 4150 is required for 2 pole machines above 1000HP

38 Bearings: Sleeve Lubrication: Self Lube Constant Level Oilers (Oil-Rite brand) Provisions for flood lubrication
 39 Antifriction for horizontal motors Lubrication: Grease Oil mist Provisions for oil mist
 40 Antifriction for vertical Top bearing Grease Oil sump Bottom bearing Grease Oil sump
 41 Both bearings Insulated Further details: _____

42 Paint System: ABB/Baldor-Reliance enhanced APEX paint system (4824-7-BPX) C5M - Extreme Duty for Off Shore Applications
 43 ABB/Baldor-Reliance Standard Color Special Color: _____

44 Hardware-Fasteners (Through M12, 1/2 inch): 300 Series Stainless Steel 316 Series Stainless Steel (For Offshore)

45 Baseplate by: Driven Equipment Mfr Existing Soleplate: By: Driven Equipment Mfr ABB Type: 1 Piece 2 Piece

47 Notes: _____
 48 _____
 49 _____
 50 _____

| | | |
|---|--|--|
| Medium Voltage Induction Motor Frame Agreement - Data Sheets Multi-Country Master Goods & Services Agreement No A2136181 Amendment #004 US Customary Units | User: <u>ExxonMobil</u> Supplier: <u>ABB / Baldor Reliance</u> Site Name & Location: <u>Baytown, Texas</u> Project Name: <u>BAYTOWN GOLD</u> Project No: <u>216119C</u> EPC: - EPC Proj No.: - | |
|---|--|--|

| | |
|-------------------------------------|---|
| Purchaser: _____ | ABB / Baldor Reliance Ref No: _____ |
| PO Number: _____ | Rev No: <u>0</u> Date: _____ Applicable to: _____ |
| Qty: _____ Item Name / Tag #: _____ | By: _____ Approved: _____ |

KEY: Completed by Purchaser Purchaser or ABB/Baldor

Main Terminal Box

Main Box Location Facing Non-Drive End (NDE): Right Side (F-1) Left Side (F-2) Breather Drains: Yes No

Box Size: NEMA Type II with Tin Plated Bus Bars Fault Withstand: Blowout Panel Leads: Oil Resistant Silicone Lugs

Lead Entry Location: Bottom Toward DE Toward NDE Lead Entry Type: Blank Panel NPT Fitting Size: _____

Stator Leads in Terminal Box: 6 Leads with neutral bus 3 Differential Current Transformers 50:5 100:5 (Req'd above 2500HP)

Accessories: Space Heaters _____ Phase _____ Voltage 1 Current Transformer for Ammeter (CT accuracy class = C10)

Surge Capacitors Lightning Arrestors **Note:** SC's and LA's are not available for ASD driven motors

Note: SC's and LA's are not common: 1) Below 5kV; 2) Low HP's; 3) Contactor fed motors

Motor Accessories

Space Heaters Temp Code: T3 Volts: _____ Phase: _____

Stator Temperature Detectors: RTD's 2 per phase 100 ohm Stator RTD box location facing NDE: Left side Right side

Bearing Temperature Detectors: Thermocouples Type: J Qty: 1 per brg Bearing temperature detector leads wired to:

RTD's _____ ohm Qty: _____ per bearing Conduit head at bearing In the Stator RTD box

Vibration Probes: Not required Provisions for shaft proximity and phase reference probes _____

Shaft proximity and phase reference probes _____

Adjustable Speed Drive Operation

ASD operation only Capable of ASD and Direct On Line operation

Variable torque speed range: Min speed _____ RPM _____ ft-lb Max speed _____ RPM _____ ft-lb

Constant torque speed range: Min speed _____ RPM Max speed _____ RPM _____ ft-lb

Constant power speed range: Min speed _____ RPM Max speed _____ RPM _____ HP

Additional information: _____

Testing

| | <u>Required</u> | <u>Observed</u> | <u>Witnessed</u> |
|---------------------------------------|----------------------------------|-----------------------|-----------------------|
| Design review | <input type="radio"/> | | |
| Lateral critical speed analysis | <input type="radio"/> | | |
| Data for torsional analysis by others | <input type="radio"/> | | |
| Test procedures 6 weeks prior to test | <input type="radio"/> | | |
| Routine test per GP16-09-02 | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Routine test per API-541 4th ed | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Complete test per GP16-09-02 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Complete test per API-541 4th ed | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sealed winding conformance test | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Unbalance response test | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sound level test | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Other tests: | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| _____ | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| _____ | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| _____ | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Notes: _____

INDUCTION MOTOR
API 541 5th Edition -- DATASHEETS
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MOTOR PROPOSAL DATA

Bold Italics = Indicate Default Selection

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MOTOR SUPPLIER / MANUFACTURER PROPOSAL DATA

1 Manufacturer _____ Type / Model No. _____ Frame size / Designation _____
2 Qty. _____ HP _____ RPM (Synch.) _____ Poles _____ Volts _____ Phase _____ Hz _____
3 Full Load speed _____ RPM _____ Insulation class **F** _____ Temperature rise _____ Class **B** _____ Service factor 1.0
4 Enclosure _____ Full Load torque (FLT) _____ ft-lb Rotor inertia [8.1.3 c)] _____ lb-ft² WK² GR² GD²
5 Locked rotor torque (LRT) _____ % FLT Pull-Up torque (PUT) _____ % FLT Breakdown torque (BDT) _____ % FLT
6 **Calculated Expected Data [8.1.3 f)] at the following Loads:** For recip. comp., calc. eff. is based on pulsating current conditions from pg.6
7 Load Point 50% 75% 100% Other: _____ % Area Classification (4.1.8): Nonclassified
8 Efficiency _____ % _____ % _____ % _____ % Classified: Class _____ Group _____ Div. _____
9 Power Factor _____ % _____ % _____ % _____ % _____ or Zone _____
10 Current _____ Amps _____ Amps _____ Amps _____ Amps Autoignition temp _____ °C or Temp.code _____
11 Guaranteed efficiencies [8.1.3 f)] at _____ % Load = _____ % Test method [8.1.3 f)]:
12 Max. sound pressure level (4.1.3): **85 dBA @ 1 m. No-Load, Full Voltage/Frequency, Sine Wave Power** Other: _____ dBA
13 Motor power source: **Sine Wave Power** ASD Power only ASD only w-bypass to utility power
14 ASD + DOL start capability ASD w-DOL start and bypass to utility power
15 Variable torque speed range: Min. speed _____ RPM _____ ft-lb Max. speed _____ RPM _____ ft-lb
16 Constant torque speed range: Min. speed _____ RPM _____ Max. speed _____ RPM _____ ft-lb
17 Constant power speed range: Max. speed _____ RPM _____ ft-lb Avoiding lateral natural frequencies by at least 15% not
18 Method of efficiency determination to be used [8.1.3 f)]:
19 Base frequency(ies) and harmonics assumed present in the supply waveform(s) [8.1.3 f)]:
20 **Separately Powered Auxiliary Fan(s) (4.4.10.6.3): Driver Information (where applicable)**
21 Quantity _____ Location _____ Encl. _____ HP _____ RPM _____ Volts _____ Phase _____ Hertz
22 Quantity _____ Location _____ Encl. _____ HP _____ RPM _____ Volts _____ Phase _____ Hertz
23 **TEAAC Heat Exchanger Tube Material [4.4.10.8 a)]:**
24 **TEWAC Heat Exchanger Requirements (4.4.1.2.4):** Tube materials [4.4.10.8 b)]: **90-10 Cu-Ni** Other tube material:
25 Cooling water conditions **per 4.4.1.2.4 a)** Other cooling water conditions:
26
27 **Bearings (4.4.7.1):** **Hydrodynamic (4.4.7.1.1)** Sleeve (4.4.7.1.1) Tilting pad (4.4.7.1.1) Antifriction (horizontal) (4.4.7.1.3)
28 Antifriction thrust bearing (vertical) (4.4.7.1.5) Hydrodynamic thrust bearing (vertical) (4.4.7.1.10)
29 Thrust bearing load capability [4.4.7.1.11 Downthrust Momentary _____ lbs Upthrust Momentary _____ lbs
30 a)] Continuous _____ lbs Continuous _____ lbs
31 **Lubrication (4.4.8):** **Ring Type Self Lubrication (4.4.8.1)** Machine bearings require pressure lube system Yes No
32 Pressurized lube system (4.4.8.4) Common with driven equipment (4.4.8.5) System supplied by (4.4.8.4): Others Motor supplier
33 Type/viscosity of oil (4.4.8.5; 4.4.8.8; 5.1.4.2): _____ Oil rings included Yes No
34 Oil requirements per bearing (8.1.4): Flow: _____ GPM Pressure: _____ PSI Volume: _____ QTS
35 Heat loss to be removed per bearing: _____ kW
36 Oil mist provisions (4.4.7.4) (see Guide): Purge oil mist, hydrodynamic brg's Pure oil mist, antifriction brg's Oil mist ready, antifriction brg's.
37 Grease, Type: _____ Oil mist provisions only, a/f brg's.
38 Magnetic stator slot wedges used (4.3.10): Yes No
39 When enclosure pre-start purging is specified, vendor defined maximum allowable pressure [4.4.1.1 e)]:
40 Low ambient temperature precautions (4.4.10.4):
41 Special winterizing requirements (8.1.15):
42 Machine net weight (8.1.5): _____ lbs
43 Special tools included in proposal (4.1.11, 8.1.13):
44 Machine proposed is in strict compliance with API 541 5th edition? (8.1.9) Yes No List of applicable exceptions attached

INDUCTION MOTOR
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Page 1/4 Motor Supplier Order Data

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AS-DESIGNED **AS-BUILT**

1 USER ExxonMobil APPLICATION _____
2 LOCATION Baytown, Texas SUPPLIER _____
3 PROJECT NAME BAYTOWN GOLD SUPPLIER REF. No. _____
4 SITE / PLANT _____ NUMBER of UNITS REQUIRED _____
5 _____ MOTOR TAG No.(s) _____

MOTOR RATING - ELECTRICAL AND PERFORMANCE DATA

6 Quantity _____ Type / Model no. _____ Frame size / Designation _____ Motor power: Utility-Grid ASD
7 Nameplate power / RPM rating (4.2.1.1): HP kW RPM Full Load _____ RPM synchronous _____ Poles _____
8 Nameplate Voltage/Ph/Hz rating (4.2.1.2): 2300 Volts (4.2.1.2) 3 Phase 60 Hertz
9 Insulation class [4.3.1.1 a): **Class F** Temperature rise [4.3.1.1 b): **Class B** Enclosure (4.4.1.2): _____ TEFC
10 Full-Load torque (FLT) _____ ft-lb Percent FLT at: Locked-Rotor (LRT) _____ Pull-Up (PUT) _____ Breakdown (BDT) _____

Expected Data [8.1.3 f] at the following Loads (100% Voltage):

12 Load Point: Locked-Rotor 50% 75% 100% Other: _____ % Data is: _____
13 Efficiency: _____ % _____ % _____ % _____ % _____ % Calculated
14 Power Factor: _____ % _____ % _____ % _____ % _____ % Previously tested unit
15 Current: _____ Amps _____ Amps _____ Amps _____ Amps _____ Amps Tested this order
16 Guaranteed efficiency [8.1.3 f] _____ % Efficiency at _____ % Load Efficiency determination test method [8.1.3 f]: _____
17 For reciprocating loads [8.1.3 f] _____ % Efficiency at _____ % Load with _____ % Current pulsation Max. current variation [8.1.3 g]: _____ A
18 For motors operating on ASD power [8.1.3 f]: Base frequency(ies) and harmonics assumed in the supply waveform(s) [8.1.3 f]: _____

19 Curve No.'s [8.1.3 a), b): Speed-Torque _____ Speed-Current _____ Speed-Power Factor _____
20 When specified: Calculated rotor-response curve no. [8.6.2 b): _____ Acceleration curve No. _____
21 Acceleration time [8.1.3 d): At rated voltage: _____ sec. At minimum starting voltage/MVA: _____ sec. At _____ % Voltage _____ Sec
22 Thermal capacity / limit curve no. (4.2.4.2) _____ Rotor inertia - Wk^2 [8.1.3 c)] _____ lb-ft²
23 Locked-Rotor withstand time, cold [4.2.4.2 a); 8.1.3 e)] _____ at 100% Voltage _____ Sec at 80% voltage _____ Sec at _____ % voltage _____ Sec
24 Locked-Rotor withstand time, hot [4.2.4.2 b); 8.1.3 e)] _____ at 100% Voltage _____ Sec at 80% voltage _____ Sec at _____ % voltage _____ Sec

Starting Capability (4.2.4.1):

25 Consecutive successful starts with : Locked-Rotor current at 100 % Voltage _____ Amps
26 Motor initially at ambient temperature 3 Locked-Rotor current at 80 % Voltage _____ Amps
27 Motor temp. above ambient but not exceeding rated operating temperature 2 Locked-Rotor current at _____ % Voltage _____ Amps
28 Wait time after all consecutive starts exhausted [4.2.4.2 d), e]): With motor running _____ Minutes With motor stopped _____ Minutes

Max. Sound Pressure Level (4.1.3)

29 dBA @ 1 m., no-load Other: _____

Induction Motor Equivalent Circuit Data:

30 Phase-to-Phase resistance _____ Ohms, @ _____ °F
31 _____ kVA base at rated voltage and 77°F Subtransient reactance X'd _____ Total winding capacitance to ground _____ uF
32 Locked-Rotor at rated voltage: Stator R _____ Rotor R _____ Magn R _____
33 Stator X _____ Rotor X _____ Magn X _____
34 Rated load at rated voltage: Stator R _____ Rotor R _____ Magn R _____
35 Stator X _____ Rotor X _____ Magn X _____
36 Residual Voltage Open-Circuit Time Constant: Motor Only _____ sec. With Surge Capacitors _____ sec.

MOUNTING, WEIGHTS

37 **Mounting:** Horizontal foot mounted Horizontal flange mounted with feet Vertical foot mounted
38 Vertical flange mounted Shaft down Shaft up Solid shaft Hollow shaft Non-reverse ratchet
39 Flange type: _____ Flange bolt circle diameter: _____
40 Soleplate furnished with motor Baseplate furnished with motor Adapter plate furnished with motor
41 **Weights:** Motor net: _____ lbs. Stator _____ lbs. Rotor _____ lbs. Shipping _____ lbs.

AS-DESIGNED AS-BUILT

BEARINGS, HOUSINGS AND SEALS

1 **Bearings:** Type: **Hydrodynamic (4.4.7.1.1)** Antifriction (4.4.7.1.3) AFBMA number(s): _____
2 Split sleeve (4.4.7.1.1) Drive end: _____
3 Tilting pad (4.4.7.1.1) Non-drive end: _____
4 Hydrodynamic bearings: Oil rings included (4.4.8.1) Yes No
5 Bearing, drive end: Capable of self-lube Yes No Manufacturer _____ Model / part no. _____
6 Bore diameter: Min _____ in. Max _____ in. Bore length _____ in. Type _____
7 Design clearance with Shaft: Min _____ in. Max _____ in. Bearing loading: _____ PSI
8 Bearing, non-drive end: Capable of self-lube Yes No Manufacturer _____ Model / part no. _____
9 Bore diameter: Min _____ in. Max _____ in. Bore length _____ in. Type _____
10 Design clearance with shaft: Min _____ in. Max _____ in. Bearing loading: _____ PSI
11 Special seals for gas purge [4.4.7.3 a)] Non-conducting seals [4.4.7.3 b)] Other seal type _____
12 Thrust bearing: Antifriction (4.4.7.1.5) Hydrodynamic (4.4.7.1.10) Bearing loading: _____ PSI
13 Thrust bearing load Momentary _____ lbs Momentary _____ lbs
14 capability (4.4.7.1.11) Downthrust Continuous _____ lbs Upthrust Continuous _____ lbs
15 Position: Non-drive end Drive end Manufacturer _____ Model / part no. _____

LUBRICATION SYSTEM

16 **Hydrodynamic Bearing Ring Type Self Lubrication (4.4.8.1)** Constant-level oilers (4.4.7.2.2)
17 Pressurized lube (4.4.8.1, 4.4.8.4) Oil rings provided: Yes No Bearings designed to operate w/o lube system: Yes No
18 Common with driven eqpt. (4.4.8.4) System supplied by (4.4.8.4): Driven eqpt. supplier End user Motor supplier Other
19 Motor only lube system Required / recommended type/viscosity of oil (4.4.8.5; 4.4.8.8): _____
20 Total bearing oil requirements (8.1.4): _____ GPM _____ PSI Heat loss to be removed per bearing _____ kW
21 Motor prepared for supplemental purge oil mist (4.4.7.4.1) Other lube system information: _____
22 Antifriction bearings: Grease Type: _____
23 Pure oil mist (4.4.7.4.5) Oil mist ready or Oil mist provisions only
24 Grease removal required before operation with oil mist? Yes No
25 Vertical motor bearings: Thrust bearing: _____ Guide bearing: _____ Mfg. recommended lubricant: _____
26 Oil sump lubrication Oil sump lubrication Type/viscosity of oil: _____
27 Grease lubrication Grease lubrication Grease type: _____

VIBRATION DETECTORS

28 **Non-contact Shaft Probes (5.8.1):** Number per bearing: **TWO (2) (5.8.1)** Four (4) (5.8.2)
29 Shaft Probes: Provisions Installed Manufacturer: _____ Model: _____
30 Phase reference probe (5.8.1): Provisions Installed Manufacturer: _____ Model: _____
31 Oscillator-Demodulators: Provisions Installed Manufacturer: _____ Model: _____
32 **Bearing Housing Seismic Sensors (5.8.3):** Per API 670 (5.8.3)
33 Sensor: Provisions Installed Type: _____ Manufacturer: _____ Model: _____
34 Vibration Switch: Provisions Installed Type: _____ Manufacturer: _____ Model: _____
35 D.E. bearing Qty.: _____ Position(s): Horizontal Vertical Axial Other: _____
36 N.D.E. bearing Qty.: _____ Position(s): Horizontal Vertical Axial Other: _____
37 **Recommended Vibration Settings:** Alarm _____ Shutdown _____ Inches per sec. Other _____
38 Alarm _____ Shutdown _____ Mills. Other _____
39 Frequency of shaft resonance closest to operating speed: _____ Hertz

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Page 3/4 Motor Supplier Order Data

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ACCESSORIES & SETTINGS

1 **Heaters:** Single voltage design: _____ Dual voltage design (if specified): _____
2 Operating voltage kW Phase Operating voltages kW Phase Sheath material
3 Frame heaters (5.4.1; 5.4.2; 5.4.3): _____ / _____
4 Main t/box heaters: _____ / _____
5 Bearing heaters (4.4.8.3): _____ / _____

6 **Temperature Detectors:**
7 **Winding Temperature Detectors (5.2):** RTD-Platinum, 3 Wire, 100 Ohms at 0°C (5.2.1.1) No. per phase (5.2.1.2): **Three (3)** Other _____
8 Other RTD material: _____ Wires: _____ Resistance: _____ No. per phase (5.2.1.2): **Three (3)** Other _____
9 One common lead each element grounded in box. (5.2.1.2)
10 Thermocouples: Type: _____ No. per phase (5.2.1.2): **Three (3)** Other _____
11 Other _____
12 **Recommended Settings:** Alarm: _____ Shutdown: _____

13 **Bearing Temperature Detectors (5.3):** **RTD - Platinum, 3 Wire, 100 Ohms at 0°C; One (1) Per Bearing for Hydrodynamic & Thrust Bearings (5.3.1)**
14 Other qty. per bearing _____ Dual element used Installed per API 670 (5.3.1) One (1) common lead grounded Provisions only
15 Other RTD material: _____ Wires: _____ Resistance: _____ Other info: _____
16 Thermocouples: Type: _____
17 Dial type thermometers (4.4.7.1.16): Type _____ Alarm contacts Number of contacts _____ NO NC
18 Antifriction bearings: Above selections applied to antifriction bearings
19 **Recommended Settings:** Alarm: _____ Shutdown: _____

20 **Enclosure Accessories**
21 **WP-II, WP-I, DPG/ODP (4.4.1.2.2)** Air filters: Provided (5.5.4): **Required for WP-II (5.5.3)** Air filters not provided (5.5.4)
22 Filter capability (5.5.4): **90% of particles > 10 micron** Other _____ Air filter provisions only (5.5.2)
23 Filter manufacturer: _____ Type: _____ Model: _____
24 Differential pressure device (5.5.5): **Provisions Required for WP-II** Provisions only supplied Device not provided
25 Differential pressure switch provided (5.5.5): Differential pressure gauge provided (5.5.5) Combination switch / gauge provided
26 Device manufacturer: _____ Type: _____ Model: _____
27 **Recommended Settings for Differential Pressure Switch:** Alarm: _____ Shut-Down: _____

28 **TEAAC Enclosure (4.4.1.2.3)** Heat exchanger tube materials [4.4.10.8 a): _____
29 **TEWAC Enclosure (4.4.1.2.4)** Heat exchanger tube materials [4.4.10.8 b): **90-10 Cu-Ni** Other _____
30 Tube construction [4.4.1.2.4 d); 4.4.10.8 b), c): **Single tube** Double tube
31 Leak detection [4.4.1.2.4 c): **Required** Double tube leak detection: **Inner tubes only** Outer also
32 Cooler location/orientation [4.4.1.2.4 c): _____ Redundant coolers [4.4.1.2.4 b)]
33 Water flow (GPM): Max _____ Min _____ Water pressure (PSI): Max _____ Min _____
34 Flow sensor local indicator provided [4.4.1.2.4 g)] Provisions only Manufacturer: _____ Type: _____ Model: _____
35 Relay contacts provided: Normally open Normally closed _____
36 High flow alarm set point _____ GPM Low flow shutdown set point _____ GPM
37 Cooler air inlet & outlet temperature sensor [4.4.1.2.4 h): **Required** Manufacturer: _____ Type: _____ Model: _____
38 Sensor type: _____
39 Cooling water conditions per 4.4.1.2.4 a) Water/Glycol solution Other cooling water conditions (purchaser specified)
40 When enclosure pre-start purging is specified, supplier defined max. allowable pressure [4.4.1.1 e): _____

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AS-DESIGNED AS-BUILT

STATOR WINDING AND ROTOR REPAIR DATA

1 **Stator Coil Information [8.6.2 d], reference Annex G:** Coil dimensional drawing no.: _____

2 Total copper weight: _____ lbs. Copper strand size: _____ Insulation: _____

3 Number of strands per coil turn: _____ Number of turns per coil: _____

4 Turn insulation description: _____

5 Ground-Wall insulation description: _____

6 Thickness turn insulation: _____ mils Thickness strand insulation: _____ mils o _____ mils

7 Coil configuration: _____ Rows by _____ Columns

8 Finished coil dimension in slot, W x H x L (also give tolerances): _____

9 Total number of stator slots: _____ Winding throw: _____ Winding connection: _____

10 Slot filler description - thickness: Top _____ mils Side _____ mils Middle _____ mils Slot dimensions: _____

11 Slot wedge material: _____ Magnetic slot wedges: No Yes

12 Stator bore diameter: _____ Stress grading description if applicable: _____

13 Special end-turn rasing: _____

14 Other: _____

15 **Rotor Information:** Total Conductor Weight: _____ lbs. Number of Bars: _____ Strand or bar size: _____

16 Conductor material: _____ Ring material: _____ Retaining ring alloy, if applicable: _____

17 Shaft material: _____ Ring dimensions premachining: _____

- 18 **Notes:** Following data should be supplied by the motor vendor
- 19 • %pf @ 100%/75%/50%
 - 20 • %eff @ 100%/75%/50%
 - 21 • NEMA Design Letter
 - 22 • General arrangement (GA)
 - 23 • Wiring diag showing the customer connections
 - 24 • Hazardous Area Classification suitability
 - 25 • Temperature rise and insulation class
 - 26 • Lock rotor current @ 100%/80% starting voltage
 - 27 • Acceleration times @ 100%/80% starting voltage
 - 28 • Hot & cold stall times @ 100%/80% starting voltage
 - 29 • Max no. of consecutive starts (hot & cold)
 - 30 • Time to wait before next start (cool down time)
 - 31 • Stator/Bearing RTD Alarm and Trip Set Point (°C)
 - WR^2 (mtr & load) (for mtr start study)
 - Locked Rotor pf %
 - Locked Rotor Torque %
 - Max (Breakdown) Torque %
 - Motor - Speed vs. Torque Curve
 - Load - Speed vs. Torque Curve
 - Speed vs. Current Curve
 - Speed vs. pf Curve
 - Thermal Damage Curve (Current vs. Time)
 - Running Cool Time Constant
 - Stopped Cool Time Constant
 - Open circuit (transient) time constant
- 32 _____
- 33 _____
- 34 _____
- 35 _____
- 36 _____
- 37 _____
- 38 _____
- 39 _____
- 40 _____
- 41 _____
- 42 _____

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DATA SHEET FOR MEDIUM VOLTAGE INDUCTION MOTOR - SIEMENS

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| A | 17-Sep-2024 | IFR-Issued for Review | S. SAHU | M.BHATT | T.DEHARIYA |
| REV. | DATE | STATUS | WRITTEN BY (NAME & SIGN) | CHECKED BY (NAME & SIGN) | APPROVED BY (NAME & SIGN) |
| DOCUMENT REVISIONS | | | | | |

REVISION LOG

| REVISION NO. | SECTION / PAGE NO. | CHANGE DESCRIPTION |
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HOLD STATUS

This revision has the following HOLDS:

| SECTION | PARAGRAPH NO. | DESCRIPTION OF HOLD |
|---------|---------------|---------------------|
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INDUCTION MOTOR
API 541 5th Edition -- DATASHEETS
U.S. CUSTOMARY UNITS

PURCHASER'S SELECTIONS

Bold Italics = Indicate Default Selection

JOB NO. _____ ITEM / TAG NO. _____
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1 USER ExxonMobil
2 LOCATION Baytown, Texas
3 PROJECT NAME BAYTOWN GOLD
4 Agreement Siemens Frame Agreement Template
(Agreement Number: Appendix 4 to Exhibit C,
A2630511)
5 Applicable To: Proposal Purchase As Designed As Built

APPLICATION _____
SUPPLIER Siemens (USA)
SUPPLIER REF. No. _____
NUMBER of UNITS REQUIRED _____
MOTOR TAG No.(s) _____

Bold Italics = Indicate the Standard's default selections - refer to Annex C for Datasheet Guide

BASIC DESIGN - General

6 Applicable Standards (1.3.2; 2.0): **North American (i.e., ANSI, NEMA)** Use SI (metric) datasheets for International Standards (IEC, etc.)
7 Power / RPM ratings are specified by: User/Project OEM Other _____
8 Nameplate power rating (4.2.1.1): _____ HP kW Motor speed: _____ RPM (Synchronous)
9 Nameplate Voltage/Ph/Hz rating (4.2.1.2): 2300 Volts 3 Phase 60 Hertz
10 Nameplate ambient temp. rating [4.3.1.1 b)]: 40° C Other: _____ °C Minimum rated operating ambient temp.(4.1.2): 0 °C
11 Stator insulation class [4.3.1.1 a)]: **Class F** Other Class: _____
12 Stator temperature rise [4.3.1.1 b)]*: **Class B** Other: _____ * (See underlined sentences in Datasheet Guide for this item)
13 Duty (4.1.2): **Continuous** Other: _____ 80C Rise by Resistance & 90C Rise by RTD @ 1.0 SF
14 Max. sound pressure level @ 1 m. @ no load, full voltage/frequency on sine wave power (4.1.3; 4.1.4): **85 dBA** Other: _____ dBA
15 Voltage and frequency variations (4.2.1.3): **Per NEMA** Other: _____
16 Motor power source: **Sine Wave Power** ASD power (complete below section) Solid state soft starter - complete data on page 6, line 8
17 Adjustable Speed Drive (ASD) conditions, if applicable (4.1.4; 4.1.5; 4.2.1.2.3, 4.3.1.2):
18 ASD only operation (4.2.4.5) ASD+DOL start capability ASD only w-bypass to utility power ASD w-DOL start & bypass to utility
19 Variable Torque speed range: Min speed _____ RPM _____ ft-lb Max. speed _____ RPM _____ ft-lb
20 Constant Torque speed range: Min speed _____ RPM _____ Max. speed _____ RPM _____ ft-lb
21 Constant Power speed range: Max speed _____ RPM _____ ft-lb
22 ASD description and information affecting motor design (obtain from ASD Supplier; refer to Datasheet Guide)
23 ASD type / topology: _____
24 ASD output harmonics, describe and/or attach data (4.3.1.2): _____
25 ASD maximum voltage spike amplitude and rise-time at drive output (4.3.1.2.1): _____ Volts @ _____ microseconds
26 ASD Maximum common mode voltage (CMV) at drive output (4.3.1.2.2): _____ Volts
27 Other ASD information / motor requirements: _____
28 Copper Cage Rotor Required

29 **Area Classification (4.1.8):** Nonclassified Classified as: Class 1 Group B,C,D Division 2 or Zone _____
30 Temperature code (T-code): T3 Autoignition temperature (AIT): _____ °C
31 Other: _____

32 **Site Data (4.1.2; 4.4.8.3; 4.4.10.4):** Site ambient temperature: 42.22 Max -15 Min °F °C
33 Minimum rated storage ambient temp.(4.1.2): _____ °F °C Site elevation: <3300 ft.
34 Relative humidity: _____ % Max _____ % Min Use this higher elevation for motor rating: _____ ft.
35 Motor location: Indoor Building temperature controlled: No Yes Controlled temp.: _____ °F °C Use for motor rating
36 Outdoor Roof over motor: No Yes Offshore platform / similar marine environment [4.4.1.1 c)]
37 Seismic loading (4.4.2.2), IBC Zone: _____ Importance Factor: _____ Other seismic requirements: _____

38 **Unusual Site Conditions, Define:** _____
39 Additional environment considerations, chemicals, etc. (4.1.2): _____
40 Abrasive dust protection for open enclosures [4.4.1.2.2 c)]: _____
41 Corrosive agents in environment, re: stress corrosion cracking (4.4.10.1.2): _____
42 Other: _____
43 Magnetic Top Wedges are not permitted in stator design (4.3.10)

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BASIC DESIGN - Enclosure, Mounting, Electrical system

1 **Enclosure (4.4.1.2)** Degree of Protection (4.4.1.2.1) IP _____ Method of Cooling (4.4.1.2.1) IC _____
2 WP-II (Weather Protected Type II) (4.4.1.2.2) WP-I (Weather Protected Type I) (4.4.1.2.2) DPG (Dripproof Guarded) (4.4.1.2.2)
3 Air filters: **Required for WP-II (5.5.3)** Provisions only for WP-I or DPG (5.5.2) Provide filters for WP-I or DPG (5.5.4)
4 Air filter capability (5.5.4): **90% of particles \geq 10 micron** Other: _____
5 Purchaser specified filters: Manufacturer: _____ Type: _____ Model: _____
6 Differential pressure device (5.5.5): **Provisions required for WP-II** Differential pressure switch (5.5.5) Combination
7 Provisions only for WP-I or DPG (5.5.5) Differential pressure gauge (5.5.5) switch / gauge
8 Purchaser specified device: Manufacturer: _____ Type: _____ Model: _____
9 Enclosure for motors rated 6kV and above: [4.4.1.1 f]: **TEFC, TEAAC, or TEAAC (IP44 or higher)** or Use enclosure selected in line 2
10 TEFC (4.4.1.2.3) TEPV (4.4.1.2.3) Other enclosure: _____
11 TEAAC (4.4.1.2.3) Heat exchanger tube materials [4.4.10.8 a]: Aluminum Alum. Alloy Copper Copper Alloy Other _____
12 Stainless Steel 300 Series Stainless Steel 316 Series (req'd for offshore) [4.4.10.8 a)]
13 TEWAC (4.4.1.2.4) Heat exchanger tube materials [4.4.10.8 b]: **90-10 Cu-Ni** Other _____
14 Cooling water conditions **per 4.4.1.2.4 a):** Water & glycol solution Other cooling water conditions or chemistry (attach documentation)
15 Cooler location-orientation [4.4.1.2.4 c): Supplier decision Above stator Other _____
16 Cooler inlet-outlet location (facing NDE): Supplier decision Right side Left side Other _____
17 Tube construction [4.4.1.2.4 d); 4.4.10.8 c): Double tube Redundant coolers [4.4.1.2.4 b)]
18 Leak detection [4.4.1.2.4 c): **Required** For double tube coolers: **inner tube leak detection required** Outer tube detection also
19 Flow sensor with local indicator [4.4.1.2.4 g): **Required** Not required Relay contacts: Norm.Open (NO) Norm.closed (NC)
20 Purchaser specified device: Manufacturer: _____ Type: _____ Model: _____
21 Cooler air inlet & outlet temperature sensor [4.4.1.2.4 h): **Required** Not required Same as winding Other _____
22 Purchaser specified device: Manufacturer: _____ Type: _____ Model: _____
23 System of units for hardware (1.3.1): U.S. / North American Customary SI (Metric)
24 Hardware-fasteners material [4.4.1.1 c): **Stainless Steel 300 series through M12 (1/2 in.)** SS 316 series through 1/2 in. for offshore
25 Provision for pre-start purging [4.4.1.1 e): Purchaser specified purge details: _____
26 Field piping connection sizes (4.4.3.1): **Supplier std.** Other: _____
27 Duct gaskets/bolts provided by (4.4.3.8): **Supplier std.** Other: _____
28 Auxiliary motor driven fans (4.4.10.6.3): Yes No Ph / Volts.: _____ Phase _____ Volts
29 Paint system: **Supplier's paint system** Purchaser specified paint system Paint system spec. no.: _____
30 Paint color: **Supplier's paint color** Purchaser specified paint color Define paint color and code: _____
31 **Mounting:** Horizontal foot mounted Horizontal flange mounted with feet Vertical foot mounted
32 Vertical flange mounted Shaft down Shaft up Solid shaft Hollow shaft Non-reverse ratchet (NRR)
33 Vertical Motor to carry thrust (if selected, complete applicable area of Bearing &/or Driven Equipment / OEM section, pg. 6, lines 39 and 40)
34 Flange type / bolt circle: Supplier decision Other: _____
35 Other mounting requirements: _____
36 Baseplate: furnished by (4.4.2.6): **Driven Equipment Supplier** Soleplate: furnished by (4.4.2.6): _____
37 Non-massive Foundation applies (4.4.6.1.3, 4.4.6.2.1.2), Description: _____
38 Data for non-massive system dynamic analysis required from machine vendor per 4.4.6.1.3 a), b), c), d)
39 **Electrical System:** Primary power source 2400 Volts 3 Phase 60 Hertz Maximum ground fault _____ Amps
40 Method of system grounding (5.6.2.3) Resistance Reactance Ungrounded Solid
41 3-Phase fault Current at machine terminals (5.1.2) _____ MVA Let-through energy (5.1.2.1): _____ I²t (Ampere-squared seconds)
42 Min S.C. at motor bus [4.2.3.2 c)] _____ MVA at _____ V_{base} X/R ratio: _____ Min.motor term. start voltage _____ % rated
43 Other information: _____

PURCHASER'S SELECTIONS

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BASIC DESIGN - Bearings, Seals

1 **Bearings:** Horizontal machines
2 Bearing type: **Hydrodynamic (4.4.7.1.1)** Sleeve (4.4.7.1.1) Tilting pad (4.4.7.1.1)
3 Bearing constant-level oilers required (4.4.7.2.2) Type: _____
4 Antifriction (4.4.7.1.3)
5 Other: _____
6 **Bearings:** Vertical machines
7 Thrust bearing load Downthrust Momentary _____ lbs Upthrust Momentary _____ lbs
8 [4.4.7.1.11 a] Continuous _____ lbs Continuous _____ lbs
9 Other: _____
10 **Seals:** Special seals for gas purge [4.4.7.3 a]) Non-conducting seals [4.4.7.3 b])
11 **Other:** _____
12 _____

BASIC DESIGN - Bearing Lubrication

13 **Hydrodynamic Bearings: Ring type self lubrication (4.4.8.1)**
14 Type/viscosity of oil (4.4.8.5; 4.4.8.8; 5.1.4.2) Supplier decision Other, define: _____
15 Pressurized lube required (4.4.8.4) Common with driven equipment (4.4.8.5)
16 System supplied by (4.4.8.4): Driven equipment supplier End user Motor supplier Other _____
17 Lube System to comply with API 614 (4.4.8.6): Part 3 General Purpose Part 2: Special Purpose ISO 10438-1
18 Main oil pump driven by: Supplier decision Separate, independent motor Main motor shaft
19 Other lube system information: _____
20 Meet cleanliness requirements of API 614 for 5 GPM & above capacity (6.2.3.2)
21 Purge oil mist (4.4.7.4.1) (describe or attach requirements): _____
22 **Antifriction Bearings:** Grease type: Supplier decision Other _____
23 Pure oil mist (4.4.7.4.1; 4.4.7.4.5) Oil mist ready or Oil mist provisions only (bearing grease removal may be required - see guide)
24 **Vertical Motor Bearings:** Thrust bearing: Supplier decision Grease lubrication Oil Sump lubrication
25 Guide bearing: Supplier decision Other: _____
26 **Other:** _____

SPECIAL CONDITIONS

27 Shaft and spider one piece forging for 4 or more poles [4.4.5.1.4; 4.4.5.1.2 b])
28 Special lower vibration limits, define (6.3.3.12): _____
29 Efficiency evaluation factor (8.1.2), EF = _____ cost / kW C = _____ cost / KWH applied at _____ % of full load
30 Test method for expected and guaranteed efficiency data (8.1.3.f): _____
31 Local codes, define (4.1.8): _____
32 External loads imposed on motor enclosure when connected at installation site, define (4.4.4): _____
33 _____
34 Special overspeed requirement (4.1.5, 4.4.5.2.7): _____
35 **Other:** _____
36 **Notes / Other Requirements:** _____
37 **Stainless steel screen is to be installed over any sound abatement material that may fragment**
38 **All Aluminum is to contain less than 0.2% Cu**

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ACCESSORIES

1 **Heaters:** Frame space heaters (5.4.1; 5.4.2; 5.4.3): Sheath material: Supplier decision Other: _____
2 Single voltage design Operating voltage _____ Phase 1
3 or Dual voltage design Operating voltages 120 / 240 Phase _____
4 Bearing heaters (4.4.8.3): Operating voltage _____ Phase _____
5 Main terminal box space heaters required: also see main terminal box section, page 5
6 For classified areas provide Temp. code (from pg.1): T3 used for labeled heaters if not specified
7 max. surface temp. (5.4.2): _____ Max. surface temp.: _____ °C (less than or equal to 80% of AIT on pg.1 for unlabeled heaters, **160° C** if AIT not specified)

8 **Winding Temperature Detectors (5.2):** **RTD - Platinum, 3 Wire, 100 Ohms at 0°C (5.2.1.1)** Other RTD Material: _____
9 Required number per phase (5.2.1.2): **Three (3)** Other _____ Wires: _____ Resistance: _____
10 Ground one (1) common lead each element in terminal box (5.2.1.2)
11 Thermocouples: Type: _____ No. per phase: **Three (3)** Other _____

12 **Bearing Temperature Detectors (5.3):** **RTD - Platinum, 3 Wire, 100 Ohms at 0°C; One (1) Per Bearing for Hydrodynamic & Thrust Bearings (5.3.1)**
13 Other qty. per bearing 4 Dual element OK Install per API 670 (5.3.1) Ground one (1) common lead Provisions only
14 Other RTD material: _____ Wires: _____ Resistance: _____ Other info: (2) Dual Element/Brg- Stick Type - Spring loaded
15 Thermocouples: Type: _____
16 Oil temp. indicators (dial thermometers) (4.4.7.1.16) Type: _____ Alarm contacts Number of contacts: _____ NO NC
17 Location of terminations for bearing temp. det. (5.1.14): Supplier decision Terminal head T-box T-box with winding temp. det.
18 Antifriction bearings: Use selections above when antifriction bearings are specified

19 **Vibration Detectors (5.8)**

| Non-contact Shaft Probes (5.8.1): | | Motors operating at 1200 rpm and higher | Motors operating at less than 1200 rpm |
|---|--|---|--|
| Shaft probes (X-Y) (5.8.1): | <input type="radio"/> Provisions <input type="radio"/> Installed | <input type="radio"/> Provisions <input type="radio"/> Installed | <input type="radio"/> Provisions <input type="radio"/> Installed |
| Phase reference probe (5.8.1): | <input type="radio"/> Provisions <input type="radio"/> Installed | <input type="radio"/> Provisions <input type="radio"/> Installed | <input type="radio"/> Provisions <input type="radio"/> Installed |
| Number per bearing (X-Y) (5.8.2): | Two (2) <input type="radio"/> Four (4) | Two (2) <input type="radio"/> Four (4) | Two (2) <input type="radio"/> Four (4) |
| Provide two (2) axial-position probes for hydrodynamic thrust bearings at the thrust end (5.8.2): | Provisions Required <input type="radio"/> Installed | | |
| Probe lead protection (5.8.1.1): | Conduit <input type="radio"/> Other: _____ | | |
| Manufacturer of probes, oscillator-demodulator: | <input type="radio"/> Supplier decision <input type="radio"/> Purchaser defined, type: _____ | | |
| Probes provided by: | <input type="radio"/> Supplier <input type="radio"/> Other: _____ | Installed By: <input type="radio"/> Supplier <input type="radio"/> Other: _____ | |
| Oscillator-Demodulator By: | <input type="radio"/> Supplier <input type="radio"/> Other: _____ | Installed By: <input type="radio"/> Supplier <input type="radio"/> Other: _____ | |
| Location of terminations (5.1.14): | <input checked="" type="radio"/> Supplier decision <input type="radio"/> In osc.-demodulators box <input type="radio"/> In sensor housing <input type="radio"/> Other: _____ | | |

30 **Bearing Housing Seismic Sensors:** Manufacturer: _____
31 Sensor: Installed Provisions only Per API 670 (5.8.3) Supplier decision Purchaser defined: _____
32 Vibration switch: Installed Provisions only Per API 670 (5.8.3) Supplier decision Purchaser defined: _____
33 Device provided by: Supplier Other: _____ Installed by: Supplier Other: _____
34 Define mounting / hole size if purchaser defines device: _____ If switch, type: Manual reset Electric reset
35 D.E. bearing Qty.: _____ Position(s): Horizontal Vertical Axial Other: _____
36 N.D.E. bearing Qty.: _____ Position(s): Horizontal Vertical Axial Other: _____
37 Location of terminations (5.1.14): Supplier decision Terminal box Terminal head In sensor housing

38 **Other Monitors and Devices**
39 Monitor to alarm for shaft grounding brush replacement (4.4.7.1.9) Describe: _____
40 Other monitors or devices: _____

41 **Alarm and Control Switches (5.6.1):** **SPDT 10 Amp 120VAC & 125VDC** Other: _____
42 **Auxiliary Equipment T-Boxes (5.1.4.1):** Location of aux. boxes (facing non-drive end): Left side Right side Other: _____
43 Stainless Steel aux. boxes/encl. (5.1.4.1) Cond./cable entry (5.1.4.1, 5.1.13): Bottom Left or Right side facing non-drive end
44 **Accessory Equipment Wiring Outside Enclosure (5.1.11):** **Rigid Conduit** Other: Flex conduit < 36". External ground wire req'd hub-to-hub

PURCHASER'S SELECTIONS

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ACCESSORIES - Main Terminal Box

- 1 **Main Terminal Box (5.1.1):** Box size: **Minimum size is Type II per NEMA MG 1 Part 20 with Copper Bus Bar & Standoff Insulators Required**
- 2 Other Size: Supplier decision for required accessories For shielded cable term. [5.1.6 e] Other: _____
- 3 Box location facing non-drive end: Left side Right side Other: _____ Thermal insulation [5.1.6 a)]
- 4 Cable enter from (5.1.4.1): Bottom Top Drive end side Non drive end side Quick disconnect studs or receptacles [5.1.6 f)]
- 5 Incoming conductor size: _____ Type _____ Insulation _____ Qty. per phase _____ Provision for purging [5.1.6 c)]
- 6 All phase leads in terminal box (4.3.6): **Required 750kW (1000HP) and larger** Provide in < 750kW (1000HP) Removable links [5.1.6 d)]
- 7 Copper bus joint plating [5.1.6 i)]: Tin (Preferred for H2S environments) Silver (Preferred Chloride) Copper ground bus [5.1.6 k)]
- 8 Insulated terminations and interior jumpers [5.1.6 m)] 6kV & up use insulated bus bar between stator windings and main terminals (4.3.9)
- 9 Main t/box space heaters [5.1.6 b)]: Single voltage design Operating voltage _____ Phase _____
or Dual voltage design Operating voltages _____ / _____ Phase _____
- 10 Refer to page 4 for heater T-code, etc.
- 11 For the devices following below, the purchaser may make a Provide-Install selection; the default is **Provide and Install by Supplier**:
- 12 Differential protection current transformers [5.1.6 h); 5.1.8; 5.6.3] Provided By _____ and Installed By _____
- 13 Type: Self-balancing Full differential _____
- 14 Accuracy class _____ Ratio _____ Quantity: _____
- 15 Surge capacitors [5.1.6 g); 5.6.2.1, 5.6.2.3]: Microfarads _____
- 16 Surge arresters [5.1.6 g); 5.6.2.2, 5.6.2.3]: kV Rated _____
- 17 Current transformers [5.1.6 h)] for phase current meter _____
- 18 Accuracy class _____ Ratio _____ Quantity: _____
- 19 Voltage transformers [5.1.6 j)] for voltage meter Fuses required _____
- 20 Accuracy class _____ Ratio _____ Quantity: _____
- 21 Partial discharge (PD) detectors [5.1.6 l), 5.6.4.1] _____
- 22 Describe required system: _____
- 23 PD t-box location (5.6.4.3): **vertical outside surface of main t-box** Other: _____

MISCELLANEOUS, SUPPLIER'S DATA

- 24 Qty. special tools and lifting devices (4.1.11, 4.1.12, 4.4.2.14): _____ Proof of non-sparking, corrosion resistant fan (4.4.10.6.1)
- 25 Separate nameplate with purchaser's information - list below (4.4.11.4) Electronic vibration test data - define digital format below (6.3.3.17)
- 26 _____
- 27 **Shipment (6.4.1)** Domestic Export boxing Special shipping bearings [6.4.1 k)] Outdoor storage more than six (6) months (6.4.2)
- 28 **Proposals (8.1)** Typical drawings & literature with proposal (8.1.8) Purchaser defined efficiency method [8.1.3 f)]: _____
- 29 Separate price for each test on datasheet page 7 (8.1.14) Packaged price for all tests on datasheet page 7 (8.1.14)
- 30 Provide requirements for special weather & winterizing protection (8.1.15) Provide safe stall time calculation method and limits (4.2.4.3)
- 31 Provide quote for supervision of installation and erection (8.1.17) Provide quote for start-up commissioning service (8.1.17)
- 32 Materials to be identified with ANSI, ASTM, or ASME numbers (8.1.18): _____
- 33 **Contract Data (8.3)** Special identification for transmittals (8.3.2) Define below or specify where this information is to be found
- 34 _____
- 35 **Drawings (8.5)** System of units for drawings / data (1.3.1): U.S. / N.Am. customary only SI (Metric) only U.S. (SI) SI (U.S.)
- 36 Supplier to provide curve data in tabular format (8.5.1) Define preferred digital format: _____
- 37 Quantities of documents & drawings, and documentation schedule (or define source for this information) (8.5.1): _____
- 38 After purchaser review of drawings, quantity of certified drawings to be provided (8.5.2): _____
- 39 **Instruction Manuals (8.7)** Quantity of instruction manuals to provide (8.7.1) (typically supplied in digital format): _____
- 40 Detailed instructions and photo's, etc. for disassembly and inspection of bearings and seals [8.7.4 c)]
- 41 Photos showing machine assembly steps required; including each step of bearing assembly (8.7.5)
- 42 Copies of applicable certifications, including NRTL, material certification's (including PMI), and other certifications for the machine(s) (8.7.6)
- 43 Define any/all certifications required, including materials: _____
- 44 _____

NOTE! A schematic of lifting is required to be included on motor GA drawing, wherever a spreader bar is required.

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LOAD REQUIREMENTS AND STARTING CONDITIONS

- 1 **Load torque and inertia requirements (4.2.2):** **Per NEMA MG 1 Part 20** or Per specified load curve & data (lines 25 and 26 below) [4.2.2.1 a)]
- 2 Design load curve condition: Unloaded (e.g. closed valve or damper) Loaded (e.g. open valve or damper) Partially loaded (e.g. min.flow)
- 3 Load re-acceleration required [4.2.2.1 b)]: **NO** Yes Re-acceleration load data or curve no.: _____
- 4 If yes above, complete the following (4.2.3.5): Max time of voltage interruption _____ Seconds
- 5 Voltage at motor terminals during re-acceleration _____ Volts
- 6 **Motor Starting (4.2.3):** **Starting with 80% of rated voltage at motor terminals (4.2.3.1)** or Other percent of rated voltage _____ %
- 7 Other starting method [4.2.3.2 a)]: Autotransformer Captive transformer Reactor Solid state soft starter ASD
- 8 Other method % volts: _____ % If Soft Starter, define percent Locked Rotor current limit during acceleration: _____ %
- 9 Maximum Locked Rotor current other than in 4.2.4.4 a) (450 to 650%): _____ % of Full Load amps or Maximum amps
- 10 Determine starting capability per [4.2.3.2 b)]: Min. _____ Volts at motor terminals under _____ Amps Locked Rotor current
- 11 or [4.2.3.2 c)]: Min. _____ S.C. MVA and _____ X/R ratio with _____ base voltage and _____ % Rated volts at motor terminals
- 12 Provide curves & data [8.1.3 a), b)]: **at rated voltage & min.start conditions** Other: _____ % Volts Other: _____
- 13 No. of consecutive starts other than Table 4 (4.2.4.1): With motor temperature at ambient: **3** Other: _____
- 14 With motor temperature greater than ambient but less than rated operating temp.: **2** Other: _____
- 15 No. of full voltage starts if more than 5000 required (4.2.4.1; 4.4.5.1.1): _____
- 16 Min. locked-rotor, pull-up, and breakdown torques per NEMA MG1 (4.2.4.4.b) or Min. LRT, PUT and BDT per GP 16-09-02 Section 11, Part 2).

DRIVEN EQUIPMENT INFORMATION - OEM DATA

- 17 Driven equipment: Tag no.(s): _____ Description _____ Location _____
- 18 Driven equipment mfr.: _____ Type / Model no. _____ RPM _____
- 19 Driven equip. rotation **viewed from non drive end of motor**: Clockwise Counterclockwise Bi-directional
- 20 Required motor rotation **viewed from non drive end of motor**: Clockwise Counterclockwise Bi-directional Overspeed trip point (if applicable) (4.1.5)
- 21 Type of load: Centrifugal: Pump Compressor Fan Other _____ RPM
- 22 Positive displacement: Pump Reciprocating compressor Compressor factor "C": _____
- 23 Maximum current pulsation per API 618 (4.2.3.6): **40%** Other: _____ %
- 24 Provide crank-effort chart or torque-effort curve no. [8.1.3 g)]: _____
- 25 Load characteristics per (4.2.2.1): **NEMA MG 1 Part 20** Other - provide load speed-torque curve no. [4.2.2.1 a)]: _____
- 26 Total driven equipment load inertia reflected to motor [4.2.2.1 c)]: Wk^2 : _____ lb-ft² or GD^2 : _____ kg-m² at: _____ RPM
- 27 Speed increasing or reducing gearbox [4.2.2.1 c)]: Ratio: _____ Note: affect on inertia to be included in total inertia above
- 28 Driver connection to load: Direct Coupled Gearbox V or cog belt Belt Ratio: _____
- 29 Motor shaft extension (4.4.5.1.9): Cylindrical fit Taper fit Integral flange
- 30 Coupling: Specified by: Purchaser Driven equipment supplier Motor supplier Per API 671
- 31 Coupling manufacturer: _____ Type: _____ Model: _____
- 32 Supplied by: Purchaser Driven equipment supplier Motor supplier Other: _____
- 33 Motor half coupling mounted by (4.4.9.4): (requires vibration test in 6.3.1.5)
- 34 Purchaser Driven equipment supplier Motor supplier Other: _____
- 35 Coupling inertia [4.2.2.1 c)]: Wk^2 : _____ lb-ft² or GD^2 : _____ kg-m² (To be included in total inertia above)
- 36 Mass moment of half coupling assy. [4.4.6.2.1.1 f)]: _____ lb-ft² or _____ kg-m² (For damped unbal. response analysis)
- 37 Center of gravity of half coupling assy., drawing reference or dimensions (6.3.5.3): _____
- 38 Other information: _____
- 39 Vertical pumps: Thrust bearing load _____ lbs Momentary _____ lbs
- 40 [4.4.7.1.11 a)] Downthrust Continuous _____ lbs Upthrust Momentary _____ lbs
- 41 Other information: _____
- 42 _____

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PURCHASER'S SELECTIONS

Bold Italics = Indicate Default Selection

ANALYSIS, SHOP INSPECTION, AND TESTS

- 1 (m) Indicates line item is not required ◁ (v) Indicates line item applies to only one machine in a multiple machine application/order
2 (I) Indicates Purchaser required line item ◀ (t) Indicates line item applies to all machines in a multiple machine application/order

3 Make selections in only one column for each item

| | <u>Required</u> | <u>Witnessed</u> | <u>Observed</u> |
|---|------------------------------------|----------------------------------|----------------------------------|
| | <u>(6.1.3.3; 6.3.1)</u> | <u>(6.1.3; 6.1.3.1; 6.3.1.1)</u> | <u>(6.1.3; 6.1.3.2; 6.3.1.1)</u> |
| 5 Coordination meeting (8.2) | <input type="radio"/> | | |
| 6 Design review (8.4) | <input type="radio"/> | | |
| 7 Lateral critical speed analysis [4.4.6.2.1; 8.6.2 b)] | <input type="radio"/> | | |
| 8 Torsional analysis data (4.4.6.2.2) Analysis by: _____ | <input type="radio"/> | | |
| 9 Submit test procedures and acceptance criteria 6 weeks before tests (6.3.1.4) | <input type="radio"/> | | |
| 10 Demonstrate accuracy of test equipment (6.3.1.15) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 11 Stator core test (6.3.4.1) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 12 Surge comparison test - required for all machines (6.3.4.2) | <input type="radio"/> ◁ | <input type="radio"/> | <input type="radio"/> |
| 13 Special surge test of coils (6.3.4.2.1) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 14 Power factor tip-up test (6.3.4.3) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 15 Stator inspection prior to VPI (6.3.4.5) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 16 Sealed winding conformance test (6.3.4.4) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 17 Partial discharge test for machines 6kV and greater (6.3.4.6) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 18 Rotor residual unbalance verification test (4.4.6.3.4) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 19 Unbalance response test with half coupling mass (6.3.5.3) (Purchaser must also select one of below) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 20 <input type="radio"/> Purchaser to supply the contract motor coupling hub plus a mass moment simulator for half coupling spacer for test (6.3.5.3) | | | |
| 21 <input type="radio"/> Other arrangement (Define here & refer to Datasheet Guide for this) | | | |
| 22 Vibration test with half coupling (6.3.1.5) (req'd if Supplier mounts cplg. 4.4.9.4) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 23 Inspection of equipment, piping for cleanliness before final assembly (6.2.3.3) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 24 Routine test - always required for all machines (6.3.2) | <input checked="" type="radio"/> ◀ | <input type="radio"/> | <input type="radio"/> |
| 25 Bearing dimensional & alignment checks before tests [6.3.2.1 k)] | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 26 Bearing dimensional & alignment checks after tests [6.3.2.1 l)] | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 27 Purchaser supplied vibration monitoring / recording (6.3.3.7) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 28 Complete test (6.3.5.1.1) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 29 Includes: Efficiency, LR current, PF & torque, FL Current, FL Slip, BD Torque, Heat Run, Speed v. Torque, Noise test at NL | | | |
| 30 DC high-potential test (6.3.5.1.2) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 31 Rated rotor temperature vibration test (6.3.5.2.1) (If not using Complete test) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 32 Bearing housing natural frequency test (6.3.5.4.1) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 33 Heat exchanger performance verification test (TEWAC enclosures) (6.3.5.5) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 34 Overspeed test (6.3.5.6; 4.1.5) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 35 Final rotating assembly clearance data storage [6.2.1.1 e)] | <input type="radio"/> ◁ | | |
| 36 Radiographic test (6.2.2.2), define parts: _____ | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 37 Ultrasonic inspection of shaft forging (4.4.5.1.8; 6.2.2.3.1) | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 38 Ultrasonic test (6.2.2.3.2), define parts: _____ | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 39 Magnetic particle test (6.2.2.4), define parts: _____ | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 40 Liquid penetrant test (6.2.2.5), define parts: Any welded lifting lugs | <input checked="" type="radio"/> ◀ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 41 Hydrostatic test (6.2.2.6), define parts: _____ | <input type="radio"/> ◁ | <input type="radio"/> ◁ | <input type="radio"/> ◁ |
| 42 Certified data prior to shipment [8.6.2 a)] | <input type="radio"/> ◁ | | |
| 43 All required test and inspection equipment (6.1.4) provided by supplier <input type="radio"/> Other: _____ | | | |
| 44 Notes: _____ | | | |

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MOTOR PROPOSAL DATA

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MOTOR SUPPLIER / MANUFACTURER PROPOSAL DATA

1 Manufacturer _____ Type / Model No. _____ Frame size / Designation _____
2 Qty. _____ HP _____ RPM (Synch.) _____ Poles _____ Volts _____ Phase _____ Hz _____
3 Full Load speed _____ RPM Insulation class **F** Temperature rise _____ Class **B** Service factor **1.0**
4 Enclosure _____ Full Load torque (FLT) _____ ft-lb Rotor inertia [8.1.3 c)] _____ lb-ft² Wk² GR² GD²
5 Locked rotor torque (LRT) _____ % FLT Pull-Up torque (PUT) _____ % FLT Breakdown torque (BDT) _____ % FLT
6 **Calculated Expected Data [8.1.3 f] at the following Loads:** For recip. comp., calc. eff. is based on pulsating current conditions from pg.6
7 Load Point 50% 75% 100% Other: _____ % Area Classification (4.1.8): Nonclassified
8 Efficiency _____ % _____ % _____ % _____ % Classified: Class _____ Group _____ Div. _____
9 Power Factor _____ % _____ % _____ % _____ % or Zone _____
10 Current _____ Amps _____ Amps _____ Amps _____ Amps Autoignition temp _____ °C or Temp.code _____
11 Guaranteed efficiencies [8.1.3 f] at _____ % Load = _____ % Test method [8.1.3 f]: _____
12 Max. sound pressure level (4.1.3): **85 dBA @ 1 m. No-Load, Full Voltage/Frequency, Sine Wave Power** Other: _____ dBA
13 Motor power source: **Sine Wave Power** ASD Power only ASD only w-bypass to utility power
14 ASD + DOL start capability ASD w-DOL start and bypass to utility power
15 Variable torque speed range: Min. speed _____ RPM _____ ft-lb Max. speed _____ RPM _____ ft-lb
16 Constant torque speed range: Min. speed _____ RPM _____ ft-lb Max. speed _____ RPM _____ ft-lb
17 Constant power speed range: Max. speed _____ RPM _____ ft-lb Avoiding lateral natural frequencies by at least 15% not
18 Method of efficiency determination to be used [8.1.3 f]: _____ practical over specified speed range (4.4.6.1.2)
19 Base frequency(ies) and harmonics assumed present in the supply waveform(s) [8.1.3 f]: _____
20 **Separately Powered Auxiliary Fan(s) (4.4.10.6.3): Driver Information (where applicable)**
21 Quantity _____ Location _____ Encl. _____ HP _____ RPM _____ Volts _____ Phase _____ Hertz
22 Quantity _____ Location _____ Encl. _____ HP _____ RPM _____ Volts _____ Phase _____ Hertz
23 **TEAAC Heat Exchanger Tube Material [4.4.10.8 a):** _____
24 **TEWAC Heat Exchanger Requirements (4.4.1.2.4):** Tube materials [4.4.10.8 b): **90-10 Cu-Ni** Other tube material: _____
25 Cooling water conditions **per 4.4.1.2.4 a)** Other cooling water conditions: _____
26 _____
27 **Bearings (4.4.7.1):** **Hydrodynamic (4.4.7.1.1)** Sleeve (4.4.7.1.1) Tilting pad (4.4.7.1.1) Antifriction (horizontal) (4.4.7.1.3)
28 Antifriction thrust bearing (vertical) (4.4.7.1.5) Hydrodynamic thrust bearing (vertical) (4.4.7.1.10)
29 Thrust bearing load Momentary _____ lbs Momentary _____ lbs
30 capability [4.4.7.1.11 a)] Downthrust _____ lbs Upthrust _____ lbs
Continuous _____ lbs Continuous _____ lbs
31 **Lubrication (4.4.8):** **Ring Type Self Lubrication (4.4.8.1)** Machine bearings require pressure lube system Yes No
32 Pressurized lube system (4.4.8.4) Common with driven equipment (4.4.8.5) System supplied by (4.4.8.4): Others Motor supplier
33 Type/viscosity of oil (4.4.8.5; 4.4.8.8; 5.1.4.2): _____ Oil rings included Yes No
34 Oil requirements per bearing (8.1.4): Flow: _____ GPM Pressure: _____ PSI Volume: _____ QTS
35 Heat loss to be removed per bearing: _____ kW
36 Oil mist provisions (4.4.7.4) (see Guide): Purge oil mist, hydrodynamic brg's Pure oil mist, antifriction brg's Oil mist ready, antifriction brg's.
37 Grease, Type: _____ Oil mist provisions only, a/f brg's.
38 Magnetic stator slot wedges used (4.3.10): Yes No
39 When enclosure pre-start purging is specified, vendor defined maximum allowable pressure [4.4.1.1 e): _____
40 Low ambient temperature precautions (4.4.10.4): _____
41 Special winterizing requirements (8.1.15): _____
42 Machine net weight (8.1.5): _____ lbs
43 Special tools included in proposal (4.1.11, 8.1.13): _____
44 Machine proposed is in strict compliance with API 541 5th edition? (8.1.9) Yes No List of applicable exceptions attached

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Page 1/4 Motor Supplier Order Data

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AS-DESIGNED **AS-BUILT**

1 USER ExxonMobil APPLICATION _____
2 LOCATION Baytown, Texas SUPPLIER _____
3 PROJECT NAME BAYTOWN GOLD SUPPLIER REF. No. _____
4 SITE / PLANT - NUMBER OF UNITS REQUIRED _____
5 MOTOR TAG No.(s) _____

MOTOR RATING - ELECTRICAL AND PERFORMANCE DATA

6 Quantity _____ Type / Model no. _____ Frame size / Designation _____ Motor power: Utility-Grid ASD
7 Nameplate power / RPM rating (4.2.1.1): _____ HP kW _____ RPM Full Load _____ RPM synchronous _____ Poles _____
8 Nameplate Voltage/Ph/Hz rating (4.2.1.2): 2300 Volts (4.2.1.2) 3 Phase 60 Hertz
9 Insulation class [4.3.1.1 a): **Class F** Temperature rise [4.3.1.1 b): **Class B** Enclosure (4.4.1.2): TEFC
10 Full-Load torque (FLT) _____ ft-lb Percent FLT at: Locked-Rotor (LRT) _____ Pull-Up (PUT) _____ Breakdown (BDT) _____
11 **Expected Data [8.1.3 f] at the following Loads (100% Voltage):**
12 Load Point: Locked-Rotor 50% 75% 100% Other: _____ % Data is: _____
13 Efficiency: _____ % _____ % _____ % _____ % _____ % Calculated
14 Power Factor: _____ % _____ % _____ % _____ % _____ % Previously tested unit
15 Current: _____ Amps _____ Amps _____ Amps _____ Amps _____ Amps Tested this order
16 Guaranteed efficiency [8.1.3 f] _____ % Efficiency at _____ % Load Efficiency determination test method [8.1.3 f]: _____
17 For reciprocating loads [8.1.3 f] _____ % Efficiency at _____ % Load with _____ % Current pulsation Max. current variation [8.1.3 g]: _____ A
18 For motors operating on ASD power [8.1.3 f]: Base frequency(ies) and harmonics assumed in the supply waveform(s) [8.1.3 f]: _____
19 Curve No.'s [8.1.3 a, b): Speed-Torque _____ Speed-Current _____ Speed-Power Factor _____
20 When specified: Calculated rotor-response curve no. [8.6.2 b): _____ Acceleration curve No. _____
21 Acceleration time [8.1.3 d): At rated voltage: _____ sec. At minimum starting voltage/MVA: _____ sec. At _____ % Voltage _____ Sec
22 Thermal capacity / limit curve no. (4.2.4.2) _____ Rotor inertia - Wk^2 [8.1.3 c)] _____ lb-ft²
23 Locked-Rotor withstand time, cold [4.2.4.2 a); 8.1.3 e)] at 100% Voltage _____ Sec at 80% voltage _____ Sec at _____ % voltage _____ Sec
24 Locked-Rotor withstand time, hot [4.2.4.2 b); 8.1.3 e)] at 100% Voltage _____ Sec at 80% voltage _____ Sec at _____ % voltage _____ Sec
25 **Starting Capability (4.2.4.1):** Consecutive successful starts with : _____ Locked-Rotor current at 100 % Voltage _____ Amps
26 _____ Motor initially at ambient temperature 3 _____ Locked-Rotor current at 80 % Voltage _____ Amps
27 _____ Motor temp. above ambient but not exceeding rated operating temperature 2 _____ Locked-Rotor current at _____ % Voltage _____ Amps
28 Wait time after all consecutive starts exhausted [4.2.4.2 d, e): With motor running _____ Minutes With motor stopped _____ Minutes
29 **Max. Sound Pressure Level (4.1.3)** dBA @ 1 m., no-load Other: _____
30 **Induction Motor Equivalent Circuit Data:** Phase-to-Phase resistance _____ Ohms, @ _____ °F
31 _____ kVA base at rated voltage and 77°F Subtransient reactance X"d _____ Total winding capacitance to ground _____ uF
32 Locked-Rotor at rated voltage: Stator R _____ Rotor R _____ Magn R _____
33 _____ Stator X _____ Rotor X _____ Magn X _____
34 Rated load at rated voltage: Stator R _____ Rotor R _____ Magn R _____
35 _____ Stator X _____ Rotor X _____ Magn X _____
36 Residual Voltage Open-Circuit Time Constant: Motor Only _____ sec. With Surge Capacitors _____ sec.

MOUNTING, WEIGHTS

37 **Mounting:** Horizontal foot mounted Horizontal flange mounted with feet Vertical foot mounted
38 Vertical flange mounted Shaft down Shaft up Solid shaft Hollow shaft Non-reverse ratchet
39 Flange type: _____ Flange bolt circle diameter: _____
40 Soleplate furnished with motor Baseplate furnished with motor Adapter plate furnished with motor
41 **Weights:** Motor net: _____ lbs. Stator _____ lbs. Rotor _____ lbs. Shipping _____ lbs.

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AS-DESIGNED **AS-BUILT**

BEARINGS, HOUSINGS AND SEALS

1 **Bearings:** Type: **Hydrodynamic (4.4.7.1.1)** Antifriction (4.4.7.1.3) AFBMA number(s): _____
2 Split sleeve (4.4.7.1.1) Drive end: _____
3 Tilting pad (4.4.7.1.1) Non-drive end: _____
4 Hydrodynamic bearings: Oil rings included (4.4.8.1) Yes No
5 Bearing, drive end: Capable of self-lube Yes No Manufacturer _____ Model / part no. _____
6 Bore diameter: Min _____ in. Max _____ in. Bore length _____ in. Type _____
7 Design clearance with Shaft: Min _____ in. Max _____ in. Bearing loading: _____ PSI
8 Bearing, non-drive end: Capable of self-lube Yes No Manufacturer _____ Model / part no. _____
9 Bore diameter: Min _____ in. Max _____ in. Bore length _____ in. Type _____
10 Design clearance with shaft: Min _____ in. Max _____ in. Bearing loading: _____ PSI
11 Special seals for gas purge [4.4.7.3 a] Non-conducting seals [4.4.7.3 b] Other seal type _____
12 Thrust bearing: Antifriction (4.4.7.1.5) Hydrodynamic (4.4.7.1.10) Bearing loading: _____ PSI
13 Thrust bearing load capability (4.4.7.1.11) Downthrust Momentary _____ lbs Upr thrust Momentary _____ lbs
14 Continuous _____ lbs Continuous _____ lbs
15 Position: Non-drive end Drive end Manufacturer _____ Model / part no. _____

LUBRICATION SYSTEM

16 **Hydrodynamic Bearing Ring Type Self Lubrication (4.4.8.1)** Constant-level oilers (4.4.7.2.2)
17 Pressurized lube (4.4.8.1, 4.4.8.4) Oil rings provided: Yes No Bearings designed to operate w/o lube system: Yes No
18 Common with driven eqpt. (4.4.8.4) System supplied by (4.4.8.4): Driven eqpt. supplier End user Motor supplier Other
19 Motor only lube system Required / recommended type/viscosity of oil (4.4.8.5; 4.4.8.8): _____
20 Total bearing oil requirements (8.1.4): _____ GPM _____ PSI Heat loss to be removed per bearing _____ kW
21 Motor prepared for supplemental purge oil mist (4.4.7.4.1) Other lube system information: _____
22 Antifriction bearings: Grease Type: _____
23 Pure oil mist (4.4.7.4.5) Oil mist ready or Oil mist provisions only
24 Grease removal required before operation with oil mist? Yes No
25 Vertical motor bearings: Thrust bearing: _____ Guide bearing: _____ Mfrg. recommended lubricant: _____
26 Oil sump lubrication Oil sump lubrication Type/viscosity of oil: _____
27 Grease lubrication Grease lubrication Grease type: _____

VIBRATION DETECTORS

28 **Non-contact Shaft Probes (5.8.1):** Number per bearing: **TWO (2) (5.8.1)** Four (4) (5.8.2)
29 Shaft Probes: Provisions Installed Manufacturer: _____ Model: _____
30 Phase reference probe (5.8.1): Provisions Installed Manufacturer: _____ Model: _____
31 Oscillator-Demodulators: Provisions Installed Manufacturer: _____ Model: _____
32 **Bearing Housing Seismic Sensors (5.8.3):** Per API 670 (5.8.3)
33 Sensor: Provisions Installed Type: _____ Manufacturer: _____ Model: _____
34 Vibration Switch: Provisions Installed Type: _____ Manufacturer: _____ Model: _____
35 D.E. bearing Qty.: _____ Position(s): Horizontal Vertical Axial Other: _____
36 N.D.E. bearing Qty.: _____ Position(s): Horizontal Vertical Axial Other: _____
37 **Recommended Vibration Settings:** Alarm _____ Shutdown _____ Inches per sec. Other _____
38 Alarm _____ Shutdown _____ Mils. Other _____
39 Frequency of shaft resonance closest to operating speed: _____ Hertz

Bold Italics = Indicate Default Selection

AS-DESIGNED **AS-BUILT**

ACCESSORIES & SETTINGS

1 **Heaters:** Single voltage design: Dual voltage design (if specified):

2 Operating voltage kW Phase Operating voltages kW Phase Sheath material

3 Frame heaters (5.4.1; 5.4.2; 5.4.3): _____ / _____

4 Main t/box heaters: _____ / _____

5 Bearing heaters (4.4.8.3): _____ / _____

6 **Temperature Detectors:**

7 **Winding Temperature Detectors (5.2):** **RTD-Platinum, 3 Wire, 100 Ohms at 0°C (5.2.1.1)** No.per phase (5.2.1.2): **Three (3)** Other _____

8 Other RTD material: _____ Wires: _____ Resistance: _____ No.per phase (5.2.1.2): **Three (3)** Other _____

9 One common lead each element grounded in box. (5.2.1.2)

10 Thermocouples: Type: _____ No.per phase (5.2.1.2): **Three (3)** Other _____

11 Other _____

12 **Recommended Settings:** Alarm: _____ Shutdown: _____

13 **Bearing Temperature Detectors (5.3):** **RTD - Platinum, 3 Wire, 100 Ohms at 0°C; One (1) Per Bearing for Hydrodynamic & Thrust Bearings (5.3.1)**

14 Other qty. per bearing _____ Dual element used Installed per API 670 (5.3.1) One (1) common lead grounded Provisions only

15 Other RTD material: _____ Wires: _____ Resistance: _____ Other info: _____

16 Thermocouples: Type: _____

17 Dial type thermometers (4.4.7.1.16): Type _____ Alarm contacts Number of contacts _____ NO NC

18 Antifriction bearings: Above selections applied to antifriction bearings

19 **Recommended Settings:** Alarm: _____ Shutdown: _____

20 **Enclosure Accessories**

21 **WP-II, WP-I, DPG/ODP (4.4.1.2.2)** Air filters: Provided (5.5.4): **Required for WP-II (5.5.3)** Air filters not provided (5.5.4)

22 Filter capability (5.5.4): **90% of particles > 10 micron** Other _____ Air filter provisions only (5.5.2)

23 Filter manufacturer: _____ Type: _____ Model: _____

24 Differential pressure device (5.5.5): **Provisions Required for WP-II** Provisions only supplied Device not provided

25 Differential pressure switch provided (5.5.5): Differential pressure gauge provided (5.5.5) Combination switch / gauge provided

26 Device manufacturer: _____ Type: _____ Model: _____

27 **Recommended Settings for Differential Pressure Switch:** Alarm: _____ Shut-Down: _____

28 **TEAAC Enclosure (4.4.1.2.3)** Heat exchanger tube materials [4.4.10.8 a)]: _____

29 **TEWAC Enclosure (4.4.1.2.4)** Heat exchanger tube materials [4.4.10.8 b)]: **90-10 Cu-Ni** Other _____

30 Tube construction [4.4.1.2.4 d); 4.4.10.8 b), c)]: **Single tube** Double tube

31 Leak detection [4.4.1.2.4 c)]: **Required** Double tube leak detection: **Inner tubes only** Outer also

32 Cooler location/orientation [4.4.1.2.4 c)]: _____ Redundant coolers [4.4.1.2.4 b)]

33 Water flow (GPM): Max _____ Min _____ Water pressure (PSI): Max _____ Min _____

34 Flow sensor local indicator provided [4.4.1.2.4 g)] Provisions only Manufacturer: _____ Type: _____ Model: _____

35 Relay contacts provided: Normally open Normally closed

36 High flow alarm set point _____ GPM Low flow shutdown set point _____ GPM

37 Cooler air inlet & outlet temperature sensor [4.4.1.2.4 h)]: **Required** Manufacturer: _____ Type: _____ Model: _____

38 Sensor type: _____

39 Cooling water conditions per 4.4.1.2.4 a) Water/Glycol solution Other cooling water conditions (purchaser specified)

40 When enclosure pre-start purging is specified, supplier defined max. allowable pressure [4.4.1.1 e)]: _____

Bold Italics = Indicate Default Selection

AS-DESIGNED **AS-BUILT**

STATOR WINDING AND ROTOR REPAIR DATA

1 **Stator Coil Information [8.6.2 d), reference Annex G]:** Coil dimensional drawing no.: _____

2 Total copper weight: _____ lbs. Copper strand size: _____ Insulation: _____

3 Number of strands per coil turn: _____ Number of turns per coil: _____

4 Turn insulation description: _____

5 Ground-Wall insulation description: _____

6 Thickness turn insulation: _____ mils Thickness strand insulation: _____ mils Thickness groundwall insulation: _____ mils

7 Coil configuration: _____ Rows by _____ Columns

8 Finished coil dimension in slot, W x H x L (also give tolerances): _____

9 Total number of stator slots: _____ Winding throw: _____ Winding connection: _____

10 Slot filler description - thickness: Top _____ mils Side _____ mils Middle _____ mils Slot dimensions: _____

11 Slot wedge material: _____ Magnetic slot wedges: No Yes

12 Stator bore diameter: _____ Stress grading description if applicable: _____

13 Special end-turn rasing: _____

14 Other: _____

15 **Rotor Information:** Total Conductor Weight: _____ lbs. Number of Bars: _____ Strand or bar size: _____

16 Conductor material: _____ Ring material: _____ Retaining ring alloy, if applicable: _____

17 Shaft material: _____ Ring dimensions premachining: _____

- 18 **Notes:** Following data should be supplied by the motor vendor
- 19 • %pf @ 100%/75%/50%
 - 20 • %eff @ 100%/75%/50%
 - 21 • NEMA Design Letter
 - 22 • General arrangement (GA)
 - 23 • Wiring diag showing the customer connections
 - 24 • Hazardous Area Classification suitability
 - 25 • Temperature rise and insulation class
 - 26 • Lock rotor current @ 100%/80% starting voltage
 - 27 • Acceleration times @ 100%/80% starting voltage
 - 28 • Hot & cold stall times @ 100%/80% starting voltage
 - 29 • Max no. of consecutive starts (hot & cold)
 - 30 • Time to wait before next start (cool down time)
 - 31 • Stator/Bearing RTD Alarm and Trip Set Point (°C)
 - WR^2 (mtr & load) (for mtr start study)
 - Locked Rotor pf %
 - Locked Rotor Torque %
 - Max (Breakdown) Torque %
 - Motor - Speed vs. Torque Curve
 - Load - Speed vs. Torque Curve
 - Speed vs. Current Curve
 - Speed vs. pf Curve
 - Thermal Damage Curve (Current vs. Time)
 - Running Cool Time Constant
 - Stopped Cool Time Constant
 - Open circuit (transient) time constant
- 32 _____
- 33 _____
- 34 _____
- 35 _____
- 36 _____
- 37 _____
- 38 _____
- 39 _____
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Annexure-IV

| Parent Company Name | Legal Company Name | P&S Category L2 | P&S Category L3 | P&S Category L4 | P&S Category L5 | Qualification Status Name | Qualification Status Rationale | Alternate Location Name | Specific Limitations | Location Name | Location Country |
|---|--|----------------------|-----------------------|--|--|---------------------------|--------------------------------|---------------------------------|--|--------------------------------|------------------|
| WEIR GROUP PLC(THE) | TRILLIUM FLOW TECHNOLOGIES FRANCE SAS | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Weir | Brand: Sarasin | Vendin-le-Viel, FRANCE | France |
| | André Ramseyer AG | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Leser | Assembly only | Flamatt, SWITZERLAND | Switzerland |
| | LESER LLP | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Leser | Assembly only | Singapore | Singapore |
| EAST BRISTOL ENGINEERS LIMITED | LESER UK LIMITED | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Leser | Assembly only | Bristol, UNITED KINGDOM | United Kingdom |
| GEBR. LESER KG | LESER GmbH & Co. KG | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Leser | | Hohenwestedt, GERMANY | Germany |
| GEBR. LESER KG | Leser, LLC | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Leser | Assembly only | Charlotte, NC, USA | USA |
| GENERAL ELECTRIC COMPANY | DRUCK LIMITED | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | General Electric | Brand: Consolidated | Skelmersdale, UNITED KINGDOM | United Kingdom |
| | FUKUI SEISAKUSHO CO., LTD. | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Fukui Seisakusho Co. Ltd | | Osaka, JAPAN | Japan |
| Emerson Electric Co. | Anderson Greenwood | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Emerson | Brand: Anderson Greenwood | Shanghai, CHINA | China |
| Emerson Electric Co. | Anderson Greenwood | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Emerson | Existing Stock Only. Brands: Anderson Greenwood, Crosby, and Sapag | Armentières, FRANCE | France |
| Emerson Electric Co. | Bailey | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Emerson | Brands: Anderson Greenwood, Bailey and Birkett | Manchester, UNITED KINGDOM | United Kingdom |
| Emerson Electric Co. | Crosby | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Emerson | Brand: Crosby | Quing Pu, CHINA | China |
| Emerson Electric Co. | Emerson Automation Solutions Final Control US LP | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Emerson | Brand: Kunkle | Black Mountain, NC, USA | USA |
| Emerson Electric Co. | Emerson Automation Solutions Final Control US LP | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Emerson | Brands: Anderson Greenwood and Crosby | Stafford, TX, USA | USA |
| EMERSON PROCESS MANAGEMENT GMBH & CO. OHG | Sempell GmbH | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Emerson | Brand: Sempell | Korschenbroich, GERMANY | Germany |
| Curtiss-Wright Corporation | Curtiss-Wright Corporation | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Curtiss Wright | Brand: Farris | Corby, UNITED KINGDOM | United Kingdom |
| Curtiss-Wright Corporation | Curtiss-Wright Flow Control Corporation | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Curtiss Wright | Brand: Farris | Brantford, OH, USA | Canada |
| Curtiss-Wright Corporation | Curtiss-Wright Flow Control Corporation | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Curtiss Wright | Brand: Farris | Brecksville, OH, USA | USA |
| IMI PLC | IMI Critical Engineering Holding GmbH | Piping & Valves (L2) | Valves - Special (L3) | Pressure Relief Valves (EMDC and EMPC only) (L4) | Pressure Relief Valves (EMDC and EMPC only) (L5) | Qualified-Globally | | Bopp & Reuther Messtechnik GmbH | | Mannheim, GERMANY | Germany |
| SUMITOMO HEAVY INDUSTRIES, LTD. | SUMITOMO HEAVY INDUSTRIES GEARBOX CO., LTD. | Machinery (L2) | Gearboxes (L3) | Gearboxes, Special Purpose - API 613 (L4) | Gearboxes, Special Purpose - API 613 (L5) | Qualified-Globally | | Former: Osaka Chain | Primarily in the Asia Pacific Region | SUMITOMO HEAVY - Japan | Japan |
| Freudenberg & Co. Kommanditgesellschaft | EagleBurgmann Germany GmbH & Co. KG | Machinery (L2) | Compressor Seals (L3) | Compressor Seals, Dry Gas Seals - API 692 (L4) | Compressor Seals, Dry Gas Seals - API 692 (L5) | Qualified-Globally | | Eagle Burgmann | Primarily in the Europe and Middle East Region | Wolfratshausen, GERMANY | Germany |
| Baker Hughes Company | Nouvo Pignone SRL | Machinery (L2) | Steam Turbines (L3) | Steam Turbines, Special Purpose - API 612 (L4) | Steam Turbines, Special Purpose - API 612 (L5) | Qualified-Globally | | Baker Hughes | | Nouvo Pignone SRL - Florence | Italy |
| | SPX Cooling Technologies, Inc. | Machinery (L2) | Gearboxes (L3) | Gearboxes, General Purpose - API 677 (L4) | Gearboxes, General Purpose - API 677 (L5) | Qualified-Globally | | | Primarily in the Americas Region | SPX Cooling Tec - USA | USA |
| AB SKF | Kaydon Ring & Seal, Inc. | Machinery (L2) | Compressor Seals (L3) | Compressor Seals, Circumferential Gas Seals (L4) | Compressor Seals, Circumferential Gas Seals (L5) | Qualified-Globally | | | | Kaydon Ring & S - Baltimore | USA |
| Altra Industrial Motion Corp. | Ameridrives International, LLC | Machinery (L2) | Couplings (L3) | Couplings, Special Purpose - API 671 (L4) | Couplings, Special Purpose - API 671 (L5) | Qualified-Globally | | | Primarily in the Americas Region | Ameridrives Int - Erie | USA |
| Baker Hughes Company | Baker Hughes Holdings LLC | Machinery (L2) | Steam Turbines (L3) | Steam Turbines, Special Purpose - API 612 (L4) | Steam Turbines, Special Purpose - API 612 (L5) | Qualified-Globally | | | | Baker Hughes, a - All Mfg Locs | All Countries |
| Baker Hughes Company | Lufkin Industries, LLC | Machinery (L2) | Gearboxes (L3) | Gearboxes, General Purpose - API 677 (L4) | Gearboxes, General Purpose - API 677 (L5) | Qualified-Globally | | | | Lufkin Industri - Lufkin | USA |
| Baker Hughes Company | Lufkin Industries, LLC | Machinery (L2) | Gearboxes (L3) | Gearboxes, Special Purpose - API 613 (L4) | Gearboxes, Special Purpose - API 613 (L5) | Qualified-Globally | | | | Lufkin Industri - Lufkin | USA |
| Berkshire Hathaway Inc. | Amarillo Gear Company LLC | Machinery (L2) | Gearboxes (L3) | Gearboxes, General Purpose - API 677 (L4) | Gearboxes, General Purpose - API 677 (L5) | Qualified-Globally | | | Primarily in the Americas Region | Amarillo Gear C - USA | USA |
| Coöperatie Flowserve W.A. | Flowserve Dortmund GmbH & Co. KG | Machinery (L2) | Compressor Seals (L3) | Compressor Seals, Dry Gas Seals - API 692 (L4) | Compressor Seals, Dry Gas Seals - API 692 (L5) | Qualified-Globally | | | | Flowserve Dortmund - Dortmund | Germany |
| EAGLE INDUSTRY CO.,LTD. | EAGLE INDUSTRY CO.,LTD. | Machinery (L2) | Couplings (L3) | Couplings, Special Purpose - API 671 (L4) | Couplings, Special Purpose - API 671 (L5) | Qualified-Globally | | | Limited to Bendix Type | EAGLE INDUSTRY - Japan | Japan |
| EBARA CORPORATION | Elliott Company | Machinery (L2) | Steam Turbines (L3) | Steam Turbines, General Purpose - API 611 (L4) | Multi-Stage (L5) | Qualified-Globally | | | | Elliott Company - Jeannette | USA |
| EBARA CORPORATION | Elliott Company | Machinery (L2) | Steam Turbines (L3) | Steam Turbines, Special Purpose - API 612 (L4) | Steam Turbines, Special Purpose - API 612 (L5) | Qualified-Globally | | | | Elliott Company - Jeannette | USA |
| FLOWERVE CORPORATION | FLOWERVE PTE LTD | Machinery (L2) | Compressor Seals (L3) | Compressor Seals, Dry Gas Seals - API 692 (L4) | Compressor Seals, Dry Gas Seals - API 692 (L5) | Qualified-Globally | | | | FLOWERVE PTE L - Singapore | Singapore |

Annexure-IV

| | | | | | | | | | | | |
|------------------------------------|--|---------------------------------|------------------------------|--|--|--------------------|--|--------------------------------------|--|--|-----------------|
| FLOWERVE CORPORATION | Flowserve US Inc. | Machinery (L2) | Compressor Seals (L3) | Compressor Seals, Circumferential Gas Seals (L4) | Compressor Seals, Circumferential Gas Seals (L5) | Qualified-Globally | | | | Flowserve US In - Kalamazoo | USA |
| FLOWERVE CORPORATION | Flowserve US Inc. | Machinery (L2) | Compressor Seals (L3) | Compressor Seals, Dry Gas Seals - API 692 (L4) | Compressor Seals, Dry Gas Seals - API 692 (L5) | Qualified-Globally | | | | Flowserve US In - Kalamazoo | USA |
| FLSMIDTH & CO. A/S | Flsmith A/S | Machinery (L2) | Gearboxes (L3) | Gearboxes, Special Purpose - API 613 (L4) | Gearboxes, Special Purpose - API 613 (L5) | Qualified-Globally | | | | Flsmith A/S - Switzerland | Switzerland |
| HITACHI, LTD. | HITACHI, LTD. | Machinery (L2) | Gearboxes (L3) | Gearboxes, Special Purpose - API 613 (L4) | Gearboxes, Special Purpose - API 613 (L5) | Qualified-Globally | | Primarily in the Asia Pacific Region | | HITACHI, LTD. - Tsuchiura | Japan |
| MITSUBISHI HEAVY INDUSTRIES, LTD. | MITSUBISHI HEAVY INDUSTRIES COMPRESSOR CORPORATION | Machinery (L2) | Steam Turbines (L3) | Steam Turbines, Special Purpose - API 612 (L4) | Steam Turbines, Special Purpose - API 612 (L5) | Qualified-Globally | | | | MITSUBISHI HEAV - Hiroshima | Japan |
| Raytheon Technologies | Goodrich Corporation | Machinery (L2) | Couplings (L3) | Couplings, Special Purpose - API 671 (L4) | Couplings, Special Purpose - API 671 (L5) | Qualified-Globally | | | | Goodrich Corpor - Utica | USA |
| REGAL REXNORD CORPORATION | Kop-Flex, Inc. | Machinery (L2) | Couplings (L3) | Couplings, Special Purpose - API 671 (L4) | Couplings, Special Purpose - API 671 (L5) | Qualified-Globally | | | | Kop-Flex, Inc. - USA | USA |
| SIEMENS AG | FLENDER GRAFFENSTADEN | Machinery (L2) | Gearboxes (L3) | Gearboxes, General Purpose - API 677 (L4) | Gearboxes, General Purpose - API 677 (L5) | Qualified-Globally | | | | FLENDER GRAFFEN - Strasbourg | France |
| SIEMENS AG | FLENDER GRAFFENSTADEN | Machinery (L2) | Gearboxes (L3) | Gearboxes, Special Purpose - API 613 (L4) | Gearboxes, Special Purpose - API 613 (L5) | Qualified-Globally | | | | FLENDER GRAFFEN - Strasbourg | France |
| SMITHS GROUP PLC | John Crane Inc. | Machinery (L2) | Compressor Seals (L3) | Compressor Seals, Dry Gas Seals - API 692 (L4) | Compressor Seals, Dry Gas Seals - API 692 (L5) | Qualified-Globally | | | | John Crane Inc. - Morton Grove | USA |
| SMITHS GROUP PLC | JOHN CRANE JAPAN, INC. | Machinery (L2) | Compressor Seals (L3) | Compressor Seals, Dry Gas Seals - API 692 (L4) | Compressor Seals, Dry Gas Seals - API 692 (L5) | Qualified-Globally | | | | JOHN CRANE JAPA - Japan | Japan |
| SMITHS GROUP PLC | JOHN CRANE UK LIMITED | Machinery (L2) | Compressor Seals (L3) | Compressor Seals, Dry Gas Seals - API 692 (L4) | Compressor Seals, Dry Gas Seals - API 692 (L5) | Qualified-Globally | | | | JOHN CRANE UK L - Slough | United Kingdom |
| SMITHS GROUP PLC | JOHN CRANE UK LIMITED | Machinery (L2) | Couplings (L3) | Couplings, Special Purpose - API 671 (L4) | Couplings, Special Purpose - API 671 (L5) | Qualified-Globally | | | | JOHN CRANE UK L - England | United Kingdom |
| SUMITOMO HEAVY INDUSTRIES, LTD. | Hansen Industrial Transmissions | Machinery (L2) | Gearboxes (L3) | Gearboxes, General Purpose - API 677 (L4) | Gearboxes, General Purpose - API 677 (L5) | Qualified-Globally | | | | Hansen Industri - Edegem | Belgium |
| SUMITOMO HEAVY INDUSTRIES, LTD. | SHIN NIPPON MACHINERY CO., LTD. | Machinery (L2) | Steam Turbines (L3) | Steam Turbines, General Purpose - API 611 (L4) | Single-Stage (L5) | Qualified-Globally | | Primarily in the Asia Pacific Region | | SHIN NIPPON MAC - Japan | Japan |
| Triton Investments Advisers LLP | Renk Aktiengesellschaft | Machinery (L2) | Gearboxes (L3) | Gearboxes, Special Purpose - API 613 (L4) | Gearboxes, Special Purpose - API 613 (L5) | Qualified-Globally | | | | Renk Aktiengese - Augsburg | Germany |
| Voith Turbo BHS Getriebe GmbH | Voith Turbo BHS Getriebe GmbH | Machinery (L2) | Gearboxes (L3) | Gearboxes, Special Purpose - API 613 (L4) | Gearboxes, Special Purpose - API 613 (L5) | Qualified-Globally | | | | Voith Turbo BHS - Sonthofen | Germany |
| Voith Turbo Wind GmbH & Co. KG | Voith Turbo Wind GmbH & Co. KG | Machinery (L2) | Fluid Couplings (L3) | Fluid Couplings (L4) | Fluid Couplings (L5) | Qualified-Globally | | SVNL, SVTL, SVNK | | Voith Turbo Win - Crailsheim | Germany |
| Voith Turbo Wind GmbH & Co. KG | Voith Turbo Wind GmbH & Co. KG | Machinery (L2) | Gearboxes (L3) | Gearboxes, Epicyclic (L4) | Gearboxes, Epicyclic (L5) | Qualified-Globally | | | | Voith Turbo Win - Crailsheim | Germany |
| | GEP TEST 1013 | Machinery (L2) | Steam Turbines (L3) | Steam Turbines, Special Purpose - API 612 (L4) | Steam Turbines, Special Purpose - API 612 (L5) | Qualified-Globally | | | | ALL | |
| Baker Hughes Company | Thermodyn | Machinery (L2) | Steam Turbines (L3) | Steam Turbines, Special Purpose - API 612 (L4) | Steam Turbines, Special Purpose - API 612 (L5) | Qualified-Globally | | | | Thermodyn-Le Creusot | France |
| EBARA CORPORATION | EBARA CORPORATION | Machinery (L2) | Steam Turbines (L3) | Steam Turbines, Special Purpose - API 612 (L4) | Steam Turbines, Special Purpose - API 612 (L5) | Qualified-Globally | | | | EBARA CORPORATION - Futtsu District (Futtsu Plant) | Japan |
| OEL GROUP LTD | Osborne Engineering LLC | Machinery (L2) | Machinery Services (L3) | Hydrodynamic bearings (L4) | White metal (Babbitt) Lined Bearings (L5) | Accepted-Locally | | | | Dubai | Unit.Arab Emir. |
| Rexnord Couplings | Euroflex Transmissions India Pvt. Ltd. | Machinery (L2) | Couplings (L3) | Couplings, Special Purpose - API 671 (L4) | Couplings, Special Purpose - API 671 (L5) | Qualified-Globally | | | | Balanagar | India |
| | Clark-Reliance Corporation | Instrumentation & Controls (L2) | Flow Instruments (L3) | Sight Flow (L4) | Sight Flow (L5) | Qualified-Globally | | Jerguson | Brand: Jacoby-Tarbox, Alternate: Jerguson | Clark-Reliance - All Mfg Locs | All Countries |
| Baker Hughes Company | PANAMETRICS LIMITED | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Ultrasonic (Process Clampon) - Gas (L5) | Qualified-Globally | | GE Infrastructure Sensing | | PANAMETRICS LIM - All Mfg Locs | All Countries |
| Baker Hughes Company | PANAMETRICS LIMITED | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Ultrasonic (Process Clampon) - Liquid (L5) | Qualified-Globally | | GE Infrastructure Sensing | Flare Metering Only | PANAMETRICS LIM - All Mfg Locs | All Countries |
| MRC GLOBAL INC. | MRC Global (US) Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Orifice Plate Fittings - Meter Runs (L5) | Qualified-Globally | | Former: Red Man Pipe and Supply | | MRC Global (US) - All Mfg Locs | All Countries |
| ITT Inc. | ITT Inc. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Switch (L4) | Pressure Switch (L5) | Qualified-Globally | | Former: ITT NeoDyn | | ITT Inc. - All Mfg Locs | All Countries |
| ITT Inc. | ITT Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Switches (L4) | Temperature Switches (L5) | Qualified-Globally | | Former: ITT NeoDyn | | ITT Inc. - All Mfg Locs | All Countries |
| WIKA Alexander Wiegand SE & Co. KG | Wika Instrument LP | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Orifice Plate Fittings - Meter Runs (L5) | Qualified-Globally | | Former: Fluidic Techniques | | Wika Instrument - All Mfg Locs | All Countries |
| Outokumpu Oyj | Outokumpu Stainless AB | Instrumentation & Controls (L2) | Miscellaneous (L3) | Instrument Tubing (L4) | Instrument Tubing (L5) | Qualified-Globally | | Former: Avesta Sheffield | | Outokumpu Stain - All Mfg Locs | All Countries |
| HSBC HOLDINGS PLC | PROSERV UK LIMITED | Instrumentation & Controls (L2) | Miscellaneous (L3) | Misc. Local Instrument Panels (L4) | Misc. Local Instrument Panels (L5) | Qualified-Globally | | Former: Automation USA | | PROSERV UK LIMI - All Mfg Locs | All Countries |
| | Daily Instruments Corporation | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Elements (L4) | Reactor Multipoint (Electronic) (L5) | Qualified-Globally | | Daily Thermetrics | | Daily Instrumen - All Mfg Locs | All Countries |
| | Schneider Electric The Netherlands B.V. | Instrumentation & Controls (L2) | Automation (L3) | Programmable Logic Controller (PLC) (L4) | Programmable Logic Controller (PLC) (L5) | Qualified-Globally | | Alternate & Brand: Sarel | Only use models M340 and M580 using X80 I/O platform | Schneider Elect - All Mfg Locs | All Countries |

Annexure-IV

| | | | | | | | | | | | |
|---------|--|---------------------------------|------------------------------|--|--|--------------------|--|--|--|--------------------------------|---------------|
| | Autoclave Engineers | Instrumentation & Controls (L2) | Miscellaneous (L3) | Instrument Tubing (L4) | Instrument Tubing (L5) | Qualified-Globally | | | | Autoclave Engin - All Mfg Locs | All Countries |
| | Autoclave Engineers | Instrumentation & Controls (L2) | Miscellaneous (L3) | Tube Fittings (L4) | Hydraulic (L5) | Qualified-Globally | | | | Autoclave Engin - All Mfg Locs | All Countries |
| | Carpenter Technology Corporation | Instrumentation & Controls (L2) | Miscellaneous (L3) | Instrument Tubing (L4) | Instrument Tubing (L5) | Qualified-Globally | | | | Carpenter Techn - All Mfg Locs | All Countries |
| | Custom Control Sensors, LLC | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Switch (L4) | Pressure Switch (L5) | Qualified-Globally | | | | Custom Control - All Mfg Locs | All Countries |
| | Custom Control Sensors, LLC | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Switches (L4) | Temperature Switches (L5) | Qualified-Globally | | | | Custom Control - All Mfg Locs | All Countries |
| | Dwyer Instruments Inc | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Switch (L4) | Pressure Switch (L5) | Qualified-Globally | | | | Dwyer Instrumen - All Mfg Locs | All Countries |
| | Gayesco-Wika USA, LP | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Elements (L4) | Reactor Multipoint (Electronic) (L5) | Qualified-Globally | | | | Gayesco-Wika US - All Mfg Locs | All Countries |
| | HIMA Paul Hildebrandt GmbH | Instrumentation & Controls (L2) | Automation (L3) | Safety Instrumented System (SIS) (L4) | Safety Instrumented System (SIS) (L5) | Qualified-Globally | | | Limited to Models Himatrix, HIQuad, HIMax, and Planar 4 only | HIMA Paul Hilde - All Mfg Locs | All Countries |
| | HIMA Paul Hildebrandt GmbH | Instrumentation & Controls (L2) | Automation (L3) | Turbine Control & Protection System (L4) | Turbine Control & Protection System (L5) | Qualified-Globally | Consult Discipline Technical Lead for the selection of model | | HIMax | HIMA Paul Hilde - All Mfg Locs | All Countries |
| | Honeywell International Inc. | Instrumentation & Controls (L2) | Automation (L3) | Process Control Systems (L4) | Process Control Systems (L5) | Qualified-Globally | | | Model Experion only | Honeywell Inter - All Mfg Locs | All Countries |
| | Honeywell International Inc. | Instrumentation & Controls (L2) | Automation (L3) | Safety Instrumented System (SIS) (L4) | Safety Instrumented System (SIS) (L5) | Qualified-Globally | | | Model Safety Manager only | Honeywell Inter - All Mfg Locs | All Countries |
| | Honeywell International Inc. | Instrumentation & Controls (L2) | Automation (L3) | Turbine Control & Protection System (L4) | Turbine Control & Protection System (L5) | Qualified-Globally | Consult Discipline Technical Lead for the selection of model | | C300 | Honeywell Inter - All Mfg Locs | All Countries |
| | Honeywell International Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Differential Pressure (DP) (L5) | Qualified-Globally | | | | Honeywell Inter - All Mfg Locs | All Countries |
| | Honeywell International Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Magnetic (L5) | Qualified-Globally | | | | Honeywell Inter - All Mfg Locs | All Countries |
| | Honeywell International Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Vortex (L5) | Qualified-Globally | | | | Honeywell Inter - All Mfg Locs | All Countries |
| | Honeywell International Inc. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Transmitters (L4) | Electronic (L5) | Qualified-Globally | Temporary Hold for Downstream | | | Honeywell Inter - All Mfg Locs | All Countries |
| | Honeywell International Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Transmitters (L4) | Electronic (L5) | Qualified-Globally | Temporary Hold for Downstream | | | Honeywell Inter - All Mfg Locs | All Countries |
| | Puffer-Sweiven Holdings, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Misc. Local Instrument Panels (L4) | Misc. Local Instrument Panels (L5) | Qualified-Globally | | | | Puffer-Sweiven - All Mfg Locs | All Countries |
| | Rockwell Automation, Inc. | Instrumentation & Controls (L2) | Automation (L3) | Programmable Logic Controller (PLC) (L4) | Programmable Logic Controller (PLC) (L5) | Qualified-Globally | | | Only use models 1756-L71 ControlLogix with 1771 Universal I/O and programming software version 20.04 | Rockwell Automa - All Mfg Locs | All Countries |
| | SOCIETE PYRENEENNE DE METALLURGIE SCOP | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Orifice Plate Fittings - Meter Runs (L5) | Qualified-Globally | | | | SOCIETE PYRENEE - All Mfg Locs | All Countries |
| | SWAGELOK COMPANY | Instrumentation & Controls (L2) | Miscellaneous (L3) | Instrument Tubing (L4) | Instrument Tubing (L5) | Qualified-Globally | | | | Swagelok Compan - La Porte | USA |
| | SWAGELOK COMPANY | Instrumentation & Controls (L2) | Miscellaneous (L3) | Manifold (L4) | Manifold (L5) | Qualified-Globally | | | | Swagelok Compan - La Porte | USA |
| | SWAGELOK COMPANY | Instrumentation & Controls (L2) | Miscellaneous (L3) | Tube Fittings (L4) | Instrument Air/Process (L5) | Qualified-Globally | | | | Swagelok Compan - La Porte | USA |
| | Versatech Automation Services, LLC | Instrumentation & Controls (L2) | Miscellaneous (L3) | Misc. Local Instrument Panels (L4) | Misc. Local Instrument Panels (L5) | Qualified-Globally | | | | Versatech Autom - All Mfg Locs | All Countries |
| | WIKA INSTRUMENTS LIMITED | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Gauge (L4) | Pressure Gauge (L5) | Qualified-Globally | | | | Wika Instrument - All Mfg Locs | All Countries |
| | WIKA INSTRUMENTS LIMITED | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Bimetalic (L5) | Qualified-Globally | | | | Wika Instrument - All Mfg Locs | All Countries |
| | WIKA INSTRUMENTS LIMITED | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Liquid Filled (L5) | Qualified-Globally | | | | Wika Instrument - All Mfg Locs | All Countries |
| | WIKA INSTRUMENTS LIMITED | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Thermowells (L4) | Thermowells (L5) | Qualified-Globally | | | | Wika Instrument - All Mfg Locs | All Countries |
| ABB LTD | ABB TECHNOLOGIES W.L.L. | Instrumentation & Controls (L2) | Automation (L3) | Process Control Systems (L4) | Process Control Systems (L5) | Qualified-Globally | | | | ABB TECHNOLOGIE All Mfg Locs | Bahrain |
| ABB LTD | ABB TECHNOLOGIES W.L.L. | Instrumentation & Controls (L2) | Automation (L3) | Safety Instrumented System (SIS) (L4) | Safety Instrumented System (SIS) (L5) | Qualified-Globally | | | August 800xa SIS under Technology evaluation | ABB TECHNOLOGIE All Mfg Locs | Bahrain |
| ABB LTD | ABB TECHNOLOGIES W.L.L. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Differential Pressure (DP) (L5) | Qualified-Globally | | | | ABB TECHNOLOGIE All Mfg Locs | Bahrain |
| ABB LTD | ABB TECHNOLOGIES W.L.L. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Vortex (L5) | Qualified-Globally | | | | ABB TECHNOLOGIE All Mfg Locs | Bahrain |
| ABB LTD | ABB TECHNOLOGIES W.L.L. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Variable Area Meter (L4) | Variable Area Meter (L5) | Qualified-Globally | | | | ABB TECHNOLOGIE All Mfg Locs | Bahrain |
| ABB LTD | ABB TECHNOLOGIES W.L.L. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Transmitters (L4) | Electronic (L5) | Qualified-Globally | | | | ABB TECHNOLOGIE All Mfg Locs | Bahrain |
| ABB LTD | ABB TECHNOLOGIES W.L.L. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Transmitters (L4) | Pneumatic (L5) | Qualified-Globally | | | | ABB TECHNOLOGIE All Mfg Locs | Bahrain |

Annexure-IV

| | | | | | | | | | | | |
|--|---|---------------------------------|------------------------------|--|--|--------------------|--|------------------|--|--------------------------------|---------------|
| ABB LTD | ABB TECHNOLOGIES W.L.L. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Transmitters (L4) | Electronic (L5) | Qualified-Globally | | | | ABB TECHNOLOGIE All Mfg Locs | Bahrain |
| Accudyne Industries, LLC | Haskel International, LLC | Instrumentation & Controls (L2) | Miscellaneous (L3) | Tube Fittings (L4) | Hydraulic (L5) | Qualified-Globally | | | | Haskel Internat - All Mfg Locs | All Countries |
| Allegheny Technologies Incorporated | Allegheny Ludlum, LLC | Instrumentation & Controls (L2) | Miscellaneous (L3) | Instrument Tubing (L4) | Instrument Tubing (L5) | Qualified-Globally | | | | Allegheny Ludlu - All Mfg Locs | All Countries |
| Alloy Metals and Tubes International, Inc. | Alloy Metals and Tubes International, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Instrument Tubing (L4) | Instrument Tubing (L5) | Qualified-Globally | | | | Alloy Metals an - All Mfg Locs | All Countries |
| AMETEK, Inc. | Ametek, Drexelbrook Level & Analytical Products | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Gauge (L4) | Pressure Gauge (L5) | Qualified-Globally | | | | Ametek, Drexelb - All Mfg Locs | All Countries |
| AMETEK, Inc. | Ametek, Drexelbrook Level & Analytical Products | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Bimetalic (L5) | Qualified-Globally | | | | Ametek, Drexelb - All Mfg Locs | All Countries |
| AMETEK, Inc. | Ametek, Drexelbrook Level & Analytical Products | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Liquid Filled (L5) | Qualified-Globally | | | | Ametek, Drexelb - All Mfg Locs | All Countries |
| Astra Associates, Inc. | Astra Associates, Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Pitot Tubes (Averaging) (L5) | Qualified-Globally | | | | Astra Associate - All Mfg Locs | All Countries |
| Astra Associates, Inc. | Astra Associates, Inc. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Switch (L4) | Pressure Switch (L5) | Qualified-Globally | | | | Astra Associate - All Mfg Locs | All Countries |
| Baker Hughes Company | BAKER HUGHES DIGITAL SOLUTIONS AUSTRALIA PTY LTD | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Ultrasonic (Process Clampon) - Flare (L5) | Qualified-Globally | | | | GE ENERGY MEASU - All Mfg Locs | All Countries |
| Baker Hughes Company | Dresser, LLC | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Gauge (L4) | Pressure Gauge (L5) | Qualified-Globally | | | | Dresser, LLC - All Mfg Locs | All Countries |
| Baker Hughes Company | MASONEILAN SLU | Instrumentation & Controls (L2) | Miscellaneous (L3) | Transducers (I/P) (L4) | Transducers (I/P) (L5) | Qualified-Globally | | | | MASONEILAN SLU - All Mfg Locs | All Countries |
| Baker Hughes Company | MASONEILAN SLU | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Transmitters (L4) | Pneumatic (L5) | Qualified-Globally | | | | MASONEILAN SLU - All Mfg Locs | All Countries |
| Brisco Inc Balancing | Brisco Inc Balancing | Instrumentation & Controls (L2) | Miscellaneous (L3) | Misc. Local Instrument Panels (L4) | Misc. Local Instrument Panels (L5) | Qualified-Globally | | | | Brisco Inc Bala - All Mfg Locs | All Countries |
| Churchill Companies, The | TSI, Incorporated | Instrumentation & Controls (L2) | Miscellaneous (L3) | Misc. Local Instrument Panels (L4) | Misc. Local Instrument Panels (L5) | Qualified-Globally | | | | TSI, Incorporat - All Mfg Locs | All Countries |
| CIDRA HOLDINGS LLC | Cidra Oilsands Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Acoustic (Process Clampon) - Gas (L5) | Qualified-Globally | | Brand: Sonartrac | | Cidra Oilsands - All Mfg Locs | All Countries |
| CIDRA HOLDINGS LLC | Cidra Oilsands Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Acoustic (Process Clampon) - Liquid (L5) | Qualified-Globally | | Brand: Sonartrac | | Cidra Oilsands - All Mfg Locs | All Countries |
| CIDRA HOLDINGS LLC | Cidra Oilsands Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Acoustic (Process Clampon) - Slurries (L5) | Qualified-Globally | | Brand: Sonartrac | | Cidra Oilsands - All Mfg Locs | All Countries |
| CIRCOR INTERNATIONAL, INC. | Circor Instrumentation Technologies, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Manifold (L4) | Manifold (L5) | Qualified-Globally | | Brand: Hoke | | Circor Instrume - All Mfg Locs | All Countries |
| CIRCOR INTERNATIONAL, INC. | Circor Instrumentation Technologies, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Tube Fittings (L4) | Instrument Air/Process (L5) | Qualified-Globally | | Brand: Gyrolok | | Circor Instrume - La Porte | USA |
| CSE GLOBAL LIMITED | W Cse Industries Inc | Instrumentation & Controls (L2) | Miscellaneous (L3) | Misc. Local Instrument Panels (L4) | Misc. Local Instrument Panels (L5) | Qualified-Globally | | | | W Cse Industrie - All Mfg Locs | All Countries |
| DANAHER CORPORATION | McCrometer, Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Cone Meters (L5) | Qualified-Globally | | | | McCrometer, Inc - All Mfg Locs | All Countries |
| EMERSON | Intelligent Platforms, LLC | Instrumentation & Controls (L2) | Automation (L3) | Programmable Logic Controller (PLC) (L4) | Programmable Logic Controller (PLC) (L5) | Qualified-Globally | | | | GE Intelligent - All Mfg Locs | All Countries |
| Emerson Electric Co. | Crosby Valve & Gage International, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Manifold (L4) | Manifold (L5) | Qualified-Globally | | | | Crosby Valve & - All Mfg Locs | All Countries |
| Emerson Electric Co. | Emerson Process Management Flow Technologies Co., Ltd | Instrumentation & Controls (L2) | Automation (L3) | Process Control Systems (L4) | Process Control Systems (L5) | Qualified-Globally | | | | Emerson Process - All Mfg Locs | All Countries |
| Emerson Electric Co. | Emerson Process Management Flow Technologies Co., Ltd | Instrumentation & Controls (L2) | Automation (L3) | Safety Instrumented System (SIS) (L4) | Safety Instrumented System (SIS) (L5) | Qualified-Globally | | | | Emerson Process - All Mfg Locs | All Countries |
| Emerson Electric Co. | Emerson Process Management Flow Technologies Co., Ltd | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Pitot Tubes (Averaging) (L5) | Qualified-Globally | | | | Emerson Process - All Mfg Locs | All Countries |
| Emerson Electric Co. | Emerson Process Management Flow Technologies Co., Ltd | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Wedge (L5) | Qualified-Globally | | | | Emerson Process - All Mfg Locs | All Countries |
| Emerson Electric Co. | Emerson Process Management LLLP | Instrumentation & Controls (L2) | Flow Instruments (L3) | Variable Area Meter (L4) | Variable Area Meter (L5) | Qualified-Globally | | Brand: Penberthy | | Emerson Process - All Mfg Locs | All Countries |
| Emerson Electric Co. | Fisher Controls International LLC | Instrumentation & Controls (L2) | Automation (L3) | Supervisory Control And Data Acquisition (SCADA) System (L4) | Supervisory Control And Data Acquisition (SCADA) System (L5) | Qualified-Globally | | | | Fisher Controls - All Mfg Locs | All Countries |
| Emerson Electric Co. | Fisher Controls International LLC | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Pitot Tubes (Averaging) (L5) | Qualified-Globally | | | | Fisher Controls - All Mfg Locs | All Countries |
| Emerson Electric Co. | Fisher Controls International LLC | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Differential Pressure (DP) (L5) | Qualified-Globally | | | | Fisher Controls - All Mfg Locs | All Countries |
| Emerson Electric Co. | Fisher Controls International LLC | Instrumentation & Controls (L2) | Miscellaneous (L3) | Pneumatic Controller (L4) | Indicating (L5) | Qualified-Globally | | | | Fisher Controls - All Mfg Locs | All Countries |
| Emerson Electric Co. | Fisher Controls International LLC | Instrumentation & Controls (L2) | Miscellaneous (L3) | Transducers (I/P) (L4) | Transducers (I/P) (L5) | Qualified-Globally | | | | Fisher Controls - All Mfg Locs | All Countries |
| Emerson Electric Co. | Fisher Controls International LLC | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Transmitters (L4) | Pneumatic (L5) | Qualified-Globally | | | | Fisher Controls - All Mfg Locs | All Countries |

Annexure-IV

| | | | | | | | | | | | |
|--|--|---------------------------------|------------------------------|-------------------------------|--|--------------------|--|--|---|--------------------------------|---------------|
| Emerson Electric Co. | Measurement Solutions Systems & Services | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Flow Nozzles (L5) | Qualified-Globally | | | | Daniel Measurem - All Mfg Locs | All Countries |
| Emerson Electric Co. | Measurement Solutions Systems & Services | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Venturi (L5) | Qualified-Globally | | | | Daniel Measurem - All Mfg Locs | All Countries |
| Emerson Electric Co. | Measurement Solutions Systems & Services | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Tubes (L4) | Flow Tubes (L5) | Qualified-Globally | | | | Daniel Measurem - All Mfg Locs | All Countries |
| Emerson Electric Co. | Measurement Solutions Systems & Services | Instrumentation & Controls (L2) | Flow Instruments (L3) | Sight Flow (L4) | Sight Flow (L5) | Qualified-Globally | | | | Daniel Measurem - All Mfg Locs | All Countries |
| Emerson Electric Co. | Micro Motion Inc | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Coriolis Meter (L5) | Qualified-Globally | | | | Micro Motion In - All Mfg Locs | All Countries |
| Emerson Electric Co. | MOBREY GROUP LIMITED | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Pitot Tubes (Averaging) (L5) | Qualified-Globally | | | ExxonMobil agrees to allow exemption for Emerson Process Management divisions from the material country of origin requirements. | MOBREY GROUP LI - All Mfg Locs | All Countries |
| Emerson Electric Co. | MOBREY GROUP LIMITED | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Switch (L4) | Flow Switch (L5) | Qualified-Globally | | | 1) Custody Transfer or process 2) ExxonMobil agrees to allow exemption for Emerson Process Management divisions from the material country of origin requirements. | MOBREY GROUP LI - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Conditioning Orifice Plate (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Pitot Tubes (Averaging) (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Differential Pressure (DP) (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Magnetic (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Vortex (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Integral Orifice (L4) | Integral Orifice (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Variable Area Meter (L4) | Variable Area Meter (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Manifold (L4) | Manifold (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Transmitters (L4) | Electronic (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Transmitters (L4) | Electronic (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| Emerson Electric Co. | Rosemount Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Thermowells (L4) | Thermowells (L5) | Qualified-Globally | | | | Rosemount Inc. - All Mfg Locs | All Countries |
| ENDRESS+HAUSER AG | Endress + Hauser Inc | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Coriolis Meter (L5) | Qualified-Globally | | | | Endress + Hause - All Mfg Locs | All Countries |
| ENDRESS+HAUSER AG | Endress + Hauser Inc | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Differential Pressure (DP) (L5) | Qualified-Globally | | | | Endress + Hause - All Mfg Locs | All Countries |
| ENDRESS+HAUSER AG | Endress + Hauser Inc | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Ultrasonic (Process Clampon) - Liquid (L5) | Qualified-Globally | | | | Endress + Hause - All Mfg Locs | All Countries |
| ENDRESS+HAUSER AG | Endress + Hauser Inc | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Vortex (L5) | Qualified-Globally | | | | Endress + Hause - All Mfg Locs | All Countries |
| ENDRESS+HAUSER AG | Endress + Hauser Inc | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Transmitters (L4) | Electronic (L5) | Qualified-Globally | | | | Endress + Hause - All Mfg Locs | All Countries |
| En-Fab, Inc. | En-Fab, Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Orifice Plate Fittings - Meter Runs (L5) | Qualified-Globally | | | | En-Fab, Inc. - All Mfg Locs | All Countries |
| EXPRO INTERNATIONAL GROUP HOLDINGS LIMITED | Expro Norway AS | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Acoustic (Process Clampon) - Gas (L5) | Qualified-Globally | | | | Expro Norway AS - All Mfg Locs | All Countries |
| EXPRO INTERNATIONAL GROUP HOLDINGS LIMITED | Expro Norway AS | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Acoustic (Process Clampon) - Liquid (L5) | Qualified-Globally | | | | Expro Norway AS - All Mfg Locs | All Countries |
| EXPRO INTERNATIONAL GROUP HOLDINGS LIMITED | Expro Norway AS | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Acoustic (Process Clampon) - Slurries (L5) | Qualified-Globally | | | | Expro Norway AS - All Mfg Locs | All Countries |
| FLEXIM FLEXIBLE INDUSTRIEMEßTECHNIK GMBH | Flexim Americas Corporation | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Ultrasonic (Process Clampon) - Gas (L5) | Qualified-Globally | | | | Flexim Americas - All Mfg Locs | All Countries |
| FLEXIM FLEXIBLE INDUSTRIEMEßTECHNIK GMBH | FLEXIM Flexible IndustrieMeßtechnik GmbH | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Ultrasonic (Process Clampon) - Liquid (L5) | Qualified-Globally | | | | FLEXIM Flexible - All Mfg Locs | All Countries |
| Fluid Components International LLC | Fluid Components International LLC | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Switch (L4) | Flow Switch (L5) | Qualified-Globally | | | | Fluid Component - All Mfg Locs | All Countries |
| Fluid Components International LLC | Fluid Components International LLC | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Thermal (Mass Flow) (L5) | Qualified-Globally | | | | Fluid Component - All Mfg Locs | All Countries |
| FOXBORO ECKARDT GMBH - 40003890 | FOXBORO ECKARDT GmbH | Instrumentation & Controls (L2) | Automation (L3) | Process Control Systems (L4) | Process Control Systems (L5) | Qualified-Globally | | | Model I/A only | FOXBORO ECKARDT - All Mfg Locs | All Countries |
| FOXBORO ECKARDT GMBH - 40003890 | FOXBORO ECKARDT GmbH | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Differential Pressure (DP) (L5) | Qualified-Globally | | | | FOXBORO ECKARDT - All Mfg Locs | All Countries |
| FOXBORO ECKARDT GMBH - 40003890 | FOXBORO ECKARDT GmbH | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Magnetic (L5) | Qualified-Globally | | | | FOXBORO ECKARDT - All Mfg Locs | All Countries |

Annexure-IV

| | | | | | | | | | | | |
|--|--------------------------------------|---------------------------------|------------------------------|--|--|--------------------|--|--|--|--------------------------------|---------------|
| FOXBORO ECKARDT GMBH - 40003890 | FOXBORO ECKARDT GmbH | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Vortex (L5) | Qualified-Globally | | | | FOXBORO ECKARDT - All Mfg Locs | All Countries |
| FOXBORO ECKARDT GMBH - 40003890 | FOXBORO ECKARDT GmbH | Instrumentation & Controls (L2) | Miscellaneous (L3) | Pneumatic Controller (L4) | Indicating (L5) | Qualified-Globally | | | | FOXBORO ECKARDT - All Mfg Locs | All Countries |
| FOXBORO ECKARDT GMBH - 40003890 | FOXBORO ECKARDT GmbH | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Transmitters (L4) | Electronic (L5) | Qualified-Globally | | | | FOXBORO ECKARDT - All Mfg Locs | All Countries |
| FOXBORO ECKARDT GMBH - 40003890 | FOXBORO ECKARDT GmbH | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Transmitters (L4) | Electronic (L5) | Qualified-Globally | | | | FOXBORO ECKARDT - All Mfg Locs | All Countries |
| Illinois Tool Works Inc. | Brooks Instrument LLC | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Magnetic (L5) | Qualified-Globally | | | | Brooks Instrume - All Mfg Locs | All Countries |
| Illinois Tool Works Inc. | Brooks Instrument LLC | Instrumentation & Controls (L2) | Flow Instruments (L3) | Sight Flow (L4) | Sight Flow (L5) | Qualified-Globally | | | | Brooks Instrume - All Mfg Locs | All Countries |
| Illinois Tool Works Inc. | Brooks Instrument LLC | Instrumentation & Controls (L2) | Flow Instruments (L3) | Variable Area Meter (L4) | Variable Area Meter (L5) | Qualified-Globally | | | | Brooks Instrume - All Mfg Locs | All Countries |
| Ludwig Krohne GmbH & Co Kommanditgesellschaft | KROHNE Messtechnik GmbH | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Magnetic (L5) | Qualified-Globally | | | | KROHNE Messtech - All Mfg Locs | All Countries |
| Ludwig Krohne GmbH & Co Kommanditgesellschaft | KROHNE Messtechnik GmbH | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Ultrasonic - Liquid (L5) | Qualified-Globally | | | | KROHNE Messtech - All Mfg Locs | All Countries |
| Marshall Instruments Inc | Marshall Instruments Inc | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Bimetalic (L5) | Qualified-Globally | | | | Marshall Instru - All Mfg Locs | All Countries |
| Marshall Instruments Inc | Marshall Instruments Inc | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Liquid Filled (L5) | Qualified-Globally | | | | Marshall Instru - All Mfg Locs | All Countries |
| NAGANO KEIKI CO., LTD. | Ashcroft Inc. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Gauge (L4) | Pressure Gauge (L5) | Qualified-Globally | | | | Ashcroft Inc. - All Mfg Locs | All Countries |
| NAGANO KEIKI CO., LTD. | Ashcroft Inc. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Switch (L4) | Pressure Switch (L5) | Qualified-Globally | | | | Ashcroft Inc. - All Mfg Locs | All Countries |
| NAGANO KEIKI CO., LTD. | Ashcroft Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Bimetalic (L5) | Qualified-Globally | | | | Ashcroft Inc. - All Mfg Locs | All Countries |
| NAGANO KEIKI CO., LTD. | Ashcroft Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Liquid Filled (L5) | Qualified-Globally | | | | Ashcroft Inc. - All Mfg Locs | All Countries |
| NAGANO KEIKI CO., LTD. | Ashcroft Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Switches (L4) | Temperature Switches (L5) | Qualified-Globally | | | | Ashcroft Inc. - All Mfg Locs | All Countries |
| NIPPON STEEL & SUMITOMO METAL CORPORATION | Nippon Steel North America, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Instrument Tubing (L4) | Instrument Tubing (L5) | Qualified-Globally | | | | Nippon Steel No - La Porte | USA |
| O'NEAL INDUSTRIES, INC | TW Metals, LLC | Instrumentation & Controls (L2) | Miscellaneous (L3) | Instrument Tubing (L4) | Instrument Tubing (L5) | Qualified-Globally | | | | TW Metals, LLC - All Mfg Locs | All Countries |
| Parker-Hannifin Corporation | Parker-Hannifin Corporation | Instrumentation & Controls (L2) | Miscellaneous (L3) | Manifold (L4) | Manifold (L5) | Qualified-Globally | | | | Parker-Hannifin - All Mfg Locs | All Countries |
| Parker-Hannifin Corporation | Parker-Hannifin Corporation | Instrumentation & Controls (L2) | Miscellaneous (L3) | Tube Fittings (L4) | Hydraulic (L5) | Qualified-Globally | | | | Parker-Hannifin - All Mfg Locs | All Countries |
| Parker-Hannifin Corporation | Parker-Hannifin Corporation | Instrumentation & Controls (L2) | Miscellaneous (L3) | Tube Fittings (L4) | Instrument Air/Process (L5) | Qualified-Globally | | | | Parker-Hannifin - All Mfg Locs | All Countries |
| Parker-Hannifin Corporation | Parker-Hannifin Corporation | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Thermowells (L4) | Thermowells (L5) | Qualified-Globally | | | | Parker-Hannifin - All Mfg Locs | All Countries |
| Pepperl+Fuchs AG | Pepperl + Fuchs, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Intrinsic Safety Barriers (L4) | Intrinsic Safety Barriers (L5) | Qualified-Globally | | | | Pepperl + Fuchs - All Mfg Locs | All Countries |
| Peter Gläsel Beteiligungs GmbH & Co. Kommanditgesellschaft | WEIDMULLER LIMITED | Instrumentation & Controls (L2) | Miscellaneous (L3) | Terminal Blocks (L4) | Terminal Blocks (L5) | Qualified-Globally | | | | WEIDMULLER LIMI - All Mfg Locs | All Countries |
| PHOENIX CONTACT GMBH & CO. KG | Phoenix Contact GmbH & Co. KG | Instrumentation & Controls (L2) | Miscellaneous (L3) | Intrinsic Safety Barriers (L4) | Intrinsic Safety Barriers (L5) | Qualified-Globally | | | | Phoenix Contact - All Mfg Locs | All Countries |
| PHOENIX CONTACT GMBH & CO. KG | Phoenix Contact GmbH & Co. KG | Instrumentation & Controls (L2) | Miscellaneous (L3) | Terminal Blocks (L4) | Terminal Blocks (L5) | Qualified-Globally | | | | Phoenix Contact - All Mfg Locs | All Countries |
| R. Stahl Aktiengesellschaft | R. Stahl, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Intrinsic Safety Barriers (L4) | Intrinsic Safety Barriers (L5) | Qualified-Globally | | | | R. Stahl, Inc. - All Mfg Locs | All Countries |
| Ran Technologies, Inc. | Ran Technologies, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Misc. Local Instrument Panels (L4) | Misc. Local Instrument Panels (L5) | Qualified-Globally | | | | Ran Technologie - All Mfg Locs | All Countries |
| Rheonik Messtechnik GmbH | Rheonik Messtechnik GmbH | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Coriolis Meter (L5) | Qualified-Globally | | | | Rheonik Messtec - All Mfg Locs | All Countries |
| ROPER TECHNOLOGIES, INC. | Compressor Controls Corporation B.V. | Instrumentation & Controls (L2) | Automation (L3) | Turbine Control & Protection System (L4) | Turbine Control & Protection System (L5) | Qualified-Globally | Consult Discipline Technical Lead for the selection of model | | | Compressor Cont - All Mfg Locs | All Countries |
| Rüeger Holding S.A. | Rüeger S.A. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Gauge (L4) | Pressure Gauge (L5) | Qualified-Globally | | | | Rüeger S.A. - All Mfg Locs | All Countries |
| S.C.F.M. | FLUIDES SERVICE DISTRIBUTION | Instrumentation & Controls (L2) | Miscellaneous (L3) | Misc. Local Instrument Panels (L4) | Misc. Local Instrument Panels (L5) | Qualified-Globally | | | | FLUIDES SERVICE - All Mfg Locs | All Countries |
| SANDVIK AB | Alleima | Instrumentation & Controls (L2) | Miscellaneous (L3) | Instrument Tubing (L4) | Instrument Tubing (L5) | Qualified-Globally | | | | Sandvik, Inc. - All Mfg Locs | All Countries |
| Schlumberger N.V. | Cameron International Corporation | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Cone Meters (L5) | Qualified-Globally | | | | Cameron Interna - All Mfg Locs | All Countries |
| Schlumberger N.V. | Cameron International Corporation | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Switch (L4) | Flow Switch (L5) | Qualified-Globally | | | | Cameron Interna - All Mfg Locs | All Countries |

Annexure-IV

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|------------------------------------|------------------------------------|---------------------------------|------------------------------|--|--|----------------------|---|--|-----------------------------|--------------------------------|---------------|
| Schlumberger N.V. | Cameron International Corporation | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Switch (L4) | Pressure Switch (L5) | Qualified-Globally | | | | Cameron Interna - All Mfg Locs | All Countries |
| Schneider Electric | TRICONEX SYSTEMS INC | Instrumentation & Controls (L2) | Automation (L3) | Safety Instrumented System (SIS) (L4) | Safety Instrumented System (SIS) (L5) | Qualified-Globally | | | Models Trident, Tricon only | TRICONEX SYSTEM - All Mfg Locs | All Countries |
| Schneider Electric | TRICONEX SYSTEMS INC | Instrumentation & Controls (L2) | Automation (L3) | Turbine Control & Protection System (L4) | Turbine Control & Protection System (L5) | Qualified-Globally | Consult Discipline Technical Lead for the selection of model | | | TRICONEX SYSTEM - All Mfg Locs | All Countries |
| SOR, Inc. | SOR, Inc. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Switch (L4) | Pressure Switch (L5) | Qualified-Globally | | | | SOR, Inc. - All Mfg Locs | All Countries |
| SOR, Inc. | SOR, Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Switches (L4) | Temperature Switches (L5) | Qualified-Globally | | | | SOR, Inc. - All Mfg Locs | All Countries |
| TE Connectivity Ltd. | TE Connectivity Corporation | Instrumentation & Controls (L2) | Miscellaneous (L3) | Terminal Blocks (L4) | Terminal Blocks (L5) | Qualified-Globally | | | | TE Connectivity - All Mfg Locs | All Countries |
| Tel-Tru, Inc. | Tel-Tru, Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Thermowells (L4) | Thermowells (L5) | Qualified-Globally | | | | Tel-Tru, Inc. - All Mfg Locs | All Countries |
| Triad Measurement & Equipment Inc. | Triad Measurement & Equipment Inc. | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Element (L4) | Orifice Plate Fittings - Meter Runs (L5) | Qualified-Restricted | 4-2-2019 Company in financial distress. Use supplier understanding the associated business risk. | | | Triad Measureme - All Mfg Locs | All Countries |
| United Electric Controls Company | United Electric Controls Company | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Switches (L4) | Temperature Switches (L5) | Qualified-Globally | | | | United Electric - All Mfg Locs | All Countries |
| Woodward, Inc. | Woodward, Inc. | Instrumentation & Controls (L2) | Automation (L3) | Turbine Control & Protection System (L4) | Overspeed Protection System (L5) | Qualified-Globally | Consult Discipline Technical Lead for the selection of model | | | Woodward, Inc. - All Mfg Locs | All Countries |
| Woodward, Inc. | Woodward, Inc. | Instrumentation & Controls (L2) | Automation (L3) | Turbine Control & Protection System (L4) | Turbine Control & Protection System (L5) | Qualified-Globally | Consult Discipline Technical Lead for the selection of model | | | Woodward, Inc. - All Mfg Locs | All Countries |
| WTG Holdings Coöperatief U.A. | Evoqua Water Technologies GmbH | Instrumentation & Controls (L2) | Flow Instruments (L3) | Variable Area Meter (L4) | Variable Area Meter (L5) | Qualified-Globally | | | Brand: Wallace & Tiernan | Evoqua Water Te - All Mfg Locs | All Countries |
| YOKOGAWA ELECTRIC CORPORATION | YOKOGAWA ELECTRIC CORPORATION | Instrumentation & Controls (L2) | Automation (L3) | Process Control Systems (L4) | Process Control Systems (L5) | Qualified-Globally | | | | YOKOGAWA ELECTR - All Mfg Locs | All Countries |
| YOKOGAWA ELECTRIC CORPORATION | YOKOGAWA ELECTRIC CORPORATION | Instrumentation & Controls (L2) | Automation (L3) | Safety Instrumented System (SIS) (L4) | Safety Instrumented System (SIS) (L5) | Qualified-Globally | | | | YOKOGAWA ELECTR - All Mfg Locs | All Countries |
| YOKOGAWA ELECTRIC CORPORATION | YOKOGAWA ELECTRIC CORPORATION | Instrumentation & Controls (L2) | Automation (L3) | Supervisory Control And Data Acquisition (SCADA) System (L4) | Supervisory Control And Data Acquisition (SCADA) System (L5) | Qualified-Globally | | | | YOKOGAWA ELECTR - All Mfg Locs | All Countries |
| YOKOGAWA ELECTRIC CORPORATION | YOKOGAWA ELECTRIC CORPORATION | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Differential Pressure (DP) (L5) | Qualified-Globally | | | | YOKOGAWA ELECTR - All Mfg Locs | All Countries |
| YOKOGAWA ELECTRIC CORPORATION | YOKOGAWA ELECTRIC CORPORATION | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Magnetic (L5) | Qualified-Globally | | | | YOKOGAWA ELECTR - All Mfg Locs | All Countries |
| YOKOGAWA ELECTRIC CORPORATION | YOKOGAWA ELECTRIC CORPORATION | Instrumentation & Controls (L2) | Flow Instruments (L3) | Flow Transmitters (L4) | Vortex (L5) | Qualified-Globally | | | | YOKOGAWA ELECTR - All Mfg Locs | All Countries |
| YOKOGAWA ELECTRIC CORPORATION | YOKOGAWA ELECTRIC CORPORATION | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Transmitters (L4) | Electronic (L5) | Qualified-Globally | | | | YOKOGAWA ELECTR - All Mfg Locs | All Countries |
| YOKOGAWA ELECTRIC CORPORATION | YOKOGAWA ELECTRIC CORPORATION | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Transmitters (L4) | Electronic (L5) | Qualified-Globally | | | | YOKOGAWA ELECTR - All Mfg Locs | All Countries |
| | AMETEK, Inc. | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Gauge (L4) | Pressure Gauge (L5) | Accepted-Locally | Imperial Oil - The "Accepted" status applies to suppliers that have been used or accepted in a specific or limited context in the past. These suppliers have not gone through a formal EM Global Engineering and Quality evaluation for use globally by Projects / Business Units. These suppliers may be considered for use by Projects / Business units after evaluating and mitigating risk. | | | Calgary | Canada |
| | AMETEK, Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Bimetalic (L5) | Accepted-Locally | Imperial Oil - The "Accepted" status applies to suppliers that have been used or accepted in a specific or limited context in the past. These suppliers have not gone through a formal EM Global Engineering and Quality evaluation for use globally by Projects / Business Units. These suppliers may be considered for use by Projects / Business units after evaluating and mitigating risk. | | | Calgary | Canada |
| | AMETEK, Inc. | Instrumentation & Controls (L2) | Temperature Instruments (L3) | Temperature Gauges (L4) | Liquid Filled (L5) | Accepted-Locally | Imperial Oil - The "Accepted" status applies to suppliers that have been used or accepted in a specific or limited context in the past. These suppliers have not gone through a formal EM Global Engineering and Quality evaluation for use globally by Projects / Business Units. These suppliers may be considered for use by Projects / Business units after evaluating and mitigating risk. | | | Calgary | Canada |
| | Gayesco-Wika USA, LP | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Gauge (L4) | Pressure Gauge (L5) | Qualified-Globally | | | | ALL | |

Annexure-IV

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|--|---|---------------------------------|---------------------------|---|---|--------------------|---|---|----------------------|---|---------------|
| Argus Machine Co. Ltd | Argus Machine Co. Ltd | Instrumentation & Controls (L2) | Pressure Instruments (L3) | Pressure Switch (L4) | Pressure Switch (L5) | Accepted-Locally | Imperial Oil - The "Accepted" status applies to suppliers that have been used or accepted in a specific or limited context in the past. These suppliers have not gone through a formal EM Global Engineering and Quality evaluation for use globally by Projects / Business Units. These suppliers may be considered for use by Projects / Business units after evaluating and mitigating risk. | | | EDMONTON | Canada |
| Baker Hughes Company | BENTLY NEVADA INC | Instrumentation & Controls (L2) | Automation (L3) | Vibrating Monitoring System (L4) | Vibrating Monitoring System (L5) | Qualified-Globally | | | | ALL | |
| EATON CORPORATION PUBLIC LIMITED COMPANY | MTL Group, Inc. | Instrumentation & Controls (L2) | Miscellaneous (L3) | Intrinsic Safety Barriers (L4) | Intrinsic Safety Barriers (L5) | Qualified-Globally | | | | ALL | |
| FTS FOREST TECHNOLOGY SYSTEMS LTD | FTS FOREST TECHNOLOGY SYSTEMS LTD | Instrumentation & Controls (L2) | Miscellaneous (L3) | Transducers (I/P) (L4) | Transducers (I/P) (L5) | Accepted-Locally | Imperial Oil - The "Accepted" status applies to suppliers that have been used or accepted in a specific or limited context in the past. These suppliers have not gone through a formal EM Global Engineering and Quality evaluation for use globally by Projects / Business Units. These suppliers may be considered for use by Projects / Business units after evaluating and mitigating risk. | | | FOREST TECHNOLOGY SERVICES (FTS) VICTORIA | Canada |
| | Daily Instruments Corporation | Fired Equipment (L2) | Specialty Items (L3) | Tube Skin Thermocouples (L4) | Tube Skin Thermocouples (L5) | Qualified-Globally | | | | Daily Instrumen - Houston | USA |
| | WIKA Alexander Wiegand Beteiligungs-Gesellschaft mit beschränkter Haftung | Fired Equipment (L2) | Specialty Items (L3) | Tube Skin Thermocouples (L4) | Tube Skin Thermocouples (L5) | Qualified-Globally | | | | WIKA Alexander - Klingenberg | Germany |
| 8 Meren | Rodax | Fired Equipment (L2) | Specialty Items (L3) | Tube Skin Thermocouples (L4) | Tube Skin Thermocouples (L5) | Qualified-Globally | | | | Rodax - All Mfg Locs | All Countries |
| OKAZAKI MANUFACTURING COMPANY | Ari Industries, Inc. | Fired Equipment (L2) | Specialty Items (L3) | Tube Skin Thermocouples (L4) | Tube Skin Thermocouples (L5) | Qualified-Globally | | | | Ari Industries, - Addison | USA |
| OKAZAKI MANUFACTURING COMPANY | OKAZAKI MANUFACTURING COMPANY | Fired Equipment (L2) | Specialty Items (L3) | Tube Skin Thermocouples (L4) | Tube Skin Thermocouples (L5) | Qualified-Globally | | | | OKAZAKI MANUFAC - Kobe | Japan |
| EATON CORPORATION PUBLIC LIMITED COMPANY | EATON INDUSTRIES PRIVATE LIMITED | Electrical (L2) | Bulk Materials (L3) | Panels (L4) | Indoor, Non-Hazardous Locations (L5) | Qualified-Globally | | Cutler Hammer | | EATON INDUSTRIE - All Mfg Locs | All Countries |
| Emerson Electric Co. | Appleton GRP LLC | Electrical (L2) | Bulk Materials (L3) | Circuit Breaker Panels (L4) | Division 2 / Zone 2 Lighting and Power (L5) | Qualified-Globally | | Alternate & Brand: Nelson Firestop Products | Brand: Appleton | Appleton GRP LL - All Mfg Locs | All Countries |
| Emerson Electric Co. | Appleton GRP LLC | Electrical (L2) | Bulk Materials (L3) | Control Stations (L4) | Control Stations (L5) | Qualified-Globally | | Alternate & Brand: Nelson Firestop Products | Brand: Appleton | Appleton GRP LL - All Mfg Locs | All Countries |
| Emerson Electric Co. | Appleton GRP LLC | Electrical (L2) | Bulk Materials (L3) | Control Stations and Push Buttons (L4) | Hand-Off Auto (HOA) (L5) | Qualified-Globally | | Alternate & Brand: Nelson Firestop Products | Brand: Appleton | Appleton GRP LL - All Mfg Locs | All Countries |
| Emerson Electric Co. | Appleton GRP LLC | Electrical (L2) | Bulk Materials (L3) | Outlets, Single Phase (L4) | Outdoor, Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | Alternate & Brand: Nelson Firestop Products | Brand: Appleton | Appleton GRP LL - All Mfg Locs | All Countries |
| Emerson Electric Co. | Appleton GRP LLC | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, 3 Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | Alternate & Brand: Nelson Firestop Products | Brand: Appleton | Appleton GRP LL - All Mfg Locs | All Countries |
| Emerson Electric Co. | Appleton GRP LLC | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, Single Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | Alternate & Brand: Nelson Firestop Products | Brand: Appleton | Appleton GRP LL - All Mfg Locs | All Countries |
| | Dong Yang Corrosion Engineering Co., Ltd. | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | | | Dong Yang Corro - All Mfg Locs | All Countries |
| | Rockwell Automation, Inc. | Electrical (L2) | Bulk Materials (L3) | Control Stations and Push Buttons (L4) | Hand-Off Auto (HOA) (L5) | Qualified-Globally | | | Brand: Allen Bradley | Rockwell Automa - All Mfg Locs | All Countries |
| ABB LTD | ABB Ltd | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, 3 Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | ABB Ltd - All Mfg Locs | All Countries |
| ABB LTD | ABB Ltd | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, Single Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | ABB Ltd - All Mfg Locs | All Countries |
| ABB LTD | W.J. FURSE & CO LIMITED | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Cable Lugs (L4) | Earthing (Grounding) Materials, Cable Lugs (L5) | Qualified-Globally | | | | W.J. FURSE & CO - All Mfg Locs | All Countries |
| ABB LTD | W.J. FURSE & CO LIMITED | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Ground Rods (L4) | Earthing (Grounding) Materials, Ground Rods (L5) | Qualified-Globally | | | | W.J. FURSE & CO - All Mfg Locs | All Countries |
| ABB LTD | W.J. FURSE & CO LIMITED | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Miscellaneous Fittings (L4) | Earthing (Grounding) Materials, Miscellaneous Fittings (L5) | Qualified-Globally | | | | W.J. FURSE & CO - All Mfg Locs | All Countries |
| DRISHAUN HOLDINGS LIMITED | ABTECH LIMITED | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | | | ABTECH LIMITED - All Mfg Locs | All Countries |
| EATON CORPORATION PUBLIC LIMITED COMPANY | Cooper Industries, LLC | Electrical (L2) | Bulk Materials (L3) | Circuit Breaker Panels (L4) | Division 2 / Zone 2 Lighting and Power (L5) | Qualified-Globally | | | | Cooper Industri - All Mfg Locs | All Countries |
| EATON CORPORATION PUBLIC LIMITED COMPANY | Cooper Industries, LLC | Electrical (L2) | Bulk Materials (L3) | Control Stations (L4) | Control Stations (L5) | Qualified-Globally | | | | Cooper Industri - All Mfg Locs | All Countries |
| EATON CORPORATION PUBLIC LIMITED COMPANY | Cooper Industries, LLC | Electrical (L2) | Bulk Materials (L3) | Control Stations and Push Buttons (L4) | Hand-Off Auto (HOA) (L5) | Qualified-Globally | | | | Cooper Industri - All Mfg Locs | All Countries |
| EATON CORPORATION PUBLIC LIMITED COMPANY | Cooper Industries, LLC | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | | | Cooper Industri - All Mfg Locs | All Countries |
| EATON CORPORATION PUBLIC LIMITED COMPANY | Cooper Industries, LLC | Electrical (L2) | Bulk Materials (L3) | Outlets, Single Phase (L4) | Outdoor, Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | Cooper Industri - All Mfg Locs | All Countries |

Annexure-IV

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|--|--------------------------------------|-----------------|---------------------|---|---|--------------------|--|----------------------------|--|--------------------------------|---------------|
| EATON CORPORATION PUBLIC LIMITED COMPANY | Cooper Industries, LLC | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, 3 Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | Cooper Industri - All Mfg Locs | All Countries |
| EATON CORPORATION PUBLIC LIMITED COMPANY | Cooper Industries, LLC | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, Single Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | Cooper Industri - All Mfg Locs | All Countries |
| Eaton Moeller | CEAG Notlichtsysteme GmbH | Electrical (L2) | Bulk Materials (L3) | Circuit Breaker Panels (L4) | Division 2 / Zone 2 Lighting and Power (L5) | Qualified-Globally | | | | CEAG Notlichtsy - All Mfg Locs | All Countries |
| Eaton Moeller | CEAG Notlichtsysteme GmbH | Electrical (L2) | Bulk Materials (L3) | Control Stations (L4) | Control Stations (L5) | Qualified-Globally | | | | CEAG Notlichtsy - All Mfg Locs | All Countries |
| Eaton Moeller | CEAG Notlichtsysteme GmbH | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | | | CEAG Notlichtsy - All Mfg Locs | All Countries |
| Eaton Moeller | CEAG Notlichtsysteme GmbH | Electrical (L2) | Bulk Materials (L3) | Outlets, Single Phase (L4) | Outdoor, Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | CEAG Notlichtsy - All Mfg Locs | All Countries |
| Eaton Moeller | CEAG Notlichtsysteme GmbH | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, 3 Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | CEAG Notlichtsy - All Mfg Locs | All Countries |
| Eaton Moeller | CEAG Notlichtsysteme GmbH | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, Single Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | CEAG Notlichtsy - All Mfg Locs | All Countries |
| FRIEDELH LOH STIFTUNG & CO. KG | RITTAL RWG Wandgehäuse GmbH & Co. KG | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | | | RITTAL RWG Wand - All Mfg Locs | All Countries |
| Hubbell Holdco Luxembourg | HUBBELL LIMITED | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Cable Lugs (L4) | Earthing (Grounding) Materials, Cable Lugs (L5) | Qualified-Globally | | Brand: Thermoweld | | HUBBELL LIMITED - All Mfg Locs | All Countries |
| Hubbell Holdco Luxembourg | HUBBELL LIMITED | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Ground Rods (L4) | Earthing (Grounding) Materials, Ground Rods (L5) | Qualified-Globally | | Brand: Thermoweld | | HUBBELL LIMITED - All Mfg Locs | All Countries |
| Hubbell Holdco Luxembourg | HUBBELL LIMITED | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Miscellaneous Fittings (L4) | Earthing (Grounding) Materials, Miscellaneous Fittings (L5) | Qualified-Globally | | Brand: Thermoweld | | HUBBELL LIMITED - All Mfg Locs | All Countries |
| Hubbell Holdco Luxembourg | HUBBELL LIMITED | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | Brand: Hawke International | | HUBBELL LIMITED - All Mfg Locs | All Countries |
| HUBBELL INCORPORATED | Burndy LLC | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Cable Lugs (L4) | Earthing (Grounding) Materials, Cable Lugs (L5) | Qualified-Globally | | | | Burndy LLC - All Mfg Locs | All Countries |
| HUBBELL INCORPORATED | Burndy LLC | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Ground Rods (L4) | Earthing (Grounding) Materials, Ground Rods (L5) | Qualified-Globally | | | | Burndy LLC - All Mfg Locs | All Countries |
| HUBBELL INCORPORATED | Burndy LLC | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Miscellaneous Fittings (L4) | Earthing (Grounding) Materials, Miscellaneous Fittings (L5) | Qualified-Globally | | | | Burndy LLC - All Mfg Locs | All Countries |
| HUBBELL INCORPORATED | Hubbell Incorporated | Electrical (L2) | Bulk Materials (L3) | Circuit Breaker Panels (L4) | Division 2 / Zone 2 Lighting and Power (L5) | Qualified-Globally | | Brand: Killark | | Hubbell Incorpo - All Mfg Locs | All Countries |
| HUBBELL INCORPORATED | Hubbell Incorporated | Electrical (L2) | Bulk Materials (L3) | Control Stations (L4) | Control Stations (L5) | Qualified-Globally | | Brand: Killark | | Hubbell Incorpo - All Mfg Locs | All Countries |
| HUBBELL INCORPORATED | Hubbell Incorporated | Electrical (L2) | Bulk Materials (L3) | Outlets, Single Phase (L4) | Outdoor, Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | Brand: Killark | | Hubbell Incorpo - All Mfg Locs | All Countries |
| LEGRAND | Legrand North America, LLC | Electrical (L2) | Bulk Materials (L3) | Outlets, Single Phase (L4) | Indoor, Non-Hazardous Locations (L5) | Qualified-Globally | | | | Legrand North A - All Mfg Locs | All Countries |
| Martin Hilti Familien Treuhänderschaft | Hilti Aktiengesellschaft | Electrical (L2) | Bulk Materials (L3) | Multi-Cable Transits (MCT) (L4) | Multi-Cable Transits (MCT) (L5) | Qualified-Globally | | | | Hilti Aktienges - All Mfg Locs | All Countries |
| Melby Gärd Holding AB | Roxtec GmbH | Electrical (L2) | Bulk Materials (L3) | Multi-Cable Transits (MCT) (L4) | Multi-Cable Transits (MCT) (L5) | Qualified-Globally | | | | Roxtec GmbH - All Mfg Locs | All Countries |
| NVENT ELECTRIC PUBLIC LIMITED COMPANY | Erico International Corporation | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Cable Lugs (L4) | Earthing (Grounding) Materials, Cable Lugs (L5) | Qualified-Globally | | | | Erico Internati - All Mfg Locs | All Countries |
| NVENT ELECTRIC PUBLIC LIMITED COMPANY | Erico International Corporation | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Ground Rods (L4) | Earthing (Grounding) Materials, Ground Rods (L5) | Qualified-Globally | | | | Erico Internati - All Mfg Locs | All Countries |
| NVENT ELECTRIC PUBLIC LIMITED COMPANY | Erico International Corporation | Electrical (L2) | Bulk Materials (L3) | Earthing (Grounding) Materials, Miscellaneous Fittings (L4) | Earthing (Grounding) Materials, Miscellaneous Fittings (L5) | Qualified-Globally | | | | Erico Internati - All Mfg Locs | All Countries |
| PHOENIX CONTACT GMBH & CO. KG | Phoenix Contact GmbH & Co. KG | Electrical (L2) | Bulk Materials (L3) | Terminal Blocks (L4) | Terminal Blocks (L5) | Qualified-Globally | | | | Phoenix Contact - All Mfg Locs | All Countries |
| PHOENIX MECANO AG | PHOENIX MECANO | Electrical (L2) | Bulk Materials (L3) | Circuit Breaker Panels (L4) | Division 2 / Zone 2 Lighting and Power (L5) | Qualified-Globally | | | | PHOENIX MECANO - All Mfg Locs | All Countries |
| PHOENIX MECANO AG | Rose Systemtechnik GmbH | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | | | Rose Systemtech - All Mfg Locs | All Countries |
| R. Stahl Aktiengesellschaft | R. Stahl Tranberg AS | Electrical (L2) | Bulk Materials (L3) | Circuit Breaker Panels (L4) | Division 2 / Zone 2 Lighting and Power (L5) | Qualified-Globally | | | | R. Stahl Tranbe - All Mfg Locs | All Countries |
| R. Stahl Aktiengesellschaft | R. Stahl Tranberg AS | Electrical (L2) | Bulk Materials (L3) | Control Stations (L4) | Control Stations (L5) | Qualified-Globally | | | | R. Stahl Tranbe - All Mfg Locs | All Countries |
| R. Stahl Aktiengesellschaft | R. Stahl Tranberg AS | Electrical (L2) | Bulk Materials (L3) | Control Stations and Push Buttons (L4) | Hand-Off Auto (HOA) (L5) | Qualified-Globally | | | | R. Stahl Tranbe - All Mfg Locs | All Countries |
| R. Stahl Aktiengesellschaft | R. Stahl Tranberg AS | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | | | R. Stahl Tranbe - All Mfg Locs | All Countries |
| R. Stahl Aktiengesellschaft | R. Stahl Tranberg AS | Electrical (L2) | Bulk Materials (L3) | Outlets, Single Phase (L4) | Outdoor, Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | R. Stahl Tranbe - All Mfg Locs | All Countries |
| R. Stahl Aktiengesellschaft | R. Stahl Tranberg AS | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, 3 Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | R. Stahl Tranbe - All Mfg Locs | All Countries |
| R. Stahl Aktiengesellschaft | R. Stahl Tranberg AS | Electrical (L2) | Bulk Materials (L3) | Plugs & Receptacles, Single Phase (L4) | Division 2/Zone 2 Hazardous Locations (L5) | Qualified-Globally | | | | R. Stahl Tranbe - All Mfg Locs | All Countries |

Annexure-IV

| | | | | | | | | | | | |
|---------------------------------------|---------------------------|-----------------|---------------------|--|---|--------------------|---|--|----------------------|--------------------------------|---------------|
| Schneider Electric | SCHNEIDER ELECTRIC FRANCE | Electrical (L2) | Bulk Materials (L3) | Control Stations and Push Buttons (L4) | Hand-Off Auto (HOA) (L5) | Qualified-Globally | | | Brand: Telemecanique | Schneider Elect - All Mfg Locs | All Countries |
| Schneider Electric | Square D LLC | Electrical (L2) | Bulk Materials (L3) | Control Stations and Push Buttons (L4) | Hand-Off Auto (HOA) (L5) | Qualified-Globally | | | | Square D LLC - All Mfg Locs | All Countries |
| Schneider Electric | Square D LLC | Electrical (L2) | Bulk Materials (L3) | Panels (L4) | Indoor, Non-Hazardous Locations (L5) | Qualified-Globally | | | | Square D LLC - All Mfg Locs | All Countries |
| WATLING STREET CAPITAL PARTNERS LLP | BARTEC FRANCE | Electrical (L2) | Bulk Materials (L3) | Control Stations and Push Buttons (L4) | Hand-Off Auto (HOA) (L5) | Qualified-Globally | | | | BARTEC FRANCE - Fegersheim | France |
| WATLING STREET CAPITAL PARTNERS LLP | BARTEC GmbH | Electrical (L2) | Bulk Materials (L3) | Circuit Breaker Panels (L4) | Division 2 / Zone 2 Lighting and Power (L5) | Qualified-Globally | | | | BARTEC GmbH - All Mfg Locs | All Countries |
| Weidmuller Investment USA Inc. | Weidmuller Inc | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | | | Weidmuller Inc - All Mfg Locs | All Countries |
| Weidmuller Investment USA Inc. | Weidmuller Inc | Electrical (L2) | Bulk Materials (L3) | Terminal Blocks (L4) | Terminal Blocks (L5) | Qualified-Globally | | | | Weidmuller Inc - All Mfg Locs | All Countries |
| | SPARTAN CONTROLS LTD | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Accepted-Locally | Imperial Oil - The "Accepted" status applies to suppliers that have been used or accepted in a specific or limited context in the past. These suppliers have not gone through a formal EM Global Engineering and Quality evaluation for use globally by Projects / Business Units. These suppliers may be considered for use by Projects / Business units after evaluating and mitigating risk. | | | SPARTAN CONTROLS LTD CALGARY | Canada |
| | SPARTAN CONTROLS LTD | Electrical (L2) | Bulk Materials (L3) | Panels (L4) | Indoor, Non-Hazardous Locations (L5) | Accepted-Locally | Imperial Oil - The "Accepted" status applies to suppliers that have been used or accepted in a specific or limited context in the past. These suppliers have not gone through a formal EM Global Engineering and Quality evaluation for use globally by Projects / Business Units. These suppliers may be considered for use by Projects / Business units after evaluating and mitigating risk. | | | SPARTAN CONTROLS LTD CALGARY | Canada |
| NVENT ELECTRIC PUBLIC LIMITED COMPANY | Hoffman Enclosures Inc. | Electrical (L2) | Bulk Materials (L3) | Junction Boxes (L4) | Junction Boxes (L5) | Qualified-Globally | | | Brand: Hoffman | Hoffman Enclosu - All Mfg Locs | All Countries |



ExxonMobil - ABB Technical Approval

Specification GP 16-09-01, revision May 2012

1 Scope

This document covers below listed types of low voltage ABB induction motors for fixed speed applications. The technical clarifications for other motors can be prepared on a case by case basis.

M3GP = LV Flameproof Induction Motor (IEC)
 M3KP = Engineered modular squirrel cage induction motor
 Baldor LV = IEEE 841 squirrel cage induction motor

2 Included specifications

This document contains the standard comments to ExxonMobil GP 16-09-01:2012 specification regarding induction motors listed above table.

3 Comments

| Paragraph and Abstract of Text in Specification | Comment | Customer Approval/ Comment | M3GP (EnA) | M3KP (Exde) | Baldor LV (IEEE841) |
|---|---|----------------------------|------------|-------------|---------------------|
| | | | | | |
| Scope 1) [I] This Global Practice (GP) covers design and testing of low voltage alternating current (AC) squirrel cage induction motors rated up to and including 200 hp (150 kW). | This agreement includes pricing up to and including 250HP (200kW) | | X | X | X |
| 1, 2, 7. 1), 8. 3), 6. 6), (GP-02-01-01) Additional requirements for use in the US; standards | Low voltage motors are quoted according to certificates and standards in force at time of delivery, including those according to IEC, ISO, EN 50014, EN 50018, ATEX 94/9/EC and EN/IEC 60079. Motors are not designed in accordance with any API, NEMA, IEEE UL or ABMA standard. | Accepted | X | X | |
| 1.1 | Providing motors that meet 80dBa at 3 feet unloaded or less where possible. Sound level will be stated in quotation. Sound data will be provided in standard format. As an option for motors that do not meet the 80dBA limit sound reducing auxiliary devices will be offered. | Accepted | X | X | |

| Paragraph and Abstract of Text in Specification | Comment | Customer Approval/ Comment | M3GP (EnA) | M3KP (Exde) | Baldor LY (IEE841) |
|--|--|----------------------------|------------|-------------|--------------------|
| 3. Documentation | <p>Data sheets, curves, drawings and/or test records will be provided according to ABB standard form, format (.pdf, .xls or .doc) and data content.</p> <p>Outline drawings and data sheets will include a listing of customer tag numbers if provided with purchase order data.</p> <p>Technical data is typically not included in outline drawings but in separate data sheets.</p> <p>Standard ABB Operation & Maintenance manuals and relevant ATEX/IEC certificates are also included.</p> <p>Data requiring information regarding load or driven equipment, such as speed/torque curves, can only be provided after necessary data has been received from the OEM.</p> | Accepted | X | X | X |
| 4.1) Surface treatment | <p>Quoted painting is special painting system C3 according to ISO 12944-2 1998. Color will be standard ABB Munsell Blue. C4 and C5M painting system for offshore installations, including a zinc rich epoxy primer layer, is offered as an option. Special RAL color shade can be offered on request.</p> | Accepted | X | X | |
| 4.2.2 | Open Bearings are quoted | Accepted | | | X |
| 4.2. 3) b) Be capable of operating for at least 8000 hours without requiring addition of grease or a complete change of grease. | <p>ABB recommends re-greasing according to the L1 principle. If the L10 (Approx $L_{10}=2,7 \times L_1$) principle is followed the defined L10 8,000 hours is not possible to reach for some 2 pole motor types and particularly in elevated ambient temperatures.</p> <p>Lubrication interval will be stated on a lubrication plate on the motor. Also the motor manual will have information about lubrication.</p> | Accepted | X | X | |
| 4.2.3 b) Be capable of operating for at least 8000 hours without requiring addition of grease or a complete change of grease. | <p>Lubrication of bearings is dependent on service conditions. In extreme conditions (IEE841 section 3.2) lubrication may be required more frequently. See instruction manual.</p> | Accepted | | | X |

| Paragraph and Abstract of Text in Specification | Comment | Customer Approval/ Comment | M3GP (EnA) | M3KP (Exde) | Baldor LY (IEEE841) |
|---|---|--|------------|-------------|---------------------|
| 4.2.3 c), d) | Motor frame sizes 160-450 have grease lubricated, re-greasable deep groove ball bearings and lubrication construction of ABB standard design (grease ports according to industry standards). Grease outlet requires a valve below the bearing that needs to be opened for old grease to be pushed out when re-greasing. Old grease will drop down below the bearing. Fan housing is not required to be removed. | Accepted | X | X | |
| 4.2.3 e) Have seals provided to prevent loss of lubricant. | IP-56, non-contact, labyrinth Inpro Seal bearing isolators are included. | Accepted | | | X |
| 4.2.5 Anti-friction bearings shall have an L10 rated life, per ABMA 9 and ABMA 11, of at least 100,000 hours for all direct connected horizontal motors and at least 50,000 hours for normally loaded belt-connected motors. | Belt loading data is required to verify bearing life on belted applications. As a minimum, motors will be suitable for 26,280 hours minimum per IEEE-841 for belted applications assuming standard NEMA belt load. Motors for air-cooled heat exchanger applications will be designed per API 661 with 40,000 hours L10 bearing life. | Accepted. Belt loading to be provided during RFQ | | | X |
| 4.2.5 Anti-friction bearings shall have an L10 rated life, per ABMA 9 and ABMA 11, of at least 100,000 hours for all direct connected horizontal motors and at least 50,000 hours for normally loaded belt-connected motors. | Loading limits are calculated based on L10 40,000 hours. Lifetimes for other loadings can be calculated on a case by case basis following submission of complete loading types and amounts. | Accepted. Belt loading to be provided during RFQ | X | X | |
| 4.4) Motor efficiency shall be IE3 where available and IE2 as a minimum per IEC 60034-30. | Motors will have an efficiency according to IEC IE2 as standard. IE3 ExnA motors are also available and quoted as an option. | Accepted | X | X | |
| 4.6) VFD operation | Where motors quoted are indicated to be suitable for inverter duty, motors will be according to IEC standards. ABB mandatory VFD duty options are included. The correct motor frame size can only be determined once complete load details and speed ranges have been provided. | Accepted for IEC | X | X | |

| Paragraph and Abstract of Text in Specification | Comment | Customer Approval/ Comment | M3GP (EnA) | M3KP (Exde) | Baldor LY (IEEE841) |
|---|---|---|------------|-------------|---------------------|
| | | | | | |
| 6. 4), 6. 5), 6. 6) Bearings for vertical motors, bearing life | <p>Loading limits are calculated based on L10 40,000 hours. Lifetimes for other loadings can be calculated on a case by case basis following submission of complete loading types and amounts.</p> <p>Thrust bearings are located at the driven end to keep thermal expansion as neutral as possible.</p> <p>Shaft run out will be according to IEC 6007 2-1 class N</p> | Accepted if according to IEC standard. | X | X | |
| 4.3 Lifting Provisions | Motors above 25 kg have lifting lugs. | Accepted | X | X | |
| 4.5 Terminal Boxes | <p>Terminal boxes are provided according to IEC standards.</p> <p>For ExnA (M3GP) motors ABB provides oversized terminal boxes as standard mounted on the top of the motor for frame size 132mm and below approx. 7,5kW. For frame 160mm and above greater motors will have on the right hand side mounted terminal boxes.</p> <p>For all Exde (flameproof) (M3KP) motors the terminal box will be on the top of the motor.</p> <p>Motors supplied with top mounted terminal boxes will be clearly stated in the quotation.</p> | Accepted with clear statement of location in Quotation | X | X | |
| 5. 5) Earthing bolt | There is an earthing bolt on the motor frame as standard, the location will be according to ABB standard. | Accepted | X | X | |
| 5.6) Horizontal motors rated 100 hp (75 kW) and above shall be provided with foot mounting pads that have been integrally designed with provisions for doweling and jacking. | The Stock motor available at distributors does not come with provisions for doweling and jacking. When stock motors are purchased through distributors, these provisions can be requested by the purchaser at an extra cost. However, these provisions will be provided by default for factory-filled motors | | X | X | X |
| 6. 1)a), b), c) Non-reverse ratchets | Non-reverse ratchets are not available for IEC. NEMA motors can be supplied. | Accepted. For IEC motors other vendors will be accepted | X | X | X |
| 7.1),2) Rotor balance and Vibration | Balancing and vibration are quoted in accordance with IEC60034-14 grade A for frames sizes 280 and smaller and Grade B for frames 315 and above | Accepted for IEC motors | X | X | |
| 8.1) Motors shall be suitable for full-voltage starting and for each of the following..... | Motors are capable of 2 cold and 1 hot start per NEMA standards. Load Curves and Inertia reflected to the motor shaft are required to verify additional capability. | Accepted | | | X |

| Paragraph and Abstract of Text in Specification | Comment | Customer Approval/ Comment | M3GP (EnA) | M3KP (Exde) | Baldor LV (IEEE841) |
|---|--|---|------------|-------------|---------------------|
| 8.3) Noise levels | Noise levels in dB(A) are according to data delivered separately without attenuation methods. Completion of octave band reports is not included. ABB will provide the lowest noise motor to XOM. ABB will provide silencer as an option. | Accepted | X | X | |
| 9. Inspection and test | Routine testing and vibration level testing in accordance with IEC or NEMA MG1 and IEEE841-2009 standards are included. Other tests and/or inspections can be offered as options. Single phase LR offered as part of 841. Prototype Data is available. (IEEE 841 motors only) 1,3,4,5 are per chapter 9, item 2: For IEC motors locked rotor point measured at lowered voltage. | Accepted Routine testing for IEC and IEEE841. | X | X | X |

Technical Acceptance:

Designs according to the above fulfil the requirements of ExxonMobil specification GP 16-09-01
ExxonMobil has reviewed and accepted ABB, Reliance and Baldor named product design based upon the above mentioned comments.

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ExxonMobil - ABB Technical Approval

Specification GP 16-09-02, revision May 2012

1 Scope

This document covers below listed types of low voltage ABB induction motors for fixed speed applications. The technical clarifications for other motors can be prepared on a case by case basis.

- AMD = MV Flameproof Induction Motor (IEC)
- AMI = Engineered modular squirrel cage induction motor
- HXR = Engineered squirrel cage rib cooled motor
- Baldor MV = Engineered Squirrel cage motor, Baldor (Reliance)

2 Included specifications

This document contains the standard comments to ExxonMobil GP 16-09-02:2012 specification regarding induction motors listed in above table.

3 Comments

| Paragraph and Abstract of text in specification | Comment | ExxonMobil approval / comments | AMD | AMI | HXR | Baldor MV |
|--|--|--------------------------------|-----|-----|-----|-----------|
| 1 Required references | Flameproof motors Exd(e) are available according to IEC standards 60079-0 and 60079-1, and on request per area classified according to NEC 505, with Aexd(e) designation. | Accepted | X | | | |
| 1.1 GP 02-01-01 Facility Sound Level Design Criteria | Unless otherwise specified in the quotation, ABB will comply with requested noise level. Motors equipped with silencer will be specified within the quotation. Further details are specified at clause 6.15 | Accepted | X | X | X | X |
| 2.1 GP 10-12-01 Vibration, Axial-Position, and Bearing-Temperature Monitoring Systems for Compressors and Drivers | Remarks to GP 10-12-01 will be issued case by case when this is applicable. | Accepted | X | X | X | X |
| 3.2 The following two standards shall be used when specified for large critical unspared motors | The motors are also available according to API 541 standard on request and relevant purchase datasheet shall be provided. Separate comments to API541 standard will be delivered with the bid. API 546 is not applicable to frame agreement scope of supply. | Accepted | X | X | X | X |
| 5.0 The list of the required material to be delivered with the motor | Documents requested under letter w) "For unspared critical motors, and motors larger than 1500 HP (1100 kW)" will be delivered to Exxon Mobil only, with data as specified in API 541 data sheet. | Accepted | X | X | X | X |
| 6.1.3 General requirements | All stators of induction motors will go through the VPI treatment as one piece. The details of VPI facilities are available on special request. | Accepted | X | X | X | |
| 6.1.3 f) Vendor shall provide the following information including coil cross section dimensions, on the proposed stator winding insulation design: i) Strand insulation material. ii) Turn insulation material. iii) Ground wall insulation. iv) Slot anti corona, and stress grading protection. | As per remark specified under clause 5.0. | Accepted | X | X | X | |

| Paragraph and Abstract of text in specification | Comment | ExxonMobil approval / comments | AMD | AMI | HXR | Baldor MV |
|--|--|--------------------------------|-----|-----|-----|-----------|
| 6.2 Bearings and Lubrication | Vertical motors will be offered based on oil lubricated bearings unless ABB has limited experience or does not recommend for the application. ABB will specify bearing types, life and lubrication intervals. | Accepted | X | X | X | |
| 6.2.3 b) Motors with grease lubricated bearings shall meet the following: b) Be capable of operating for at least 8000 hours without requiring addition of grease or a complete change of grease. | Shorter re-greasing intervals will be specified during bidding phase for customer review and approval. | Accepted | X | X | X | X |
| 6.2.6 All horizontal sleeve bearing motors, and all motors with axially unrestrained roller bearings, shall have a location bearing or other thrust provision.... | Baldor sleeve bearing designs do not have continuous mechanical thrust provisions. The 440 frame design is not available with sleeve bearings. | | | | | X |
| 6.2.6 All horizontal sleeve bearing motors, and all motors with axially unrestrained roller bearings, shall have a location bearing or other thrust provision.... | Standard sleeve bearings construction does not need a location bearing since motors will be coupled with a limited end float coupling. All motors are suitable to run continuously and be tested at no load. | Accepted | X | X | X | |
| 6.2.7 L10=100,000 hrs horizontal coupled motors, L10 = 50,000 hrs belted motors | HXR, AMI and AMD meet the requested bearing life. In the exceptional case this is not possible it will be highlighted during the bidding stage. Coupled motors will meet requirement. Belted service we need to review data before promising L10=50,000hrs. | Accepted | X | X | X | X |
| 6.2.7 b) Anti-friction bearings, except for the angular contact type, shall have loose internal clearance fit equivalent to ABMA Fit No. 3 | Exception: Bearings are open, grease is restricted by motor construction and PLS system. Bearing inner cap serves purpose of shield to restrict grease migration into motor. | Accepted | | | | X |
| 6.2.8 b) Bearing housings -wall thickness to permit sleeving without required redrilling and tapping of end cap bolts. | Exception: The brackets do not have sufficient wall section between the bearing and cap bolts to allow for sleeving. | Accepted | | | | X |
| 6.3.1 Motors shall have a total end play of at least 1/2 in. (12 mm). The running center of the rotor shall not shift from either side of the geometric center of the rotor's total endplay by more than 3/32 in. (2 mm). | Flameproof motor types Exd IIB (type AMD) motors have the maximum rotor float as +/- 3 mm [1/8 inch] in case there are equipped with a sleeve bearing. That is due to the protection type of the motor (flame paths). Running center of HXR and AMI manufactured according to Exxon Mobil specification is 3/32 inches = 2.4 mm (and not 2mm). | Accepted | X | | | |
| 6.3.2 An indicator, to indicate allowable limits of rotor movement after coupling installation and alignment, shall be furnished equivalent to the following:.... | Exception: On sleeve bearing TEFC motors an indicator may not be available due to space constraints but on all motors the indicator reduces the amount of useable shaft. | Accepted | | | | X |
| 6.3.2.b Notch on the indicator shall be adjacent to a shaft shoulder and shall mark the allowable excursion of the shoulder. | Exception: ABB-Baldor places a line or 3 lines on the shaft in order to show the float limits and magnetic centerline. These lines are cut into the shaft and are permanent markers for the limits. | Accepted | X | X | X | X |
| 6.5 Vibration | API vibration levels quoted. 0.10 in/sec velocity measured on the bracket. All levels are uncoupled, no load, unfiltered measurements with motor mounted to a massive foundation at the manufacturing facility. | Accepted | | | | X |
| 6.5 Vibration | ABB confirms combined electrical and mechanical run-out per API 541 4th edition. The required vibration levels are confirmed per table 1 at GP 16-09-02 with remarks as specified in Appendix 3.1 | Accepted | X | X | X | |

| Paragraph and Abstract of text in specification | Comment | ExxonMobil approval / comments | AMD | AMI | HXR | Baldor MV |
|--|---|--------------------------------|-----|-----|-----|-----------|
| 6.5.2 b) If Vendor can demonstrate that electrical run-out (due to shaft material anomalies) is present in measurements made with proximity probes, this may be added to the allowable vibration level up to a maximum of 0.25 mils (0.006 mm), provided a hand-held shaft contacting probe gives results not exceeding the allowable limit. | Vibration Probe Total Runout - 3 attempts will be made to meet .25 mils in V-Blocks. After 3 attempts. Motor will meet .375 mils in V-Blocks (as defined in 4.3.3.1). At test, with the motor assembled, motor will meet the .45 mils | Accepted | | | | X |
| 6.10.1 Air Filters | Exception: Air Filters are capable of filtering particles of 0.0015 mm but the filter efficiency of filtering that size particle is about 60%. The entire filter (the filter frame and media) is stainless steel. The frame in the motor hood that the filters slide into is carbon steel and has the same coating system as the rest of the motor. The filter access is by way of a hinged panel in the top hood. The hinge is stainless steel, the hinge pin is brass. | Accepted | | | | X |
| 6.12.4 Motor terminal box shall be designed to reduce the risk of motor terminal box explosion. Details of the method used shall be submitted with the proposal. Acceptable methods include the following: a) Terminal box with phase segregation and insulated connections and bus. b) Terminal box with fully insulated conductors and connections. c) Terminal box capable of withstanding three-phase fault pressure or designed with pressure relief for three-phase fault pressure. i) The desired direction of the discharge of pressure relief systems shall be included in the motor specification provided to Manufacturer. ii) Pressure design capabilities shall not alter the motor's suitability for service in specified area classification. | Unless otherwise specified, motors will be supplied with air insulated main terminal box, with 6 terminals and pressure relief protection – method (c). Also available on request: (a) Phase segregated terminal box (with no insulated cable lugs) (b) Terminal box with elastimold connections. Both in case (a) and (b), only 3 terminals are available in main terminal box. Remaining 3 leads will be provided in a dedicated terminal box. Refer to appendix 3.2 for drawings and further information. | Accepted | X | X | X | |
| 6.12.4 Terminal Boxes As above | Baldor standard main terminal box will be provided with a fault withstand and bus bars. The boxes are NEMA 4 and are not designed for rotation. Standard cable entry design is bottom, however interchangeable side plates can be provided. The box is 11 gauge fabricated steel construction. Refer to appendix 3.2 for pressure calculations. | Accepted | | | | X |
| 6.13.2 Die-cast aluminum rotors are permitted only on motors driving low inertia, non-frequent starting, non-critical, centrifugal loads up to 1000 HP (750 kW). Die-cast aluminum rotors are not permitted on motors above 1000 HP (750 kW). Die-cast aluminum rotors are not permitted for use with variable speed drives. | Die cast aluminum rotors will be offered as the base price offer for motors 1000HP and below. Fabricated copper bar rotors will be offered as an option in these cases. | | | | | X |
| 6.14.3 Sole Plates | Sole Plates are not provided for Baldor motors | Accepted | | | | X |
| 6.15 Noise level shall be in accordance with the sound pressure level specified in GP 02-01-01 when measured at 3 ft (1 m) from the surface at rated voltage and load. | Noise measurement will be carried out under no-load, conditions according to ISO or IEEE standards. The noise level will be designed as close to 82 dB(A) as technically feasible. Motors exceeding requested value will be specified during bidding phase for approval. In case noise damper is needed it will be specified in our proposal. | Accepted | X | X | X | X |
| 7.1 c Additional requirement for unspared critical motors driving special purpose equipment Maximum mechanical and electrical run-out (total indicator reading) of 0.25 mils (6.4 µm) | Combined electrical and mechanical run-out per API 541 4 th edition. | Accepted | X | X | X | X |

| Paragraph and Abstract of text in specification | Comment | ExxonMobil approval / comments | AMD | AMI | HXR | Baldor MV |
|--|---|--------------------------------|-----|-----|-----|-----------|
| <p>8 Additional Requirements for Unspared Critical Motors Driving Special Purpose Equipment 1) [A] [R] Induction Machines over 500 HP (375 kW) shall be designed and constructed to comply with API STD 541 unless otherwise approved by the Owner's Engineer. Synchronous Machines shall be designed and constructed to comply with API STD 546. 2) [*] [I] Main drive motors required to meet the following additional requirements of items (3)–(31) below shall be specified. 3) [*] [I] Each main drive motor shall comply with the following additional requirements of this GP:</p> | <p>Section 8 motors are not included in the frame agreement and they will be quoted on a case by cases basis, when required.</p> | Accepted | X | X | X | X |
| <p>8.12 Applicable only for unspared critical motors Coil connections shall be such as to minimize the voltage between the top and bottom coil in the slots. Details of the coil connections shall be submitted with the proposal</p> | <p>The required material regarding coils and leads have been submitted to Exxon Mobil for review, and accepted as a principle. The material will not be sent separately with each case.</p> | Accepted | X | X | X | |
| <p>8.13 Applicable only for unspared critical motors The sizing basis for motor lead sizing and confirmation of the leads' insulation material and resistance to lubricating oil shall be submitted with the proposal.</p> | <p>The required material regarding coils and leads have been submitted to Exxon Mobil for review, and accepted as a principle. The material will not be sent separately with each case.</p> | Accepted | X | X | X | |
| <p>8.15 Applicable only for unspared critical motors A pressurized labyrinth, with braided-metal jacketed tubing, from the fan discharge or from an external instrument air source shall be provided. Rigid supports are required for the tubing to prevent vibration and failure. A pressure indicator shall be provided at each motor bearing to indicate positive pressure at the labyrinth inlet</p> | Not applicable to our scope of supply. | Accepted | X | X | X | |
| <p>8.17 Applicable only for unspared critical motors a) Vendor shall submit calculations to confirm space heater can maintain motor interior temperature above dew point for site temperature and humidity ranges. b) Access plates shall be provided for space heaters and interconnections. c) Space heaters and interconnections shall be designed to allow ready access for maintenance and replacement without dismantling motor end plates or exchangers.</p> | <p>Motors space heater selection based on more than 10 years' experience, and their power is selected to maintain internal temperature of the motor 5K above the external temperature. It is not possible to replace space heaters without dismantling the motor end plates in case of the IC 411 (TEFC) and flameproof motors.</p> | Accepted | X | X | X | |
| <p>8.30 Applicable only for unspared critical motors Motors shall be designed with access panels for safe inspection of the motor stator end windings with the motor installed in the field and disconnected from its power source.</p> | <p>Access panel on cast iron motors (HXR motors) is not available, since the enclosure is moulded from a casting. Access panel on Exd motors (AMD) is not available, due to explosion proof construction.</p> | Accepted | X | | X | |
| <p>9.5 Terminal boxes shall be watertight and made of cast iron, or of fabricated carbon steel 1/8 in. (3 mm) minimum thickness.</p> | <p>The junction boxes for wiring of the auxiliary accessories are fabricated from the corrosion protected metals and not necessarily fulfill all requirements. The main junction boxes are per the requirement. Auxiliary boxes are IP55 minimum.</p> | Accepted | X | X | X | |

| Paragraph and Abstract of text in specification | Comment | ExxonMobil approval / comments | ExxonMobil | | | Baldor MV |
|--|---|---|------------|-----|-----|-----------|
| | | | AMD | AMI | HXR | |
| 9.8 External cooling fans shall be made of a materials designed to prevent sparking due to mechanical contact from failure of motor bearings or any rotating parts, or due to static discharge. Cooling fans shall also be constructed to prevent failure due to fatigue or corrosion. | The external cooling fans are fabricated from the corrosion resistance materials are such as painted steel (standard), stainless steel, aluminum or plastic. Motors with plastic fans are not fitted with a key. Fan system is according to the applicable non-sparking IEC 60079-15 international standard. External fans made of steel will be painted according to C5-M painting cycle (suitable for marine installation) according to ISO ISO12944-2 (atmospheric-corrosivity categories). | Accepted | X | X | X | |
| 9.13 The ventilating systems for forced-ventilated motors shall have two blowers for supplying air to the motor. Each blower shall have capacity to supply the quantity of air required at the motor's highest continuous overload capability. Motors of motor-driven blowers shall be three-phase and terminated so that they may be fed from independent power sources. | In cases the redundancy of the forced ventilation system is not available, it will be communicated during bidding stage. | Accepted | X | X | X | |
| 9.15 Motors specified for use in Class I, Division 1 locations shall be pressurized with clean, dry, non-contaminated air (such as instrument air, where available, or otherwise with an inert gas, as specified). Total leakage from the enclosure and shaft seals shall be limited to less than 100 cu ft (2.8 cu m) per day provided the internal pressure does not exceed 2 in. H ₂ O (0.5 kPa). | The leakage rate of the Class I Division 1 pressurized motors exceed the required value, acceptance of that shall be reviewed on a case by case basis by ExxonMobil. | Accepted | X | X | X | |
| 9.15 Motors specified for use in Class I, Division 1 locations shall be pressurized with.... | Motors for class I, division 1 atmospheres are TEFC and are not pressurized. | Accepted | | | | X |
| 10.2 Non-reverse ratchet devices | Non-reverse ratchet will be mounted either Non-drive or Drive-end on motor if equipped. Non-reverse ratchet is not available on Exd motors. | Accepted | X | X | X | |
| 10.6 Motors with rolling element bearings, designed for radial or axial loads transmitted from the pump, shall be designed with bearings as follows... | The vertical induction motors are typically equipped with deep groove ball bearing in case of low thrust force. In case of the high axial force the oil lubricated thrust bearings are used. However, the final confirmation for the maximum acceptable axial forces needs to be studied case by case. Flameproof motors (AMD) bearing lifetime shall be confirmed case by case base. | Accepted | X | X | X | |
| 10.6 Motors with rolling element bearings, designed for radial or axial loads transmitted from the pump, shall be designed with bearings as follows... | Top bearing (thrust bearing) is oil lubricated, bottom bearing (guide bearing) is grease lubricated. | Accepted | | | | X |
| 11.2 Performance characteristics, with rated voltage and frequency applied, shall be as follows: | Locked rotor torque requirement of 100% of the motor rated torque applies only to motors up to 1100 kW (1500 Hp). Motors above 1100 kW (1500 Hp) will be according to API 541. Motors having lower locked rotor torque values will be advised at quotation and require ExxonMobil approval. | Accepted | X | X | X | |
| 12.8.1 Squirrel cage induction motors shall be capable of carrying out at least 30,000 starts over a 30-year motor life cycle | To be checked and agreed on a case by case basis. | Limited to extruder motors which are larger and limited units sold. | X | X | X | |

| Paragraph and Abstract of text in specification | Comment | ExxonMobil approval / comments | AMD | AMI | HXR | Baldor MV |
|--|---|--------------------------------|-----|-----|-----|-----------|
| 13 Inspection and testing | For motors according to NEMA standards the efficiency determination will be according to IEEE 112 method B or as alternative method F. For motors manufactured according to IEC, equivalent IEC method shall be used. Different methods shall requires ExxonMobil approval. | Accepted | X | X | X | |
| 13.1.5.e Full load heat run including a minimum running time of two hours after temperature has stabilized... | Preferred method for temperature rise acceptance criteria is based on RTD's method. As alternative, resistance method may be proposed but requires ExxonMobil approval. | Accepted | X | X | X | |
| 13.1.5.f Vibration on bearing housings and shaft shall not exceed limits in Table 1. | Acceptance criteria for vibration measurement are referred at no load and at operating temperature for motors subjected to heat run. Vibration test is carried out at 50Hz or 60 Hz depending on motor design frequency. | Accepted | X | X | X | |
| 13.1.7 Submerged test of motor insulation, if specified in the order or if specified as a later addition to the order, shall conform to the procedure described in NEMA MG 1 Part 20.18.1 "Test for Stator Which Can Be Submerged." | Depending on the factory capability, when the immersion test is not possible, the stator winding conditions will be tested by the spray test method according to NEMA MG 1 Part 20.18.1. | Accepted | X | X | X | |

Technical Acceptance:

Designs according to the above fulfil the requirements of ExxonMobil specification GP 16-09-02
ExxonMobil has reviewed and accepted ABB, Reliance and Baldor named product design based upon the above mentioned comments.

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4 Appendices

4.1 Supplementary Material – Vibration (2.1)

I accept bearing vibration changes listed below for >3000rpm which are per API 541 standard.

| Synchronous Speed | | Anti-Friction Bearings | | | | Hydrodynamic Journal Bearings (Sleeve or Pad) | | | | | |
|-------------------|-------|------------------------|--------|----------------------------|-------------------------------|--|--------|----------------------------|-------------------------------|----------------------------|-------------------------------|
| | | On Bearing Housing (1) | | | | On Bearing Housing (1) | | | | On Shaft (2) | |
| | | Zero-to-Peak Velocity | | Peak-to-Peak Displacement | | Zero-to-Peak Velocity | | Peak-to-Peak Displacement | | Peak-to-Peak Displacement | |
| Rev/m | Rev/s | in. | (mm) | in. | (mm) | in. | (mm) | in. | (mm) | in. | (mm) |
| | | per second | | | | per second | | | | | |
| < 1500 | < 25 | 0.08 | (2.03) | 0.002 | (0.051) | 0.1 | (2.54) | 0.0015 | (0.038) | 0.0015 | (0.038) |
| 1500–2999 | 25–50 | 0.08 | (2.03) | 0.0015 | (0.038) | 0.1 | (2.54) | 0.0012 | (0.030) | 0.0015 | (0.038) |
| ≥ 3000 | ≥ 50 | 0.08 | (2.03) | 0.001 0.0015 | (0.025) (0.038) | 0.1 | (2.54) | 0.001 0.0012 | (0.025) (0.030) | 0.001 0.0015 | (0.025) (0.038) |

Notes:
 (1) Axial Limit = 0.8 x Radial Limit.
 (2) Excludes Shaft Runout.

Vibration limit values are guaranteed at no load because in ABB test field, motor cannot be fully insulated from basement and breaking equipment, and the whole system will induce additional vibration on the motor, affecting measurement.

International standards like IEC and NEMA already define low vibration limits to be matched at no-load to guarantee that motors perform well on-site.

For your knowledge and reference, based on ABB experience, even with no-load measurements being higher than mentioned values, vibration levels at site have always been at satisfactory levels.

We guarantee vibration limits on the base of proposed comment. As further demonstration, vibration at full load will be monitored during load test to secure that levels do not change and no harmful vibration is generated, but cannot be used as acceptance criteria.

Discussions with ABB engineers have also generated some considerations about limits for faster motors (3000 rpm and up). Exxon limits are even lower than API limits. Until today no comment has been advanced, but there is the risk that shaft has to go through further machining after test (especially for bigger shafts), still not matching Exxon values. This will impact time schedule and costs. Therefore ABB proposes values as highlighted in the table.

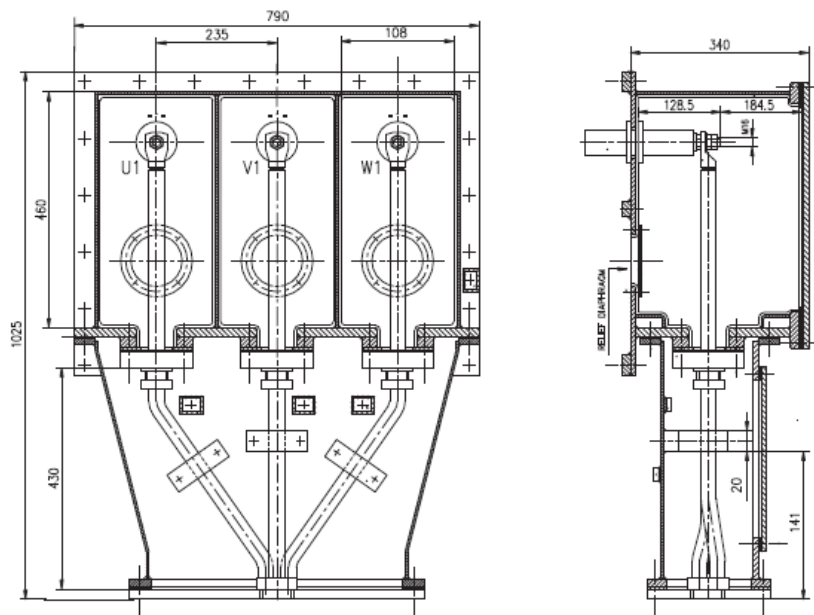
4.2 Supplementary Material –Terminal Box (6.12.4)

Solution (a)

AMD and AMI 710mm and up

| DocumentKind | Status | DocumentID | Rev |
|----------------|----------|------------|-----|
| AMD MDD | Approved | Exd-13060 | I |
| Title | Date | Pages | |
| Terminal boxes | 23/01/09 | 20(32) | |

2.3.12 Phase segregated terminal box - II2G-Ex e II code: 105674 (11kV)



Technical data:

| | | |
|------------------------------------|-------------|---|
| Voltage (max.) | 11 | kV |
| Current (max.) | 400 | A |
| No of cables (max.) | 1 | per phase |
| Cross section of cables (min/max); | 125-150/300 | mm ² /cable (depending on max fault level) |
| Connection terminals | M16 | |
| Ground connections | 3 x M12 | |
| Protection | IP55 | (on request IP56) |
| Fault level (peak) | 30 kA | for 0.5 sec. (75 kA) |
| | 40kA | for 0.25 sec. (100 kA) |
| | 50kA | for 0.2 sec. (125 kA) |

Materials:

| | | |
|---|-----------------|---|
| Box | welded steel | internal walls and separations barriers are coated by epoxy resin and fiber glass (thickness 2mm) |
| Insulators | epoxy resin | |
| Grounding bolt | stainless steel | |
| Entry cable removable plate in amagnetic material | | |

Note: star point shall be in a separate terminal box

HXR and AMI up to 630 mm

| | | | |
|-----------------------|-------|------------|--------|
| Technical description | Valid | 3AAM100099 | K |
| Main terminal boxes | | 2012-11-02 | 43(43) |

4.7 Phase segregated terminal box

Phase segregated terminal box is so designed that phase segregation is provided by earthed metallic barriers forming completely distinct individual phase compartments so as to restrict any electrical breakdown to an earth fault. Phase segregated terminal box is shown in figure 43.

Technical data:

| | |
|--------------------------------|---|
| Voltage (max.) | 11 kV |
| Rated current | 545 A with silicone rubber cables |
| Fault capacities | - 3.3 kV 250 MVA - 6.6 kV 500 MVA - 11 kV 833 MVA |
| No of cables (max.) | two cables per phase can be accommodated with special spreading chamber |
| Cross section of cables (max.) | 240 mm ² |
| Protection | IP 55 |
| Ex protection | Ex e, Ex nA |

Phase segregated terminal boxes eliminate phase to phase faults. In the event of a fault developing between phase and earth in one of the glass reinforced plastic terminal enclosures, the rapid build up of pressure will cause the enclosure to fracture across the rear wall, thus releasing hot gases and flame into the steel phase-segregating compartment.

- If the faulty energy is low it is likely that the fault products will be contained within the compartment.
- If the fault energy is excessive, the bakelite relief disc will fail and the fault product will pass into the equipment interior where it will rapidly cool and disperse. By venting this way phase to phase faults are thus eliminated.

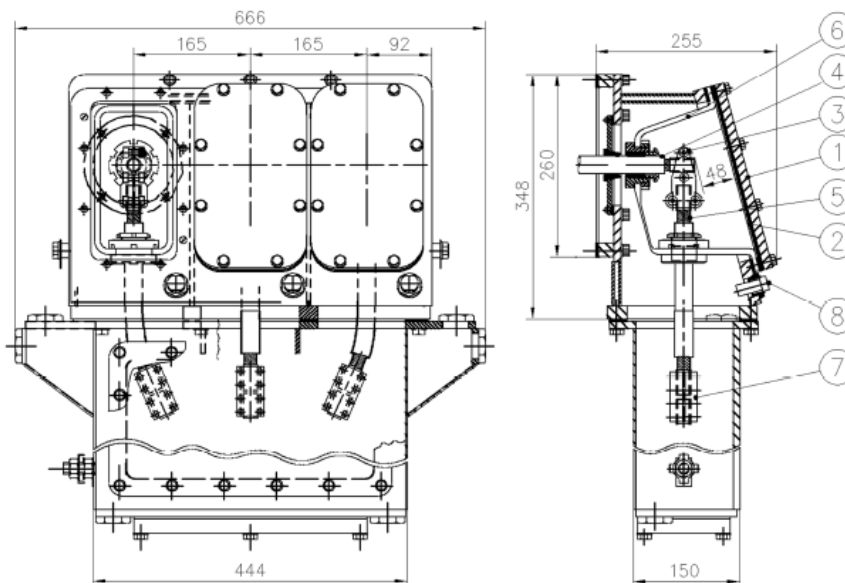


Figure 43. Typical phase segregated terminal box

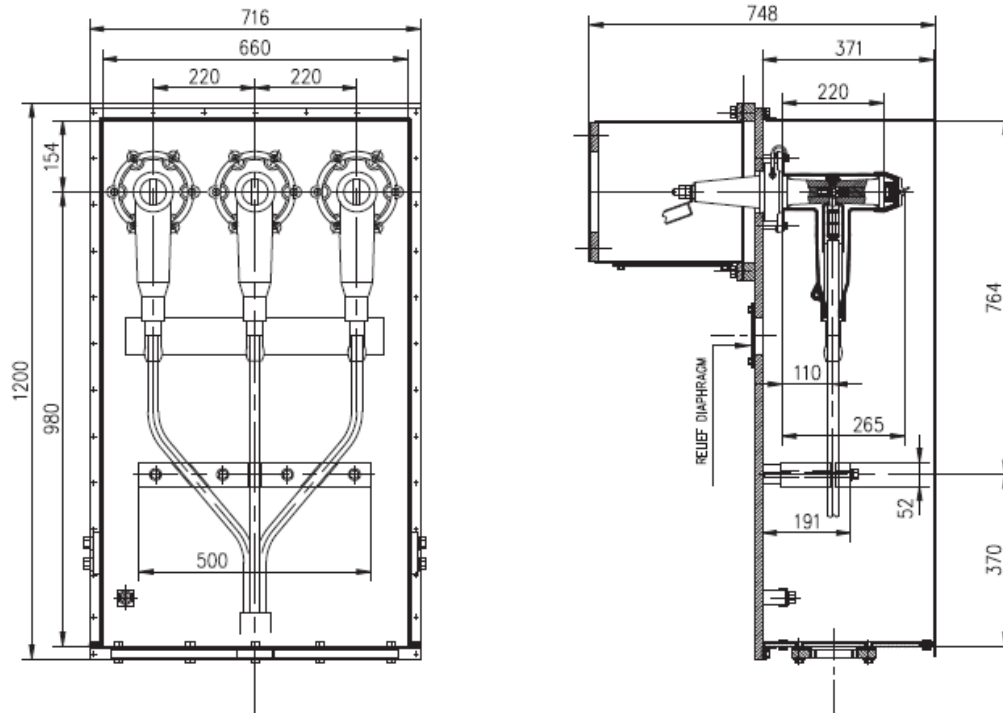
- | | |
|-----------------------------------|---|
| 1) Terminal box cover plates | 6) Glass reinforced plastic terminal enclosures |
| 2) Glass reinforced plastic liner | 7) Intermediate/supply cable clamps |
| 3) Motor cable connection clamps | 8) Indicating desiccator |
| 4) Stator winding cables | |
| 5) Intermediate cables | Shallow and deep sealing chambers available. |

Note: star point shall be in a separate terminal box

Solution (b)

AMD and AMI 710mm and up

| DocumentKind | Status | DocumentID | Rev |
|----------------|----------|------------|-----|
| AMD MDD | Approved | Exd-13060 | I |
| Title | Date | Pages | |
| Terminal boxes | 23/01/09 | 18(32) | |

2.3.10 Phase insulated terminal box (Elastimold system or Bimold) - II2G-Ex e II code: 207357 (11kV)*Technical data:*

| | | |
|--------------------------------|-----------------|--|
| Voltage (max.) | 11 | kV |
| Current (max.) | 630 | A |
| No of cables (max.) | 1 | per phase |
| Cross section of cables (max.) | 300 | mm ² /cable (min cable section depending on max fault level required) |
| Connection terminals | different sizes | acc. to dimensions and material (Cu or Al) |
| Ground connections | M12 | |
| Mechanical protection degree | IP55 | (on request IP56) |
| Fault level (peak) | 50 kA | for 1 sec. (125 kA) – value guaranteed by insulators and their connectors |

Materials:

Box welded sheet steel - Termination kit supplied by Elastimold;
 Entry cable removable plate in amagnetic material - Grounding bolt stainless steel;
 For low temperature (less than -20°C) II2G-Ex e heating elements inside terminal box are available (P=145 W max. power) connected into II2G-Ex e auxiliary terminal box.

Note: star point shall be in a separate terminal box

HXR and AMI up to 630mm

| | | | |
|-----------------------|-------|------------|--------|
| Technical description | Valid | 3AAM100099 | K |
| Main terminal boxes | | 2012-11-02 | 37(43) |

4.1 Phase insulated high voltage terminal box, max 11 kV / 400 A

Technical data:

| | |
|---------------------------------------|---|
| Voltage (max.) | 11.0 kV (with CSA approval 7.2 kV @ 400 A) |
| Current (max.) | 400 A |
| No of cables (max.) | 1 per phase ¹⁾ |
| Cross section of cables (max.) | 300 mm ² /cable ¹⁾ |
| Cable gland | blind gland (1 pcs) ¹⁾ |
| Gross volume | 197 dm ³ |
| Usable volume | 189 dm ³ |
| Connection screws | M16 (1 pcs/phase) |
| Tightening torque for connection nuts | 40 Nm |
| Ground connections | M12 (both in- and outside) |
| Weight | 81 kg |
| Protection | IP66 |
| Ex protection | Ex e, Ex nA, Ex t, Ex p |
| Insulated connectors | ZWE KAP630-11 (supply cable 50 ... 120 mm ²) |
| | ZWE KAP630-12 (supply cable 150 ... 185 mm ²) |
| | ZWE KAP630-22 (supply cable 240 ... 300 mm ²) |

Complete insulated connectors according to cable cross area

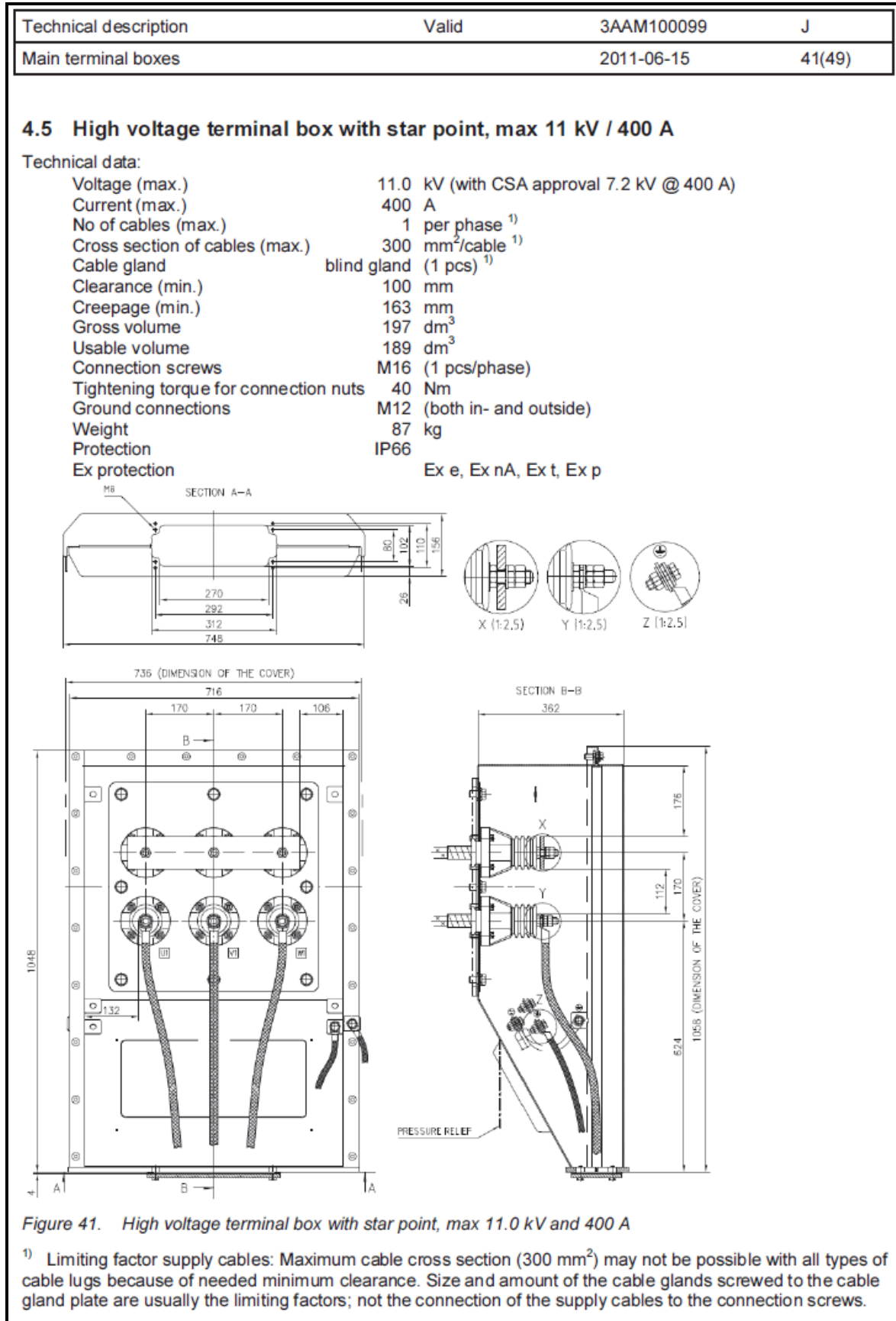
Figure 37. Phase insulated high voltage terminal box, max 11.0 kV and 400 A

¹⁾ Limiting factor supply cables: Maximum cable cross section (300 mm²) may not be possible with all types of cable lugs because of needed minimum clearance. Size and amount of the cable glands screwed to the cable gland plate are usually the limiting factors; not the connection of the supply cables to the connection screws.

Note: star point shall be in a separate terminal box

Solution (c) (This is the solution we propose as standard)

AMD, HXR and AMI



Supplementary Material –Terminal Box (6.12.4)



Pressure Relief Calculations

Pressure Developed by Arcs

$$P=11.58 \times I_{arc} / D^{0.9}$$

Formula per "Pressures Developed by Arcs" Ralph H. Lee , IEEE Applications on Industry Applications, Vol. 1A-23 No. 4, July/August 1987

$I_{arc} = 50$ Kamps

$D = 4.53$ inches

$$P = 1396.43 \text{ lb/ft}^2 = 9.697 \text{ lbs/in}^2$$

Here is the Website for the calculator used:

person standing 2 feet away from the arc source and weighing 75kg (170 lbs) with acceleration of approx 100 meters (330 feet) per second.

The arc flash blast energy or pressure is not currently addressed in IEEE 1584 or NFPA 70E. Ralph Lee's IEEE paper *Pressures Developed by Arcs* addresses arc blast phenomenon and provides the formula for calculating initial impulse force:

$$P = 11.58 \times I_{arc} / D^{0.9}$$

where,
 P is pressure in lbs/ft²
 I_{arc} is arcing current in kA
 D is distance from arc in feet

Arcing current I_{arc} can be calculated using ARCAD [online arc flash calculator](#), *Arc-Flash-Analytic* or the IEEE 1584 formula 5.2 and substituted in the above equation or arc blast pressure calculator below:

Iarc, kA D, inches P, lbs/ft²

Energies produced by arc flash explosions are comparable to dynamite explosions. These forces can be significant. They have been known to blow workers tens of meters away from the arc causing falls and injuries that may be more severe than the burns themselves.

130 pages of expert advice on Arc Flash and Arc Flash safety

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Pressure Calculations for the one Bolt in the Conduit Box Cover

Per Machinery Handbook 24th Edition page 1325

$$A_t = 0.7854 (D - (0.9743/n))^2$$

For RKN part number 32018-006-BG

$$D = 0.2982 \text{ in}$$

$$n = 18$$

$$S = 75,000 \text{ psi}$$

Using these values, solving for A_t .

$$A_t = 0.04679 \text{ in}^2$$

Using the A_t value and the properties on the bolt.

$$P = S \times A_t$$

$$P = 3509.25 \text{ Lbs}$$

Pressure to Rupture the Designed Rupture Disk

$$\text{Thickness on the Metal} = 0.0296''$$

$$\text{Width of the Cut} = 0.25''$$

$$\text{Area} = 0.0074''$$

$$\text{Material Tensile Strength} = 70,000 \text{ psi}$$

$$\text{Pressure} \times \text{Area} = \text{Force to Rupture}$$

$$\text{Force to Rupture} = 518 \text{ lbs}$$

Revision history

| Rev. | Date (yyyy-mm-dd) | Prepared by | Division/ Department | Description |
|------|----------------------|-------------|-------------------------|------------------|
| A | 2013-03-11 | G. Moroni | PG LACM | Original version |
| B | | | | |

Exhibit D

ABB NEMA MV TEFC / TEAAC Motor Features for Agreement A2136181

Customer: ExxonMobil

Delivery Terms: FCA Kings Mountain, North Carolina, USA

Specification: 16-09-02 ; Revision: March 05, 2013

Price Sheet Revision Date: 11/15/2017

Basic Features:

Complies with API 541 4th Edition
3300 ft (1000 m) Elevation Above Sea Level Altitude
Division 2, Class I, C & D T3
Zone 2, Class I, IIA, IIB T3
1.0 Service Factor
+40 0 C Maximum Ambient
-18 0 C Minimum Ambient
Class F Insulation
Class B Temperature Rise
Energy Efficient design
Direct Coupled
Horizontal Mounting

Bearings:

Sleeve Bearings
Oil Lubrication
Self Lube or Provision for Flood Lube
IP 55 Ingress Protection
Insulated Bearings
Constant Level Oiler - Self Lube machines only

Vibration/Balance/Sound:

API 541 vibration (0.10 in/sec)
API Foot Planarity (0.002 in / ft.)
85dBA maximum Sound Pressure Level No Load @3 feet

Stator/Rotor:

Stator and rotor epoxy coated for corrosion protection
Cast Aluminum Rotor (up through 1000HP)*
Fabricated Copper Bar Rotor (>1000HP)

* Fabricated Copper Bar Available

Enclosure/Frame:

Totally-Enclosed – TEFC and TEAAC
XTS Enclosure Enhancement
Bi-Directional, Non- sparking Fan
Vertical Jacking and Dowell Holes
Spot Faced For Hold-Down Bolts
Threaded drains in frame

Shaft

4150 Forged shafts on 2 Pole motors 1000HP and above
1040 Class I Shaft Material all others
Application may require shaft material change

Main Terminal Box

Fab. Steel NEMA 4X Painted Terminal Box
Oversized for Accessories
Lead Entry Location – Bottom
Double Hole Lead Lugs
Oil Resistant Silicon Leads
Main Terminal Box Breather Drains
BUS Bars & Standoffs (Tin Plated)
Fault Withstand
Differential Current Transformers- Qty 3, 50:1 (above 2500HP)

Hardware:

Stainless steel nameplates
Grounding lug in terminal box
2 Frame Grounds
304 Stainless steel hardware

Nameplates:

Phase Sequence
Starting Duty
Direction Arrow
Equipment Tag
Flood lubricated motors: oil flow rate and oil pressure required
CSA Label
High Voltage Warning Label
Additional Main N/P

Other:

Taconite Seals
Permanent End Float Marker
APEX (UV Resistant) Paint System
Low Temp. Space Heater wired to Auxiliary T/Box
3.5 pu rise time 0.1 to 0.2 micro seconds surge withstand
Solid Seal Insulation, (2 cycle capable of passing sealed winding test)
Stator RTD's - Qty (6) 2 / ph. 100 Ohm 0.00392 TCR (3 wire)
Bearing Thermocouples - Iron Constantan Type J, 1/ bearing

Exhibit D

ABB NEMA MV WPII Motor Features for Agreement A2136181

Customer: ExxonMobil

Delivery Terms: FCA Kings Mountain, North Carolina, USA

Specification: 16-09-02 ; Revision: March 05, 2013

Price Sheet Revision Date: 11/15/2017

Basic Features:

Complies with API 541 4th Edition
3300 ft (1000 m) Elevation Above Sea Level Altitude
Division 2, Class I, C & D T3
Zone 2, Class I, IIA, IIB T3
1.0 Service Factor
+40 °C Maximum Ambient
-18 °C Minimum Ambient
Class F Insulation
Class B Temperature Rise
Energy Efficient design
Direct Coupled
Horizontal Mounting

Bearings:

Sleeve Bearings
Oil Lubrication
Self Lube or Provision for Flood Lube
IP 55 Ingress Protection
Insulated Bearings
Constant Level Oiler - Self Lube machines only

Vibration/Balance/Sound:

API 541 vibration (0.10 in/sec)
API Foot Planarity (0.002 in / ft.)
85dBA maximum Sound Pressure Level No Load @3 feet

Stator/Rotor

Stator and rotor epoxy coated for corrosion protection
Cast Aluminum Rotor (up through 1000HP) *
Fabricated Copper Bar Rotor (>1000HP)

* Fabricated Copper Bar Available

Enclosure/Frame

WPII
Stainless Steel Filters
Stainless Steel Screens
Provision for Differential Pressure Switch
Bi-Directional, Non- sparking Fan
Vertical Jacking and Dowell Holes
Spot Faced For Hold-Down Bolts
Threaded drains in frame

Shaft

4150 Forged shafts on 2 Pole motors 1000HP and above
1040 Class I Shaft Material all others
Application may require shaft material change

Main Terminal Box

Fab. Steel NEMA 4X Painted Terminal Box
Oversized for Accessories
Lead Entry Location – Bottom
Double Hole Lead Lugs
Oil Resistant Silicon Leads
Main Terminal Box Breather Drains
BUS Bars & Standoffs (Tin Plated)
Fault Withstand
Differential Current Transformers- Qty 3, 50:1 (above 2500HP)

Hardware:

Stainless steel nameplates
Grounding lug in terminal box
2 Frame Grounds
304 Stainless steel hardware

Nameplates:

Phase Sequence
Starting Duty
Direction Arrow
Equipment Tag
Flood lubricated motors: oil flow rate and oil pressure required
CSA Label
High Voltage Warning Label
Additional Main N/P

Other:

Taconite Seals
Permanent End Float Marker
APEX (UV Resistant) Paint System
Low Temp. Space Heater wired to Auxiliary T/Box
3.5 pu rise time 0.1 to 0.2 micro seconds surge withstand
Solid Seal Insulation, (2 cycle capable of passing sealed winding test)
Stator RTD's - Qty (6) 2 / ph. 100 Ohm 0.00392 TCR (3 wire)
Bearing Thermocouples - Iron Constantan Type J, 1/ bearing

| | | |
|---|---|--|
| Medium Voltage Induction Motor Frame Agreement - Data Sheets Multi-Country Master Goods & Services Agreement No A2136181 Amendment #004 US Customary Units | User: <u>ExxonMobil</u> Supplier: <u>ABB / Baldor Reliance</u> Site Name & Location: _____ Project Name: _____ Project No: _____ EPC: _____ EPC Proj No.: _____ | |
|---|---|--|

| | |
|---|---|
| Purchaser: _____ PO Number: _____ Qty: _____ Item Name / Tag #: _____ | ABB / Baldor Reliance Ref No: _____ Rev No: <u>0</u> Date: _____ Applicable to: _____ By: _____ Approved: _____ |
|---|---|

KEY: Completed by Purchaser Purchaser or ABB/Baldor

1 Applicable Standards: NEMA API-541, 4th Ed GP 16-09-02 May 2012 Technical Approval from Agreement No A2136181
 2 (Except as modified by this data sheet. When API-541, 4th Ed is specified, this datasheet replaces the API datasheets for this agreement)

3 **Site Conditions:**

4 Ambient temperature: -18 °C to 40 °C Altitude: 3300 ft (1000 m) Max Location: Indoor Outdoor With Roof
 5 Seismic Loading IBC Zone: _____ Importance Factor: _____ Onshore Offshore
 6 Exposed to: Dust Corrosive Agents Chemicals: _____
 7 Area Classification: Class: 1 Groups: C & D Division 2 Zone _____ Other Zone 2, Class I, IIA, IIB, T3
 8 Temperature Code / Autoignition Temperature: T3 / 200 °C Non-hazardous location

9 **Driven Equipment and Starting Requirements**

10 Load Speed vs Torque and Inertia: Per NEMA MG1 Part 20 (1/2 NEMA Inertia for 2 pole) Per actual load (Include load details)
 11 **Note:** Actual load data is required for 2 pole machines as it can have a significant impact on motor design

12 Starting Load condition: Unloaded (Closed Valve / Damper) Loaded (Open Valve / Damper) Partially Loaded
 13 If NEMA Load curve specified, what is the % load at full speed in starting conditions: _____ % loaded NEMA curve (centrifugal load)
 14 Starting: Direct On Line Min Starting Voltage for DOL Start: 80 % volts
 15 Other Starting Method Details: _____
 16 Maximum allowable Locked Rotor Current (% of FL): 650 % Allowable Consecutive Starts 3 Motor at Ambient 2 Motor Above Ambient

17 **Motor Basic Requirements**

18 Nameplate Rating: _____ HP kW _____ RPM (Synchronous) _____ Volts 3 Phase 60 Hertz
 19 Motor Power Source: Sine Wave Power Adjustable Speed Drive (ASD) - Complete details on page 2 lines 20 to 25
 20 Service Factor: 1.0 Insulation: Class F - VPI - Solid Seal Temperature Rise: Class B at Full Load
 21 Connection to Load: Direct Coupled Belted - details _____
 22 Mounting: Horizontal Vertical Foot Mounted Flange Mounted - details _____
 23 Axial thrust / radial load details: _____
 24 Enclosure: WP-II Stainless Steel Filters Galvanized Filters Pressure Switch Pressure Gauge
 25 TEFC TEAAC TEAAC Tube Material: Aluminum 300 Series Stainless 316 Series Stainless
 26 TEWAC Tube Material: 90-10 Cu-Ni Other: _____
 27 TEWAC Tube Construction: Single Tube Double Tube Leak Detector
 28 TEWAC Cooling Water: Water / Glycol _____ % Glycol Other Water Conditions / Chemistry (attach details)
 29 TEWAC Other: _____
 30 Other Enclosure: _____

31 Max Sound Pressure Level @ 3 ft (1M), No Load, Full Voltage and Frequency, Sine Wave, Overall Average 82 dBA _____ dBA
 32 Rotor Construction: Fabricated Copper Bar Die Cast Aluminum
 33 **Note:** Per 16-09-02 cast aluminum is acceptable with ExxonMobil approval for 1000HP and below
 34 Shaft Material: ABB / Baldor Standard Hot Rolled AISI 4150 Forged AISI 4150 (4150 is required w/ probes, or prov for probes)
 35 Note: Forged AISI 4150 is required for 2 pole machines above 1000HP
 36 Bearings: Sleeve Lubrication: Self Lube Constant Level Oilers (Oil-Rite brand) Provisions for flood lubrication
 37 Antifriction for horizontal motors Lubrication: Grease Oil mist Provisions for oil mist
 38 Antifriction for vertical Top bearing Grease Oil sump Bottom bearing Grease Oil sump
 39 Both bearings Insulated Further details: _____

40 Paint System: ABB/Baldor-Reliance enhanced APEX paint system (4824-7-BPX) C5M - Extreme Duty for Off Shore Applications
 41 ABB/Baldor-Reliance Standard Color Special Color: _____
 42 Hardware-Fasteners (Through M12, 1/2 inch): 300 Series Stainless Steel 316 Series Stainless Steel (For Offshore)
 43 Baseplate by: Driven Equipment Mfr Existing Soleplate: By: Driven Equipment Mfr ABB Type: 1 Piece 2 Piece

44 Notes: _____
 45 _____
 46 _____

| | | |
|---|---|--|
| Medium Voltage Induction Motor Frame Agreement - Data Sheets Multi-Country Master Goods & Services Agreement No A2136181 Amendment #004 US Customary Units | User: <u>ExxonMobil</u> Supplier: <u>ABB / Baldor Reliance</u> Site Name & Location: _____ Project Name: _____ Project No: _____ EPC: _____ EPC Proj No.: _____ | |
|---|---|--|

| | |
|-------------------------------------|---|
| Purchaser: _____ | ABB / Baldor Reliance Ref No: _____ |
| PO Number: _____ | Rev No: <u>0</u> Date: _____ Applicable to: _____ |
| Qty: _____ Item Name / Tag #: _____ | By: _____ Approved: _____ |

KEY: Completed by Purchaser Purchaser or ABB/Baldor

Main Terminal Box

Main Box Location Facing Non-Drive End (NDE): Right Side (F-1) Left Side (F-2) Breather Drains: Yes No

Box Size: NEMA Type II with Tin Plated Bus Bars Fault Withstand: Blowout Panel Leads: Oil Resistant Silicone Lugs

Lead Entry Location: Bottom Toward DE Toward NDE Lead Entry Type: Blank Panel NPT Fitting Size: _____

Stator Leads in Terminal Box: 6 Leads with neutral bus 3 Differential Current Transformers 50:5 100:5 (Req'd above 2500HP)

Accessories: Space Heaters _____ Phase _____ Voltage 1 Current Transformer for Ammeter (CT accuracy class = C10)

Surge Capacitors Lightning Arrestors **Note:** SC's and LA's are not available for ASD driven motors

Note: SC's and LA's are not common: 1) Below 5kV; 2) Low HP's; 3) Contactor fed motors

Motor Accessories

Space Heaters Temp Code: T3 Volts: _____ Phase: _____

Stator Temperature Detectors: RTD's 2 per phase 100 ohm Stator RTD box location facing NDE: Left side Right side

Bearing Temperature Detectors: Thermocouples Type: J Qty: 1 per brg Bearing temperature detector leads wired to:

RTD's _____ ohm Qty: _____ per bearing Conduit head at bearing In the Stator RTD box

Vibration Probes: Not required Provisions for shaft proximity and phase reference probes _____

Shaft proximity and phase reference probes _____

Adjustable Speed Drive Operation

ASD operation only Capable of ASD and Direct On Line operation

Variable torque speed range: Min speed _____ RPM _____ ft-lb Max speed _____ RPM _____ ft-lb

Constant torque speed range: Min speed _____ RPM Max speed _____ RPM _____ ft-lb

Constant power speed range: Min speed _____ RPM Max speed _____ RPM _____ HP

Additional information: _____

| Testing | <u>Required</u> | <u>Observed</u> | <u>Witnessed</u> |
|---------------------------------------|----------------------------------|-----------------------|-----------------------|
| Design review | <input type="radio"/> | | |
| Lateral critical speed analysis | <input type="radio"/> | | |
| Data for torsional analysis by others | <input type="radio"/> | | |
| Test procedures 6 weeks prior to test | <input type="radio"/> | | |
| Routine test per GP16-09-02 | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Routine test per API-541 4th ed | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Complete test per GP16-09-02 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Complete test per API-541 4th ed | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sealed winding conformance test | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Unbalance response test | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sound level test | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Other tests: | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| _____ | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| _____ | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| _____ | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Notes: _____

| Technical Data Sheet (T160901C01) - Low Voltage AC Motors Up to 200 HP (150 kW) | | | | | | | |
|---|---|-------|-------------|---|----------|------------|-------------|
| Electric Motors - Customary/Metric Units | | | | | | | |
| Facility Name: | | | | Purchase Order No.: | | | |
| Location: | | | | Requisition No.: | | | |
| Item Name: | | | | ExxonMobil Project No.: | | | |
| Item No.: | | | | Contractor Project No.: | | | |
| 1 | USER'S REQUIREMENTS | | | | | | |
| 2 | PLANT IDENTIFICATION: | | | SHAFT EXTENSION OR SPECIAL FITTING: <input type="checkbox"/> Yes <input type="checkbox"/> No | | | |
| 3 | DRIVEN EQUIPMENT ID: | | | AREA CLASSIF: _____ CLASS/DIV _____ ZONE | | | |
| 4 | ADDITIONAL STANDARDS: <input type="checkbox"/> IEEE 841 <input type="checkbox"/> OTHER | | | GAS GROUP: _____ TEMP. CLASS: _____ | | | |
| 5 | SYNCHRONOUS SPEED: _____ rpm | | | MOTOR ENCLOSURE TYPE: <input type="checkbox"/> TEFC <input type="checkbox"/> EX <input type="checkbox"/> IP _____ | | | |
| 6 | RATED OUTPUT: _____ hp _____ kW | | | HAZARDOUS AREA CERTIFICATE REQUIRED: <input type="checkbox"/> Yes <input type="checkbox"/> No | | | |
| 7 | RATED VOLTAGE: _____ V <input type="checkbox"/> 3-PH <input type="checkbox"/> 50 HZ <input type="checkbox"/> 60 HZ | | | MOUNTING AS PER: <input type="checkbox"/> NEMA MG 1 <input type="checkbox"/> IEC 34-7 | | | |
| 8 | WINDING CONNECTION: <input type="checkbox"/> WYE <input type="checkbox"/> DELTA <input type="checkbox"/> OTHER | | | SHAFT HEIGHT: _____ <input type="checkbox"/> in. NEMA MG <input type="checkbox"/> mm IEC 72.1 | | | |
| 9 | STARTING: <input type="checkbox"/> FVNR <input type="checkbox"/> FVR <input type="checkbox"/> VFD <input type="checkbox"/> OTHER | | | MAX SOUND PRESS: ____dBA @ _____ | | | |
| 10 | BEARING TYPE: _____ | | | BEARING LUBRICATION METHOD: _____ | | | |
| 11 | ROTATION FACING NON-DRIVE END: | | | SECTIONAL BEARING DRAWING REQUIRED: <input type="checkbox"/> Yes <input type="checkbox"/> No | | | |
| 12 | DRIVE: <input type="checkbox"/> DIRECT <input type="checkbox"/> BI <input type="checkbox"/> CW <input type="checkbox"/> CCW <input type="checkbox"/> BELT <input type="checkbox"/> GEAR | | | LOCATION: <input type="checkbox"/> OUTDOOR <input type="checkbox"/> INDOOR | | | |
| 13 | SPECIAL PAINT OR OTHER FINISH: <input type="checkbox"/> Yes <input type="checkbox"/> No | | | MAX AMBIENT TEMP: _____ ALTITUDE: _____ | | | |
| 14 | TERMINAL BOX ENTRY DIRECTION: <input type="checkbox"/> TOP <input type="checkbox"/> BOTTOM <input type="checkbox"/> NDE <input type="checkbox"/> DE | | | | | | |
| 15 | CABLE | | | CABLE BOX | | | |
| 16 | CONNCTION | TYPE | CROSS SECT. | OVERALL | LOCATION | PROTECTION | ENTRY |
| 17 | | | | | | | |
| 18 | SPECIAL REQUIREMENTS | | | | | | |
| 19 | IEEE 841 motors recommended for severe duty applications. Use of IEEE 841 data sheet recommended | | | | | | |
| 20 | | | | | | | |
| 21 | MANUFACTURER'S DATA | | | | | | |
| 22 | MANUFACTURER: | | | OUTLINE DRAWING NUMBER: | | | |
| 23 | STANDARD: | | | | | | |
| 24 | RATED OUTPUT: _____ hp _____ kW | | | MOTORS 125 hp (90 kW) AND LARGER: | | | |
| 25 | FULL LOAD SPEED: _____ RPM | | | P.F. AT %LOAD: _____ 100% _____ 75% _____ 50% | | | |
| 26 | RATED VOLTAGE: _____ V | | | EFF. AT %LOAD: _____ 100% _____ 75% _____ 50% | | | |
| 27 | CURRENT (A): _____ FULL LOAD _____ NO LOAD | | | LOCKED ROTOR POWER FACTOR: _____ | | | |
| 28 | INSULATION CLASS/TEMP RISE: _____ CL _____ °C | | | ALLOWABLE TIME AT LOCKED ROTOR WITH RATED V: _____ | | | |
| 29 | LOCKED ROTOR CURRENT (AT RATED V): _____ % FL | | | MOTOR STARTING COLD (AT 40°C AMBIENT): _____ sec | | | |
| 30 | LOCKED ROTOR TORQUE: _____ % FL | | | MOTOR STARTING HOT (AT 40°C AMBIENT): _____ sec | | | |
| 31 | PULL-UP/BREAKDOWN TORQUE: _____ / _____ % FL | | | ROTOR INERTIA (WK ²) [GD ²]: _____ lb-ft ² , kg-m ² | | | |
| 32 | MOTOR WEIGHT: _____ lb _____ kg | | | SPACE HEATER: _____ VOLTS _____ AMPS | | | |
| 33 | BEARING RECOMMENDED LUBRICANT: _____ | | | BEARING MANUFACTURER & NUMBER: _____ | | | |
| 34 | | | | ODE _____ DE _____ | | | |
| 35 | NOISE LEVEL: _____ dBA @ _____ <input type="checkbox"/> ft <input type="checkbox"/> m | | | VERTICAL MOTORS-MAXIMUM ALLOWABLE THRUST: | | | |
| 36 | MOTOR HAZ. AREA CERT.: _____ TYPE _____ NO. | | | UP _____ DOWN _____ | | | |
| Revision Log | | | | | | | |
| Rev | Date | Aprvl | Description | Rev | Date | Aprvl | Description |
| 1 | | | | 4 | | | |
| 2 | | | | 5 | | | |
| 3 | | | | Dwg. No.: | | | |

| Technical Data Sheet (T160901C01) - Low Voltage AC Motors Up to 200 HP (150 kW) | |
|---|--|
| Specification Sheet for Electric Motors - Customary/Metric Units | |
| Facility Name: | Purchase Order No.: |
| Location: | Requisition No.: |
| Item Name: | ExxonMobil Project No.: |
| Item No.: | Contractor Project No.: |
| 1 | Motor Features |
| 2 | Basic Features: |
| 3 | Complies with IEEE 841-2009 |
| 4 | 3300 ft (1000 m) Elevation Above Sea Level Altitude |
| 5 | Division 2, Class I, A,B,C,D T3 |
| 6 | Zone 2, Class I, IIA, IIB, IIC T3 |
| 7 | 1.15 Service Factor |
| 8 | +40C Maximum Ambient |
| 9 | -25C Minimum Ambient |
| 10 | Class F Insulation |
| 11 | Class B Temperature Rise |
| 12 | Efficiency - Meets or Exceeds 841-2009 Table 2 & NEMA Premium |
| 13 | |
| 14 | Enclosure/Frame: |
| 15 | TEFC Severe Mill and Chem Duty Enclosure |
| 16 | Conduit box with NPT threaded lead hole |
| 17 | All Cast iron enclosure: Frame, end shields, Conduit box(es), fan covers |
| 18 | Standard Oversized Cast Iron conduit box |
| 19 | Diagonally split, neoprene gasketed rotatable conduit box |
| 20 | Severe Mill and Chem duty paint color system with Blue-Green color |
| 21 | Bi-Directional, Non- sparking Fan |
| 22 | |
| 23 | Hardware: |
| 24 | Stainless steel nameplates |
| 25 | Grounding lug in terminal box |
| 31 | Frame grounding provision |
| 32 | Corrosion resistant hardware |
| 33 | |
| 34 | |
| 35 | |
| 36 | |
| 37 | |
| 38 | |
| 39 | |
| 36 | |
| | Vibration/Balance/Sound: |
| | Low vibration IEEE-841 (0.08 in/sec) |
| | Ultra-Standard Balance |
| | IEEE-841 Foot Planarity (0.005 in / ft.) |
| | 80dBA maximum Sound Pressure Level No Load @3 feet |
| | |
| | Bearings: |
| | IP 56 Ingress Protection |
| | Anti-Friction Ball Bearings |
| | Lubrication - ExxonMobil Polyrex EM Grease |
| | IEEE-841 Bearing Temp Rises (50C max for 2-poles, 45C max for 4-poles) |
| | Alemite grease fittings |
| | External Grease Reliefs |
| | PLS (Positive Lubrication System) in any mounting position |
| | Shaft Runouts per IEEE-841 |
| | |
| | Stator/Rotor: |
| | Cast Aluminum Rotor |
| | Stator and rotor epoxy coated for corrosion protection |
| | |
| | Other: |
| | NEMA Load Inertia |
| | Suitable for 10:1 variable torque on PWM Adjustable Speed Drives |
| | 5-year limited warranty |
| | Direct Coupled Connection |
| | Horizontal Mounting |



Date May 6, 2024 **Revision 6**
Pricing Annex A3, Attachment 3
Agreement Number Appendix 4 to Exhibit C, A2630511

Revision History T.EN India for Beaumont and Baytwn Sites

| Date | Revision | Location | Description |
|------------|----------|-----------------|-------------|
| 5/1/2015 | 0 | All | |
| 12/14/2016 | 1 | Pricing | |
| 12/14/2016 | 1 | Pricing | |
| 12/14/2016 | 1 | Pricing | |
| 12/14/2016 | 1 | Features | |
| 12/14/2016 | 1 | Com. to API | |
| 12/14/2016 | 1 | Paint System | |
| 5/25/2018 | 2 | Pricing | |
| 5/25/2018 | 2 | Features | |
| 5/25/2018 | 2 | API Features | |
| 5/25/2018 | 2 | Comments to GP | |
| 5/25/2018 | 2 | Comments to GP | |
| 5/25/2018 | 2 | Comments to API | |
| 5/25/2018 | 2 | Paint System | |
| 5/25/2018 | 2 | All | |
| 3/7/2019 | 3 | Pricing | |
| 3/7/2019 | 3 | API Features | |
| 3/7/2019 | 3 | Comments to API | |
| 3/7/2019 | 3 | All | |
| 3/7/2019 | 3 | Comments to GP | |
| 10/5/2020 | 4 | All | |
| 8/30/2021 | 5 | All | |
| 8/30/2021 | 5 | All | |
| 8/30/2021 | 5 | API 541 DS | |
| 8/30/2021 | 5 | Pricing | |
| | | | |
| | | | |
| | | | |
| | | | |



Date **May 6, 2024**
 Pricing **Annex A3, Attachment 3**
 Agreement Number **Appendix 4 to Exhibit C, A2630511**
 Siemens Above Nema Medium Voltage Horizontal Motors - Norwood, Ohio

Revision 6

API 541 5th Ed

| HP | Frame | Pole | Rotor Cage | RPM | Bearing Lube | Noise dBA* (Guar @ 1 m) | Noise Reduction Level** | Cooling Type | Cooling Type | |
|------|-------|------|------------|------|--------------|-------------------------|-------------------------|--------------|--------------|--|
| 250 | 509 | 2 | CU | 3600 | Oil Ring | 85 | 4 | IC 411 | TEFC | |
| 300 | 509 | 2 | CU | 3600 | Oil Ring | 85 | 4 | IC411 | TEFC | |
| 350 | 509 | 2 | CU | 3600 | Oil Ring | 85 | 4 | IC411 | TEFC | |
| 400 | 509 | 2 | CU | 3600 | Oil Ring | 85 | 4 | IC411 | TEFC | |
| 450 | 5011 | 2 | CU | 3600 | Oil Ring | 85 | 1 | IC411 | TEFC | |
| 500 | 5011 | 2 | CU | 3600 | Oil Ring | 85 | 1 | IC411 | TEFC | |
| 600 | 5810 | 2 | CU | 3600 | Oil Ring | 85 | 2 | IC411 | TEFC | |
| 700 | 5810 | 2 | CU | 3600 | Oil Ring | 85 | 2 | IC411 | TEFC | |
| 800 | 5812 | 2 | CU | 3600 | Forced Lube | 85 | 2 | IC411 | TEFC | |
| 900 | 5810 | 2 | CU | 3600 | Oil Ring | 85 | 2 | IC611 | TEAAC | |
| 1000 | 5810 | 2 | CU | 3600 | Oil Ring | 85 | 2 | IC611 | TEAAC | |
| 1250 | 5810 | 2 | CU | 3600 | Oil Ring | 85 | 2 | IC611 | TEAAC | |
| 1500 | 5812 | 2 | CU | 3600 | Oil Ring | 84 | 2 | IC611 | TEAAC | |
| 250 | 509 | 4 | ADC | 1800 | Oil Ring | 85 | 2 | IC 411 | TEFC | |
| 300 | 509 | 4 | ADC | 1800 | Oil Ring | 85 | 2 | IC411 | TEFC | |
| 350 | 5011 | 4 | ADC | 1800 | Oil Ring | 82 | 2 | IC411 | TEFC | |
| 400 | 5011 | 4 | ADC | 1800 | Oil Ring | 82 | 2 | IC411 | TEFC | |
| 450 | 5011 | 4 | ADC | 1800 | Oil Ring | 82 | 2 | IC411 | TEFC | |
| 500 | 5013 | 4 | ADC | 1800 | Oil Ring | 85 | 2 | IC411 | TEFC | |
| 600 | 5013 | 4 | ADC | 1800 | Oil Ring | 85 | 2 | IC411 | TEFC | |
| 700 | 5810 | 4 | ADC | 1800 | Oil Ring | 85 | 2 | IC411 | TEFC | |
| 800 | 5810 | 4 | ADC | 1800 | Oil Ring | 84 | 0 | IC611 | TEAAC | |
| 900 | 5810 | 4 | ADC | 1800 | Oil Ring | 84 | 0 | IC611 | TEAAC | |
| 1000 | 5810 | 4 | CU | 1800 | Oil Ring | 84 | 0 | IC611 | TEAAC | |
| 1250 | 5810 | 4 | CU | 1800 | Oil Ring | 84 | 0 | IC611 | TEAAC | |
| 1500 | 6811 | 4 | CU | 1800 | Oil Ring | 84 | 2 | IC611 | TEAAC | |
| 250 | 509 | 6 | ADC | 1200 | Oil Ring | 82 | 0 | IC 411 | TEFC | |
| 300 | 5011 | 6 | ADC | 1200 | Oil Ring | 82 | 0 | IC411 | TEFC | |
| 350 | 5013 | 6 | ADC | 1200 | Oil Ring | 82 | 0 | IC411 | TEFC | |
| 400 | 5013 | 6 | ADC | 1200 | Oil Ring | 82 | 0 | IC411 | TEFC | |
| 450 | 5810 | 6 | ADC | 1200 | Oil Ring | 82 | 0 | IC411 | TEFC | |
| 500 | 5812 | 6 | CU | 1200 | Oil Ring | 82 | 0 | IC411 | TEFC | |
| 600 | 5812 | 6 | CU | 1200 | Oil Ring | 82 | 0 | IC411 | TEFC | |
| 700 | 5812 | 6 | CU | 1200 | Oil Ring | 82 | 0 | IC411 | TEFC | |
| 800 | 5812 | 6 | CU | 1200 | Oil Ring | 84 | 0 | IC611 | TEAAC | |
| 900 | 5812 | 6 | CU | 1200 | Oil Ring | 84 | 0 | IC611 | TEAAC | |
| 1000 | 6813 | 6 | CU | 1200 | Oil Ring | 84 | 0 | IC611 | TEAAC | |
| 1250 | 6813 | 6 | CU | 1200 | Oil Ring | 84 | 0 | IC611 | TEAAC | |
| 1500 | 6813 | 6 | CU | 1200 | Oil Ring | 84 | 0 | IC611 | TEAAC | |
| 250 | 508 | 2 | ADC | 3600 | Oil Ring | 83 | 1 | IC01 | WPII | |
| 300 | 508 | 2 | ADC | 3600 | Oil Ring | 83 | 1 | IC01 | WPII | |
| 350 | 508 | 2 | ADC | 3600 | Oil Ring | 83 | 1 | IC01 | WPII | |
| 400 | 508 | 2 | ADC | 3600 | Oil Ring | 83 | 1 | IC01 | WPII | |
| 450 | 508 | 2 | ADC | 3600 | Oil Ring | 83 | 1 | IC01 | WPII | |
| 500 | 508 | 2 | ADC | 3600 | Oil Ring | 83 | 1 | IC01 | WPII | |
| 600 | 508 | 2 | ADC | 3600 | Oil Ring | 83 | 1 | IC01 | WPII | |
| 700 | 508 | 2 | ADC | 3600 | Oil Ring | 83 | 1 | IC01 | WPII | |
| 800 | 5010 | 2 | ADC | 3600 | Oil Ring | 82 | 1 | IC01 | WPII | |
| 900 | 5010 | 2 | ADC | 3600 | Oil Ring | 82 | 1 | IC01 | WPII | |
| 1000 | 5010 | 2 | ADC | 3600 | Oil Ring | 82 | 1 | IC01 | WPII | |
| 1250 | 5810 | 2 | CU | 3600 | Oil Ring | 84 | 1 | IC01 | WPII | |
| 1500 | 5810 | 2 | CU | 3600 | Oil Ring | 84 | 1 | IC01 | WPII | |
| 250 | 508 | 4 | ADC | 1800 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 300 | 508 | 4 | ADC | 1800 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 350 | 508 | 4 | ADC | 1800 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 400 | 508 | 4 | ADC | 1800 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 450 | 508 | 4 | ADC | 1800 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 500 | 508 | 4 | ADC | 1800 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 600 | 508 | 4 | ADC | 1800 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 700 | 5010 | 4 | ADC | 1800 | Oil Ring | 83 | 0 | IC01 | WPII | |
| 800 | 5010 | 4 | ADC | 1800 | Oil Ring | 83 | 0 | IC01 | WPII | |
| 900 | 5010 | 4 | ADC | 1800 | Oil Ring | 83 | 0 | IC01 | WPII | |
| 1000 | 5810 | 4 | ADC | 1800 | Oil Ring | 82 | 1 | IC01 | WPII | |
| 1250 | 5810 | 4 | CU | 1800 | Oil Ring | 82 | 1 | IC01 | WPII | |
| 1500 | 5812 | 4 | CU | 1800 | Oil Ring | 83 | 1 | IC01 | WPII | |
| 250 | 508 | 6 | ADC | 1200 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 300 | 508 | 6 | ADC | 1200 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 350 | 508 | 6 | ADC | 1200 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 400 | 508 | 6 | ADC | 1200 | Oil Ring | 82 | 0 | IC01 | WPII | |
| 450 | 5010 | 6 | ADC | 1200 | Oil Ring | 84 | 0 | IC01 | WPII | |
| 500 | 5010 | 6 | ADC | 1200 | Oil Ring | 84 | 0 | IC01 | WPII | |
| 600 | 5010 | 6 | ADC | 1200 | Oil Ring | 84 | 0 | IC01 | WPII | |
| 700 | 588 | 6 | ADC | 1200 | Oil Ring | 85 | 1 | IC01 | WPII | |

| | | | | | | | | | | |
|------|------|---|-----|------|----------|----|---|------|------|--|
| 800 | 5810 | 6 | ADC | 1200 | Oil Ring | 84 | 1 | IC01 | WPII | |
| 900 | 5810 | 6 | ADC | 1200 | Oil Ring | 84 | 1 | IC01 | WPII | |
| 1000 | 5810 | 6 | CU | 1200 | Oil Ring | 84 | 1 | IC01 | WPII | |
| 1250 | 5812 | 6 | CU | 1200 | Oil Ring | 85 | 1 | IC01 | WPII | |
| 1500 | 6811 | 6 | CU | 1200 | Oil Ring | 84 | 1 | IC01 | WPII | |

*DBA is guaranteed sound pressure at 1 meter, no load, free field on sine wave input.

** Reference information for Siemens Quotation Team.

Date May 6, 2024 Revision 6
Pricing Annex A3, Attachment 3
Agreement Number Appendix 4 to Exhibit C, A2630511

Medium Voltage - Above NEMA Motors

TECHNICAL DESCRIPTION OF MOTORS: (Part 1)

Electrical data:

Voltage: 4000V
Voltage tolerance: $\pm 10\%$
Frequency tolerance: $\pm 5\%$, comb. $\pm 10\%$
Insulation class: F; Temperature Rise: Class B
Temperature rise max. 80C by Resistance / 90C by RTD
Starting current I_a / I_n : max. 650%, tolerances acc. NEMA MG 1

Operation data:

Duty: S1
Starting method: DOL
Service factor: 1.00

Service Conditions:

Suitable for 3300 Feet (max)
Suitable Hazardous Area: Class I, Group BCD, Div. 2 per NEC Section 501, paragraph B

Mechanical data:

Protection class: IP55 Cooling method: TEFC or TEAAC
Undrilled cable entry plate (Main Terminal box)
*DBA is guaranteed sound pressure at 1 meter, no load, free field on sine wave input.
Painting: Harsh Duty, Motor Blue (Munsell 8.3B 3.54 / 1.9)

TECHNICAL DESCRIPTION, OPTIONAL FEATURES AND SPECIFICATION COMMENTS OF MOTORS: (Part 2)

See Accompanying Pages

Tests included:

API 541 5th Edition Routine Test (According to NEMA) - Unwitnessed

DOCUMENTATION FOR MOTORS (included):

Instruction & Operations Manual, Motor Dimension Drawing with Wiring Diagrams, Siemens Data Sheet, Current & Torque Curves
API 541 Data Sheet Pages 8 - 12

Delivery Time for Documentation:

- Pre-documentation: 6-7 working weeks after cleared order
- Final documentation: 4 working weeks after motor delivery

Conditions of Pricing and Sale

1. Price and delivery subject to review upon receipt of job-specific, motor data sheets and or additional specifications.
2. Terms and Conditions per Siemens - ExxonMobil Multi-Country Master Goods and Service Agreement
3. Pricing is applicable to new motor installations. Replacement/Duplicate motors are excluded.
4. Pricing is FCA Norwood Motor Plant (No freight included)
5. All Pricing is based on first customer of Siemens for ExxonMobil FA identified projects.



Date
Pricing
Agreement Number

May 6, 2024
Annex A3, Attachment 3
Appendix 4 to Exhibit C, A2630511

Revision 6

AboveNEMA Motors

Base Features:

- K10A API 541 5th Ed. Standard Features
 - API 541 5th Ed. Required Feature: (9) 100 Ohm Platinum DIN Standard, 3/phase, 3-wire
 - API 541 5th Ed. Required Feature: 2-plane Precision Balance
 - API 541 5th Ed. Required Feature: 300 Series Stainless Steel Hardware
 - API 541 5th Ed. Required Feature: 650 percent maximum in-rush
 - API 541 5th Ed. Required Feature: Air gap measurement
 - API 541 5th Ed. Required Feature: Both Bearings Insulated (includes ground strap)
- R50 API 541 5th Ed. Required Feature: Breather-Drain
 - API 541 5th Ed. Required Feature: C5 Core plate
 - API 541 5th Ed. Required Feature: Copper Ground Pads
 - API 541 5th Ed. Required Feature: Heavy-duty stator bracing
 - API 541 5th Ed. Required Feature: Magnetic Center Indicator
 - API 541 5th Ed. Required Feature: Material Identification - shaft only (per API 541)
 - API 541 5th Ed. Required Feature: Mounting surfaces machined to 250 micro-inches
 - API 541 5th Ed. Required Feature: Phosphorous-free Braze (Cu Rotors)
- API 541 5th Ed. Required Feature: Rupture panel for main terminal box per para 5.1.2
- API 541 5th Ed. Required Feature: Spot-faced mounting holes
- API 541 5th Ed. Required Feature: Surge comparison test
- API 541 5th Ed. Required Feature: Vertical jackscrews
- S02 API 541 5th Ed. Siemens Feature: Corrosion protection on the rotor
- S05 Stator: Class F VPI insulation
- R17 Stator: Stator RTD Shielding, Stainless Steel Stator RTD Shielding
- A84 Bearing: Bearing RTDs, (4) 100 Ohm Platinum (0.00385 TCR) DIN Std, dual-element, 3-wire, 2/brg, Stick
- R22 Bearing: Bearing RTDs, Spring loaded fittings (for bearing RTDs - stick type only)
- K10 Assembly: NEMA F-1 Assembly
- Copper Bar or ADC Rotor (as noted)
 - Special Feature: T3C Space Heaters
 - Special Feature: Removable Space Heater Design to meet API 541 Requirements
(All Units except TEFC/Fin-Cooled)
 - ExxonMobil Special Feature: No Magnetic Slot Wedges
- M52 Terminal Box - Auxiliary: Separate boxes, 1 for space heater and 1 for temperature instrumentation leads
- U95 Terminal Box - Main: Ground Bus
- U82 Terminal Box - Main: NEMA Type II, Fab Steel (FS2 - 21750 cu.in. volume)
- U99 Terminal Box - Main: Removable Bottom Plate for Main Box
 - Special Feature: Tin-Plated Bus Bars
- U93 Terminal Box - Main: Ground Lug
- U74 Terminal Box - Main: NEMA 4X Compliant
- API 541 Routine Test (non Witnessed)
- S03 Paint: Harsh duty painting system, standard color
 - Special Feature: ExxonMobil - Nameplates per GP 16-09-02, Para 6.8
- Q101 Technical/Commercial: Standard Warranty - 24 months from date of manufacture

Additional Feature(s) For Motors

- Low Noise Features for TEFC (if applicable)
 - Level 1: Lower Degree Pitch External Fan
 - Level 2: Acoustic Chamber
 - Level 3: Uni-Directional Wingfan
 - Level 4: Acoustic Chamber & Lower Degree Pitch External Fan
 - Special Feature: Stainless Steel Screen Installed over sound abatement material for improved retention.
- Differential Pressure Switch and Gauge (WPII motors)

Date **May 6, 2024** Revision **6**
 Pricing **Annex A3, Attachment 3**
 Agreement Number **Appendix 4 to Exhibit C, A2630511**

| | |
|--|--|
| Customer / Project / Standard | ExxonMobil |
| Document Type | Comments and Deviations |
| Products | |
| Factory | Norwood, Ohio |
| Product Details (e.g. cooling type and | Medium Voltage AC Induction Motors |
| Considered Document(s) | |
| Document Number | GP 16-09-02 |
| Title | AC Motors: Medium Voltage and Low Voltage Over 200 HP (150kW) |
| Version / Date | August 2018 |
| Reference No. | Version 2.2.0 |
| Author | Bart Sauer |

Siemens Norwood Comments (C) and Deviations (D) to ExxonMobil Specifications + General Comments

The following specification(s) are addressed by this quotation.
ExxonMobil GP 16-09-02 (Ver 2.2.0) AC Motors: MV and LV Over 200 Hp - Aug 2018
ExxonMobil GP 02-01-01 (Ver 4.2.0) Facility Sound Level Design Criteria
ExxonMobil GP 10-12-01 (Ver 2.0.0) Machinery Protection Systems

| Para. | Page No. | Applicable only to: | C | D | ExxonMobil GP 16-09-02 (Ver 2.2.0) AC Motors: MV and LV Over 200 Hp - Aug 2018 | 2020 Frame Agreement Notes | 13-Dec-13 Meeting Agreement |
|--------------|----------|---|---|---|--|---|--|
| 1,2,3 | 5 | | x | | Only the GP and industry specifications listed in this quotation are directly addressed by this motor quotation. Comments to API 541 are listed separately. "Area Classification" specifications GP 16-09-01 and GP 16-09-02 have not been reviewed; area classification is quoted on the basis of the submitted motor data sheet. | | Agreed |
| 6.2.4.e | 11 | Self Lube Bearings | | x | Motor piping to be Siemens standard, 300 series stainless steel, schedule 40 minimum. All connections are threaded. | Schedule 80 offered as optional feature | |
| 6.2.5.b | 11 | Flood Lube Bearings | | x | Motor piping to be Siemens standard, 300 series stainless steel, schedule 40 minimum. The customer connection points feature 150# raised face flanges. All inter-connections are threaded. Additional "specifications" for the driven equipment piping are not addressed. | Schedule 80 offered as optional feature | Agreed - with addition to Schedule 80 |
| 6.2.6 | 12 | Sleeve | x | | The Siemens sleeve bearing motors are designed with shoulders on the shaft for the bearings to bump against during uncoupled run-in; the motors do not contain a "location bearing or other thrust provision" beyond this. Motors should be horizontal when operated, particularly when uncoupled to prevent bearing and shaft damage (this addresses the phrase "approximately horizontal" in the specification). | | Agreed |
| 6.2.7.b | 12 | A/F Brg | | x | Anti-friction bearings shall be Siemens standard. They are not shielded as standard. | | Siemens design with grease flow thru accepted |
| 6.2.8 | 12 | Sleeve bearing TEFC & 6-pole and slower SH630/SH710 | x | | Motor designs features a bearing housing design that is flanged mounted, and extends outside plain of the bearing housing. | | Renk EF bearing, style that are flange-mounted, are acceptable. |
| 6.5 | 13, 14 | A/F Brgs (2-Pole) | | x | A vibration limit of 0.1 IPS on the motor housing is offered on 2-pole motors. | | API limit of 0.1IPS is accepted (GP to be updated) |
| 6.5 | 13, 14 | 2-Pole, Sleeve, with Probes | | x | Motor shaft vibration is quoted on the basis of API 541, 1.5 mil pk to pk when measured with shaft probes. | | Agreed (GP to be updated) |
| 6.10.3 | 15 | WPII | x | | Siemens offers a Dwyer 1950 Differential pressure switch and Dwyer Series 2000 Differential Pressure Gage as standard, mounted to the motor top cover. | | Agreed |
| 6.15.1 | 17 | Noise | x | | The quoted motor noise level is listed in the motor description. | | Provide lowest possible with standard product offering. Minimum criteria is 85 dBA (per API 541) Guaranteed requested |
| 6.15.1.b | 17 | Noise | x | | Motor sound material is typically secured with stainless steel screen, which is retained on metal studs with metallic clips. | | Siemens design approved with stainless steel screen. |
| 7.1.c | 17 | B/N's | | x | Siemens offers to not exceed the API 541 5th Edition, paragraph 4.4.5.1.7.a, limit of combined mechanical and electrical runout at the shaft probe locations, 0.375 mil for this motor (25% of 1.5 mil). Adherence to 0.2 mil as requested by this GP paragraph will not be guaranteed. | | Comply with API 541 |
| 8 | | Unspared, Critical Motors | | | Items in this section, entitled ADDITIONAL REQUIREMENTS FOR UNSPARED CRITICAL MOTORS DRIVING SPECIAL PURPOSE EQUIPMENT (including special features related to accessories) are not addressed, unless specifically called out on the motor data sheet, or on the motor RFQ. Section 9 - Requirements by Enclosure Type | | n/a |
| 9.12 | 22 | TEAAC | x | | TEAAC tubes are an aluminum alloy containing not more than 0.2% copper as standard. | | (Suitable standard for Offshore) |
| 9.13 | 22 | TEAAC w/ Aux Blower(s) | x | | Totally enclosed, air-to-air cooled motors that require auxiliary blowers, include only the quantity of blowers required for standard cooling. Reduced output is necessitated if blower(s) are not functioning. | | Shaft mounted preferred. For Un-spared, critical motors, one blower cannot shut down the motor. Redundancy required. |
| 9.18 | 22 | TEWAC | x | | (TEWAC) A water flow indicator is not included in the base motor pricing. Please advise make and model for Siemens to include in motor scope. | | Remove from motor scope |
| 10.2 | 23 | Verticals | x | | A non-reverse ratchet is not included in the motor price unless specified on motor data sheet or RFQ document. | | n/a |
| 10.6.a | 24 | Verticals | x | | The motor guide bearing shall be grease lubricated. | | n/a |
| 11 | 24 | <= 1500 HP | | x | (When so indicated) Exception to 100% (min) LRT, 100% (min) PUT, and 200% (min) BDT. Quoting NEMA MG 1-2011, Part 20.10.1 standard torque values, or as required to meet submitted customer load data for more optimized, higher efficiency performance. | | |
| Section 12 | | | | | Additional requirements for motors over 1500 hp (1100 kW) | | |
| 12 | 26 | Para 2 | x | | Siemens can provide standard data sheet with quotation. Complete Induction motor data is provided after receipt of order. Add \$1000 net per motor rating for Table 5 "rotor bar" data. | | Agreed |
| | 27 | Para 4 | x | | A lateral critical speed analysis is offered as an optional feature. | | Agreed |
| | 28 | Para 5 | x | | Siemens when requested, shall provide shaft/rotor input data only. The axial vibration dynamic analysis is not offered. | | Agreed |
| | 28 | Para 6 | x | | Siemens offers its standard shaft seal, bearing insulation and piping designs. Detail drawings, beyond motor GA drawing are subject to additional charge. | | Agreed |
| 12.2 | 28 | Para 1 | x | | Motor bearing RTD's shall be 100 Ohm, Platinum, DIN Type as standard. Type J thermocouples, and/or Thermometers can be offered as optional. | Bearing RTD's included | (2) Dual Element per bearing, 100 Ohm Platinum, DIN std. Spring-loaded |
| | 28 | Para 2 | x | | Bearing thermometers are not included in the base price. When supplied, the bearing thermometers are installed to measure bearing metal (not oil) temperature. When supplied only (1) RTD or Thermocouple element per bearing can be supplied in addition to the thermometer. | | Not to be required. |
| 12.4 | 29 | 2501 HP and larger | x | | Siemens offers (3) C10, 50:5 CT's, mounted in the main terminal box, for "core balance" differential protection as standard. | | Agreed |
| 12.7 | | Unspared, High Starting, > 1500 HP Motors | | | Items in this section, entitled ADDITIONAL REQUIREMENTS FOR UNSPARED MOTORS WHICH REGULARLY REQUIRE TWO OR MORE CLOSELY SPACED STARTS (< 1 HOUR) OR HAVE LONG STARTING TIMES (> 10 SECONDS) are not addressed, unless specifically called out on the motor data sheet, or on the motor RFQ. | | Agreed |
| 12.7 | 30 | Para 2 | x | | When required, Siemens utilizes a bronze retaining ring. | | Agreed |
| | 30 | Para 4 | x | | On-line rotor temperature monitoring is not offered. | | Agreed |
| | 30 | Para 9 | x | | Add \$1000 net per motor rating for the requested special rotor and stator temperature data. | | Agreed |
| 13.1 | 33 | 5) j | | x | Measurement at no load and rated voltage of the maximum force to constrain the motor rotor at each limit of its end float (horizontal sleeve bearing motors only) is not included in the base motor pricing. | | Agreed |
| | 33 | 7) Sealed Winding Conformance (When spec'd) | | x | Sealed winding conformance testing shall be per API 541, paragraph 4.3.4.4, Spray method. The minimum acceptance criteria for the final meggar test is 100 Mega Ohm. (Per Gabe D'Alleva, Dec 2009). | | Agreed |
| Section 13.2 | | | | | Additional Testing for motors over 1500 hp (1100 kW) | | |

| | | | | | | | |
|------|----|----|--|--|--|--|--------|
| 13.2 | 33 | 3) | | | Per API 541 4.3.4.2, Figure 1 of IEEE 522 will be used as criteria for test voltage and rise times for coil surge testing. | | Agreed |
|------|----|----|--|--|--|--|--------|

| Para. | Page No. | Applicable only to: | ExxonMobil GP 02-01-01 (Ver 4.2.0) Facility Sound Level Design Criteria | | | | | |
|--------|----------|---------------------|---|--|--|--|--|---|
| 1 | | | | | | | Additional Reference specifications have not been reviewed as part of this motor quotation. Exception is taken to additional requirement beyond what has been listed in the motor description. | Agreed |
| 3, 7.1 | | | | | | | The quoted motor noise level is listed in the motor description. A noise test is not included, unless an API 541 Complete test is purchased, or a separate Noise test is purchased. | Provide lowest possible with standard product offering. Minimum criteria is 85 dBA (per API 541) Guaranteed requested |
| | | | | | | | Siemens shall supply its standard noise data sheet. Any customer specific noise data sheet should be submitted prior to the order release for review of possible commercial impact. | Agreed |

| Para. | Page No. | Applicable only to: | ExxonMobil GP 10-12-01 (Ver 2.0.0) Machinery Protection Systems | | | | | |
|-------------------------|----------|--|---|---|---|--|---|---|
| 1,2 | 3 | | x | | | | This quotation is based on the ExxonMobil specifications listed above and the applicable portions of API Std 670. GP 15-07-02 is not addressed. | Agreed |
| 2.4, 3.1.1.3.b, 4.2.1.1 | 3, 4, 5 | Horizontal units with probes or provisions | | x | | | When specified by the customer data sheet, Bentley Nevada 3300XL type shaft probes offered, and installed per Siemens standard mounting. The standard arrangement includes (2) probes (or provisions) per bearing. Additional spares are not included. Probe location is frame dependent and may be internal. | Clarify motor offering on Siemens proposal(s) |
| 3.6.1 | 4 | Wiring and Conduits | | | x | | External conduit, where required shall be Seal-tite-type, flexible, conduit. | Flexible lengths cannot exceed 3' (1 meter). Flexible material to be Aluminum Seal-Tite, type, secured with moon clips maximum 18" apart. Rigid material to be aluminum. Aluminum fittings can be used offshore or onshore. All aluminum to be <0.2% Cu |
| 4.1.5.1.1 | 5 | Sleeve Bearings | x | | | | Sleeve bearings include 100 Ohm RTD's per the submitted motor data sheet. The RTD's are not embedded, unless "Install per API 670" is chosen, or otherwise specified on the API 541 motor data sheets | (2) Dual Element per bearing, 100 Ohm Platinum, DIN std. Spring-loaded |

| Item | Page No. | Applicable only to: | General Comments | | | | | |
|------|----------|---------------------|------------------|---|---|---|---|--------|
| 1 | | | x | | | | Siemens Harsh Duty Paint system is quoted unless otherwise noted. | Agreed |
| 2 | | | | x | | | Motors are to be designed, built and tested at the Siemens Norwood, Ohio facility, utilizing US and globally sourced materials. | Agreed |
| 3 | | | | | x | | Motor materials and accessory components are sourced from Siemens standard approved vendors. Customer specific vendor and material requirements are not addressed by this quotation. | Agreed |
| 4 | | | | | | x | Software will be to Siemens standard format unless expressly negotiated and entered as a separate line item on the purchase order. The Siemens software package for ExxonMobil includes, a) certified motor outline/GA drawing, b) the calculated motor electrical performance data including speed vs. torque, speed vs. current, and thermal limit curves, c) motor instruction manuals (Operating and Storage), d) completed "As Built" API 541 (or customer) motor data sheets, and e) API 541 motor test reports for items specified on Page 6 of the API 541 test page. | Agreed |
| 5 | | | | | | x | Siemens will provide one update of each of the submitted documents at no charge, for customer requested changes of ExxonMobil orders. Additional drawings updates requested by the customer are subject to commercial charge. Changes due to Siemens mistakes are not charged to customer. | Agreed |
| 6 | | | | | | x | Siemens can provide customer specific tagging on the motor GA drawing. Customer specific tagging on the motor shall be limited to motor tag and/or PO number (see above note regarding limitations). | Agreed |
| 7 | | | | | | x | API 541 requires Siemens to supply a material certification on the motor shaft. Additional material certification is not included in the base motor price. Non-Destructive Examinations are not included in the motor bid, with the exception of the motor testing required by API 541 and the API 541 motor data sheet. | Agreed |
| 8 | | | | | | x | Siemens strongly recommends that the motor quotation be reviewed by ExxonMobil and the EPC (if applicable) prior to order release. Siemens offers to be available by phone or in person for the quotation bid review to ensure understanding of the Siemens quotation scope, comments and applicable specifications. | Agreed |

December 13, 2013

GP 16-09-02 Ver 2.1 Comments and Deviations (in conjunction with API 541 4th Ed) Reviewed and Accepted by:

Gabe D'Alleva
Senior Electrical Engineering Associate
ExxonMobil Research and Engineering

Steve Kerr
Electrical Project Execution Advisor
ExxonMobil Development Company

Scott Hietpas
Electrical Global Technology Sponsor
ExxonMobil Research and Engineering

Siemens Representatives:
Bob Suomela, Bart Sauer

Additional General Comments - 13-Dec-13

| |
|---|
| VFD duty and Vertical motors are not part of the scope of this agreement. |
| API 541 vibration is acceptable. |
| API 541 correction factor for coupled test is acceptable. 4.3.3.10 |
| 316/316L lube piping required for offshore |
| Terminal Boxes - Main - Painted Steel OK for Offshore and Onshore |
| Terminal Boxes - Auxiliary Boxes - 316SS for Offshore and Onshore |
| Stainless steel does not NEED to be painted. |
| Material can be globally sourced as standard for pricing agreement, but can be project specified. |



Date **May 6, 2024** Revision **6**
Pricing **Annex A3, Attachment 3**
Agreement Number **Appendix 4 to Exhibit C, A2630511**

| | |
|-------------------------------|--|
| Customer / Project / Standard | ExxonMobil |
| Document Type | Comments and Deviations |
| Factory | Norwood, Ohio |
| Product Details | Medium Voltage AC Induction Motors |
| Considered Document(s) | |
| Title | API-541 5th Edition |
| Version / Date | Form-wound Squirrel-Cage Induction Motors-500 Horsepower and Larger December 2014 |
| Author | Bart Sauer |

General Comments

1. 2-pole, **4-pole motors with Level 3 Noise Reduction** and all TEAAC Motors: Motor will be uni-directional. Direction of rotation facing motor shaft must be specified at time of order placement.
2. Main terminal box shall require the customer to provide external support.
3. The Harsh Duty Paint process (Option Code S03) consists of SP-3 prep; high quality alkyd or zinc-rich powder primer of exterior surfaces; intermediate two-part epoxy primer of exterior surfaces; two-part acrylic-polyurethane finish.
4. Division 2 hazardous location is per NEC Section 501 and/or Section 502, paragraph B. surfaces; two-part acrylic-polyurethane finish.

| Optional Feature | API 541 5th Paragraph / Siemens Comment | Comment Criteria / Restrictions | XOM Response | 21-May-19 Siemens / XOM Review Notes |
|------------------|--|--|---|---|
| | Para 1.1.2: Completed data sheets have not been supplied. Only the listed features and tests are included. | All without API Data Sheet. | Accepted | |
| | Para 4.2.3.1: Motor is designed for 90% voltage starting pending receipt and review of the driven equipment starting conditions torque vs. speed curve and load inertia. | Without review of design relative to load data | Accepted | Can be deleted with reduced load |
| | Para 4.2.4.3: Taking exception to safe stall time of 150% of or 5 seconds greater than acceleration time. | Without review of design relative to load data | Accepted | |
| | Para 4.4.2.8.c: Individual motor mounting surface flatness acceptance criteria shall be on the basis to not exceed 0.002 inch per linear foot when measured in the vertical orientation without motor weight applied. | All horizontal motors | Accepted | XOM: Shimming is expected. Descriptive slides presented by Siemens |
| Y | Para 4.4.5.1.9: Customer must supply coupling for Siemens to mount if a complete test is purchased. | Applies when both a tapered shaft and a complete test is selected. | Accepted | |
| Y | Para 4.4.5.2.2: Motor quotation includes an aluminum die cast rotor cage. Please contact your Siemens representative if a copper rotor is required. | Applies to all motors offered with ADC rotors. | | (15-Mar-21) XOM permitted use of ADC Rotor Cage for motors up to and including 1000 HP |
| | Para 4.4.6.1.1: The motor has a stiff-rotor design with its first bending mode above the operating speed range. The motor design meets all API 541 vibration limits. The motor may show a system resonance within 15%, but is either critically damped (per API 541 5th Ed. Annex F.1.3 & F.1.9) or well damped (per API 541 5th Ed 6.3.5.3.e). | All horizontal 2-pole motors | Accepted | Descriptive slides presented by Siemens |
| Y | Para 4.4.6.1.3, 4.4.6.2.1.1: Mean coefficients only are provided for motor bearings. | If ACCESSORY Lateral Critical Speed Analysis is selected AND if Horizontal with sleeve bearings. | | N/A - Siemens added in July 2019 |
| Y | Para 4.4.6.2.1: Siemens will provide the Lateral Critical Speed Analysis based on a massive foundation base. | If ACCESSORY Lateral Critical Speed Analysis is selected. | Accepted | |
| | Para 4.4.6.3.1: Rotor shall be dynamically balanced in two planes to levels prescribed in 4.4.6.3.3. Separable rotor fans may be independently balanced prior installation on the rotor to a ISO 1940-1 G6.3 level in order to provide a more precise component balance for any possible field replacement of fans. Full compliance to the vibration limits of 6.3.3.12 is achieved. | All 2-, 4- and 6-pole motors | Accepted | |
| Y | Para 4.4.7.1.16: Siemens will supply a dial thermometer that measures bearing metal temperature, not oil temperature. The sensor is located on the bearing. | If Bearing Dial Thermometers without contacts (Option Code A70) or with contacts (Option Code A71) are selected as Base or Option Feature. | Accepted | |
| | Para 4.4.7.2.4: Clarification. Air gap shall be measured from one end only. | Applies only to Sleeve Bearing, Horizontal Motors that are either TEFC's (4-pole & Slower) or SH630 & SH710 (6-pole & slower) | Accepted | |
| | Para 4.4.7.3.a: One-piece, IP55 shaft seals are supplied. | Applies to all rotating and IP55 seals | Accepted | |
| | Para 4.4.7.3.a: The inner seal on the non-drive end bearing has a positive pressure when in operation to avoid pulling oil out of the bearing cavity. | Applies to 500/580 TEFC sleeve bearing. | Accepted | |
| | Para 4.4.7.3.c: IP55 seals are not standard on open type motors but are available as options - consult factory. | Applies to all WP11 | | WP11's were not reviewed. Same comment at API 541 4th Ed |
| Y | Para 4.4.7.3.b: Rotating shaft seals may contain conducting materials, but are designed to not conduct between the shaft and bearing housing. | Applicable to motors that have rotating shaft seal | Accepted | |
| Y | Para 4.4.9.4: Coupling must be supplied finished machined. Taking exception to any coupling modification. | Applies when Mount Customers Finished 1/2 Coupling (L17) is selected. | Accepted | |
| | Para 5.1.4.2: Drip shields will be limited to those locations above removable terminal box access covers. | All | Accepted | |
| Y | Para 5.4.2: The space heaters install on the stator end windings to maximize effectiveness. New heaters can be installed over those to be replaced. | If ACCESSORY space heaters AND TEFC motor | Accepted with modification as indicated | Only permit wrap around heaters on TEFC, not WP11 & TEAAC |
| Y | Para 5.6.2.1: Three individual surge capacitor shall be provided as standard only on motor rated above 6900V. Surge capacitors supplied on motors 6900V and below shall be supplied as a common assembly as standard. | If ACCESSORY Surge Capacitors is selected AND the motor voltage is 6900V or lower. | Accepted | |
| Y | Para 5.6.3: As standard, Siemens shall supply and mount (3) C10 50:5 ratio CT's. This constitutes "core balance". If "Full Differential" is specified on the motor data sheet, customer should supply (3) CT's to match Siemens CT's. | If ACCESSORY Current Transformers is selected | Accepted | |
| Y | Para 5.8.1: Provisions for shaft probes and phase reference probe are NOT included in base motor pricing unless the probes are specified on the motor data sheet. | All motors less than or equal to 1500 hp, sleeve bearing, Horizontal | Accepted with modification as indicated | For 1500 hp and lower HP, provisions for shaft probes are not included unless specified on the data sheet |
| Y | Para 6.1.4: Pass/Fail criteria shall be on the basis of Siemens factory equipment measurements. Any customer equipment must be installed (without any dis-assembly of the motor) and operated by customer representative in conjunction with the purchase of a Witnessed test. | When option is selected | Accepted | |
| Y | Para 6.3.1.4: The Siemens electronic submittal of Final Test procedures includes documents with details of all API standard project-specific final test procedures, data to be measured, and applicable ANSI/NEMA and IEEE test methods. Items a,b,c,d,e and g are included. Item f (LCSA) and item k (Residual Rotor Unbalance Worksheet) are included when the optional features are purchased. Item h, "listing of alarm and shutdown values", will be supplied on the motor outline/general arrangement drawing. Item j, the basic "general arrangement drawings" is included in the motor instruction manual. Items i, and l are included when "Demonstrate Accuracy of Test Equipment (6.3.1.15) is purchased; these documents are supplied at time of final test. | When Line 9 Submit Test Procedures and Acceptance Criteria 6 Weeks Before Tests (6.3.1.4) is selected | Accepted | |
| | Para 6.3.1.3: The main terminal box is not connected to the motor during final testing to permit more efficient connection to the test department power leads. | All | Accepted | |
| Y | Para 6.3.1.5: The coupling, or any customer supplied item to be mounted on the motor shaft extensions should be supplied to Siemens pre-machined and balanced | Applies when Mount Customers Finished 1/2 Coupling (L17) or Vibration Test with Half Coupling (API 541 5th Ed. 6.3.1.5 - Line 22) is selected. | Accepted | |
| Y | Para 6.3.1.15: Siemens to supply copies of certified calibrations of final test instrumentation at the time of test. | When Line 10 - Demonstrate Accuracy of Test Equipment (API 541 5th Ed. 6.3.1.15 - Line 10) is selected. | Accepted | |
| Y | Para 6.3.2.1 (e - n): The measurement data taken by Siemens is available for review when the customer selects other final tests to be witnessed at factory. | When WITNESSED, Line 25 - Bearing Dimensional & Alignment Checks Before Tests para 6.3.2.1.k is selected. | Accepted | |

| | | | | |
|---|--|---|----------|---|
| Y | Para 6.3.3.7: Pass/Fail criteria shall be on the basis of Siemens factory equipment measurements. Any customer equipment must be installed (without any dis-assembly of the motor) and operated by customer representative in conjunction with the purchase of a Witnessed test. | When Line 27 is selected. (Only offered in conjunction with a Witnessed test). | Accepted | |
| Y | Para 6.3.3.11: If a Complete Test or Rated Rotor is purchased that requires Siemens to couple the motor. | Horizontal motor with above 3000 HP with Complete or Rated Rotor test. | Accepted | |
| Y | Para 6.3.3.19: Motors to be operated on ASD's (VFD's) will be tested at the base 60 (or 50) Hz condition only. | If VFD selected | Accepted | XOM may require extra testing at alternate speeds |
| Y | Para 6.3.4.2.1: Surge Testing of sample coils may be performed at a 3rd party, North American location. | When Witnessed Line 13 is selected. | Accepted | |
| Y | Para 6.3.5.1.1: A no load bearing temperature run (6.3.2.1.h) is not provided as standard when a Complete Test is purchased. | When Line 28 Complete Test (6.3.5.1.1) is selected. | Accepted | Loaded only is OK |
| Y | Para 6.3.5.1.1.a: Clarification. Efficiency testing shall be per IEEE 112 Method F(1) or E(1) as standard. Method F(1) is typical for all units 3000 HP and lower. Method F(1) is used for all vertical motors. | When Line 28 Complete Test (6.3.5.1.1) is selected. | Accepted | |
| Y | Para 6.3.5.1.1.g: Clarification. As part of the optional Complete Test, the noise test shall be performed in accordance with ANSI/NEMA MG-1 Part 9 instead of ANSI S12.54 or ISO 3744. | When Line 28 Complete Test (6.3.5.1.1) is selected (witnessed or unwitnessed) | Accepted | |
| Y | Para 6.3.5.2.1: A no load bearing temperature run (6.3.2.1.h) is not provided as standard when a Rated Rotor Test is purchased. | When Line 31 Rated Rotor Temperature-Vibration Test (4.3.5.2.1) Test is selected. | Accepted | Loaded only is OK |
| Y | Para 6.3.5.3: Siemens shall complete the unbalance response test without the customer coupling or mass-moment simulator unless supplied by the Purchaser. | When Line 19 Unbalance Response Test (4.3.5.3) is selected. | Accepted | |
| Y | Para 6.3.5.3: The unbalance weight attachment will be on the Drive End balance plane only. The Non-Drive End balance plane is not accessible due to the internal fan construction without complete removal of the rotor from the motor, for each balance weight installation or removal. | When Line 19 Unbalance Response Test (6.3.5.3) is selected and TEFC enclosure. | Accepted | |
| Y | Para 6.3.5.4.1: Data is only measured on the DE bearing housing. | All TEFC enclosures when Line 32 Bearing Housing Natural Frequency test (Option Code U24 or U25) is selected. | Accepted | |
| Y | Para 6.3.5.6: For motors to be operated on ASD's the overspeed test shall be run for 2 minutes at 10% over the highest operating speed. | When motor is VFD and an overspeed test is selected. | Accepted | |
| | Para 8.7: Siemens to supply its standard operating manuals. Refer to Siemens website or Siemens Sales for copies. | All | Accepted | |

| | | | |
|--|---|---|--|
| INDUCTION MOTOR API 541 5th Edition -- DATASHEETS U.S. CUSTOMARY UNITS PURCHASER'S SELECTIONS <i>Bold Italics = Indicate Default Selection</i> | | JOB NO. _____ ITEM / TAG NO. _____ PURCHASE ORDER NO. _____ REQ. / SPEC. NO. _____ REVISION NO. 4 DATE 03/31/21 BY B. Sauer REV. DATE _____ PAGE 1 OF 12 | |
| 1 USER <u>ExxonMobil</u> 2 LOCATION _____ 3 PROJECT NAME Siemens Frame Agreement Template 4 SITE / PLANT _____ 5 Applicable To: <input checked="" type="radio"/> Proposal <input type="radio"/> Purchase <input type="radio"/> As Designed <input type="radio"/> As Built | APPLICATION <u>Centrifugal Pump or Centrifugal Compressor</u> SUPPLIER <u>Siemens (USA)</u> SUPPLIER REF. No. _____ NUMBER of UNITS REQUIRED _____ MOTOR TAG No.(s) _____ | | |
| Bold Italics = Indicate the Standard's default selections - refer to Annex C for Datasheet Guide | | | |
| BASIC DESIGN - General | | | |
| 6 Applicable Standards (1.3.2; 2.0): North American (i.e., ANSI, NEMA) Use SI (metric) datasheets for International Standards (IEC, etc.) | | | |
| 7 Power / RPM ratings are specified by: <input type="radio"/> User/Project <input type="radio"/> OEM <input type="radio"/> Other _____ | | | |
| 8 Nameplate power rating (4.2.1.1): <u>250 - 1500</u> <input type="radio"/> HP <input type="radio"/> kW Motor speed: <u>3600 / 1800 / 1200</u> RPM (Synchronous) | | | |
| 9 Nameplate Voltage/Ph/Hz rating (4.2.1.2): <u>4000</u> Volts <u>3</u> Phase <u>60</u> Hertz | | | |
| 10 Nameplate ambient temp. rating [4.3.1.1 b)]: 40° C <input type="radio"/> Other: _____ °C <input type="radio"/> Minimum rated operating ambient temp.(4.1.2): <u>0</u> °C | | | |
| 11 Stator insulation class [4.3.1.1 a)]: Class F <input type="radio"/> Other Class: _____ | | | |
| 12 Stator temperature rise [4.3.1.1 b)]: Class B <input type="radio"/> Other: _____ * (See <u>underlined sentences</u> in Datasheet Guide for this item) | | | |
| 13 Duty (4.1.2): Continuous <input checked="" type="radio"/> Other: _____ 80C Rise by Resistance & 90C Rise by RTD @ 1.0 SF | | | |
| 14 Max. sound pressure level @ 1 m. @ no load, full voltage/frequency on sine wave power (4.1.3; 4.1.4): 85 dBA <input type="radio"/> Other: _____ dBA | | | |
| 15 Voltage and frequency variations (4.2.1.3): Per NEMA <input type="radio"/> Other: _____ | | | |
| 16 Motor power source: Sine Wave Power ASD power (complete below section) <input type="radio"/> Solid state soft starter - complete data on page 6, line 8 | | | |
| 17 Adjustable Speed Drive (ASD) conditions, if applicable (4.1.4; 4.1.5; 4.2.1.2.3, 4.3.1.2): | | | |
| 18 <input type="radio"/> ASD only operation (4.2.4.5) <input type="radio"/> ASD+DOL start capability <input type="radio"/> ASD only w-bypass to utility power <input type="radio"/> ASD w-DOL start & bypass to utility | | | |
| 19 <input type="radio"/> Variable Torque speed range: Min speed _____ RPM _____ ft-lb Max. speed _____ RPM _____ ft-lb | | | |
| 20 <input type="radio"/> Constant Torque speed range: Min speed _____ RPM _____ Max. speed _____ RPM _____ ft-lb | | | |
| 21 <input type="radio"/> Constant Power speed range: Max speed _____ RPM _____ ft-lb | | | |
| 22 ASD description and information affecting motor design (obtain from ASD Supplier; refer to Datasheet Guide) | | | |
| 23 ASD type / topology: _____ | | | |
| 24 ASD output harmonics, describe and/or attach data (4.3.1.2): _____ | | | |
| 25 ASD maximum voltage spike amplitude and rise-time at drive output (4.3.1.2.1): _____ Volts @ _____ microseconds | | | |
| 26 ASD Maximum common mode voltage (CMV) at drive output (4.3.1.2.2): _____ Volts | | | |
| 27 Other ASD information / motor requirements: _____ | | | |
| 28 <input type="radio"/> Copper Cage Rotor Required | | | |
| 29 Area Classification (4.1.8): <input type="radio"/> Nonclassified <input checked="" type="radio"/> Classified as: Class <u>1</u> Group <u>B/C/D</u> Division <u>2</u> or Zone _____ | | | |
| 30 Temperature code (T-code): <u>T3C</u> Autoignition temperature (AIT): _____ °C | | | |
| 31 <input type="radio"/> Other: _____ | | | |
| 32 Site Data (4.1.2; 4.4.8.3; 4.4.10.4): Site ambient temperature: <u>40</u> Max <u>0</u> Min <input type="radio"/> °F <input checked="" type="radio"/> °C | | | |
| 33 Minimum rated storage ambient temp.(4.1.2): _____ °F <input type="radio"/> °C Site elevation: <u><3300</u> ft. | | | |
| 34 Relative humidity: _____ % Max _____ % Min <input type="radio"/> Use this higher elevation for motor rating: _____ ft. | | | |
| 35 Motor location: <input type="radio"/> Indoor Building temperature controlled: <input type="radio"/> No <input type="radio"/> Yes Controlled temp.: _____ °F <input type="radio"/> °C <input type="radio"/> Use for motor rating | | | |
| 36 <input type="radio"/> Outdoor Roof over motor: <input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Offshore platform / similar marine environment [4.4.1.1 c)] | | | |
| 37 <input type="radio"/> Seismic loading (4.4.2.2), IBC Zone: _____ Importance Factor: _____ <input type="radio"/> Other seismic requirements: _____ | | | |
| 38 Unusual Site Conditions, Define: _____ | | | |
| 39 <input type="radio"/> Additional environment considerations, chemicals, etc. (4.1.2): _____ | | | |
| 40 <input type="radio"/> Abrasive dust protection for open enclosures [4.4.1.2.2 c)]: _____ | | | |
| 41 <input type="radio"/> Corrosive agents in environment, re: stress corrosion cracking (4.4.10.1.2): _____ | | | |
| 42 Other: _____ | | | |
| 43 <input checked="" type="radio"/> Magnetic Top Wedges are not permitted in stator design (4.3.10) | | | |

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BASIC DESIGN - Enclosure, Mounting, Electrical system

1 **Enclosure (4.4.1.2)** Degree of Protection (4.4.1.2.1) IP _____ Method of Cooling (4.4.1.2.1) IC _____

2 WP-II (Weather Protected Type II) (4.4.1.2.2) WP-I (Weather Protected Type I) (4.4.1.2.2) DPG (Dripproof Guarded) (4.4.1.2.2)

3 Air filters: **Required for WP-II (5.5.3)** Provisions only for WP-I or DPG (5.5.2) Provide filters for WP-I or DPG (5.5.4)

4 Air filter capability (5.5.4): **90% of particles ≥ 10 micron** Other: _____

5 Purchaser specified filters: Manufacturer: _____ Type: _____ Model: _____

6 Differential pressure device (5.5.5): **Provisions required for WP-II** Differential pressure switch (5.5.5) Combination switch / gauge

7 Provisions only for WP-I or DPG (5.5.5) Differential pressure gauge (5.5.5)

8 Purchaser specified device: Manufacturer: _____ Type: _____ Model: _____

9 Enclosure for motors rated 6kV and above: [4.4.1.1 f)]: **TEFC, TEAAC, or TEAAC (IP44 or higher)** or Use enclosure selected in line 2

10 TEFC (4.4.1.2.3) (or TEAAC) TEPV (4.4.1.2.3) Other enclosure: _____

11 TEAAC (4.4.1.2.3) Heat exchanger tube materials [4.4.10.8 a)]: Aluminum Alum. Alloy Copper Copper Alloy Other _____

12 Stainless Steel 300 Series Stainless Steel 316 Series (req'd for offshore) [4.4.10.8 a)]

13 TEWAC (4.4.1.2.4) Heat exchanger tube materials [4.4.10.8 b)]: **90-10 Cu-Ni** Other _____

14 Cooling water conditions **per 4.4.1.2.4 a)**: Water & glycol solution Other cooling water conditions or chemistry (attach documentation)

15 Cooler location-orientation [4.4.1.2.4 c)]: Supplier decision Above stator Other _____

16 Cooler inlet-outlet location (facing NDE): Supplier decision Right side Left side Other _____

17 Tube construction [4.4.1.2.4 d); 4.4.10.8 c)]: **Single tube** Double tube Redundant coolers [4.4.1.2.4 b)]

18 Leak detection [4.4.1.2.4 c)]: **Required** For double tube coolers: **inner tube leak detection required** Outer tube detection also

19 Flow sensor with local indicator [4.4.1.2.4 g)]: **Required** Not required Relay contacts: Norm. Open (NO) Norm. closed (NC)

20 Purchaser specified device: Manufacturer: _____ Type: _____ Model: _____

21 Cooler air inlet & outlet temperature sensor [4.4.1.2.4 h)]: **Required** Not required Same as winding Other _____

22 Purchaser specified device: Manufacturer: _____ Type: _____ Model: _____

23 System of units for hardware (1.3.1): U.S. / North American Customary SI (Metric)

24 Hardware-fasteners material [4.4.1.1 c)]: **Stainless Steel 300 series through M12 (1/2 in.)** SS 316 series through 1/2 in. for offshore

25 Provision for pre-start purging [4.4.1.1 e)]: Purchaser specified purge details: _____

26 Field piping connection sizes (4.4.3.1): **Supplier std.** Other: _____

27 Duct gaskets/bolts provided by (4.4.3.8): **Supplier std.** Other: _____

28 Auxiliary motor driven fans (4.4.10.6.3): Yes No Ph / Volts.: _____ Phase _____ Volts _____

29 Paint system: **Paint System** Purchaser specified paint system Paint system spec. no.: _____ Siemens Harsh Duty

30 Paint color: **Supplier's paint color** Purchaser specified paint color Define paint color and code: _____

31 **Mounting:** Horizontal foot mounted Horizontal flange mounted with feet Vertical foot mounted

32 Vertical flange mounted Shaft down Shaft up Solid shaft Hollow shaft Non-reverse ratchet (NRR)

33 Vertical Motor to carry thrust (if selected, complete applicable area of Bearing &/or Driven Equipment / OEM section, pg. 6, lines 39 and 40)

34 Flange type / bolt circle: Supplier decision Other: _____

35 Other mounting requirements: _____

36 Baseplate: furnished by (4.4.2.6): Driven Equipment Supplier Soleplate: furnished by (4.4.2.6): _____

37 Non-massive Foundation applies (4.4.6.1.3, 4.4.6.2.1.2), Description: _____

38 Data for non-massive system dynamic analysis required from machine vendor per 4.4.6.1.3 a), b), c), d)

39 **Electrical System:** Primary power source 4160 Volts 3 Phase 60 Hertz Maximum ground fault _____ Amps

40 Method of system grounding (5.6.2.3) Resistance Reactance Ungrounded Solid

41 3-Phase fault Current at machine terminals (5.1.2) _____ MVA Let-through energy (5.1.2.1): _____ i²t (Ampere-squared seconds)

42 Min S.C. at motor bus [4.2.3.2 c)] _____ MVA at _____ V_{base} X/R ratio: _____ Min. motor term. start voltage _____ % rated

43 Other information: _____

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BASIC DESIGN - Bearings, Seals

1 **Bearings:** Horizontal machines

2 Bearing type: **Hydrodynamic (4.4.7.1.1)** Sleeve (4.4.7.1.1) Tilting pad (4.4.7.1.1)

3 Bearing constant-level oilers required (4.4.7.2.2) Type: _____

4 Antifriction (4.4.7.1.3)

5 Other: _____

6 **Bearings:** Vertical machines

7 Thrust bearing load [4.4.7.1.11 a] Downthrust Momentary _____ lbs Upthrust Momentary _____ lbs

8 Continuous _____ lbs Continuous _____ lbs

9 Other: _____

10 **Seals:** Special seals for gas purge [4.4.7.3 a] Non-conducting seals [4.4.7.3 b]

11 **Other:** _____

12 _____

BASIC DESIGN - Bearing Lubrication

13 **Hydrodynamic Bearings: Ring type self lubrication (4.4.8.1)**

14 Type/viscosity of oil (4.4.8.5; 4.4.8.8; 5.1.4.2) Supplier decision Other, define: _____

15 Pressurized lube required (4.4.8.4) Common with driven equipment (4.4.8.5)

16 System supplied by (4.4.8.4): Driven equipment supplier End user Motor supplier Other _____

17 Lube System to comply with API 614 (4.4.8.6): Part 3 General Purpose Part 2: Special Purpose ISO 10438-1

18 Main oil pump driven by: Supplier decision Separate, independent motor Main motor shaft

19 Other lube system information: _____

20 Meet cleanliness requirements of API 614 for 5 GPM & above capacity (6.2.3.2)

21 Purge oil mist (4.4.7.4.1) (describe or attach requirements): _____

22 **Antifriction Bearings:** Grease type: Supplier decision Other _____

23 Pure oil mist (4.4.7.4.1; 4.4.7.4.5) Oil mist ready or Oil mist provisions only (bearing grease removal may be required - see guide)

24 **Vertical Motor Bearings:** Thrust bearing: Supplier decision Grease lubrication Oil Sump lubrication

25 Guide bearing: Supplier decision Other: _____

26 **Other:** _____

SPECIAL CONDITIONS

27 Shaft and spider one piece forging for 4 or more poles [4.4.5.1.4; 4.4.5.1.2 b]

28 Special lower vibration limits, define (6.3.3.12): _____

29 Efficiency evaluation factor (8.1.2), EF = _____ cost / kW C = _____ cost / KWH applied at _____ % of full load

30 Test method for expected and guaranteed efficiency data (8.1.3.f): _____

31 Local codes, define (4.1.8): _____

32 External loads imposed on motor enclosure when connected at installation site, define (4.4.4): _____

33 _____

34 Special overspeed requirement (4.1.5, 4.4.5.2.7): _____

35 **Other:** _____

36 **Notes / Other Requirements:** _____

37 **Stainless steel screen is to be installed over any sound abatement material that may fragment**

38 **All Aluminum is to contain less than 0.2% Cu**

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ACCESSORIES

1 **Heaters:** Frame space heaters (5.4.1; 5.4.2; 5.4.3): Sheath material: Supplier decision Other: _____
2 Single voltage design Operating voltage _____ Phase _____
3 or Dual voltage design Operating voltages 120 / 240 Phase 1
4 Bearing heaters (4.4.8.3): Operating voltage _____ Phase _____
5 Main terminal box space heaters required: also see main terminal box section, page 5
6 For classified areas provide Temp. code (from pg.1): T3 used for labeled heaters if not specified
7 max. surface temp. (5.4.2): Max. surface temp.: _____ °C (less than or equal to 80% of AIT on pg.1 for unlabeled heaters, **160° C** if AIT not specified)

8 **Winding Temperature Detectors (5.2):** **RTD - Platinum, 3 Wire, 100 Ohms at 0°C (5.2.1.1)** Other RTD Material: _____
9 Required number per phase (5.2.1.2): **Three (3)** Other _____ Wires: _____ Resistance: _____
10 Ground one (1) common lead each element in terminal box (5.2.1.2)
11 Thermocouples: Type: _____ No. per phase: **Three (3)** Other _____

12 **Bearing Temperature Detectors (5.3):** **RTD - Platinum, 3 Wire, 100 Ohms at 0°C; One (1) Per Bearing for Hydrodynamic & Thrust Bearings (5.3.1)**
13 Other qty. per bearing 4 Dual element OK Install per API 670 (5.3.1) Ground one (1) common lead Provisions only
14 Other RTD material: _____ Wires: _____ Resistance: _____ Other info: (2) Dual Element/Brg- Stick Type - Spring loaded
15 Thermocouples: Type: _____
16 Oil temp. indicators (dial thermometers) (4.4.7.1.16) Type: _____ Alarm contacts Number of contacts: _____ NO NC
17 Location of terminations for bearing temp. det. (5.1.14): Supplier decision Terminal head T-box T-box with winding temp. det.
18 Antifriction bearings: Use selections above when antifriction bearings are specified

19 **Vibration Detectors (5.8)**

| Non-contact Shaft Probes (5.8.1): | | Motors operating at 1200 rpm and higher | Motors operating at less than 1200 rpm |
|---|--|---|--|
| Shaft probes (X-Y) (5.8.1): | <input checked="" type="radio"/> Provisions <input type="radio"/> Installed | <input type="radio"/> Provisions <input type="radio"/> Installed | <input type="radio"/> Provisions <input type="radio"/> Installed |
| Phase reference probe (5.8.1): | <input checked="" type="radio"/> Provisions <input type="radio"/> Installed | <input type="radio"/> Provisions <input type="radio"/> Installed | <input type="radio"/> Provisions <input type="radio"/> Installed |
| Number per bearing (X-Y) (5.8.2): | Two (2) <input type="radio"/> Four (4) | Two (2) <input type="radio"/> Four (4) | Two (2) <input type="radio"/> Four (4) |
| Provide two (2) axial-position probes for hydrodynamic thrust bearings at the thrust end (5.8.2): | Provisions Required <input type="radio"/> Installed | | |
| Probe lead protection (5.8.1.1): | Conduit <input type="radio"/> Other: _____ | | |
| Manufacturer of probes, oscillator-demodulator: | <input type="radio"/> Supplier decision <input type="radio"/> Purchaser defined, type: _____ | | |
| Probes provided by: | <input type="radio"/> Supplier <input type="radio"/> Other: _____ | Installed By: <input type="radio"/> Supplier <input type="radio"/> Other: _____ | |
| Oscillator-Demodulator By: | <input type="radio"/> Supplier <input type="radio"/> Other: _____ | Installed By: <input type="radio"/> Supplier <input type="radio"/> Other: _____ | |
| Location of terminations (5.1.14): | <input checked="" type="radio"/> Supplier decision <input type="radio"/> In osc.-demodulators box <input type="radio"/> In sensor housing <input type="radio"/> Other: _____ | | |

30 **Bearing Housing Seismic Sensors:** Manufacturer: _____

31 Sensor: Installed Provisions only Per API 670 (5.8.3) Supplier decision Purchaser defined: _____

32 Vibration switch: Installed Provisions only Per API 670 (5.8.3) Supplier decision Purchaser defined: _____

33 Device provided by: Supplier Other: _____ Installed by: Supplier Other: _____

34 Define mounting / hole size if purchaser defines device: _____ If switch, type: Manual reset Electric reset

35 D.E. bearing Qty.: _____ Position(s): Horizontal Vertical Axial Other: _____

36 N.D.E. bearing Qty.: _____ Position(s): Horizontal Vertical Axial Other: _____

37 Location of terminations (5.1.14): Supplier decision Terminal box Terminal head In sensor housing

38 **Other Monitors and Devices**

39 Monitor to alarm for shaft grounding brush replacement (4.4.7.1.9) Describe: _____

40 Other monitors or devices: _____

41 **Alarm and Control Switches (5.6.1):** **SPDT 10 Amp 120VAC & 125VDC** Other: _____

42 **Auxiliary Equipment T-Boxes (5.1.4.1):** Location of aux. boxes (facing non-drive end): Left side Right side Other: _____

43 Stainless Steel aux. boxes/encl. (5.1.4.1) Cond./cable entry (5.1.4.1, 5.1.13): Bottom Left or Right side facing non-drive end

44 **Accessory Equipment Wiring Outside Enclosure (5.1.11):** **Rigid Conduit** Other: **Flex conduit < 36". External ground wire req'd hub-to-hub**

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ACCESSORIES - Main Terminal Box

1 **Main Terminal Box (5.1.1):** Box size: **Minimum size is Type II per NEMA MG 1 Part 20 with Copper Bus Bar & Standoff Insulators Required**

2 Other Size: Supplier decision for required accessories For shielded cable term. [5.1.6 e)] Other: _____

3 Box location facing non-drive end: Left side Right side (F1) Other: _____ Thermal insulation [5.1.6 a)]

4 Cable enter from (5.1.4.1): Bottom Top Drive end side Non drive end side

5 Incoming conductor size: _____ Type _____ Insulation _____ Qty. per phase _____ Provision for purging [5.1.6 c)]

6 All phase leads in terminal box (4.3.6): **Required 750kW (1000HP) and larger** Provide in < 750kW (1000HP) Removable links [5.1.6 d)]

7 Copper bus joint plating [5.1.6 i)]: Tin (Preferred for H2S environments) Silver (Preferred Chloride) Copper ground bus [5.1.6 k)]

8 Insulated terminations and interior jumpers [5.1.6 m)] 6kV & up use insulated bus bar between stator windings and main terminals (4.3.9)

9 Main t/box space heaters [5.1.6 b)]: Single voltage design Operating voltage _____ Phase _____

10 Refer to page 4 for heater T-code, etc. or Dual voltage design Operating voltages _____ / _____ Phase _____

11 For the devices following below, the purchaser may make a Provide-Install selection; the default is **Provide and Install by Supplier**:

12 Differential protection current transformers [5.1.6 h); 5.1.8; 5.6.3] Provided By _____ and Installed By _____

13 Type: Self-balancing Full differential _____

14 Accuracy class _____ Ratio _____ Quantity: _____

15 Surge capacitors [5.1.6 g); 5.6.2.1, 5.6.2.3]: Microfarads _____ _____

16 Surge arresters [5.1.6 g); 5.6.2.2, 5.6.2.3]: kV Rated _____ _____

17 Current transformers [5.1.6 h)] for phase current meter _____

18 Accuracy class _____ Ratio _____ Quantity: _____

19 Voltage transformers [5.1.6 j)] for voltage meter Fuses required _____

20 Accuracy class _____ Ratio _____ Quantity: _____

21 Partial discharge (PD) detectors [5.1.6 l), 5.6.4.1] _____

22 Describe required system: _____

23 PD t-box location (5.6.4.3): **vertical outside surface of main t-box** Other: _____

MISCELLANEOUS, SUPPLIER'S DATA

24 Qty. special tools and lifting devices (4.1.11, 4.1.12, 4.4.2.14): _____ Proof of non-sparking, corrosion resistant fan (4.4.10.6.1)

25 Separate nameplate with purchaser's information - list below (4.4.11.4) Electronic vibration test data - define digital format below (6.3.3.17)

26 _____

27 **Shipment (6.4.1)** Domestic Export boxing Special shipping bearings [6.4.1 k)] Outdoor storage more than six (6) months (6.4.2)

28 **Proposals (8.1)** Typical drawings & literature with proposal (8.1.8) Purchaser defined efficiency method [8.1.3 f)]: _____

29 Separate price for each test on datasheet page 7 (8.1.14) Packaged price for all tests on datasheet page 7 (8.1.14)

30 Provide requirements for special weather & winterizing protection (8.1.15) Provide safe stall time calculation method and limits (4.2.4.3)

31 Provide quote for supervision of installation and erection (8.1.17) Provide quote for start-up commissioning service (8.1.17)

32 Materials to be identified with ANSI, ASTM, or ASME numbers (8.1.18): _____

33 **Contract Data (8.3)** Special identification for transmittals (8.3.2) Define below or specify where this information is to be found

34 _____

35 **Drawings (8.5)** System of units for drawings / data (1.3.1): U.S. / N.Am. customary only SI (Metric) only U.S. (SI) SI (U.S.)

36 Supplier to provide curve data in tabular format (8.5.1) Define preferred digital format: _____

37 Quantities of documents & drawings, and documentation schedule (or define source for this information) (8.5.1): _____

38 After purchaser review of drawings, quantity of certified drawings to be provided (8.5.2): _____

39 **Instruction Manuals (8.7)** Quantity of instruction manuals to provide (8.7.1) (typically supplied in digital format): _____

40 Detailed instructions and photo's, etc. for disassembly and inspection of bearings and seals [8.7.4 c)]

41 Photos showing machine assembly steps required; including each step of bearing assembly (8.7.5)

42 Copies of applicable certifications, including NRTL, material certifications (including PMI), and other certifications for the machine(s) (8.7.6)

43 Define any/all certifications required, including materials: _____

44 **NOTE! A schematic of lifting is required to be included on motor GA drawing, wherever a spreader bar is required.**

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LOAD REQUIREMENTS AND STARTING CONDITIONS

- 1 **Load torque and inertia requirements (4.2.2):** **Per NEMA MG 1 Part 20** or Per specified load curve & data (lines 25 and 26 below) [4.2.2.1 a)]
2 Design load curve condition: Unloaded (e.g. closed valve or damper) Loaded (e.g. open valve or damper) Partially loaded (e.g. min.flow)
3 Load re-acceleration required [4.2.2.1 b]): **NO** Yes Re-acceleration load data or curve no.: _____
4 If yes above, complete the following (4.2.3.5): Max time of voltage interruption _____ Seconds
5 Voltage at motor terminals during re-acceleration _____ Volts
- 6 **Motor Starting (4.2.3):** **Starting with 80% of rated voltage at motor terminals (4.2.3.1)** or Other percent of rated voltage _____ %
7 Other starting method [4.2.3.2 a): Autotransformer Captive transformer Reactor Solid state soft starter ASD
8 Other method % volts: _____ % If Soft Starter, define percent Locked Rotor current limit during acceleration: _____ %
9 Maximum Locked Rotor current other than in 4.2.4.4 a) (450 to 650%): _____ % of Full Load amps or Maximum amps
10 Determine starting capability per [4.2.3.2 b): Min. _____ Volts at motor terminals under _____ Amps Locked Rotor current
11 or [4.2.3.2 c): Min. _____ S.C. MVA and _____ X/R ratio with _____ base voltage and _____ % Rated volts at motor terminals
12 Provide curves & data [8.1.3 a), b): **at rated voltage & min.start conditions** Other: _____ % Volts Other: _____
13 No. of consecutive starts other than Table 4 (4.2.4.1): With motor temperature at ambient: **3** Other: _____
14 With motor temperature greater than ambient but less than rated operating temp.: **2** Other: _____
15 No. of full voltage starts if more than 5000 required (4.2.4.1; 4.4.5.1.1): _____
16 **Min. locked-rotor, pull-up, and breakdown torques per NEMA MG1 (4.2.4.4.b)** or Min. LRT, PUT and BDT per GP 16-09-02 Section 11, Part 2).

DRIVEN EQUIPMENT INFORMATION - OEM DATA

- 17 Driven equipment: Tag no.(s): _____ Description _____ Location _____
18 Driven equipment mfr.: _____ Type / Model no. _____ RPM _____
19 Driven equip. rotation **viewed from non drive end of motor**: Clockwise Counterclockwise Bi-directional
20 Required motor rotation **viewed from non drive end of motor**: Clockwise Counterclockwise Bi-directional Overspeed trip point (if applicable) (4.1.5)
21 Type of load: Centrifugal: Pump Compressor Fan Other _____ RPM
22 Positive displacement: Pump Reciprocating compressor Compressor factor "C": _____
23 Maximum current pulsation per API 618 (4.2.3.6): **40%** Other: _____ %
24 Provide crank-effort chart or torque-effort curve no. [8.1.3 g): _____
25 Load characteristics per (4.2.2.1): **NEMA MG 1 Part 20** Other - provide load speed-torque curve no. [4.2.2.1 a): _____
26 Total driven equipment load inertia reflected to motor [4.2.2.1 c): Wk^2 : _____ $lb-ft^2$ or GD^2 : _____ $kg-m^2$ at: _____ RPM
27 Speed increasing or reducing gearbox [4.2.2.1 c): Ratio: _____ Note: affect on inertia to be included in total inertia above
28 Driver connection to load: Direct Coupled Gearbox V or cog belt Belt Ratio: _____
29 Motor shaft extension (4.4.5.1.9): Cylindrical fit Taper fit Integral flange
30 Coupling: Specified by: Purchaser Driven equipment supplier Motor supplier Per API 671
31 Coupling manufacturer: _____ Type: _____ Model: _____
32 Supplied by: Purchaser Driven equipment supplier Motor supplier Other: _____
33 Motor half coupling mounted by (4.4.9.4): (requires vibration test in 6.3.1.5)
34 Purchaser Driven equipment supplier Motor supplier Other: _____
35 Coupling inertia [4.2.2.1 c): Wk^2 : _____ $lb-ft^2$ or GD^2 : _____ $kg-m^2$ (To be included in total inertia above)
36 Mass moment of half coupling assy. [4.4.6.2.1.1 f): _____ $lb-ft^2$ or _____ $kg-m^2$ (For damped unbal. response analysis)
37 Center of gravity of half coupling assy., drawing reference or dimensions (6.3.5.3): _____
38 Other information: _____
39 Vertical pumps: Thrust bearing load _____ Momentary _____ lbs Downthrust _____ Momentary _____ lbs
40 [4.4.7.1.11 a)] _____ Continuous _____ lbs Upthrust _____ Continuous _____ lbs
41 Other information: _____
42 _____

INDUCTION MOTOR
API 541 5th Edition -- DATASHEETS
U.S. CUSTOMARY UNITS

PURCHASER'S SELECTIONS

Bold Italics = Indicate Default Selection

JOB NO. _____ ITEM / TAG NO. _____
PURCHASE ORDER NO. _____
REQ. / SPEC. NO. _____
REVISION NO. 4 DATE 03/31/21 BY B. Sauer
REV. DATE _____ PAGE 7 OF 12

ANALYSIS, SHOP INSPECTION, AND TESTS

- 1 (m) Indicates line item is not required ◀ (v) Indicates line item applies to only one machine in a multiple machine application/order
2 (l) Indicates Purchaser required line item ◀ (t) Indicates line item applies to all machines in a multiple machine application/order
3 Make selections in only one column for each item

| | | <u>Required</u> | | <u>Witnessed</u> | |
|----|---|----------------------------------|--------------|----------------------------------|---|
| | | <u>(6.1.3.3; 6.3.1)</u> | | <u>(6.1.3; 6.1.3.1; 6.3.1.1)</u> | |
| 5 | Coordination meeting (8.2) | <input type="radio"/> | | | |
| 6 | Design review (8.4) | <input type="radio"/> | | | |
| 7 | Lateral critical speed analysis [4.4.6.2.1; 8.6.2 b)] | <input type="radio"/> | | | |
| 8 | Torsional analysis data (4.4.6.2.2) Analysis by: | <input type="radio"/> | | | |
| 9 | Submit test procedures and acceptance criteria 6 weeks before tests (6.3.1.4) | <input type="radio"/> | | | |
| 10 | Demonstrate accuracy of test equipment (6.3.1.15) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 11 | Stator core test (6.3.4.1) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 12 | Surge comparison test - required for all machines (6.3.4.2) | <input type="radio"/> | ◀ | <input type="radio"/> | |
| 13 | Special surge test of coils (6.3.4.2.1) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 14 | Power factor tip-up test (6.3.4.3) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 15 | Stator inspection prior to VPI (6.3.4.5) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 16 | Sealed winding conformance test (6.3.4.4) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 17 | Partial discharge test for machines 6kV and greater (6.3.4.6) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 18 | Rotor residual unbalance verification test (4.4.6.3.4) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 19 | Unbalance response test with half coupling mass (6.3.5.3) (Purchaser must also select one of below) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 20 | <input type="radio"/> Purchaser to supply the contract motor coupling hub plus a mass moment simulator for half coupling spacer for test (6.3.5.3) (Define here & refer to | | | | |
| 21 | <input type="radio"/> Other arrangement Datasheet Guide for this test): | | | | |
| 22 | Vibration test with half coupling (6.3.1.5) (req'd if Supplier mounts cplg. 4.4.9.4) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 23 | Inspection of equipment, piping for cleanliness before final assembly (6.2.3.3) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 24 | Routine test - always required for all machines (6.3.2) | <input checked="" type="radio"/> | ◀ | <input type="radio"/> | |
| 25 | Bearing dimensional & alignment checks before tests [6.3.2.1 k)] | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 26 | Bearing dimensional & alignment checks after tests [6.3.2.1 l)] | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 27 | Purchaser supplied vibration monitoring / recording (6.3.3.7) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 28 | Complete test (6.3.5.1.1) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 29 | Includes: Efficiency, LR current, PF & torque, FL Current, FL Slip, BD Torque, Heat Run, Speed v. Torque, Noise test at NL | | | | |
| 30 | DC high-potential test (6.3.5.1.2) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 31 | Rated rotor temperature vibration test (6.3.5.2.1) (If not using Complete test) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 32 | Bearing housing natural frequency test (6.3.5.4.1) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 33 | Heat exchanger performance verification test (TEWAC enclosures) (6.3.5.5) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 34 | Overspeed test (6.3.5.6; 4.1.5) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 35 | Final rotating assembly clearance data storage [6.2.1.1 e)] | <input type="radio"/> | ◀ | | |
| 36 | Material inspection (6.2.2) Radiographic test (6.2.2.2), define parts: _____ | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 37 | Ultrasonic inspection of shaft forging (4.4.5.1.8; 6.2.2.3.1) | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 38 | Ultrasonic test (6.2.2.3.2), define parts: _____ | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 39 | Magnetic particle test (6.2.2.4), define parts: _____ | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 40 | Liquid penetrant test (6.2.2.5), define parts: Any welded lifting lugs | <input checked="" type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 41 | Hydrostatic test (6.2.2.6), define parts: _____ | <input type="radio"/> | ◀ | <input type="radio"/> | ◀ |
| 42 | Certified data prior to shipment [8.6.2 a)] | <input type="radio"/> | ◀ | | |
| 43 | All required test and inspection equipment (6.1.4) provided by supplier | <input type="radio"/> | Other: _____ | | |
| 44 | Notes: | | | | |

Harsh Duty Paint System

1 Applications

Harsh industrial environments and outdoor locations. Suitable for environment C4 per ISO 12944-2 and 12944-6 based on salt spray test results. Passes ASTM B117 salt spray test of at least 500 hours.

2 Preparation

Motor surface treatment is SSPC SP-3, solvent and hand or power tool cleaned. With the exception of incidental hardware (plugs, bolt heads), corrosion-resistant surfaces such as copper alloys and stainless steel are not coated.

3 Base Primer

Interior and exterior coated with epoxy or epoxy ester primer (subcomponent-specific, determined by vendor).

Dry film thickness*: 1 – 4 mils (25 – 100 µm)

4 Intermediate Coat

Exterior coated with two-part polyamide epoxy primer.

Dry film thickness*: 4 – 8 mils (100 – 200 µm)

5 Finish Coat

One coat of two-part acrylic polyurethane applied to all visible surfaces of the motor except shaft extensions, oil sight glass, machined surfaces, etc.

Dry film thickness*: 3 – 8 mils (75 – 200 µm)

Finish paint is allowed to dry for at least 8 hours before handling (or dried for one hour, then baked for 60 – 120 minutes at 200°F). Baked if air temperature is below 55°F.

Total system dry film thickness*: 8 – 20 mils (200 – 500 µm)

6 Materials

Base Primer:

Epoxy or Epoxy Ester (determined by vendor)

Intermediate Coat:

Two-Part Polyamide Epoxy Primer

Finish Coat:

Two-Part Acrylic Polyurethane

Standard Color: Munsell 8.3B 3.54 / 1.9 (Motor Blue)

*Measurement and acceptance criteria are per SSPC-PA 2. Film thickness levels have been developed in accordance with the recommendations of the paint manufacturer.

| | | | | |
|--|-------------------------------------|---------------------------|----------------|-----------|
| Department responsible PD LD AP MF-NOW EN | Technical reference A5E33960720A | Created by | Approved by | Project |
| S | Document type Painting Details | Document status | | Customer |
| | Title Harsh Duty Paint System | Document number | | |
| © Siemens AG 2017 | Rev. AH | Edition date 3/27/2018 | Language EN | Page 1 |

| Producers | | | | | |
|------------|----------------------------|--|---|----------|---------|
| Discipline | Dataset | Attribute | Examples | Producer | Remarks |
| Structural | Structural Vendor 3D Model | HEADER | | | |
| Structural | Structural Vendor 3D Model | UID | 1234 | | |
| Structural | Structural Vendor 3D Model | Unit | LAU | | |
| Structural | Structural Vendor 3D Model | CWA | A1101FX0 | | |
| Structural | Structural Vendor 3D Model | Discipline | Structural | | |
| Structural | Structural Vendor 3D Model | CWP | CWP-A1101FX0-STR-001 | | |
| Structural | Structural Vendor 3D Model | Piece Mark | Unqiue mark numbers to be provided | | |
| Structural | Structural Vendor 3D Model | Parent tag | PM-001 | | |
| Structural | Structural Vendor 3D Model | Description | Steel, Grating | | |
| Structural | Structural Vendor 3D Model | Component type | column, beam, bracing, gratings, handrails, ladders | | |
| Structural | Structural Vendor 3D Model | Component type | Loose plates, column, beam, bracing, gratings, handrails, ladders | | |
| Structural | Structural Vendor 3D Model | Material | Steel, Fiberglass, Aluminum | | |
| Structural | Structural Vendor 3D Model | Fireproofing | Volume | | |
| Structural | Structural Vendor 3D Model | Width | 12.34 | | |
| Structural | Structural Vendor 3D Model | Length (Cut length) | 25m, 10'2" | | |
| Structural | Structural Vendor 3D Model | Length (Cut length) | 25m, 10'2" | | |
| Structural | Structural Vendor 3D Model | Weight (Net) | 517 | | |
| Structural | Structural Vendor 3D Model | Weight (Net) | 517 | | |
| Structural | Structural Vendor 3D Model | Dry Weight | 12.34 | | |
| Structural | Structural Vendor 3D Model | Bolt Type | Diameter, Spec, Length | | |
| Structural | Structural Vendor 3D Model | Steel piecemark list | TDHFJIRIS-002-132 | | |
| Structural | Structural Vendor 3D Model | Type detail (Section size) | i.e., W310 x 110, Ladder | | |
| Structural | Structural Vendor 3D Model | Type detail (Section size) | i.e., W310 x 110, Ladder | | |
| Structural | Structural Vendor 3D Model | Drawing | AZ-E-ZA 525,1000 | | |
| Structural | Structural Vendor 3D Model | Erection Drawing | AZ-E-ZA 525,1000 | | |
| Structural | Structural Vendor 3D Model | Shop Drawing | AZ-E-ZA 525,1000 | | |
| Structural | Structural Vendor 3D Model | Weight Category | Light, Med, Heavy | | |
| Structural | Structural Vendor 3D Model | Weight Category | Light, Med, Heavy | | |
| Structural | Structural Vendor 3D Model | Insulation | yes | | |
| Structural | Structural Vendor 3D Model | Module | yes | | |
| Structural | Structural Vendor 3D Model | Module Name | PAR-10134 | | |
| Structural | Structural Vendor 3D Model | SP3d Moniker | 3aKfSFktzArfNXrOSyW1Q | | |
| Structural | Structural Vendor 3D Model | Insulation Thickness | 20 mm | | |
| Mechanical | Equipment Vendor 3D Model | HEADER | | | |
| Mechanical | Equipment Vendor 3D Model | UID | 1234 | | |
| Mechanical | Equipment Vendor 3D Model | Unit | LAU | | |
| Mechanical | Equipment Vendor 3D Model | CWA | A1101FX0 | | |
| Mechanical | Equipment Vendor 3D Model | Discipline | Mechanical | | |
| Mechanical | Equipment Vendor 3D Model | Unique Item Tag | M-001 | | |
| Mechanical | Equipment Vendor 3D Model | Drawing / ISO | AZ-E-ZA 525,1000 | | |
| Mechanical | Equipment Vendor 3D Model | Name | Turbine-01 | | |
| Mechanical | Equipment Vendor 3D Model | Description | Turbine, wind farm | | |
| Mechanical | Equipment Vendor 3D Model | CWP | CWP-A1101FX0-MEC-001 | | |
| Mechanical | Equipment Vendor 3D Model | Width | 12,34m | | |
| Mechanical | Equipment Vendor 3D Model | Length | 25m, 10'2" | | |
| Mechanical | Equipment Vendor 3D Model | Height | 3m | | |
| Mechanical | Equipment Vendor 3D Model | Weight | 12.34 | | |
| Mechanical | Equipment Vendor 3D Model | Module | yes | | |
| Mechanical | Equipment Vendor 3D Model | Module Name | PAR-10134 | | |
| Mechanical | Equipment Vendor 3D Model | System | 700-P-28-01 | | |
| Mechanical | Equipment Vendor 3D Model | System Status | HYDRO COMP | | |
| Mechanical | Equipment Vendor 3D Model | Issued Status (Isometric Issue Status) | Issued | | |
| Mechanical | Equipment Vendor 3D Model | System Description | C2 Purge system | | |
| Mechanical | Equipment Vendor 3D Model | SP3d Moniker | 3aKfSFktzArfNXrOSyW1Q | | |
| Piping | Piping Vendor 3D Model | HEADER | | | |
| Piping | Piping Vendor 3D Model | UID | 1234 | | |
| Piping | Piping Vendor 3D Model | Unit | LAU | | |
| Piping | Piping Vendor 3D Model | CWA | A1101FX0 | | |
| Piping | Piping Vendor 3D Model | Discipline | Pipe | | |
| Piping | Piping Vendor 3D Model | Unique Item Tag | PIP-001 | | |
| Piping | Piping Vendor 3D Model | Drawing / ISO | A1101FX0-C3A1-002-PIP-JHR-001 | | |
| Piping | Piping Vendor 3D Model | Name | Cooling Water Line | | |
| Piping | Piping Vendor 3D Model | Spool Number | A1101FX0-C3A1-002-PIP-JHR-001-001 | | |
| Piping | Piping Vendor 3D Model | Description | Cooling Water | | |
| Piping | Piping Vendor 3D Model | Component type | Spool/Weld/Support | | |
| Piping | Piping Vendor 3D Model | Support Type | TRP | | |
| Piping | Piping Vendor 3D Model | P&ID | P&ID-001-AGDH6473 | | |
| Piping | Piping Vendor 3D Model | CWP | CWP-A1101FX0-PIP-001 | | |
| Piping | Piping Vendor 3D Model | Line number | A1101FX0-C3A1-002 | | |
| Piping | Piping Vendor 3D Model | NPD | 12 | | |
| Piping | Piping Vendor 3D Model | Design Pressure | 41 PSI | | |

| | | | |
|------------------------|-----------------------------------|--|--|
| Piping | Piping Vendor 3D Model | Design Temperature | 500 F |
| Piping | Piping Vendor 3D Model | Size 1 / Width | 25m, 10'2" |
| Piping | Piping Vendor 3D Model | Size 2 / Length | 25m, 10'2" |
| Piping | Piping Vendor 3D Model | Size 3 / Height | 1,5m |
| Piping | Piping Vendor 3D Model | Weight | 12,34kg |
| Piping | Piping Vendor 3D Model | Blind quantity | 12 |
| Piping | Piping Vendor 3D Model | Blind size | 2" |
| Piping | Piping Vendor 3D Model | Center Length (Model length) | 23,8ft |
| Piping | Piping Vendor 3D Model | Flow Direction | Out |
| Piping | Piping Vendor 3D Model | Material | CS |
| Piping | Piping Vendor 3D Model | Unique weld number | A1101FX0-C3A1-002-PIP-JHR-001-FW001 |
| Piping | Piping Vendor 3D Model | Pipe class | G1A-3TM |
| Piping | Piping Vendor 3D Model | Weld identification | shop/field/fit |
| Piping | Piping Vendor 3D Model | Bolt up unique ID | A1101FX0-C3A1-002-PIP-JHR-BT1 |
| Piping | Piping Vendor 3D Model | Commodity Code | FLG |
| Piping | Piping Vendor 3D Model | Module | yes |
| Piping | Piping Vendor 3D Model | Module Name | PAR-10134 |
| Piping | Piping Vendor 3D Model | Volume | 1352 |
| Piping | Piping Vendor 3D Model | Schedule | STD |
| Piping | Piping Vendor 3D Model | Test Pressure | 150 |
| Piping | Piping Vendor 3D Model | Test Type | HT |
| Piping | Piping Vendor 3D Model | Heat Trace | yes |
| Piping | Piping Vendor 3D Model | Painting systems | 12-B |
| Piping | Piping Vendor 3D Model | Issued Status (Isometric Issue Status) | Issued |
| Piping | Piping Vendor 3D Model | Insulation | yes |
| Piping | Piping Vendor 3D Model | SP3d Moniker | 3aKfSFktzArfNXrOSyW1Q |
| Piping | Piping Vendor 3D Model | Pipe support details | STD1-TRGFH46-002 |
| Instrumentation | Instrument Vendor 3D Model | HEADER | |
| Instrumentation | Instrument Vendor 3D Model | UID | 1234 |
| Instrumentation | Instrument Vendor 3D Model | Unit | LAU |
| Instrumentation | Instrument Vendor 3D Model | CWA | A1101FX0 |
| Instrumentation | Instrument Vendor 3D Model | CWP | CWP-A1101FX0-INS-001 |
| Instrumentation | Instrument Vendor 3D Model | Discipline | Instrumentation |
| Instrumentation | Instrument Vendor 3D Model | Unique Item Tag | Cable Tray, Instrument tray supports,Instrument support, |
| Instrumentation | Instrument Vendor 3D Model | ISO/Drawings | AZ-E-ZA 525,1000 |
| Instrumentation | Instrument Vendor 3D Model | P&ID | P324234 |
| Instrumentation | Instrument Vendor 3D Model | Description | Flow Meter |
| Instrumentation | Instrument Vendor 3D Model | Module | yes |
| Instrumentation | Instrument Vendor 3D Model | Module Name | PAR-10134 |
| Instrumentation | Instrument Vendor 3D Model | Component type | Type of Insturment |
| Instrumentation | Instrument Vendor 3D Model | Width | 12.34 |
| Instrumentation | Instrument Vendor 3D Model | Length | 25m, 10'2" |
| Instrumentation | Instrument Vendor 3D Model | Weight | 12.34 |
| Instrumentation | Instrument Vendor 3D Model | Module | MOD-C3A84746 |
| Instrumentation | Instrument Vendor 3D Model | Tray size | 23 |
| Instrumentation | Instrument Vendor 3D Model | SP3d Moniker | 3aKfSFktzArfNXrOSyW1Q |
| Instrumentation | Instrument Vendor 3D Model | Voltage | HV |
| Electric | Electric Vendor 3D Model | HEADER | |
| Electric | Electric Vendor 3D Model | UID | 1234 |
| Electric | Electric Vendor 3D Model | Unit | LAU |
| Electric | Electric Vendor 3D Model | CWA | A1101FX0 |
| Electric | Electric Vendor 3D Model | CWP | CWP-A1101FX0-ELE-001 |
| Electric | Electric Vendor 3D Model | Discipline | Electrical |
| Electric | Electric Vendor 3D Model | Unique Item Tag | Panel, JB, Cable Tray, Lighting fixture, Electrical Equipments |
| Electric | Electric Vendor 3D Model | Drawing | AZ-E-ZA 525,1000 |
| Electric | Electric Vendor 3D Model | Description | Flow Meter |
| Electric | Electric Vendor 3D Model | Module | yes |
| Electric | Electric Vendor 3D Model | Module Name | PAR-10134 |
| Electric | Electric Vendor 3D Model | Component type | INST |
| Electric | Electric Vendor 3D Model | Width | 12.34 |
| Electric | Electric Vendor 3D Model | Length | 25m, 10'2" |
| Electric | Electric Vendor 3D Model | Weight | 12.34 |
| Electric | Electric Vendor 3D Model | Module | MOD-C3A84746 |
| Electric | Electric Vendor 3D Model | Tray size | 23 |
| Electric | Electric Vendor 3D Model | Tray Type | Instrument and cable tray |
| Electric | Electric Vendor 3D Model | SP3d Moniker | 3aKfSFktzArfNXrOSyW1Q |
| Electric | Electric Vendor 3D Model | Voltage | HV |
| Electric | Electric Vendor 3D Model | Motor Tag | E_7324682 |
| Electric | Electric Vendor 3D Model | Tracing Code | ETH |
| Electric | Electric Vendor 3D Model | Cable Type | AL |
| Electric | Electric Vendor 3D Model | Cable Size | 1C-1000 |
| Electric | Electric Vendor 3D Model | Layout Drawing | AZ-E-ZA 525,1000 |



[REPLACE VENDOR NAME] BILL OF MATERIALS_ ANNEXURE B

| CWP | PWP | Vendor_Drawing_Number | Engineering_Drawing_Number | Parent_Tag_Number | Tag_Number | Ident_Code | Vendor_Part_Number or Model Number | Description | Quantity | UoM | Spare (Yes/No) | Weight(Kgs) | Additional_Comments |
|------------------|------------------|-----------------------|----------------------------|-------------------|------------|------------|------------------------------------|-------------|----------|-----|----------------|-------------|---------------------|
| CWP-CWA1-STL-001 | PWP-CWA1-STL-001 | Vendor Drawing 1 | Drawing 1 | F-2239 | F-2239 | 12345678 | | Compressor | 1 | ea | No | | |
| CWP-CWA1-STL-001 | PWP-CWA1-STL-001 | Vendor Drawing 1 | Drawing 1 | F-2239 | F-2239-1 | 12345678 | | Shim plate | 10 | ea | No | | |
| CWP-CWA1-STL-001 | PWP-CWA1-STL-001 | Vendor Drawing 1 | Drawing 1 | F-2239 | F-2239-2 | 12345678 | | beam | 2 | ea | No | | |
| CWP-CWA1-STL-001 | PWP-CWA1-STL-001 | Vendor Drawing 1 | Drawing 1 | F-2239 | F-2239-3 | 12345678 | | Damper | 1 | ea | No | | |
| CWP-CWA1-STL-001 | PWP-CWA1-STL-001 | Vendor Drawing 1 | Drawing 1 | F-2239 | F-2239-4 | 12345678 | | Blower | 1 | ea | No | | |



| | |
|---------------------------------|--|
| EXPORTER : | |
| IMPORTER: | |
| FINAL CONSIGNEE: | |
| PROJECT REFERENCE: | |
| FINAL DESTINATION : | |
| PURCHASE ORDER NO.: | |
| DESCRIPTION OF GOODS: | |
| PICK-UP LOCATION: | |
| CONTACT DETAILS: | |
| MODE OF SHIPMENT(AIR/ROAD/SEA): | |

ANNEXURE C

| S.No | ShippingReleaseNote/PLNumber | PWP | Package_Number | PO_Position | PO_Sub_Position | Tag_Number | Ident_Code | Vendor_Part_Number | Description | Quantity | UoM | Spare (Yes/No) | Country_Of_Origin | Preservation | Additional_Comments | Net Weight (kg or MT) | Gross Weight (kg or MT) | Dimension Length (in) | Dimension Width (in) | Dimension Height (in) | Volume (CBM) | Stackability | |
|------|------------------------------|------------------|----------------|-------------|-----------------|------------|------------|--------------------|-------------|----------|-----|----------------|-------------------|--------------|---------------------|-----------------------|-------------------------|-----------------------|----------------------|-----------------------|--------------|--------------|--|
| 1 | RN1/PL1 | PWP-CWA1-STL-001 | CRATE 1 | 1 | 1 | ABC | ABC-Ident | 12345678 | Description | 1 | ea | No | USA | | | | | | | | | | |
| 2 | RN1/PL1 | PWP-CWA1-STL-001 | WOODEN BOX | 1 | 1 | ABC | ABC-Ident | 12345678 | Description | 1 | ea | No | USA | | | | | | | | | | |

The vendor confirms that the details given above are true & correct

Digital Signature

External Paint and Protective Coatings

BTDP 19-1-1-1

Revision 0

October 2022

Scope

- 1) **[I]** This Baytown Drafting Practice (BTDP):
 - Shall be used in lieu of GP 19-01-01, Paint and Protective Coatings, for the coating of carbon steel and low chrome (1-1/4% Cr thru 9% Cr) surfaces and when specified for stainless steel surfaces under insulation where SCC is a concern, for the ExxonMobil Baytown complex.
 - Provides coating systems, color coding, and minimum standards for the application of external coatings to vessels and equipment in, or provided for, the ExxonMobil Baytown complex.
 - Provides requirements for touch-up of field welds and mechanical damage to coated surfaces.
- 2) **[I]** This supplement **does not apply to internal lining applications or concrete coatings and linings applications**. An [Internal Lining Checklist Form for Tanks, General Internal Lining Checklist Form for Equipment, and a Concrete Coatings/Lining Checklist Form](#) that will aid in supplying the data required to specify coatings and linings for these applications shall be completed and submitted to the [Baytown Site Coatings Specialist](#).
- 3) **[I]** This supplement does **not** apply where any of the following is true:
 - Steel will be damp or sweating when coating is applied.
 - Surfaces to be painted are **not** carbon steel or low chrome (1-1/4% Cr thru 9% Cr) or stainless steel under insulation as specifically addressed by this supplement.
 - Surfaces to be painted will exist in a chemically corrosive atmosphere, i.e., fumes, spills, splashes of acids, caustics, or other strong chemicals or oxidizing agents. (See [TSA Notes](#))
 - Surfaces will see immersion conditions (i.e. underwater, splash zone, etc.).
 - Underground equipment, piping or pilings. (See [BTDP 19-1-1-6](#))
 - Surfaces are plastic or plastic-coated, excluding structural steel.
 - Refractory lined equipment requiring temperature indicating paint.

[*] Contact the Site Coatings Specialist for a specification if any of the above conditions exist.
- 4) **[I]** **An asterisk** ([*]) indicates that a decision by the Owner's Engineer and/or Baytown Refinery and Chemical Plant Site (i.e. Complex) Coatings Specialist is required, that additional information is to be furnished by the Owner's Engineer and/or Site Coatings Specialist, or that information for the Owner's Engineer and/or Site Coatings Specialist is to be supplied by Vendor or Contractor.
- 5) **[R]** For **Deviations** from the criteria, procedures, recommendations, etc. *of this supplement*, a [Waiver/Deviation Form](#) and an [External Coating Request Form](#) shall be completed and submitted to the [Baytown Site Coatings Specialist](#) for approval.

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1. Required References

- 1) [I] This Section lists Practices and Standards that shall be used with this document. Unless otherwise specified herein, use the latest edition.

1.1. Baytown Area Engineering Supplements

| Baytown Area Engineering Supplements | |
|--------------------------------------|--|
| BTAES 3-7-1-0 | Piping Layout, Supports, and Flexibility |

1.2. Baytown Drafting Practices

| Baytown Drafting Practices | |
|-------------------------------|---|
| BTDP 19-1-1-6 | External Coatings for Underground Piping (BTRF and BTCP Only) |
| BTDP 19-1-1-7 | Thermal Spray Aluminum (TSA) Coating Specification |

1.3. Global Practices–ExxonMobil Engineering Practices

| Global Practices | |
|-----------------------------|---|
| GP 03-19-01 | Piping Erection, Testing, Flushing and Cleaning |
| GP 05-03-01 | Pressure Testing of Unfired Pressure Vessels |
| GP 19-01-01 | Paint and Protective Coatings - - - (For Reference Only) |

1.4. Site Mechanical Procedures – **BTRF, BTCP & MBPP**

| Site Mechanical Procedures | |
|----------------------------|--|
| SMP-1041 | Application of Volatile Protective Coatings Within Enclosed Spaces |
| SMP-1042 | General Coating Application Guidelines |

1.5. Baytown Maintenance Work Practices – **BTRF, BTCP & MBPP**

| Maintenance Work Practices | |
|----------------------------|--|
| MWP-7011 | Abrasive Blasting Operations or Equivalent Type Work on Equipment in Service |
| MWP-7012 | Thermal Spray Aluminum (TSA) Field Application |
| MWP-7021 | Hydrostatic Testing Pressure Vessels and Piping |
| MWP-9100 | Pressure Washing Operations and Hydroblasting Operations |
| MWP-9140 | Chemical Cleaning Equipment |

1.6. Baytown Site Safety Standards – **BTRF, BTCP & MBPP**

| Site Safety Standards | |
|--------------------------|--------------------------|
| SSS-3070 | Lead Containing Coatings |
| SSS-3071 | Abrasive Blast Media |

| Site Safety Standards | |
|-----------------------|--------------------------------------|
| SSS-3110 | Painting |
| SSS-3111 | Epoxy Resins and their Curing Agents |
| SSS-4060 | Car Seals, Use of on Process Valves |

1.7. SSPC – Steel Structures Painting Council Practices

| SSPC – Practices | |
|------------------|--|
| AB-1 | Abrasive Specification No. 1, Mineral and Slag Abrasives |
| AB-2 | Abrasive Specification No. 2, Cleanliness of Recycled Ferrous Metallic Abrasives |
| PA-1 | Shop, Field, and Maintenance Painting |
| PA-2 | Method for Measurement of Dry Film Thickness |
| SP-1 | Solvent Cleaning |
| SP-2 | Hand Tool Cleaning |
| SP-3 | Power Tool Cleaning |
| SP-5 | White Metal Blast Cleaning |
| SP-6 | Commercial Blast Cleaning |
| SP-7 | Brush-Off Blast Cleaning |
| SP-8 | Pickling |
| SP-10 | Near White Blast Cleaning |
| SP-11 | Power Tool to Bare Metal |
| VIS-1 | Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning |

2. General Requirements

- 1) **[S] BTRF, BTCP & MBPP – Requirements** of Contractor regarding **lead abatement** activities inside the Baytown Refinery, Chemical Plant and MBPP are provided in **SSS-3070**.
- 2) **[S] BTRF, BTCP & MBPP – Requirements** of Contractor regarding **abrasive blasting** activities inside the Baytown Refinery, Chemical Plant and MBPP are provided in **SSS-3071**.
- 3) **[E] BTRF, BTCP & MBPP – Requirements** of Contractor regarding **notification** of spray paint/coating activities, communication with ExxonMobil Process, and protection of equipment inside the Baytown Refinery, Chemical Plant and MBPP are provided in **SMP-1042**.
- 4) **[R] BTRF, BTCP, MBPP & BOP** - The Contractor QC (see Section 6) shall notify ExxonMobil Inspection (see Section 6) for all hold point inspections. The Contractor QC is responsible for and shall perform all quality control inspection steps and hold points of all surface preparation and coatings application processes prior to their notification of and acceptance by the ExxonMobil Owner's Representative (herein referred to as ExxonMobil Inspection). Hold point inspections shall at a minimum be performed prior to surface preparation, after surface preparation, between each coat of

paint applied and at final inspection. Each hold point inspection shall be passed by ExxonMobil Inspection prior to progressing to the next step in the surface preparation and/or application process. If at any time the "acceptable" status of any work changes, Contractor QC shall notify ExxonMobil Inspection of the change, and the previous hold point inspections shall be repeated as necessary until the work is returned to "acceptable" status.

- 5) **[I] Pre-job meeting:** After the Contractor has visited the jobsite and prior to ordering any materials, the Contractor Superintendent, the Contractor QC and foreman who will run the job, ExxonMobil Inspection, the coating manufacturer's representative and the Site Coatings Specialist (as required) shall attend a pre-job meeting to discuss the written specification and any non-written, job-specific requirements and other important aspects of the job such as surface preparation, application, cure time requirements, all quality requirements, material storage requirements, time constraints, accessibility to the work, etc. The Contractor shall at this time, raise questions and concerns regarding the specification or other ExxonMobil expectations regarding any aspect of the job. Quality assessment criteria, such as the use of visual comparators, test blasts, material compatibility testing, application technique and calibration of inspection tools should be discussed and agreed upon by all parties involved. It is the Contractor QC's responsibility to schedule and "Chair" the Pre-Job Meeting. The Contractor QC shall send a copy of all specifications and product data sheets used for the Project to the ExxonMobil Mechanical FLS assigned to the Project.
- 6) **[R] Manufacturer's instructions** and SSPC-PA-1 shall be followed for the application of paints and protective coatings unless modified by this supplement or the Purchaser.
- 7) **[R]** Where manufacturer's instructions or SSPC-PA-1 are given in permissive terms, e.g., "should," "may," and "recommend," they shall be considered **mandatory**.
- 8) **[I] Structural components** such as platforms, floor plates and grating, stair treads, ladders, safety cages, handrail assemblies, instrument supports, instrument raceways and other small pieces of structures and their bolting shall be hot-dip galvanized per ASTM A123.
[S] Zinc for galvanizing shall be in accordance with ASTM B 6, "High grade zinc," which contains a maximum of 0.03% lead and 0.01% cadmium.
- 9) **[R] Flanges:** Gasket surfaces and other machined surfaces shall not be blasted or coated. Bolt holes do not require coating unless specified by Owners Engineer. Areas not to be coated shall be covered or masked to prevent damage from blasting or coating material due to overspray. Bolt holes are not required to be protected from blasting and coating, unless otherwise specified.
- 10) **[R] Vessel supports** (i.e., legs, saddles, and inside and outside surfaces of skirts) provided with the equipment shall receive a coating system suitable for the operating conditions of the vessel as described in [Table 1](#).
- 11) **[R] Edges to be welded:** Coatings shall not extend within 6 inches (152.4 mm) from edges to be welded. Exception: For TSA coatings the minimum is 3 inches (76.2 mm).
- 12) **[S] [R] Vessels to be hydrotested:** Welds on vessels shall be left uncoated until after hydrotest. **GP 05-03-01** provides instructions in this regard. For the **BTRF, BTCP & MBPP** also see **MWP-7021**.
- 13) **[C] [*] Piping to be hydrotested:** All welds, shop and field, may be hydrotested **after** coating application, unless otherwise specified by Owner's Engineer. Welds in lines to be insulated shall be tested before insulation is applied. **Exception:** Per **GP 03-19-01**, joints in buried piping systems shall be left unprimed and unpainted for examination during hydrotesting.
- 14) **[R] Fireproofed and insulated equipment:** If a coating is being specified for corrosion protection under fireproofing (CUF) or insulation (CUI), **all** attachments that protrude through the insulation or fireproofing **shall be coated** in the same manner as the balance of the equipment, unless specified otherwise.

3. Materials

- 1) **[R] Abrasive media** shall be selected to yield the anchor profile range required by the manufacturer of the coating. Mineral and slag abrasive shall be designed by the abrasive supplier to suitably meet the grade requirement of SSPC-AB-1 for the matching specified range (Grades 1 through 5) and a majority percentage of profile peak-density shall be within the specified profile range, at the discretion of ExxonMobil Inspection. To insure this requirement is met, ExxonMobil Inspection shall compare the on-site grit that will be used (verified by the Contractor QC) to the grit manufacturer's Abrasive Sizing Chart (provided by the Contractor QC) before the Contractor may begin abrasive blasting operations. The selected abrasive shall contain no more than 1.0 wt. % crystalline silica as determined by SSPC-AB-1, Paragraph 4.1.7. Recycled Ferrous Metallic Abrasives shall meet the requirements of SSPC-AB2. Recycled steel grit and shot shall be maintained at a constant minimum working mix ratio of 40% grit, and the remainder, shot, unless specified otherwise. Rounded grit that has become "shot-like" in shape and appearance (rounded edges) does not contribute to the minimum grit requirement. Frequent grit additions shall be made at a minimum of 1 hour and shall suitably maintain the minimum 40% grit requirement.
- 2) **[R] Acceptable coating materials:** Paint products shall not deviate from those specified in [Table 1](#) of [BTDP 19-1-1-1](#), unless approved by the Site Coatings Specialist. All thinning and cleaning materials shall not deviate from those recommended by the manufacturer's product data sheet.
- 3) **[R] [*] Coating system selection:** The specific coating system specified by the Owner for each piece of equipment is selected from the service categories in [Table 1](#). If there is not an applicable service category, consult the Site Coatings Specialist. Selection of coating materials from Table 1 shall be based on the **normal operating temperature** range of the equipment to be painted/coated.
- 4) **[S] No lead/heavy metals or Asbestos:** All coatings shall contain no more than 0.01 wt. % lead, chromium, or other heavy metals or asbestos. See [paragraph 8.1](#). Zinc is not considered a heavy metal per this supplement. Zinc dust used in Zinc-containing coatings must conform to ASTM D520, Type II.
- 5) **[R] Single manufacturer:** Coating materials from only one manufacturer shall be utilized on any one piece of equipment or piping system. Deviations from this requirement must be presented in writing to the Site Coatings Specialist for approval.
- 6) **[R] Cold weather catalysts:** Coating application Contractor shall be responsible for the selection of coating products and the appropriate catalyzing agent that will allow adequate cure during cold weather applications. Weather temperatures averaging below 60°F (including nighttime temperatures) typically cause curing problems or delays.
- 7) **[I] Contrasting coats:** Successive coats of a paint system shall be of contrasting color. If approved by the coating manufacturer, addition of a colorant provided by the manufacturer to tint one of the coats is acceptable. Color of prime coat shall not be red, rust, or red oxide.
- 8) **[I] Colors:** Finish coat colors, other than those specifically color-coded per Table 3 or 4, shall be per [Table 2](#).
- 9) **[I] Equipment/Piping Color-coding:** Equipment or items fitting the description of any listed in [Table 3](#) shall be color-coded as indicated.
- 10) **[I] Utility Station Piping Color-coding:** All piping at utility stations shall be color-coded and identified as indicated per [Table 4](#).

4. Job Site and Equipment Preparation

- 1) **[S] [E] BTRF, BTCP & MBPP** (In Plant Only) – Baytown Site Mechanical Procedure **(SMP) 1042** provides Contractor requirements regarding protection of sensitive equipment, communication with ExxonMobil Process and notification of spray-painting activities.
- 2) **[I] Shielding:** Shielding shall be provided to protect all equipment not specified to be blasted and painted per exclusion from the Scope of Work, and the following from grit, drifting dust, and paint: (In Plant Only--Contact Owner's Representative if shielding will prevent accessibility by process operating personnel.) **BTRF, BTCP & MBPP** – Also see **SMP-1042** for additional requirements (In Plant Only).
 - Nameplates, informational markings and signs (Unless the Owner's Representative requests removal followed by replacement.).
 - Packing glands and packing seals.
 - Bearings.
 - Rotating equipment couplings and shafts.
 - Lubrication fittings.
 - Pressure and temperature gauges and gauge glasses.
 - Motor starters.
 - Instruments and control valves.
 - Vents.
 - Exposed linkages.
 - Valve stems
 - Light bulbs and their enclosures and reflectors.
 - Air intakes.
 - Rubber and plastic parts.
 - Turbine tripping mechanism.
 - Coatings on adjacent piping and equipment.
- 3) **[S] Warning signs;** For work inside the Baytown Refinery and Chemical Plant complex, warning signs warning of grit blasting and spray painting must be prominently displayed in accordance with **SMP-1042**. Contractor shall provide signs.
- 4) **[R] Drains:** For work inside the Baytown Refinery and Chemical Plant complex, area surface drains shall be temporarily covered to prevent clogging with abrasives. Remove covers at the end of each workday, unless otherwise directed by the ExxonMobil Mechanical Execution FLS.
- 5) **[S] BTRF, BTCP & MBPP – Grit removal:** For work inside the Baytown Refinery and Chemical Plant complex, abrasives and debris shall be removed per **SSS-3070**.

5. Surface Preparation and Coating Application

- 1) **[R] Documents required at the site:** Contractor must maintain at the job site: all appropriate Manufacturer's Safety Data Sheets (MSDS) for the products being used, product data sheets, application instructions (if not included as part of the data sheet), project specification (if issued), and this specification.
- 2) **[R] Pre-blast inspection:** ExxonMobil Inspection shall assess whether all metal work has been completed, and whether surfaces are satisfactorily clean/smooth for coating **BEFORE** abrasive blasting shall begin. Steel surfaces shall be clean of all hydrocarbons, chemical residue, moisture, dirt, etc. prior to abrasive blasting. This may be accomplished by pressure washing, steam cleaning, or solvent cleaning per SSPC SP-1. If pressure washing is used to remove hydrocarbon contamination, detergent or cleaning solution shall be added to pressure washing water. Detergents

or cleaning solution for pressure washing shall be approved by ExxonMobil prior to use, and shall be thoroughly rinsed off after water washing, leaving no residues. Potable or demineralized water shall be used for any washing and rinsing with water.

- 3) **[R] Surface imperfections:** All edges shall be grinded to produce a radius of 1/16" (1.6MM) minimum, except if the equipment functionality is dependent on existing edge tolerance (contact the ExxonMobil Mechanical Execution FLS or Project Engineer for a determination). For equipment receiving galvanizing, edges shall be ground only to break the sharp edge. Prior to blast cleaning all imperfections such as laminations, scabs, scale, weld spatter, gouges, slivers, and weld slag shall be corrected and approved by ExxonMobil Inspection prior to abrasive blasting. Repairs requiring removal of surface metal (e.g. by grinding) shall be approved by ExxonMobil prior to grinding. On equipment where there is an existing coating that is to be replaced or refurbished, ExxonMobil Inspection will assess whether there has been any contribution to coating failure by steel surface quality. If identified, these areas shall be corrected before continuing with coating application.
- 4) **[R] Environmental restrictions:** Blasting and painting shall not be performed in rain, drizzle, fog or frozen precipitation. Conditions inside "make-shift" plastic and scaffold containment shall be considered the same as "outside" conditions unless seams are completely sealed and inspected by Contractor QC and ExxonMobil Inspection and environmental control equipment is utilized to control the atmospheric conditions in the containment. A "positive" air pressure of the proper environmental conditions per the coating manufacturer's product data sheet and this specification shall be maintained during blasting and painting operations. Unless otherwise specified in writing by the coating manufacturer, blasting and painting operations shall not be conducted unless the following conditions exist and are maintained consistently until completion of all blasting, painting, and completion of minimum required cure times of applied paint coats:

| | |
|---------------------------|---|
| Air temperature: | 50° to 100°F |
| Steel temperature: | 50° to 110°F |
| Dew Point: | Surface temperature shall be at least 5°F greater than the atmospheric dew point temperature surrounding the work. |
| Relative Humidity: | Shall not exceed 85%, or manufacturer's data sheet maximum allowable. Shall not be borderline and rising, at the discretion of ExxonMobil Inspection. |

- 5) **[R] Blasting and Painting:** Blast cleaning air pressure shall be 95 +/- 5 psig at the nozzle at all times. Thompson's Valve shall be properly adjusted for even grit flow and optimum production in accordance to the equipment manufacturer's recommendation. Pressure at the nozzle shall be determined by the Contractor QC using a Blast Pressure Needle Gauge in accordance to the gauge manufacturer's instructions. Pressure readings shall be recorded in the QC Daily Log. During blasting and painting operations, the surface temperature shall remain a minimum of 5°F greater than the surrounding atmospheric dew point temperature. The first coat shall be applied within 4 hours of blasting. If 4 hours is surpassed, the surface shall be sweep blasted to refresh the blast cleaned substrate, prior to application, unless ExxonMobil Inspection has issued a determination that atmospheric conditions have not negatively affected the prepared substrate. If rust bloom forms after blasting, the affected area shall be re-blasted to the specified blast standard for surface cleanliness and profile prior to application of the first coat. **Note:** If climate controls (dehumidification and sealed enclosure) are in place and providing continuous atmospheric preparation and application conditions as listed in paragraph 4 above, the 4 hour window does not apply. In the event climate controls are utilized it is the Contractor's responsibility to coat the blast cleaned steel immediately after completion of all surface preparation procedures and prior to any rust bloom occurring.
- 6) **[R] Wet blasting or use of rust inhibiting solutions with wet blasting or by spray application,** shall not be performed unless specified by ExxonMobil. Wet blasting or wet vapor blasting shall only be

performed while using Hold Tight 102 or Chlor-rid "Hold Blast" corrosion inhibitive additives, and in accordance to manufacturer's data sheet.

- 7) **[R] Air quality:** Contractor shall supply air that is free of oil, water, and other contaminants. Equipment such as compressors, air dryers, and filters necessary for clean, dry air shall be provided by Contractor.
- 8) **[R] Manufacturer's instructions:** Anchor profile, steel temperature, storage temperatures, mixing, thinning, application equipment and technique, and thickness of individual coats shall be in accordance with the coating manufacturer's data sheets or written instructions, unless specified otherwise. All minimum and maximum recoat interval instructions specified for each material shall be properly followed. Applied coatings not meeting this requirement during cure shall be either removed or prepared in accordance to the manufacturer's written procedure prior to applying subsequent coating films, as determined necessary by ExxonMobil Inspection. The repair plan shall be submitted to and approved by the ExxonMobil Site Coating Specialist prior to use.
- 9) **[R] Craftsmanship:** All coating material shall be applied in a good craftsmanship like manner and result in a film of good aesthetic and proper design integrity. Applied coatings shall be uniform in thickness in the specified range and free of all defects. A defect shall be defined as any irregularity or anything other than the intended final product as outlined in the Manufacturer's Technical Data and this specification.
- 10) **[R] Stripe coating:** Rough areas, corners, edges, and all welds shall be brush stripe coated. Thickness of the stripe coating shall be adequate to fill recesses but remain within specified total system DFT range. For three (3) coat systems, brush stripe coating shall be done with the intermediate coat. For two (2) coat systems, brush stripe coating shall be done with the primer coat.
- 11) **[R] Surface cleanliness:** The contractor shall provide and utilize paper gloves, boot covers and other coverings as necessary to prevent workers from contaminating prepared or coated surfaces before application of subsequent coats of material. All contaminated or damaged prepared surfaces shall be cleaned and re-blasted, and contaminated or damaged prepared surfaces or applied paint films shall be repaired or replaced in accordance to this specification, at the discretion of ExxonMobil Inspection. All coated surfaces shall be clean prior to application of additional coats of material. All dirt and debris shall be removed by blowing down, solvent wiping with the coating manufacturer's approved thinner, or pressure washing with potable water (minimum purity), as necessary to achieve a clean condition of all applied films prior to application of additional coats of material. All dry-spray shall be removed prior to application of additional coats of material. All surfaces of applied inorganic zinc silicate (IOZ) primer coats shall be "screened" using stainless steel screen and welds lightly wire brushed with a stainless steel brush, effectively removing all dry spray from all applied IOZ prior to application of subsequent coats of material. All exudation, amine blush, and/or moisture blush shall be removed in accordance to the coating manufacturer's effective recommended procedure prior to application of additional coats of material.
- 12) **[R] Rain protection:** All rain or moisture contact with an applied paint film occurring prior to the manufacturer's established full cure time shall be reported to ExxonMobil Inspection for damage assessment. If a blush or exudation of the film has occurred, contact the ExxonMobil Coating Specialist for a path forward. If the coating has been damaged by rain or condensation, the coating shall be repaired in accordance to the manufacturer's written procedure or replaced (at the discretion of ExxonMobil Inspection).
- 13) **[R] Touchup materials:** Coating materials for touchup shall be the same as the original coating system unless the primer is inorganic zinc silicate and the manufacturer of the inorganic zinc does not allow self-recoat, or the equipment is in service and operates above 110F. In either case, submit a Coating Request Form to the Site Coating Specialist for an alternative coating system.
- 14) **[R] Touchup surface preparation and application:** Surface preparation for touchup areas shall achieve the original SSPC surface preparation designation as specified for the original coating system. Surface shall be solvent cleaned with rags or detergent washed and rinsed. Solvent shall be paint manufacturer approved, and rags shall be clean and changed frequently. Feather the edges of

the existing coating with sand paper (minimum 80 grit) to a zero-gloss condition for a minimum distance of 2", and solvent wipe prior to touch-up application.

6. Quality Control and Quality Assurance Inspection

- 1) **[R]** The Contractor shall provide a designated quality control (QC) Inspector, herein referred to as Contractor QC, who is **NACE Level 3 Certified with Peer (Peer Review)** and experienced in the application and quality control of high performance coatings. If this requirement is met, ExxonMobil Inspection shall still be notified of all QA hold points, but the expected frequency of QA activities can be reduced from 100% to between 50% - 100% (except for internal linings), at the discretion of ExxonMobil Inspection. A NACE Level 1 or 2 Certified QC Inspector may perform QC Inspector duties when assigned to and working under direct supervision of an onsite **NACE Level 3 Certified with Peer (Peer Review)** QC Supervisor from his company, with approval from Site Coatings Specialist, if the NACE Level 1 or 2 Certified QC Inspector assigned has the sole duty of Quality control and is not performing duties of Painter/Laborer, Foreman, General Foreman, etc. If other than a NACE Level 3 Certified Inspector with Peer (Review) is used for QC, the expected QA frequency remains at 100% of QA hold points.

The Contractor QC Inspector's qualifications shall be subject to approval by ExxonMobil Inspection and shall be available for ExxonMobil's review upon request.

NOTE: Any deviations to the above requirements require a waiver to be submitted to the Site Coating Specialist (for On-Site work), or to the Project Engineer (for Off-Site work).

- 2) **[R]** The Contractor QC Inspector shall maintain a daily report (and perform the duties required thereof) containing:
- List of personnel on job.
 - Each material being used with batch numbers.
 - Environmental data, including steel temperature, dry bulb temperature, wet bulb temperature, dew point temperature, relative humidity, weather climate controls (dehumidification, AC/heat, containment, etc.) being utilized, wind speed and direction, weather conditions, and the times all data are recorded.
 - Other quality control data being monitored, i.e., blotter test of compressed air, air pressure (PSI) at the blast nozzle (using a Needle Pressure Gauge), blast nozzle size and Orifice Gauge measurement of nozzle I.D. size (for wear), type and size of abrasive, quality of abrasive, blast profile height and level of substrate cleanliness, storage of materials, temperature of mixed materials, equipment operability and cleanliness, etc.
 - A detailed report depicting what (and where) surface preparation was performed and what (and where) coatings were applied, to include but not limited to: Types of coatings applied, wet film thicknesses applied, dry film thicknesses achieved, recoat times achieved (minimum and maximum), adhesion of cured films (general: poor, good, very good), defects noted and corrective actions and methods of repair performed.
 - Amount of work accomplished in that period.
- 3) **[R]** **ExxonMobil QA (ExxonMobil Inspection):** Owner/Purchaser's representative from ExxonMobil Research and Engineering (EMRE) or Baytown Engineering Services (BTES), depending on Project Support responsibilities, will perform quality assurance (QA) inspection of all surface preparation, coating application steps and hold point inspections. This individual shall be a NACE Level 3 Certified with Peer (Peer Review) Coating Inspector. This does not release the Contractor from providing a NACE Level 3 Certified Coating Inspector with Peer assigned as Contractor QC. The Contractor shall bear the cost of any rework required of any work that is deemed defective by ExxonMobil Inspection.

ExxonMobil Inspection shall have continuous access to the coating contractor's job site and Contractor QC's quality control log sheets.

Note:

- Any deviations to the above requirements require a waiver to be submitted to the ExxonMobil Project Engineer for approval.
 - Copies of all procedures, a charge number, when and where the work will occur must be provided to ExxonMobil Inspection prior to beginning any tasks.
- 4) **[R] Blotter test:** Prior to each shift of blasting or spray application of coatings involving air, Contractor QC shall perform a blotter test on the compressed air source. The test shall be performed in accordance with ASTM D4285-88 (latest edition) and the results of the test documented. Results of the test shall be verified with Owner's representative (ExxonMobil Inspection). Failure of this test requires the compressor, and its associated equipment, to be replaced or repaired and retested before use. Results of the replacement or repair and retest must be communicated to the ExxonMobil Owner's representative (ExxonMobil Inspection) or the Coatings Specialist prior to use of the equipment on the Project.
- 5) **[R] [I] Blast Anchor Profile** shall be measured with Testex Press-O-Film replica tape designed for the specified range of minimum and maximum profile height and performed in accordance with ASTM D4417. The Contractor QC shall make an anchor profile determination consisting of three (3) measurements on a blasted test area made prior to the start of production blast cleaning for each shift. Additional measurement of anchor profile shall be as follows:
- For grit blasting w/non-recycled abrasive – (3) random measurements with each new batch or load of abrasive, upon changing equipment or equipment settings, and upon changing abrasive size. Abrasive shall be sharp and angular and produce a profile that is sharp and angular.
 - For grit blasting w/recycled steel shot/grit abrasive – Every (4) hours, upon changing equipment or equipment settings, and upon changing abrasive size. Abrasive shall be sharp and angular and produce a profile that is sharp and angular.
 - For power tool cleaning – (3) random measurements every 10 to 100 (sq. ft.) of surface preparation in a single shift. (1) random measurement for every 0 to 10 (sq. ft.) area, except where multiple small areas of less than 1 (sq. ft.) each are prepared. At these, a minimum of (1) random measurement for every 5 small prepared areas is required.
- Contractor QC shall record all profile measurements and shall notify ExxonMobil's Owner's representative (ExxonMobil Inspection) of any measurements that do not meet specified requirements.
- 6) **[R] Coating thickness measurements** shall be performed in accordance to SSPC-PA2, unless otherwise specified in this document. A Type 1 or Type 2 dry film thickness gauge calibrated in accordance to SSPC-PA2 shall be used. Coating thickness measurements for vessels shall at a minimum be performed in accordance with SSPC-PA2. Additional readings may be taken at areas where the coating appears to be below minimum acceptable thickness. Coating thickness measurements for piping shall also be checked by ExxonMobil Inspection in accordance with the following minimum requirements:
- **Diameters up to 12"** - Four readings taken around the flange area and at 4 evenly spaced locations around the circumference of the pipe at 10-12 ft. intervals along the length of the pipe. A minimum of three sets of 4 readings should be taken on short spools that are less than 4 ft. in total length. Sampling or representative batch testing of items does not satisfy the intent of the specification.
 - **Diameters above 12" up to 24"** - Same as above (diameters up to 12") except 6 readings are taken around the flange area and at evenly spaced locations around the circumference of the pipe at 10-12 ft. intervals.

- **Diameters above 24"** - Same as above (diameters up to 12") except 8 readings are taken around the flange area and at evenly spaced locations around the circumference of the pipe at 10-12 ft. intervals.
 - **Thermal Spray Aluminum (TSA)** – Readings specified above shall be **doubled, at a minimum**.
- 7) **[R] Recycled ferrous metallic abrasives:** At the beginning of each work shift, the cleanliness of **recycled** abrasive (if used) shall be checked for contamination. If any abrasive is found to be contaminated, it shall be removed and replaced with clean abrasive. The cleanliness of the abrasive shall be checked using a test method similar to the following:
- Fill a small, clean, 100-200 ml (4-6 oz) bottle half full of abrasive particles.
 - Fill the remainder of the bottle with distilled water.
 - Cap and shake the bottle
 - Inspect the water for oil sheen. If any oil sheen is observed, clean the blasting equipment; replace the blasting material and retest
 - Inspect the solution for dust particles. If excessive fine particles are present, the recycling screens shall be adjusted, and the abrasive recycled prior to use.

7. Coatings for Temporary Piping – (BOP ONLY)

- 1) **[S]** The following paragraphs specify the colors that shall be used to identify temporary piping and the requirements that must be followed as outlined by the site Safe Operations Committee (JSOC) for the Baytown Olefins Plant (BOP).
- 2) **[S] Light Blue Coloring (Federal Std. ID 25200)** –
- This color will identify facilities which may be removed at a later date, but which are fully rated for plant operating conditions. This piping must be reassessed along with the basic systems if plant conditions change.

All light blue piping will be tracked by the BOP Mechanical Department and put on a work list to review the need for removal at the next scheduled plant downtime.

- 3) **[S] Purple Coloring (Federal Std. ID 27100)** –
- This color identifies piping that **shall not** be used in regular plant service.

It also indicates piping that **shall be removed** prior restarting of the unit.

8. Equipment Identification

- 1) **[S] Low lead paint identification:** Green (Marine Corps Green) metal bands will be utilized to indicate coatings that contain less than 0.01 percent lead by weight. Pipe racks, pipe supports, and all piping (new and existing) which has been abrasive blasted to SP-6 and painted with low lead paint shall be banded with green metal bands. Bands shall be installed at a minimum of every one hundred (100) feet and before and after changes in direction. Bands do not have a material number but can be supplied by Distribution International at (713) 428-3740.
- 2) **[O] Coating system identification for tanks, and vessels/equipment:** The coating system identification shall be stencil painted on using 1-1/2 inch high letters (or a smaller size to accommodate small equipment) within 2 feet of the lowermost horizontal manway or nozzle. Equipment with more than one major component, such as the channel and shell of a shell and tube heat exchanger, shall be stencil painted on each component. If the equipment is to be insulated or fireproofed, this information shall be applied to the equipment **and** to any external covering:

SP: (State level of surface prep, i.e. SSPC-xx)
PC: (Coating type and thickness) {Product Name/Manufacturer}
IC: (Coating type and thickness) {Product Name/Manufacturer}
FC: (Coating type and thickness) {Product Name/Manufacturer}
< 0.01% lead in dry film.
{Date}
{Name of Contractor}

- 3) **[O] Vessel/equipment identification:** Equipment numbers and letters shall be stencil painted on in black in accordance to the Equipment Identification Sizing Chart.

Vessel/Equipment Identification Sizing Chart

| EQUIPMENT, OR COVERING: OUTSIDE DIAMETER (Inches) | LETTER AND NUMBER HEIGHT (Inches) |
|--|--------------------------------------|
| 1 1/2 thru < 6 | 1 |
| 6 thru < 14 | 2 |
| Over 14 | 3 |

- 4) **[O] Tank identification:** Identification numbers on tanks shall be 30 inches high and 16 inches wide, with the width of the line being a black 4-inch stripe. Numbering shall be either painted or adhesive backed vinyl using the proper adhesive (resistant to the maximum operating temperature of the tank). If vinyl numbering is being applied, the application surface area shall be lightly sanded and solvent wiped prior to placement of numbering. If the tank operates above ambient (110F), painted numbering shall be provided. For insulated tanks, adhesive backed vinyl shall be applied on a piece of flat aluminum backing affixed to the external of the insulation jacketing. All tank identification numbers **shall be located at the North, South, East and West quadrants.**

NOTE: All painted on (stenciled) tank numbers, and tank and vessel coating identification shall be applied using the same finish coat paint that is specified for the equipment, and shall be black, except when the finish coat is black, in which case the numbers and letters applied shall be white. Where there are finish coats (i.e. high temperature silicone, multi-polymeric, etc.) applied that do not have existing contrasting colors suitable for numbering and identification, contact the Site Coating Specialist prior to starting the job.

- 5) **[O] [*] Liquid level gauge:** If specified by Owner, on tanks having an external liquid level indicator gauge, a scale with foot and inch graduations shall be painted along the line of travel of the liquid level indicator. One foot graduations shall be numbered as specified by Owner.

9. Handling, Transportation and Storage Requirements

- 1) **[R]** The shop coating contractor is responsible for protecting the applied coating during handling, load out and securement to the transport vehicle. Load out shall be accomplished such that piping and vessels are properly padded and protected from coating and other damage during shipment.
- 2) **[R]** ExxonMobil Inspection shall witness the loading and placement of equipment on transport vehicle and ensure that the appropriate means are utilized and padded lifting slings of the appropriate material provided so that the coatings are not damaged.

- 3) **[R]** Materials or devices used to secure vessel or equipment for shipment shall be padded if in direct contact with the coating.
- 4) **[R]** If damage to the coating is noted by ExxonMobil Inspection during loading and or prior to shipment, repairs to the damaged coating shall be performed by the applicator/vendor at their cost. ExxonMobil Inspection shall approve all repairs prior to the equipment being shipped.

10. Coating System Selection

- 1) **[R]** System selection for coating of external surfaces as specified by this standard shall be from the chart provided in Table 1. If there is not a suitable system for a specific application, contact the **Site Coatings Specialist**, David Sparkman at (346) 259-2978 or via e-mail at the following e-address: david.r.sparkman@exxonmobil.com.
- 2) **[I]** The current ExxonMobil Global Procurement Agreement is with International Paint. **International Paint products are preferred.** Any contractor providing coatings for equipment at the Baytown Site may receive ExxonMobil pricing per this agreement by contacting International Paint. Should other products be used they shall be approved by the **Site Coatings Specialist**.

11. Sealing Chine Area on Atmospheric Storage Tanks

- 1) When specified, the chine area of atmospheric storage tanks shall be sealed by application of coating material as described in this section. Moisture ingress via this metal-to-concrete joint, especially on hot service tanks, can cause accelerated soil side corrosion resulting in a significantly shortened life of the steel floor.
- 2) Abrasive blast top side of concrete ring starting at the edge of the floor protrusion plate and terminating 2" from the edge of the plate. If abrasive blasting is prohibited by Process, the concrete may be prepared by hand tool cleaning, removing all loose debris, and solvent wiping clean with MEK or Acetone. Lightly abrade existing coating from the edge of the floor protrusion plate to 1/2" above the corner weld using a wire brush, and solvent clean using MEK or Acetone. Newly applied coatings may only require solvent wiping, provided 50% of the finish coat gloss is successfully removed.
- 3) Apply Thiokol 5050 primer to all prepared surfaces of the concrete and tank chine at a thickness of 2-3 mils DFT at the chine and 3-4 mils DFT at the concrete. Allow to cure in accordance to data sheet. Apply Thiokol 2235M at a thickness of 1/4" to 1/2" to all areas that received 5050 primer.

NOTE: Thickness of 2235M shall be approximately 1/2" at the corner weld and get thinner as the film slopes downward over the edge of the protrusion plate and terminating 2" onto the concrete. After the material cures the corner of the plate shall not be distinctly felt when applying thumb pressure.

- 4) For sealing a false bottom gap below the floor protrusion plate, abrasive blast surfaces for a distance of 2" onto the bottom side of the floor protrusion plate and 2" onto the false shell below the floor plate to SSPC-SP10 Standard, with a 2-3 mil anchor profile. Apply Thiokol 5050 at 2-3 mils DFT. Allow to cure. Apply a 1" to 2" radius cove bead of Thiokol 2235M to fully seal the gap.

Table 1: Coating System Selection Chart (Note 17)

(1,2,3...) – See General Notes

(A,B,C...) – See TSA Notes

| System: | 1A, 1B and 1C | | | 2 | 3 |
|---------------------------------|---|-------------------------------|--------------------------------|--|---|
| Application / Service Category: | Bare (uninsulated) Carbon Steel and Low-Chrome Steel Surfaces That Operate at 250°F or less | | | For Field Welds and Touch-Up of Damaged Areas for System 1 That Operate at 250°F or less (1) | Rotating Equipment, Motor Operators, Valves (8), Motors, Transformers, etc. |
| | 1-A *Non-Dryfall | 1-B *Dryfall | 1-C *Dryfall (A) | | |
| Surface Preparation (2) | SP-10 | SP-10 | SP-10 | SP-10 or SP-11 | Manufacturer's Standard, Approved by Owner's Engineer |
| Anchor profile, (mils) | 2.0 to 3.0 | 2.0 to 3.0 | 3.0 to 5.0 | 2.0 to 3.0 | |
| Product Manufacturer | International Paint | Highland International | TSA (See TSA Notes) | International Paint | |
| Primer Coat | Interseal 670HS | 475R or 485R | None | Interseal 670HS Aluminum | Manufacturer's Standard |
| Primer Coat DFT, (mils) | 4.0 to 6.0 (19) | 4.0 to 6.0 (19) | | 4.0 to 6.0 (19) | |
| Intermediate Coat | None | None | None | None | --- |
| Intermediate Coat DFT, (mils) | | | | | |
| Finish Coat | Interthane 990V | 68R | Arc or Flame Spray Application | Interthane 990V | Manufacturer's Standard |
| Finish Coat DFT, (mils) | 2.0 to 3.0 (19) | 2.0 to 3.0 (19) | 12.0 to 15.0 (E) (F) | 2.0 to 3.0 (19) | |
| Color | As Specified | As Specified | Aluminum (9) (C) | As Specified | As Specified |

Table 1: Coating System Selection Chart *(continued)*

| System: | 4A and 4B | | 5 | 6A and 6B | |
|---------------------------------|--|----------------------------|---|--|-------------------------------------|
| Application / Service Category: | Bare (uninsulated) Carbon Steel and Low-Chrome Steel Surfaces Operating Between 251°F to 800°F | | Exposed Flanges and Other Protrusions Through Insulation on Equipment and Piping Operating Between 300°F to 800°F (3) | Bare (uninsulated) Carbon Steel and Low Chrome Steel Piping, Equipment, & Vessels in Sweating Service, Water Drift Areas, at Docks (above deck only), or Within 200 Feet of a Cooling Tower. | |
| | 4-A (A) (F) | 4-B | | 6-A (B) | 6-B (A) (B) |
| Surface Preparation (2) | SP-10 | SP-10 | SP-10 | SP-10 | SP-10 |
| Anchor profile, (mils) | 3.0 to 4.5 | 1.6 to 3.0 | 1.6 to 3.0 | 2.0 to 3.0 | 3.0 to 4.5 |
| Product Manufacturer | TSA (See TSA Notes) | International Paint | International Paint | International Paint | TSA (F) (See TSA Notes) |
| Primer Coat | None | Interzinc 22 | Interzinc 22 | Interzone 954 (Max. Temp. 250°F) | None |
| Primer Coat DFT, (mils) | | 2.0 to 3.0 (18) | 2.0 to 3.0 (18) | 8.0 to 10.0 (19) | N/A |
| Intermediate Coat | None | Intertherm 50 | Intertherm 50 | Interzone 954 (Max. Temp. 250°F) | None |
| Intermediate Coat DFT, (mils) | | 1.0 to 1.5 (18) | 1.0 to 1.5 (18) | 8.0 to 10.0 (19) | |
| Finish Coat | Arc or Flame Spray Application | Intertherm 50 | Intertherm 50 | Interthane 990V (Only if Color is Desired) (Max. Temp. 250°F) | Arc or Flame Spray Application |
| Finish Coat DFT, (mils) | 12.0 to 15.0 (E) (F) | 1.0 to 1.5 (18) | 1.0 to 1.5 (18) | 2.0 to 3.0 (19) | 12.0 to 15.0 (E) (F) |
| Color | Aluminum (9) (C) | Aluminum (9) | Aluminum (9) | As Specified | (9) (C) |

Table 1: Coating System Selection Chart *(continued)*

| System: | 7A, 7B and 7C | | | 8A and 8B | |
|---------------------------------|--|-------------------|-------------------|---|-------------------|
| Application / Service Category: | Galvanized Steel: Repairs and Bare Weld Touch-Up, Notes: For Color Coding Existing Galvanized See (4) For Non-Critical Minor Touch-Up See (5) (Max. Temp. 250°F) | | | [*] For Insulated Stainless Steel Piping Where SCC (Stress Corrosion Cracking) is a Concern; When Specified (6) (Max. Temp. 350°F) | |
| | 7-A | 7-B | 7-C | 8-A | 8-B |
| Surface Preparation (2) | SP-10 or SP-11 | | | SP-1 AND either SP-3 or SP-7 | |
| Anchor profile, (mils) | 2.0 to 3.0 | | | 0.5 to 1.0 | |
| Product Manufacturer | International Paint | TNEMEC | Wasser | Dampney | PPG |
| Primer Coat | 670HS Alum. | Series 90G-1K97 | MC Miozinc 100 | Thurmalox 70C | Pitt-Therm |
| Primer Coat DFT, (mils) | 4.0 to 5.0 (19) | 2.5 to 3.5 (19) | 3.0 to 5.0 (19) | 1.5 to 2.0 (18) | 1.5 to 2.0 (18) |
| Intermediate Coat | 670HS Alum. | Series 1 | MC Miomastic 100 | None | None |
| Intermediate Coat DFT, (mils) | 4.0 to 5.0 (19) | 2.5 to 3.5 (19) | 3.0 to 5.0 (19) | | |
| Finish Coat | Interthane 990V | Series 740 | MC Luster 100 | Thurmalox 70C | Pitt-Therm |
| Finish Coat DFT, (mils) | 2.0 to 3.0 (19) | 3.0 to 5.0 (19) | 2.0 to 4.0 (19) | 1.5 to 2.0 (18) | 1.5 to 2.0 (18) |
| Color | Aluminum or Gray | Aluminum or Gray | Aluminum or Gray | Black | Black |

Table 1: Coating System Selection Chart *(continued)*

| System: | 9A and 9B | |
|---------------------------------|--|--|
| Application / Service Category: | Corrosion Protection for: Carbon Steel and Low-Chrome Steel Piping or Equipment Under Insulation (CUI) With Operating Temperature Continuously or Intermittently Greater Than 25°F and Less Than 300°F | Corrosion Protection for: Carbon Steel and Low-Chrome Surfaces Under Fireproofing (CUF) When Substrate is not Galvanized and Surfaces Will Operate Less Than 300°F |
| | 9-A (A)(D)(G)(16) | 9-B (D)(7)(16) |
| Surface Preparation (2) | SP-10 | SP-10 (Small Touch-Ups & Welds May Receive SP-11) |
| Anchor profile, (mils) | 3.0 to 4.5 | 2.0 to 3.0 |
| Product Manufacturer | TSA (F) (See TSA Notes) | International Paint (Max. temp. limit = 392°F constant, |
| Primer Coat | None | Interbond 2340 UPC (Olive Gray) |
| Primer Coat DFT, (mils) | | 5.0 to 6.0 (19) |
| Intermediate Coat | None | None |
| Intermediate Coat DFT, (mils) | | |
| Finish Coat | Arc or Flame Spray Application | Interbond 2340 UPC (Gray) |
| Finish Coat DFT, (mils) | 12.0 to 15.0 (E) (F) | 5.0 to 6.0 (19) |
| Color | Aluminum (9) (C) | Gray |

Table 1: Coating System Selection Chart *(continued)*

| System: | 10A, 10B and 10C (To be used in lieu of System 9A only when Note D is applicable to the application) | | |
|---------------------------------|---|--|--|
| Application / Service Category: | Corrosion Protection for: Carbon Steel and Low-Chrome Steel Piping or Equipment Under Insulation (CUI) With Operating Temperature Continuously or Intermittently Less Than 300°F, and not exceeding 392F. | Corrosion Protection for: Carbon Steel and Low-Chrome Steel Piping or Equipment Under Insulation (CUI) With Operating Temperatures Intermittently Less Than 300F, Intermittently Greater Than 392F, and not exceeding 450F. NOTE: Application Substrate Temperature Maximum 350F. Minimum Operating Temperature 200F. | Corrosion Protection for: Carbon Steel and Low-Chrome Steel Piping or Equipment Under Insulation (CUI) With Operating Temperatures Intermittently Less Than 300°F, Intermittently Greater than 450F, and not exceeding 1000F to 1200F (see maximum service temperatures below) NOTE: Application Substrate Temperature Maximum 500F with Finish Coat, 600F without Finish Coat. |
| | 10-A (D) (16) | 10-B (D) (10) (16) | 10-C (D) (10) (16) |
| Surface Preparation (2) | SP-10 (Touch-Ups & Welds May Receive SP-11) | SP-10 (Touch-Ups & Welds May Receive SP-11) | SP-10 (Touch-Ups & Welds May Receive SP-11) |
| Anchor profile, (mils) | 2.0 to 3.0 | 1.5 to 2.5 | 1.5 to 2.5 |
| Product Manufacturer | International Paint (Max. Service Temp. Limit = 392F) | Dampney Thurmalox | Hi-Temp Coatings (HTC) (Max. Service Temp. Limit with Finish Coat =1000F. With black finish coat = 1200F. Without Finish Coat =1200F) |
| Primer Coat | Interbond 2340 UPC (Olive Gray) | Dampney Turmalox 218 | PPG Hi-Temp Coatings 1027 |
| Primer Coat DFT, (mils) | 5.0 to 6.0 (19) | 4.0 to 6.0 (18) | 5.0 to 6.0 (19) |
| Intermediate Coat | None | Dampney Turmalox 219 | PPG Hi-Temp Coatings 1027 |
| Intermediate Coat DFT, (mils) | None | 4.0 to 6.0 (18) | 5.0 to 6.0 (19) |
| Finish Coat | Interbond 2340 UPC (Gray) | Dampney Thurmalox 260 (At Protrusions and Atmospheric Service Only) | PPG Hi Temp Coatings 1000(Application Temps. 50F to 500F) (HTC 1000 is for Protrusions and Atmospheric Service Only) |
| Finish Coat DFT, (mils) | 5.0 to 6.0 (19) | 2.0 to 2.5 (18) | 2.0 to 2.5 (18) |
| Color | Gray (9) | Aluminum-Gray, and custom Colors NOTE: Do not use "Aluminum". | Black, Aluminum, and Custom Colors |

Table 1: Coating System Selection Chart *(continued)*

| System: | 11A, 11B, 11C and 11D (12) (13) | | | |
|-------------------------------------|---|---|--|---|
| Application / Service Category: | Corrosion Protection for: Carbon Steel and Low-Chrome Steel Piping or Equipment Under Insulation (CUI) With Operating Temperature Continuously Less Than 151°F. | Corrosion Protection for: Carbon Steel and Low-Chrome Steel Piping or Equipment Under Insulation (CUI) With Operating Temperature Continuously Less Than 201 °F. NOTE: Application Substrate Temperature Maximum 200F. | Bare (Uninsulated) Carbon Steel and Low Chrome Steel Piping, Equipment, & Vessels in Sweating Service, Water Drift Areas, at Docks (above deck only), or Within 200 Feet of a Cooling Tower With Operating Temperature Continuously Less Than 151°F. | Bare (Uninsulated) Carbon Steel and Low Chrome Steel Piping, Equipment, & Vessels in Sweating Service, Water Drift Areas, at Docks (above deck only), or Within 200 Feet of a Cooling Tower With Operating Temperature Continuously Less Than 201°F. NOTE: Application Substrate Temperature Maximum 200F. |
| | 11-A | 11-B | 11-C | 11-D |
| Surface Preparation (2) | SP-1 & SP-2 | SP-1 & SP-2 | SP-1 & SP-2 | SP-1 & SP-2 |
| Anchor profile, (mils) | N/A | N/A | N/A | N/A |
| Product Manufacturer | Denso | Denso | Denso | Denso |
| Primer Coat | Desno-Paste (11) | Denso HT Primer (11) | Desno-Paste (11) | Denso HT Primer (11) |
| Primer Coat DFT, (mils) | Thin, Uniform Film | Thin, Uniform Film | Thin, Uniform Film | Thin, Uniform Film |
| Profiling Mastic (Complex Geometry) | Denso Profiling-Mastic (11) (14) | Densyl Mastic (11) (14) | Denso Profiling-Mastic (11) (14) | Densyl Mastic (11) (14) |
| Wax Tape | Denso Densyl Petrolatum Wax Tape (11) | Denso Hotline Petrolatum Wax Tape (11) | Denso Densyl Petrolatum Wax Tape (11) | Denso Hotline Petrolatum Wax Tape (11) |
| Outer Wrap (Straight Run) | Denso Butyl 35 (11) | Denso Glass Outerwrap w/ Denso Poly (11) (15) | Denso Butyl 30 (11) | Denso Glass Outerwrap UV w/ Denso Poly (11) (15) |
| Outer Wrap (Complex Geometry) | Denso Glass Outerwrap w/ Denso Poly (11) (15) | Denso Glass Outerwrap w/ Denso Poly (11) (15) | Denso Glass Outerwrap UV w/ Denso Poly (11) (15) (20) | Denso Glass Outerwrap UV w/ Denso Poly (11) (15) (20) |

TABLE 1 GENERAL NOTES:

- 1) System '2' – (for new construction-maintenance) is the touch-up of areas coated per System '1' that are damaged during erection and construction. If the specific field scenario does not accommodate System '2', consult the ExxonMobil Site Coatings Specialist as required.
- 2) All surface prep designations refer to SSPC practices. A Waiver/Deviation Form shall be submitted with a Coating Request Form only where Process will not issue a hot work permit, blast cleaning is not allowed by Process, and the specified level of SSPC surface cannot be achieved. Other circumstances requiring a Waiver/Deviation Form are subject to review and approval by ExxonMobil.
- 3) All exposed surfaces are to be painted. (i.e. flanges, unions, valve bodies, dummy legs and other surfaces or items that are a part of or attached to the insulated, uncoated pipe or equipment that will protrude through the insulation). Coating shall be applied to entire component and shall extend at least 6 inches all around or from the attachment weld to the main insulated pipe or equipment. For piping flanges, the coating should extend approximately 1 foot from the flange face.
- 4) Only surface preparation SP-1, primer and finish coats are required when color coding is specified for new or un-damaged galvanized items. For older (oxidized/not shiny new), un-damaged galvanizing an SSPC-SP7 Brush-Off Blast is required.
- 5) For non-critical/non-equipment supportive structural steel such as handrails, and toe plate, etc. a cold galvanizing spray (Cold Galv) may be applied over SSPC-SP11 surface preparation using Bristle Blaster and achieving a minimum 2 mil anchor profile. Cold Galv shall comply with ASTM A780 having 65%-69% zinc dust, or above 92% zinc dust in dry film. Minimum application thickness shall be 4 mils DFT applied in multiple coats.
- 6) [*] For insulated stainless steel equipment operating below 350°F only when specified by Owner's Engineer.
- 7) Hot dip galvanized surfaces need not be coated under fireproofing if not exposed to wetted conditions.
- 8) Manufacturer's standard coating for valves is acceptable only when:
 - Valves are not welded to piping.
 - Valves are not in CUI, CUF or sweating service.
 - Valves are not within 200 ft. of a cooling tower.
 - Second Line Supervisor or Project Engineer does not require painting for color code or appearance.
 - The expected service life of high temperature valves is too short to justify long life coating suitable for the temperature.Note: Coating for all other valve scenarios shall be selected in accordance to service conditions from [Table 1](#) and approved by the Owner's Engineer.
- 9) [*] Contact the ExxonMobil Site Coatings Specialist if color is desired (e.g. for safety relief block valves, etc.).
- 10) Follow Manufacturer's High Temperature Application Procedures.
- 11) Apply in accordance to BTAES 19-1-1-6, Denso Data Sheet and Denso Spec Guide. Where there are conflicting data between these references, BTAES 19-1-1-6 and this specification shall take precedence.

- 12) May only be approved by the Unit LME or the Site Coatings Specialist. System 11 intended to be used on rare occasions where other paint systems cannot be used due to the condition of the surface, thickness of the pipe, or surface preparation restrictions. An example would be in-service piping that is corroded such that grit blasting is not allowed but a coating is needed to prevent future external corrosion.
- 13) The system may only be applied at final service destination. The system shall not be shop applied or applied at any location prior to final placement, i.e. next to ditch, etc.
- 14) Profiling mastic shall be applied to all complex geometry prior to applying Denso Wax Tape Systems. Profiling Mastic is applied after primer coat application. Profiling Mastic shall be applied in a manner that creates a smooth transition across all complex geometry, completely filling in all voids, and forming a continuous surface for the wax tape to adhere to.
- 15) Denso Poly shall be applied over Denso Glass Outerwrap or Denso Glass Outerwrap UV immediately after their application, and prior to Denso Glass Outerwrap or Denso Glass Outerwrap UV curing to a hardened state. The effect of the Denso Poly shall be to push all wrinkles in Denso Glass Outerwrap and Denso Glass Outerwrap UV firmly against the wax tape during the curing process.
- 16) When TSA or organic/inorganic coatings are applied to CUI Service equipment the following criteria with regard to flanges shall be met:
 - Welded Flanges – Blasting, TSA application and other specified coating application shall extend past the flange attachment weld and cover 100% of the flange hub/neck and terminate at the back-side of the flange face.
 - Slip Flanges – Blasting, TSA application and other specified coating application shall be performed all the way to the slip flange. No part of the piping shall be left un-coated. The slip flange does not require coating.
 - Heat Exchangers/Compressor Shells, etc. (Flanged Equipment) – Blasting, TSA application and other specified coating application shall be performed all the way to the flange. No part of the exchanger shell or channel head shall be left un-coated, unless otherwise specified. The flange does not require coating. The coating at the termination point (shell to flange junction) shall be in accordance to specification, and the flange should show appropriate over-spray. Protect bolt threads from TSA overspray.

NOTE: These rules apply only to piping/equipment that are already installed in the unit, assembled, and are being coated in-place at service location, and may require protection of the flange-to-flange interface (two flange union) from hot work by ExxonMobil Process. Piping/equipment that are being coated in a shop or lay-down yard or that are disassembled shall be fully blast cleaned and coated in accordance to specification to include flanges to the edge of the outer edge of the machined gasket mating surface. TSA application is not required inside bolt holes. Machined threads/bolt threads shall be protected from blast cleaning, and do not require TSA application.

- 17) Maximum application temperature shall be assumed ambient (110F or less) when a maximum application temperature is not specified for a system.
- 18) Specified dry film thickness tolerance in accordance to SSPC-PA2, Table 1, restriction level 1.
- 19) Specified dry film thickness tolerance in accordance to SSPC-PA2, Table 1, restriction level 3.
- 20) For color coding Denso Glass Outerwrap, clean surfaces with MEK or Acetone, then apply one coat of Tnemec UVX 740 at 3-5 mils DFT.

TSA (Thermal Spray Aluminum) NOTES:

- (A) TSA Surface Preparation and Application to be in accordance to this standard and per [BTDP 19-1-1-7](#).
- (B) Grit blasting followed by TSA application or thick-film immersion-grade epoxy application are the Baytown required coatings for piping and equipment in sweating service, within 200 ft. of a cooling tower or water drift source. There are some situations where grit blasting and TSA application is not feasible or permissible. In such cases, grit blasting/TSA waivers shall be signed by the Process BEO and the Mechanical FLS. The following are scenarios where blasting and the selection of TSA or thick-film immersion-grade epoxy for the coating system shall be waived and a surface tolerant immersion grade epoxy or other suitable coating shall be used. Submit a Coating Request Form with a signed Blast/TSA Waiver Form to the Site Coatings Specialist for issuance of a suitable coating system:
- Areas of complex geometry where grit blasting and TSA application is not possible.
 - Locations where grit blasting and/or exposed arc or flame are not allowed by Process.
 - Spill / Splash or chemical fume environments (TSA is not suitable for pH exposures less than 5.0 or greater than 8.0).
 - Shop fabricated equipment where TSA may be significantly cost disadvantaged. LCCA must be completed with usage of up to date BT annotated EDD 1A guidance. Cyclic service equipment, typically sweating with cycles above the CUI temperature range (i.e. regens), shall be reviewed by site coating specialist and coatings SME.
- (C) Sealers can be applied to improve corrosion resistance or for aesthetics if color is desired. Contact the ExxonMobil Site Coatings Specialist for details.
- (D) [*] When coating a section of pipe (new or existing) in an existing insulated pipe circuit that is currently coated with a coating rated for CUI service, the section of piping shall receive a coating rated for CUI service in lieu of TSA if the section being coated is 20' or less in length, except if the length of pipe receiving coating is a 'flange to flange' application (flanged at both ends), or tying into existing TSA, in which case TSA shall be applied.
- (E) The target thickness range for all TSA application shall be 12-15 mils. The acceptable minimum and maximum thickness range for TSA shall be 10-20 mils DFT. At the discretion of ExxonMobil Inspection, up to 10% of the total surface area inspected per piece of equipment or single pipe (flange to flange/weld to weld), and/or up to 10% of continuous TSA coated area presented for a single hold point inspection, shall be allowed a DFT range of 20-30 mils DFT. Areas in the 20 to 30 mil range that are >10% of total area inspected are not acceptable. Any readings higher than 30 mils are not acceptable, except at the discretion of ExxonMobil Inspection.
- (F) The allowable service temperature range for TSA is -50F to 1100F.
- (G) TSA is the Baytown required coating for piping and equipment under insulation (in CUI service). There are some situations where grit blasting or TSA application are not feasible or permissible. In such cases, grit blasting/TSA application waivers shall be signed by the Process BEO and the Mechanical FLS and submitted to the Coating Specialist with a Coating Request Form for issuance of an alternative CUI rated coating system. The following are scenarios where grit blasting/TSA application shall be waived:
- Areas of complex geometry where grit blasting and TSA are not possible.
 - Locations where grit blasting and/or exposed arc or flame are not allowed by Process.
 - Spill / Splash or chemical fume environments. TSA is not suitable for pH exposures less than 5.0 or greater than 8.0.
 - Shop fabricated equipment where TSA may be significantly cost disadvantaged. LCCA must be completed with usage of up to date BT annotated EDD 1A guidance. Cyclic service equipment, typically sweating with cycles above the CUI temperature range (i.e. regens), shall be reviewed by site coating specialist and coatings SME.

NOTE: A drawing shall accompany all waivers where the service is CUI. All affected areas of the equipment shall be clearly labeled on the drawings, depicting the exact location where the waived coating system will be applied. A drawing and photos (a waiver is not required) shall accompany all Coating Requests where the service is CUI and the area to be coated is located in an area that is inaccessible to TSA application (impossible to apply TSA).

Table 2: Baytown Complex Equipment Color Scheme

| FINISHED COAT COLORS | EQUIPMENT TYPE (NOTE 4) | BTRF, BTCP & MBPP COLOR (NOTE 1) | FEDERAL STD. ID | BOP COLOR | FEDERAL STD. ID |
|----------------------------|--|---|--------------------|--------------|--------------------|
| | Onsite Piping | Cirrus Gray | FS 26492 | Rich Tan | FS 30219 |
| | Onsite Structures (if painted) | Shale Gray | FS 16314 | Slate Gray | FS 36270 |
| | Furnaces | Falls Blue | FS 15450 | Gray | FS 26152 |
| | Furnace Stacks | Falls Blue | FS 15450 | Black | FS 17038 |
| | Exchangers | Falls Blue | FS 15450 | Briny Green | FS 14272 |
| | Vessels | Falls Blue | FS 15450 | Clay Tan | FS 13711 |
| | Onsite Machinery / Drivers | Shale Gray | FS 16314 | Briny Green | FS 14272 |
| | Offsite Piping | Clay Tan | FS 13711 | Rich Tan | FS 30219 |
| | Offsite Pipe Supports (if painted) | Loam Brown | FS 20095 | Slate Gray | FS 36270 |
| | API 653 Tanks and Associated Piping (NOTE 5) | White | FS 17925 | White | FS 17925 |
| | Offsite Machinery / Drivers | Loam Brown | FS 20095 | Briny Green | FS 14272 |
| | Bridges and Overhead Cranes | None | N/A | Yellow | FS 33685 |
| TABLE NOTES | <ol style="list-style-type: none"> 1. Aluminum is a site approved alternate color when the coating system specified to be used is only available as aluminum. 2. Excludes surfaces color-coded per Table 3 or Table 4. 3. Hot-dip galvanized steel should not be painted unless it is to be color-coded or fireproofed. 4. TSA coated equipment should not be painted unless it is required to be color-coded for safety, fire protection or equipment identification. 5. Tank color may be different if driven by product or operating temperatures. | | | | |

Table 3: Color Coding and Decals for Utility Station Piping

| SERVICE | BTRF, BTCP & MBPP COLORS & IDENTIFICATION | | | BOP COLORS | | |
|-------------------------------|--|---------------------------------------|--------------------|------------|------------------|--------------------|
| | PIPE & HOSES | DECALS (2) | FEDERAL STD. ID | HOSES | PIPE | FEDERAL STD. ID |
| Industrial (Utility) Air | Safety Green | White Letters on Green Background | FS 14120 | N/A | Dark Green | FS 14062 |
| Industrial (Utility) Water | Safety Blue | White Letters on Blue Background | FS 15092 | Blue | Dark Blue | FS 25052 |
| Nitrogen | Safety Yellow | Black Letters on Yellow Background | FS 13591 | Yellow | Safety Orange | FS 12473 |
| Steam | Black | White Letters on Black Background | FS 17038 | Red | Red | FS 11105 |

TABLE 3 NOTES:

- 1) Paint color is for the last 40" ± of pipe at utility stations. This color-coding may be used to identify utility piping in other situations as instructed.
- 2) Normal utility station design provides identification signs. Decals may be used for identification of utility piping in other uses or areas as instructed. For details of utility station piping requirements, see [BTAES 3-6-3-0](#).

Table 4: Color Coding and Decals for Safety, Fire Protection, and Equipment Identification(See [BTAES 3-7-1-0](#) for Identification of Dangerous, Toxic, and Corrosive Materials)

| EQUIPMENT / ITEM | BTRF, BTCP & MBPP COLOR ID | FEDERAL STD. ID | BOP COLOR ID | FEDERAL STD. ID |
|---|---------------------------------------|----------------------|-----------------|--------------------|
| Fire Hydrants, Fire Monitors, Fire Hose Reels, Aboveground Fire Water Piping (including exposed portions of underground valves), Deluge Manifolds and Background where Fire Extinguishers are mounted | Safety Red | FS 11086 | Safety Red | FS 11086 |
| Mobile Fire-Fighting Equipment | Safety Red | FS 11086 | Safety Red | FS 11086 |
| Scott Air Paks and Background where mounted | Safety Yellow | FS 13591 | Safety Yellow | FS 13591 |
| First Aid and Safety Equipment Cabinets, Safety Equipment Centers | Green Markings on White Background | FS 34230 FS 17925 | Green | FS 34230 |
| CSO Valves Upstream of Safety Shower Eye/Face Wash Stations and System Block Valves at Battery Limits | Red | FS 11105 | N/A | N/A |
| Escape Ladders, Cages & Handrails on Escape Stairways (Paths of Egress) | Safety Yellow | FS 13591 | Safety Yellow | FS 13591 |
| Foam Equipment and Piping – Tanks (1) | Red | FS 11105 | Red | FS 11105 |
| Foam Equipment and Piping – Dock Area | Yellow | FS 33685 | Red | FS 11105 |

| | | | | |
|--|---|----------------------------------|---|----------------|
| Tripping Hazards / Overhead Obstructions | Safety Yellow | FS 13591 | Safety Yellow | FS 13591 |
| Railway Crossing Gates | Black and White Stripes | FS 17038 FS 17925 | N/A | N/A |
| Sewer Vents (above ground portions) | Safety Yellow | FS 13591 | Safety Yellow | FS 13591 |
| Safety Relief Valves and the CSO Isolation Valves Associated with Safety Relief Systems (i.e. those valves located in pressure relieving paths and sensing lines to pilot operated relief valves.) | Safety Red | FS 11086 | Safety Yellow | FS 13591 |
| Safety Critical Car Seal Valves (Valves, either CSO or CSC for safety reasons only per SSS-4060 or SPM 516). | Safety Red | FS 11086 | Safety Yellow | FS 13591 |
| Uninterruptible Steam Tracing (UST) Isolation Valves | Safety Red | FS 11086 | N/A | N/A |
| Operational Car Seal Open Valves (OCSO) and Operational Car Seal Closed Valves (OCSC) (Valves, either CSO or CSC for operational reasons per SSS-4060 or SPM 516). | Blue | FS 15056 | Magenta Purple | FS 17142 |
| Bonnets and Vents of Bellows Safety Relief Valves | Safety Yellow | FS 13591 | Safety Red | FS 11086 |
| Environmental Car Seal Open Valves (ECSO) and Environmental Car Seal Closed Valves (ECSC) (Valves, either CSO or CSC for environmental reasons per SSS-4060 or SPM 516). | Green | FS 34230 | Black | FS 17038 |
| H ₂ S-Bearing Pipelines (Acid Gas) (2) | Decals - Black Lettering on Safety Yellow Background on Safety Orange Jacketing (2) | FS 17038 FS 13591 FS 12473 | Pink | FS 21630 |
| Battery Limit Block Valves (BLBV) (3) | Green - KRYLON #2012, Clover/Safety Green | Or FS 14120 | Green - KRYLON #2012, Clover/Safety Green | Or FS 14120 |
| Oxygen-Bearing Pipelines (\geq 35% O ₂ by volume) (4) | Yellow | FS 23685 | N/A | N/A |
| Potable Water | Blue w/White on Blue Decals | FS 15056 FS 17925 | N/A | N/A |
| Instrument Air | Decals - Black Lettering on Green Background | FS 17038 FS 34230 | N/A | N/A |
| Process Sewer Covers | N/A | N/A | Red | FS 11105 |
| Contaminated Sewer Covers | N/A | N/A | Yellow | FS 23685 |
| Goose Creek/Rain Water Covers | N/A | N/A | Blue | FS 15056 |

| | | | | |
|--|--------------------------|---------|--------------------------------------|----------------------------------|
| Temporary Pipeline (per paragraph 7.2) | N/A | N/A | Light Blue | FS 25200 |
| Temporary Pipeline (per paragraph 7.3) | N/A | N/A | Purple | FS 27100 |
| Electrical Transformers | Light Gray (Edison Gray) | FS26495 | Light Gray (Edison Gray) | FS 26495 |
| Vacuum Breakers, Pressure Vents, Manhole Covers, Hatches and Emergency Vents | N/A | N/A | White | FS 17925 |
| Flare Stacks | N/A | N/A | International Orange and White Bands | FS 12197 FS 12925 FS 17925 |

TABLE 4 NOTES:

- 1) Includes all foam piping facilities located at the road within 5' of the foam hose attachment nozzle. Where part of a manifold meets this requirement, the entire manifold shall be coated. **Do not** coat brass fittings and non-carbon steel components of the foam hose attachment nozzle.
- 2) H₂S-bearing pipelines shall be identified at intervals and locations as designated by the Owner's Engineer as follows: Apply a 1-foot long minimum, OSHA orange pre-coated section of aluminum jacketing with a black on yellow decal reading "Deadly Gas." The decal shall be over coated with clear polyurethane. For additional reference material, see [BTAES 3-7-1-0](#).
- 3) Signs for Battery Limit Block Valves (BLBV) per [BTAES 17-1-1-3](#).
- 4) Decals and signs for Oxygen piping shall be as specified.

Record of Change

| Revision 0 | | | Date: 10/22 |
|------------|--------|---------------------------------------|-------------|
| Location | Action | Description | |
| | | Initial publication. Moved from BTAES | |
| | | | |

Paint and Protective Coatings

GP 19-01-01D

Scope

0-1

[I] This Global Practice (GP) defines the minimum requirements for the selection, application, and quality control of coatings for new construction of external surfaces of steel structures and equipment.

0-2

[I] Coating systems covered by this GP include the following as applicable to aboveground, underground, underwater, and marine exposures:

- a. Liquid-applied organic and inorganic coatings
- b. Thermal Spray Aluminum (TSA)
- c. Wrapping systems, including aluminum foil
- d. Galvanizing

0-3

[I] This GP does not cover the following:

- a. Internal linings
 - b. Concrete
 - c. Indoor coatings
 - d. Maintenance coatings
-

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1. References

1.1. Required References

1.1-1

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.1-2

[I] Industry standards from different trade organizations may be redundant but are included to allow for local preference of international users of this GP.

1.1-3

[I] Standards and test methods that are included on coating product Data Sheets but that are not listed below are a required part of this GP.

1.1-4

[*] [I] Other national standards or codes may be substituted for those listed as directed by the Purchaser.

1.1-5

[R] Conflicts with specified requirements. If site-specific conditions or past experience warrant a deviation from this GP or required reference, then a Practice Deviation Request shall be prepared and issued. (See example form in Data Sheet [T190101C01](#).)

1.1.1. Global Practices

1.1.1-1

| GP Reference | Reference Title |
|------------------------------|---|
| GP 04-06-01D | Reinforced Concrete Foundations, Anchorage, and Grout |

1.1.2. Industry Standards

1.1.2-1

| Industry Standard Number | Industry Standard Title |
|-----------------------------------|--|
| ANSI Z400.1 | Hazardous Industrial Chemicals - Material Safety Data Sheets - Preparation |
| ASME B31.3 | Process Piping |
| ASTM A 123/A 123M | Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 153/A 153M | Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A 354 | Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners |

| Industry Standard Number | Industry Standard Title |
|-----------------------------------|---|
| ASTM A 792/A 792M | Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process |
| ASTM B 479 | (Withdrawn) Standard Specification for Annealed Aluminum and Aluminum-Alloy Foil for Flexible Barrier, Food Contact, and Other Applications |
| ASTM B 6 | Standard Specification for Zinc |
| ASTM B 695 | Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel |
| ASTM D 2583 | Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor |
| ASTM D 3359 | Standard Test Methods for Measuring Adhesion by Tape Test |
| ASTM D 4285 | Standard Test Method for Indicating Oil or Water in Compressed Air |
| ASTM D 4414 | Standard Practice for Measurement of Wet Film Thickness by Notch Gages |
| ASTM D 4417 | Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel |
| ASTM D 4752 | Standard Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub |
| ASTM D 520 | Standard Specification for Zinc Dust Pigment |
| ASTM D 5402 | Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs |
| ASTM D 6677 | Standard Test Method for Evaluating Adhesion by Knife |
| ASTM E 337 | Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures) |
| AWS C2.25/C2.25M | Specification for Thermal Spray Feedstock - Wire and Rods |
| BSI BS EN 14594 | Respiratory Protective Devices - Continuous Flow Compressed Air Line Breathing Apparatus - Requirements, Testing Marking |
| CINI Handbook | CINI-Commission for Nederlands Insulation Industry |
| ISO 11014 | Safety Data Sheet for Chemical Products - Content and Order of Sections |
| ISO 12944-2 | Paints and Varnishes - Corrosion Protection of Steel Structures by Protective Paint Systems - Part 2: Classification of Environments |
| ISO 20340 | (Withdrawn) Paints and Varnishes - Performance Requirements for Protective Paint Systems for Offshore and Related Structures |

| Industry Standard Number | Industry Standard Title |
|------------------------------------|---|
| ISO 8501-1 | Preparation of Steel Substrates before Application of Paints and Related Products - Visual Assessment of Surface Cleanliness - Part 1: Rust Grades and Preparation Grades of Uncoated Steel Substrates and of Steel Substrates after Overall Removal of Previous Coatings |
| ISO 8502-3 | Preparation of Steel Substrates before Application of Paint and Related Products - Tests for the Assessment of Surface Cleanliness - Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method) |
| NACE NO. 12 | Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel (AWS C2.23M/C2.23) (SSPC CS 23.00) |
| NACE RP0287 | (Withdrawn) Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape |
| NACE SP0198 | Control of Corrosion under Thermal Insulation and Fireproofing Materials—A Systems Approach - Item No. 21084 |
| SSPC AB 1 | Mineral and Slag Abrasives |
| SSPC AB 3 | Newly Manufactured or Re-Manufactured Steel Abrasives |
| SSPC GUIDE 15 | Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates |
| SSPC PA 2 | Measurement of Dry Coating Thickness with Magnetic Gages |
| SSPC QP 1 | Standard Procedure for Evaluating Painting Contractors (Field Application to Complex Industrial Structures) |
| SSPC QP 3 | Standard Procedure for Evaluating Qualifications of Shop Painting Applicators |
| SSPC SP 1 | Solvent Cleaning |
| SSPC VIS 1 | Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning |
| TMEE-062 MP 4-40-1 | Corrosion Under Insulation Manual (Document for internal Company use only - release to third parties requires Document Owner approval and compliance with Company MPI requirements) |

1.1.3. Data Sheets

1.1.3-1

| Data Sheet Number | Data Sheet Title |
|----------------------------|---|
| D190101C01 | Paint and Protective Coatings - Example of Subcontractor's Daily Documentation - Documentation Requirements Sheet |

| Data Sheet Number | Data Sheet Title |
|----------------------------|--|
| I190101C01 | Paint and Protective Coatings - Example of Daily QA Inspection Checklist - Inspection and Testing Requirements |
| T190101C01 | Paint and Protective Coatings - Example of Subcontractor's Specification Deviation Request Form |
| T190101C02 | Paint and Protective Coatings - Example of Nonconformance Report |
| T190101C03 | Paint and Protective Coatings - Pre-job Meeting Guidance |

1.1.4. Other Publications

1.1.4-1

| Publication Number | Publication Title |
|---|--|
| Coating System Descriptions and Accepted Coatings | ExxonMobil Downstream - External Protective Coatings - Coating System Descriptions and Acceptance Products (Document for internal Company use only - release to third parties requires Document Owner approval and compliance with Company MPI requirements) |

1.2. Additional References

1.2-1

[*]This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply. Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.2.1. Industry Standards

1.2.1-1

| Industry Standard Number | Industry Standard Title |
|-----------------------------|---|
| ASTM D 2583 | Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor |
| ISO 4624 | Paints and Varnishes - Pull-Off Test for Adhesion |
| ISO 8503 | Preparation of Steel Substrates before Application of Paints and Related Products - Surface Roughness Characteristics of Blast-Cleaned Steel Substrates (all current parts) |
| NACE RP0287 | (Withdrawn) Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape |
| NACE RP0375 | Field-Applied Underground Wax Coating Systems for Underground Pipelines: Application, Performance, and Quality Control |
| NACE RP0394 | (Inactive) Application, Performance, and Quality Control of Plant-Applied, Fusion-Bonded Epoxy External Pipe Coating |

| Industry Standard Number | Industry Standard Title |
|------------------------------------|--|
| NACE RP0399 | Plant Applied, External Coal Tar Enamel Pipe Coating Systems: Application, Performance, and Quality Control |
| NACE SP0169 | Control of External Corrosion on Underground or Submerged Metallic Piping Systems |
| NACE SP0188 | Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates |
| NACE SP0198 | Control of Corrosion under Thermal Insulation and Fireproofing Materials—A Systems Approach - Item No. 21084 |
| SSPC AB 2 | Cleanliness of Recycled Ferrous Metallic Abrasives |
| SSPC PA 1 | Shop, Field, and Maintenance Painting of Steel |
| SSPC PA GUIDE 3 | Guide to Safety in Paint Application |
| SSPC PS GUIDE 8.00 | Guide to Topcoating Zinc-Rich Primers |
| SSPC SP 10 | Near-White Metal Blast Cleaning (NACE NO. 2) |
| SSPC SP 11 | Power Tool Cleaning to Bare Metal |
| SSPC SP 13 | Surface Preparation of Concrete |
| SSPC SP 3 | Power Tool Cleaning |
| SSPC SP 5 | White Metal Blast Cleaning (NACE NO. 1) |
| SSPC SP 6 | Commercial Blast Cleaning (NACE NO. 3) |
| SSPC SP 7 | Brush-off Blast Cleaning - NACE No. 4 |
| SSPC SP 8 | Pickling |
| SSPC VIS 3 | Visual Standard for Power- and Hand-Tool Cleaned Steel (Standard Reference Photographs) |

2. Acronyms and Definitions

2.1. Acronyms

2.1-1

| Acronym | Description |
|----------------|--|
| ACQPA | Association for Certification and Qualification of Anticorrosive Paintwork |
| CUI | Corrosion Under Insulation |
| DFT | Dry Film Thickness (of a fully cured coating material or system) |

| Acronym | Description |
|----------------|--|
| EMRE | ExxonMobil Research and Engineering Company |
| ESD | Emergency Shutdown |
| FBE | Fusion Bonded Epoxy |
| IOZ | Inorganic Zinc |
| ISO | International Organization for Standardization |
| JSA | Job Safety Analysis |
| LEL | Lower Explosive Limit |
| MEK | Methyl Ethyl Ketone |
| MIBK | Methyl Iso-butyl Ketone |
| MIO | Micaceous Iron Oxide |
| MSDS | Material Safety Data Sheet |
| NACE | National Association of Corrosion Engineers |
| NDE | Non Destructive Examination |
| NORM | Naturally Occurring Radioactive Material |
| NORSOK | Norwegian Offshore Standard |
| OEM | Original Equipment Manufacturer |
| OH&S | Occupational Health and Safety |
| PEL | Permissible Exposure Limit |
| PPE | Personal Protective Equipment |
| QA | Quality Assurance |
| QC | Quality Control |
| RIE | Remote Instrument Enclosure |
| SHE | Safety, Health, and Environment |
| SSPC | The Society for Protective Coatings |
| TSA | Thermal Spray Aluminum |
| VOC | Volatile Organic Compound |
| WFT | Wet Film Thickness |

2.2. Definitions

2.2-1

| Term | Definition |
|-------------|-------------------|
| | |

| Term | Definition |
|---|--|
| Bare Surfaces | Surfaces, equipment, or structures that are not insulated or fireproofed. |
| Coating System Design Temperature | The maximum of normal operating, steamout, or upper-end cyclic temperature. |
| Company | ExxonMobil or any of its affiliates. |
| Confined Space | If work is being performed at a Company site, then the definition is as defined in the site's safety requirements. If work is not being performed at a Company site, then the definition is as defined in the appropriate statutory authority's regulations. |
| Cyclic Sweating Service | Service where the metal temperature due to changes in operation cycles below and above the atmospheric dew point resulting in a wetted surface without continuous freezing. |
| Fingerprinting | Method of positive identification of a coating material as defined in ISO 20340, Annex B. |
| Fresh Water | Potable water with a minimum pH of 5.5 and maximum pH of 8. |
| Inspector | Company's or Purchaser's representative assigned to provide quality assurance inspection as outlined in Section 15 of this GP. |
| Intermittent Service | Service in which the process temperature cycles on a recurrent basis, into and out of the corrosion under insulation (CUI) temperature range 25°F to 300°F (-4°C to 150°C). |
| Marine Atmosphere | Atmosphere containing a high concentration of chlorides and water in the air, i.e., Corrosivity Category C5-I. |
| Original Equipment Manufacturer (OEM) Equipment | Equipment, such as machinery and other specialty items, which typically receive Manufacturer's standard coating system at the location of Manufacture. |
| Owner's Engineer | A designated ExxonMobil subject matter expert on coatings. |
| Purchaser | The party originating the technical requirements for inclusion in an Inquiry or 'direct' Purchase Order. If an engineering job is contracted, the Engineering Contractor is considered to be the Purchaser. |
| Subcontractor | For the purposes of this GP, the company that performs surface preparation and coating application. |
| Sweating Service | Service in which the metal temperature due to the operating conditions is continuously below the atmospheric dew point of water. |
| Wetted Area | Locations subject to moisture fallout from steam plumes, overhead sweating equipment, deluge system testing, or other frequent water contact. |
| Work | As described in Company's contract document. |
| Worksite | As defined in Company's contract document. |

3. General

3-1

[C] **Removal of burrs, slivers, weld porosity, and contaminants:** Purchaser shall ensure that the job scope and cost estimate for fabrication of new equipment include the removal by Fabricator of burrs, slivers, weld porosity, and contaminants remaining from Nondestructive Examination (NDE) inspection.

3-2

[C] **Removal of visible salt, oil, or grease:** Purchaser shall ensure that the job scope and cost estimate for the coating of new or existing equipment include removal of visible salt, oil, or grease that may have been deposited from transportation or from mechanical work.

3-3

[S] [A] **Abrasive blasting on live or pressurized equipment:** Owner's approval is required prior to working on live or pressurized equipment.

3-4

[S] [A] **Company approval to remove heavy rust:** Removal of thick layers of corrosion product on in-service equipment must be approved by Company.

3-5

[R] **Compliance with Manufacturer instructions and product data sheets:** Subcontractor shall comply with all requirements of Manufacturer's most recent application instructions and product data sheets. This includes surface cleanliness and anchor profile requirements, in addition to transportation, storage, straining, mixing, thinning, pot agitation, application, and recoat intervals of coatings.

3-6

[R] **No zinc under insulation:** Metallic zinc-based coatings shall not be applied to surfaces that will be insulated.

3-7

[C] **Shop or offsite application preferable:** Wherever possible, coating systems shall be applied in full prior to delivery of items to the Company site.

3-8

[R] **Structurally deleterious defects:** Subcontractor shall report structurally deleterious defects to Company Representative.

3-9

[R] **Inaccessible areas:** Company Representative shall be notified of any areas that are not accessible for blasting or coating.

3-10

[C] [R] **Coating before erection:** For new construction, areas that are inaccessible or difficult to paint after erection shall be coated prior to assembly or erection.

3-11

[R] **Weld joints:** Weld joints that must be hydrotested prior to coating application are as follows:

- a. Pressure-containing vessel fabrication welds. This does not include skirt or saddle support attachments or fillet welds to attach clips or other attachments to a vessel shell.
- b. Joints requiring sensitive leak tests.
- c. [*] Joints located in an environmentally sensitive area (such as underground or over water) as specified by Owner's Engineer.
- d. Piping containing Category M fluids (per [ASME B31.3](#)).
- e. Per the requirement of the local jurisdiction.

3-12

[C] [O] **Refractory-lined equipment:** Coatings applied to refractory-lined equipment shall have an emissivity of not less than 0.85. Coatings that do not contain aluminum usually meet this requirement.

3-13

[R] **Insulation protrusions:** A coating system, appropriate for the operating temperature, must be applied to all metal surfaces, such as nozzles, supports, and attachments, which extend outside the insulation. The coating system shall be provided for the protrusion and 6 in. (150 mm) radially on the equipment from the protrusion attachment weld. When a full coating system is specified for under the insulation, the coating on the protrusion may be the same as that under the insulation.

3-14

[R] **Fayed surfaces:** Direct-contact, non-seal-welded (fayed) surfaces of non-galvanized components shall be fully coated prior to assembly. Vertical lap joints that will be attached via intermittent welding shall receive a continuous weld along the top end. The bottom end shall be left unsealed. Horizontal lap joints shall be fully sealed with silicone caulk after being solvent wiped per [SSPC SP 1](#).

4. Corrosivity Categories

4-1

[A] Atmospheric coating systems for three corrosivity categories are provided herein. Corrosivity categories are described in [ISO 12944-2](#). Owner's Engineer shall identify the proper corrosivity category, inclusive of corrosion categories C1 and C2, or alternative site requirements for the selection of coatings for atmospheric exposure.

4-2

[*] [R] Chemical fumes or spill/splash exposure of corrosive chemicals require specialty coating systems, which are not covered in this document. Consult Owner's Engineer.

5. Safety and Industrial Hygiene

5-1

[*] Safety and industrial hygiene practices and requirements shall be consistent with all facility and site-specific requirements.

6. Specification, Subcontractor's Proposal, and Documentation

6-1

[*] [R] Purchaser shall provide a technical coating specification (for non-OEM equipment) to accompany the requirements in this GP. The specification shall include, but is not limited to, the following:

- a. Name of Company site for which the equipment is being coated.
- b. Name of the operating unit at which the equipment will exist.
- c. Identification of the equipment as assigned by Company.
- d. Location at which the coating work will be performed.
- e. Operating temperature of each piece of equipment or piping, inclusive of its normal operating, maximum, and minimum temperatures.

- f. If the equipment or piping is subject to cyclic service, this shall be noted in addition to the frequency (i.e., cycles/year).
- g. Scope of the coating work.
- h. Required surface preparation and coating system.
- i. Required inspection-hold points.
- j. Description of surfaces that will be protected from blast and paint.
- k. Weld joints that must be hydrotested prior to coating; see [Paragraph 4-11](#).
- l. Requirements, if any, for salt contamination control or removal. (This is a function of the service and the coating material.)
- m. Coating repair procedure.
- n. Whether any erection markings will be provided.
- o. Need for color coding required for safety or identification.
- p. Signage or equipment identification painted on the new coating system.

6-2

[A] [R] Subcontractor's proposal or quotation shall include the following:

- a. Acknowledgement of, and exceptions to, the technical specification provided by Purchaser.
- b. Coating materials to be used and their product data sheets.
- c. Copy of a functioning Quality Control (QC) Plan. The plan shall include the following:
 - i. QC inspection—details regarding the extent of and by whom it will be provided
 - ii. Qualifications of Subcontractors' QC personnel, detail of responsibilities, and chain of command
 - iii. The following minimum QC hold points: immediately prior to surface preparation, immediately prior to coating application, following application of each coat, and following the cure of the coating
- d. Proof of certification by the Society for Protective Coatings (SSPC) to [SSPC QP 1](#) or [SSPC QP 3](#), as applicable, or equivalent qualifications from the Association for Certification and Qualification of Anticorrosive Paintwork (ACQPA), Norwegian Offshore Standard (NORSOK), or other international organizations with written approval from Company.
- e. A list of the last 12 months of industrial experience, plus names and telephone numbers of people who can verify this experience.

6-3

[A] [R] Subcontractor's proposal information and QC plan shall be reviewed and approved by Purchaser's Nonmetallic Materials Specialist prior to awarding work to Subcontractor.

6-4

[R] Subcontractor shall maintain a daily log equal to the example in Data Sheet [D190101C01](#).

6-5

[R] Subcontractor shall provide copies of all daily logs to Purchaser upon completion of the work. Purchaser shall include this documentation when project details are provided to Company upon project completion.

7. Pre-Job Meeting

7-1

[*] [R] For all coating jobs or campaigns, a pre-job meeting shall be arranged by Purchaser to review Purchaser's specification and Subcontractor's exceptions and procedures.

7-2

[I] Guidance on meeting purpose, necessary attendees, and the content of the agenda is covered in Data Sheet [T190101C03](#).

7-3

[*] [R] Changes to the specification made necessary by the proceedings of the pre-job meeting will be made by Purchaser, who will re-issue the revised specification to the project team and all meeting attendees prior to the commencement of work.

8. General Requirements

8.1. Work Environment Considerations

8.1-1

[R] Surface preparation and coating application shall be performed only under environmental conditions and within the steel temperature limitations provided by Coating Manufacturer. This may, in some weather conditions, require the provision of enclosures and controlled environments to obtain the necessary conditions.

8.1-2

[R] Work environment conditions shall be measured and recorded in accordance with Appendix B. The record shall form part of the daily reports.

8.2. Items to Be Protected from Abrasive Blasting and Coating

8.2-1

[*] [I] The following surfaces are not to be blasted or coated and shall be protected from damage by the work :

- a. Nonferrous surfaces such as aluminum and brass.
- b. Chrome or nickel-plated surfaces.
- c. Thin wall alloy bellows.
- d. Galvanized or aluminum-coated carbon steel surfaces.
- e. Metallic and nonmetallic insulation jacketing, .
- f. Building brick, masonry units, and wall tile.
- g. Concrete structures and foundations.
- h. Plastic and plastic-coated materials.

8.2-2

[R] The following are items requiring protection from accumulation of dust, debris, and overspray:

- a. Internal surfaces of piping and nozzles.
- b. Small openings in equipment. If temporary plugs are used, then they must be removed prior to completion of the job.
- c. Assembled rotating equipment and equipment that has been coated by Equipment Manufacturer. This does not apply to touchup coating for repairing coating damage.

- d. Air intakes on motors.
- e. Nameplates and equipment identification tags.
- f. Stainless steel tubing.
- g. Machined surfaces, gasket seating surfaces, and surfaces within the inside diameter of the seating surface.
- h. Electrical/instrument wire, raceways, and cable.
- i. Lighting fixtures, switches, and receptacles.
- j. Grease fittings.
- k. Sight glasses, gauges, and thermometers.
- l. Pilot valves.
- m. Controllers, recorders, transmitters, switches, and relays.
- n. Transducers, solenoid valves, valve positioners, and valve stems.
- o. Bug screens.
- p. Gaskets on insulating flanges.
- q. [M] Protection of new and existing surfaces. Subcontractor shall protect new and existing surfaces from over-blast damage, overspray, and coating drips.

8.2-3

[R] Masking materials.

8.2-4

[R] All materials used to mask areas requiring protection during blasting and painting operations shall be removed upon completion. Particular attention must be paid to the removal of masking on valve stems, vents on storage tanks, and air intakes on rotating equipment.

8.3. Colors, Signage, and Identification Stenciling

8.3-1

[*] [M] Topcoat color schedule shall be as required by Statutory and Company site requirements.

8.3-2

[*] Subcontractor is responsible for obtaining requirements for color coding and safety identification markings from a Company Representative of the site.

8.3-3

[*] The following information shall be stenciled on large diameter vessels and tanks at locations as directed by Site Representative:

- a. Surface preparation—identify method(s) used and level of cleanliness (i.e., [SSPC SP 6](#), Swedish Std. SA 2.5).
- b. Coating Manufacturer and product name for each coat—primer, intermediate, and finish coats.
- c. Month and year of application.
- d. Subcontractor name.
- e. Lead, chromium, and/or cadmium content of any coating.
- f. Identification of equipment as post-weld heat treated and any related precautions regarding welding.

8.3-4

[S] [*] Labels and markings that are damaged or destroyed by blasting and painting operations shall be replaced unless directed otherwise by Company's Site Representative.

8.4. Subcontractor's Tools and Equipment

8.4-1

[R] Subcontractor is responsible for the provision and maintenance of properly sized equipment, tools, and supplies necessary to perform surface preparation, coating application, QC, and environmental control as covered in the technical specification or approved procedure.

8.4-2

[R] Subcontractor shall provide the following to the point of use: compressed air, coolers, moisture traps, etc. as necessary to provide clean, dry air of sufficient quantity and pressure at the nozzle to achieve the specified surface preparation or coating application.

8.4-3

[R] Subcontractor shall test the quality of compressed air sources used for blasting or coating operation per [ASTM D 4285](#) at the beginning of each shift, as a minimum. Observance of oil or water will be cause for suspension of blasting or coating operations until such time as the source is located, corrected, and retested, or an alternative clean air source is found.

8.4-4

[R] Oil and water traps, automatic drains, and after-coolers on compressed air supply systems shall be checked and drained at the beginning of each shift as a minimum, and more frequently if required, to maintain quality of the air source.

9. Selection of Coating Systems

9.1. Coating System Selection

9.1-1

[*] Appendix A of this GP shall be used to select coating systems. Flowcharts in Appendix A are provided for each of the following service categories:

- a. **Category A:** Uninsulated aboveground carbon steel and low-chrome equipment, vessels, piping, stacks, and ductwork
- b. **Category B:** Externally insulated aboveground carbon steel and low-chrome equipment, vessels, piping, stacks, and ductwork
- c. **Category C:** Aboveground structural steel and repair of galvanizing
- d. **Category D:** Underground piping and fittings and field welds and repair
- e. **Category E:** Underwater/splash zone and marine and land piles and sheet piling
- f. **Category F:** Stainless steel, when specified
- g. **Category G:** Purchased equipment (OEM): Machinery, motors, instruments, transformers, valves, etc.
- h. **Category H:** Refractory-lined equipment
- i. **Category I:** Remote Instrument Enclosures (RIEs), substation enclosures, and small metallic buildings
- j. **Category J:** Aboveground storage tanks—external steel surfaces

9.2. Coating Materials

9.2-1

[A] [I] Coating materials that comprise the coating systems prescribed by this GP shall be those listed in the Downstream [Coating System Descriptions and Accepted Coatings](#) list. The selection of any other coating system shall be approved by the Company..

9.2-2

[A] Qualification of coating materials other than those specified in the [Coating System Descriptions and Accepted Coatings](#) list may be qualified per Appendix A of that document.

9.2-3

[S] Coatings shall not contain more than 0.01 wt. % lead or other heavy metals or asbestos. Coating materials listed in the [Coating System Descriptions and Accepted Coatings](#) list comply with this requirement.

9.2-4

[S] Zinc-rich coatings. Only [ASTM D 520](#) Type II or Type III zinc dust shall be used in the manufacture of zinc-rich coatings.

9.3. Galvanizing

9.3-1

[R] Galvanizing on forged steel shapes, such as plate, castings, bars and strips shall be according to [ASTM A 123/A 123M](#). Galvanizing on threaded fasteners shall be according to [ASTM A 153/A 153M](#).

9.3-2

[S] [*] Unless waived by Company Site Management, zinc for galvanizing shall be in accordance with [ASTM B 6](#), "High grade zinc," which contains a maximum of 0.03% lead and 0.01% cadmium.

9.3-3

[R] Per [GP 04-06-01D](#), [ASTM A 354](#) Grade BC high-strength bolts may be hot-dip galvanized. High-strength bolting that should not be galvanized may be coated by mechanical galvanizing or with an inorganic zinc (IOZ) rich primer.

10. Surface Preparation

10.1. General

10.1-1

[R] **Pre-Blast Inspection:** Per Appendix B, prior to the start of work, Contractor shall verify all surfaces to be coated as being free of oil, grease, dirt, burrs, slivers, undercut welds, excessive weld porosity, and visible salt contamination.

10.1-2

[R] **Acceptable forms of surface preparation:** Contractor shall defer to Manufacturer's data sheet as the source of information for the recommended form of surface preparation for any given coating system type and service category.

10.1-3

[A] [R] **Approval of non-specified methods:** Forms of surface preparation other than that specified on the coating system sheet shall be used only after approval by Purchaser in writing. Use of wet grit blasting methods may be beneficial for dust suppression, but requires Purchaser approval and possible need to modify the coating system.

10.1-4

[A] [R] **Notification of unacceptable surfaces:** If the surfaces are found to be unacceptable for commencement of work, then Subcontractor shall immediately notify Purchaser in writing and shall not commence work until corrective action has been taken. Commencement of work prior to the taking of corrective action shall preclude any subsequent claim by Subcontractor. Corrective action must be approved by Purchaser or it shall be at Subcontractor's expense.

10.1-5

[R] **Removal of dust/abrasive media:** Surface preparation shall not be considered complete until the dust and abrasive particles have been removed from the surface to be coated.

10.1-6

[R] **Anchor profile:** Anchor profile shall be measured in accordance with [ASTM D 4417](#).

10.1-7

[R] **Contamination of wet paint:** Dry grit blasting shall not take place when wind-blown dust and debris could contaminate uncured coatings. Other contaminants, such as insect swarms or falling debris, should be considered prior to beginning coating work.

10.1-8

[R] **Precautions for stainless steel:**

- a. Stainless steel and nonferrous metals shall be protected from blasting, overspray, and coatings intended for carbon steel, especially coatings containing zinc.
- b. Abrasives for use on stainless steel shall be in accordance with [SSPC AB 1](#) and shall be free of metals.
- c. Tools used to clean carbon steel shall not be used to clean stainless steel.
- d. Coatings that are harmful to stainless steel shall be avoided. Coatings and solvents for use on stainless steel and nonferrous metals shall be free of substances such as chlorides, sulfur, halogens, or metallic pigments, which can have harmful effects.
- e. Items of alloy or dual materials of construction shall be handled, prepared, and coated in such a way as to not contaminate the stainless steel surfaces with the improper tools, abrasive, or coatings. This includes bi-metallic welds.

10.2. Abrasive Blast Cleaning

10.2-1

[S] [R] Subcontractor must obtain an analysis certificate of the blast media for each batch of blast media to be used, which, as a minimum, indicates the batch number, the media's gradation, and chloride levels. The media shall comply with the requirements of [SSPC AB 1](#) Class A (less than 1% crystalline silica) for mineral sands and slags and [SSPC AB 3](#) for steel abrasive.

10.2-2

[R] Abrasive must be capable of providing a sharp, dense angular profile of the specified depth.

10.2-3

[R] Abrasive blasting may be performed if the ambient or substrate temperature is greater than 5 °F (3 °C) above the dew point temperature and is expected to increase during the blasting process. Dew point temperature shall be determined by sling psychrometer in accordance with [ASTM E 337](#) at the location where the work is being performed. Substrate temperature shall be measured with a contact thermometer.

10.2-4

[R] Dry blast-cleaned surfaces that show evidence of rust bloom shall be re-cleaned to the specified degree of cleanliness before coating.

10.2-5

[O] [R] Buildup of dust and abrasive particles deposited on surrounding equipment shall be removed prior to job completion.

10.2-6

[R] Recycled abrasive may be used only in blast rooms where automated dust removal equipment exists.

10.2-7

[R] Abrasive for use in dry abrasive blasting shall be stored to remain dry during the entire job.

10.2-8

[R] When steel grit and shot abrasive is used, routine and frequent addition of grit to the grit/shot mixture is necessary to achieve a sharp, dense angular profile of the specified depth. The minimum grit/shot ratio shall be 65%. Blast media consisting solely of steel shot is prohibited.

10.2-9

[A] [R] Wet abrasive blasting, where necessary, may be used only after approval in writing by Company.

10.3. Power Tool Cleaning**10.3-1**

[A] [R] Power tool cleaning is acceptable in areas where abrasive blasting is not suitable and where the tools and techniques used provide a sharp, angular profile of the specified depth and level of cleanliness. Subcontractor shall submit for Owner's Engineer approval any power tool to be used, listing its name, model, and Manufacturer.

10.3-2

[R] If the power tool used is air-powered, then the area must be solvent wiped to ensure that the tool did not contaminate the surface with oil through worn seals.

10.3-3

[R] Any surrounding coating shall be feather etched for a minimum overlap of 2 in. (50 mm).

11. Application of Liquid Coatings**11.1. Coating Storage, Handling, and Traceability****11.1-1**

[R] Coating and solvent materials must be transported and stored in accordance with Coating Manufacturer's recommendations.

11.1-2

[R] **Coating containers unopened and labeled:** Coating materials shall be maintained in the original unopened containers prior to use, free from damage, and with complete labeling. All containers shall be legibly labeled throughout the duration of the job. Any container on which labeling has been damaged or removed shall not be used.

11.1-3

[R] **Shelf life:** Coating material must be used within Coating Manufacturer's advised shelf life.

11.1-4

[R] **Batch numbers:** Manufacturer batch numbers shall be recorded and documented for all coatings and solvents.

11.2. Mixing and Thinning**11.2-1**

[R] **New or original containers:** All mixing shall be done in containers provided by Coating Manufacturer or in clean, new containers that have not been previously used.

11.2-2

[R] **Container covers:** Containers shall be kept covered to prevent contamination by dust, debris, and rain.

11.2-3

[R] **Mixing and stirring devices:** The rotational speed and design of mixers shall be that recommended on the product data sheet or per Coating Manufacturer's instruction.

11.2-4

[R] **Partial kit mixing is not permitted:** For touchup purposes, mixing of small amounts is permissible only when precise measuring of components is witnessed by Inspector.

11.2-5

[R] Each liquid component shall be stirred and strained separately prior to mixing. Materials shall be strained to remove undispersed particles. Excessive retention of the pigment and other products on the screen shall be cause for the product to be remixed and re-sieved before use or to be discarded.

11.2-6

[R] Measurement of remaining pot life shall begin after all components have been thoroughly mixed.

11.2-7

[R] Thinning shall not cause the total volatile organic compound (VOC) content to exceed local regulations and shall be in accordance with Coating Manufacturer's recommendations.

11.2-8

[A] [R] Retardants and accelerants are not permitted unless written acknowledgement is received from Coating Manufacturer and approved by Purchaser.

11.3. Priming**11.3-1**

[R] Primer shall have a uniform thickness, especially at welds, edges, and corners and shall be free of mud cracking.

11.3-2

[R] Primer coat shall not be brick red or rust colored.

11.3-3

[R] Primer shall not be applied within 4 in. (100 mm) of unblasted surfaces or edges to be welded.

11.3-4

[R] IOZ primer, and other primers when required by Manufacturer, shall be applied using an agitated pot.

11.3-5

[R] IOZ primer shall have dry spray removed with wire screen and shall be confirmed as sufficiently cured according to the methyl ethyl ketone (MEK) rub test per Coating Manufacturer's instructions before topcoating.

11.4. Topcoating**11.4-1**

[R] Each coat of a multi-coat system shall be of a contrasting color to indicate the extent of coverage.

11.4-2

[R] Each coat of a multi-coat system shall be allowed to cure sufficiently in accordance with Coating Manufacturer's instructions prior to topcoating. Minimum cure time between coats shall be in compliance with Manufacturer's instructions for the time-averaged substrate temperature and humidity.

11.4-3

[R] **Stripecoat:** All corners, edges, and welds shall be stripecoated.

11.4-4

[A] When specified by Owner's Engineer, light-colored, reflective coatings shall be used to coat the exterior of uninsulated hydrocarbon storage tanks, bullets, and spheres.

11.4-5

[R] IOZ that is to be topcoated shall have a mist coat applied prior to application of the balance of the wet film thickness.

11.5. Film Thickness

11.5-1

[R] Wet film thickness (WFT) shall be checked during the application of each coat to assure the specified Dry Film Thickness (DFT) is achieved. Refer to [ASTM D 4414](#) for further guidance.

Note: Wet film thickness measurements are not suitable for some heavily pigmented coatings such as IOZ.

11.5-2

[R] Measurement of DFT shall be in accordance with [Table 1: Instructions for Measurement of Dry Film Thickness](#) of this GP.

11.5-3

[R] The DFT of each coat shall be within the specified range according to the measurement protocol being used (either [SSPC PA 2](#) or [Table 1: Instructions for Measurement of Dry Film Thickness](#) of this GP).

11.5-4

[R] Coating thickness gauges shall be Type 2 gauges (equal to Positector 6000 FN-memory version) calibrated on certified shims and adjusted to compensate for the substrate effect.

11.5-5

[R] Thickness measurements for all coatings shall be taken after removal of dry spray and overspray.

Table 1: Instructions for Measurement of Dry Film Thickness

| Type of Equipment | Specification | Criteria |
|---|--|--|
| Large Vessels > 48 in. (1220 mm) | SSPC PA 2 | As in SSPC PA 2 |
| Vessels and Piping: 24 in. (610 mm) > d > 48 in. (1220 mm) | 8 readings per band with bands spaced at 10–12 ft (3–3.5 m) intervals. | Min. 85% of readings within specified range. Random spot readings may be more or less than specified by 1 mil (25 μ). |
| Piping: 12 in. (300 mm) to 24 in. (610 mm) dia. | Same band spacing as above, with 6 readings per band. | Single reading may exceed the spec by as much as |
| Piping: Up to 12 in. (610 mm) dia. | Same band spacing as above with 4 readings per band. Including one band at flange area. Minimum 3 bands of readings per spool. | 3 mils (75 μ) if 3 additional readings taken within 8 in. (200 mm) around the reading are within specified range. |

11.6. Defects

11.6-1

[R] Coating shall be of uniform film thickness and appearance and free of defects such as sags, pinholes, drips, runs, skips, wrinkles, mud cracking, and blisters.

11.6-2

[R] Before application of any coat, all defects and damage to the previous coat(s) shall be repaired.

11.7. Touchup**11.7-1**

[R] If coating damage has occurred exposing steel, then the area shall be spot-blast cleaned (vacuum blast is acceptable) or power tool cleaned to restore the exposed steel to the originally specified degree of cleanliness. Requirements regarding power tool cleaning are covered in Section 11.3.

11.7-2

[R] Adjacent coating shall be feathered back approximately 2 in. (50 mm) to form a uniform etched surface. The prepared surface shall be free of loose, lifting, burned, or blistered coating.

11.7-3

[R] If the coating thickness is deemed to be outside of Coating Manufacturer's permissible DFT (range, i.e., too high or too low) the final overall coating thickness shall be adjusted to be within the prescribed range. Follow Coating Manufacturer's recommended steps in rectifying the overall coating thickness.

11.7-4

[I] Coating materials suitable for touchup are covered on the coating system sheets included in [Coating System Descriptions and Accepted Coatings](#).

12. Wrap Systems**12-1**

[I] Limitations and installation requirements for the two approved wrap systems suitable for piping in certain service categories are provided in [Coating System Descriptions and Accepted Coatings](#).

13. Thermal Spray Aluminum**13-1**

[*] [R] The Owner's Engineer shall supply a job specification that establishes the criteria for Subcontractor qualification, surface preparation, application, and inspection of Thermal Spray Aluminum (TSA).

13-2

[I] Arc spray or flame spray equipment may be used.

13-3

[A] [R] The thermal spray wire shall be 99% Al, conforming to [AWS C2.25/C2.25M](#), C2.25 Classification W-AL-1100 (UNS No. A91100). The Manufacturer or Supplier shall provide a certificate of conformance for each batch supplied.

13-4

[*] When specified by Owner's Engineer, a seal coat shall be applied over the TSA application.

13-5

[S] Except for Category D Fluid Service as defined by [ASME B31.3](#), TSA shall be used for piping and equipment in sweating or cyclic sweating CUI services. Insulation protrusions shall be coated as per the requirements of [Paragraph 4-13](#) of this GP.

14. Inspection and Testing

14-1

[A] [I] When coatings will be underground, underwater, marine, or chemical exposure, Inspector shall be a certified NACE International Coating Inspector or Company-approved equivalent.

14-2

[R] Inspection methods, frequency, and acceptance criteria are a required part of this GP and are listed in Appendix B.

14-3

[A] [M] [R] Work shall not proceed with the next step in the system sequence (i.e., surface preparation, priming, intermediate, finish coat application) until the previous work has been inspected and approved by Inspector.

Appendix A: Coating System Selection Flowcharts

A-1

This Appendix is a required part of this GP.

A-2

[*] The flowcharts in this Appendix shall be used to determine the correct coating system for various service categories, operating environments, and equipment types. When the correct coating system has been identified, reference the [Coating System Descriptions and Accepted Coatings](#) list to obtain the required surface preparation, coating materials, and relevant details.

A-3

[A] Deviation from the following coating selection flowcharts requires approval by Purchaser or Owner's Engineer.

A-4

The following service categories are included in this Appendix:

| | |
|-------------|---|
| Category A: | Uninsulated aboveground carbon steel and low-chrome equipment, vessels, piping, stacks, and ductwork |
| Category B: | Externally insulated aboveground carbon steel and low-chrome equipment, vessels, piping, stacks, and ductwork |
| Category C: | Aboveground structural steel and repair of galvanizing |
| Category D: | Underground piping and fittings and field welds and repair |
| Category E: | Underwater/splash zone and marine and land piles and sheet piling |
| Category F: | Stainless steel, when specified |
| Category G: | Purchased equipment (OEM) – Machinery, motors, instruments, transformers, valves, etc. |
| Category H: | Refractory-lined equipment |
| Category I: | Remote instrument enclosures (RIEs), substation enclosures, and small metallic buildings |
| Category J: | Aboveground atmospheric storage tanks – external steel surfaces |

Table : Coating System Legend

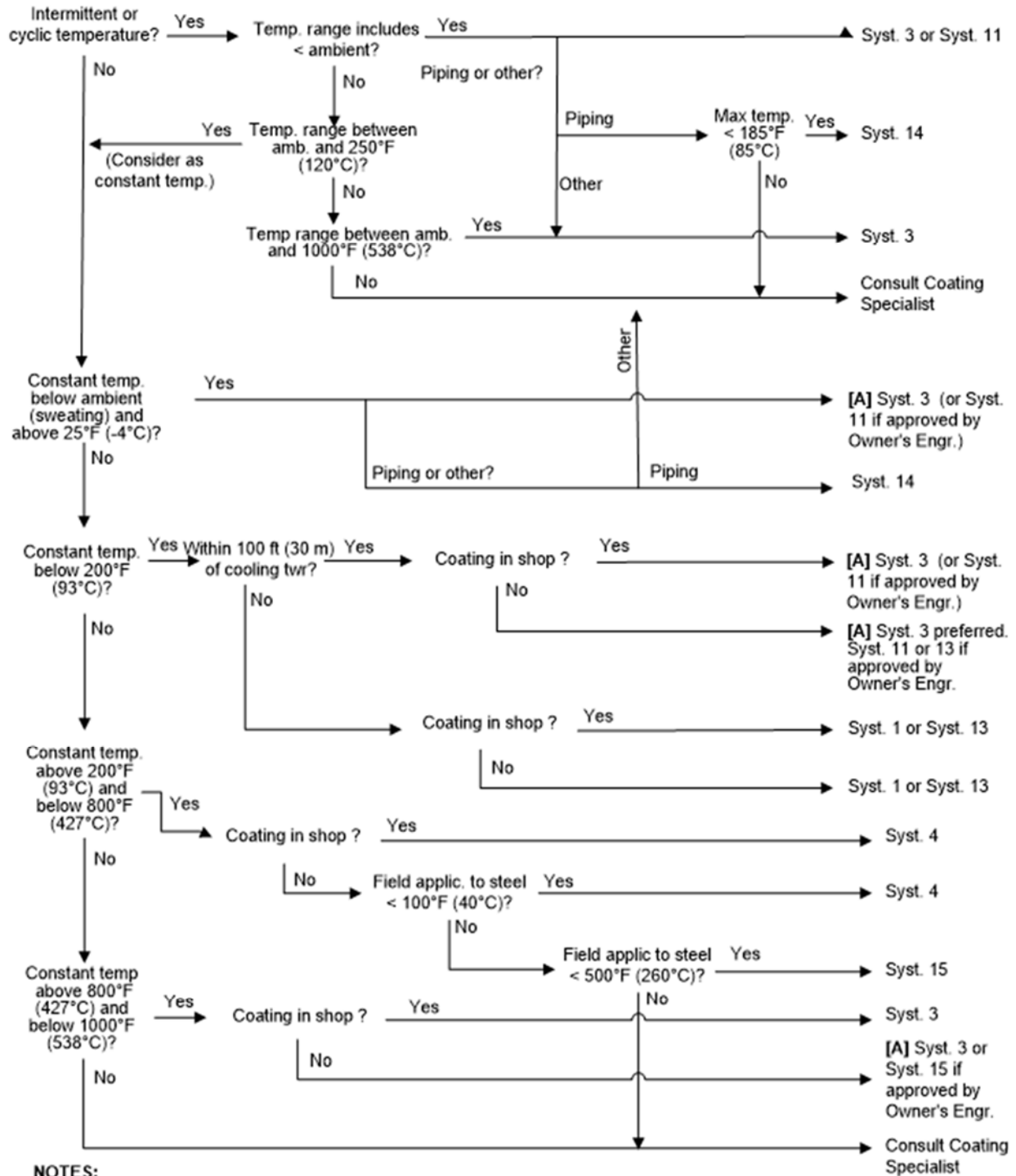
See EMEPS website (Other Standards) for [Coating System Descriptions and Accepted Coatings](#).

| System Name | Coating Type | Service Category | Corrosivity Category |
|-------------|-----------------------------|------------------|----------------------|
| Syst. 1 | Organic Zinc/Epoxy/Urethane | A; J | C5-I |
| Syst. 1A | Epoxy/Acrylic | A; J | C4 |
| Syst. 1B | Zinc-Rich Epoxy/Epoxy | J | C3 |

| System Name | Coating Type | Service Category | Corrosivity Category |
|-------------|--|------------------|----------------------|
| Syst. 2 | Epoxy Mastic/Epoxy/Urethane | C; J | All |
| Syst. 2A | Epoxy/Acrylic | J | C4 |
| Syst. 2B | Option 1: Zinc-Rich Epoxy/Epoxy Option 2: Epoxy/Acrylic | J | C3 |
| Syst. 3 | Thermal Spray Aluminum (TSA) | A; B; C; F; J | All |
| Syst. 4 | Inorganic Zinc/High Temperature Silicon Aluminum (multi-coats) | A; C; H; J | All |
| Syst. 4p | Inorganic Zinc/High Temperature Silicon Aluminum (multi-coats) | A; C; H; J | All |
| Syst. 5A | Option 1: Solvent-Borne Zinc-Rich Epoxy/Epoxy Mastic Option 2: Low VOC Zinc-Rich Primer/Moisture-Cured Urethane | C | All |
| Syst. 5B | Option 1: Solvent-Borne Zinc-Rich Epoxy/Epoxy Mastic Option 2: Low VOC Zinc-Rich Primer/Moisture-Cured Urethane | C | All |
| Syst. 6 | Solvent-Borne Epoxy | B; F; J | All |
| Syst. 7 | 100%-Solids Epoxy | D; E | All |
| Syst. 8 | Coal Tar Epoxy | D | All |
| Syst. 9 | Temperature-Indicating | H | All |
| Syst. 10 | Aluminum Foil | F | All |
| Syst. 11 | Epoxy | A; J | All |
| Syst. 12 | Wax Tape | A; D | All |
| Syst. 13 | Inorganic Zinc or MIO/Moisture-Cured Urethane | J | All |
| Syst. 14 | Viscoelastic Tape | A; D; G; J | All |
| Syst. 15 | Modified Silicone Primer/Silicone | A | All |
| Syst. 16 | High-Solids Epoxy | J | All |
| Syst. 17 | Polysulfide Caulk | J | All |
| Syst. 18 | FBE/High Density Polyethylene | D | All |
| Syst. 18A | Urethane/Coal Tar Epoxy/Epoxy | D | All |

Figure Category A: Uninsulated Aboveground Carbon Steel and Low-Chrome Equipment, Vessels, Piping, Stacks, and Ductwork

(See Notes 1, 2)



NOTES:

- 1) [A] When approved by the Material's Engineer: - Syst. 1A or 1B may be substituted for Syst. 1.
- 2) Temperature values throughout the flowchart refer to Operating Temperatures.

Figure Category B: Externally Insulated Aboveground Carbon Steel and Low-Chrome Equipment, Vessels, Piping, Stacks, and Ductwork

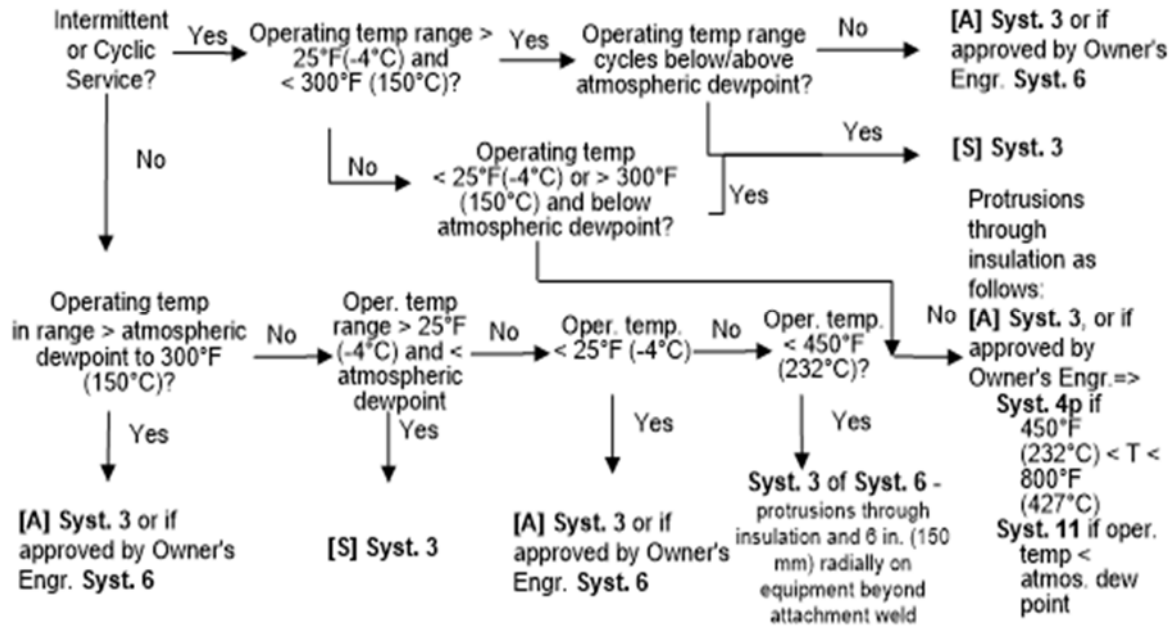
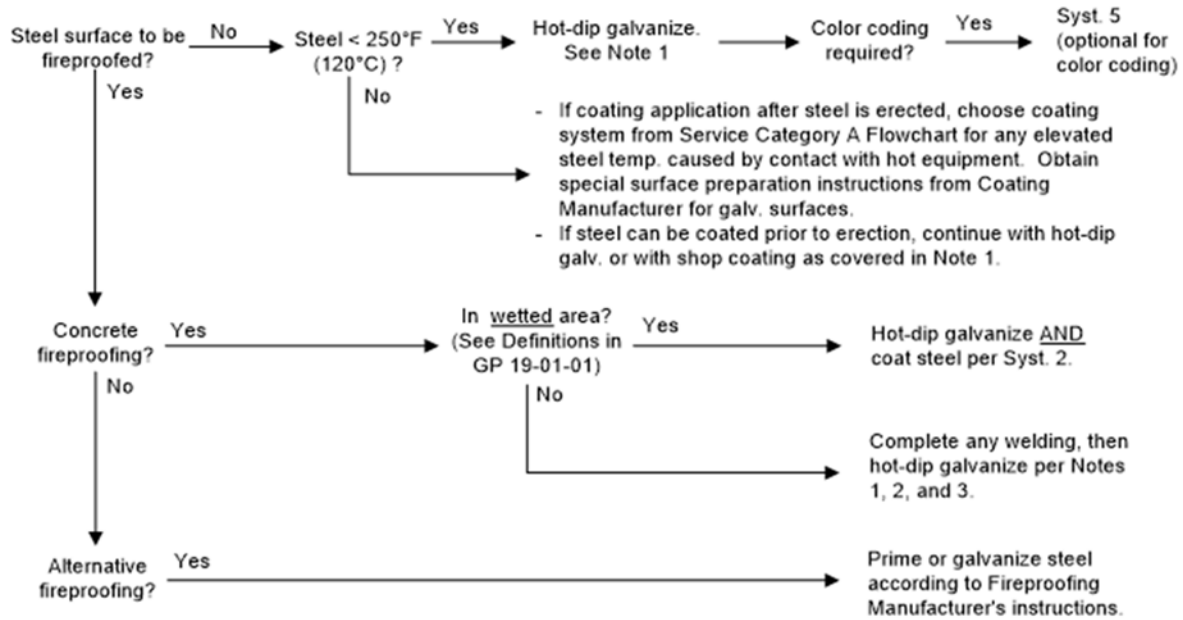


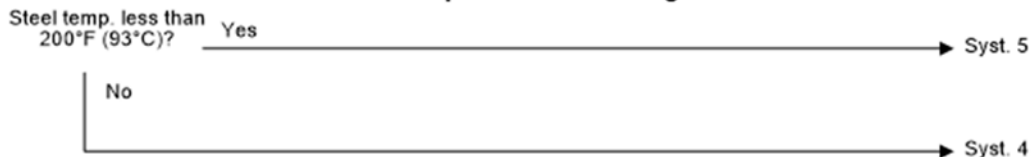
Figure Category C: Aboveground Structural Steel and Repair of Galvanizing

(See Notes 3 through 6)

Structural Steel



Repair of Galvanizing



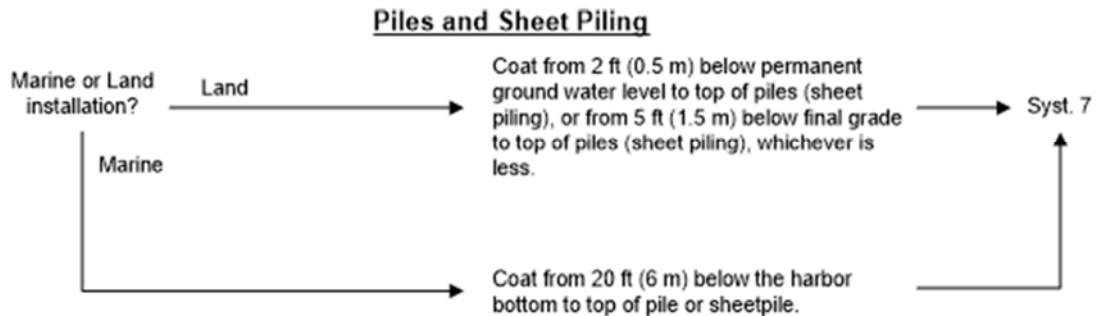
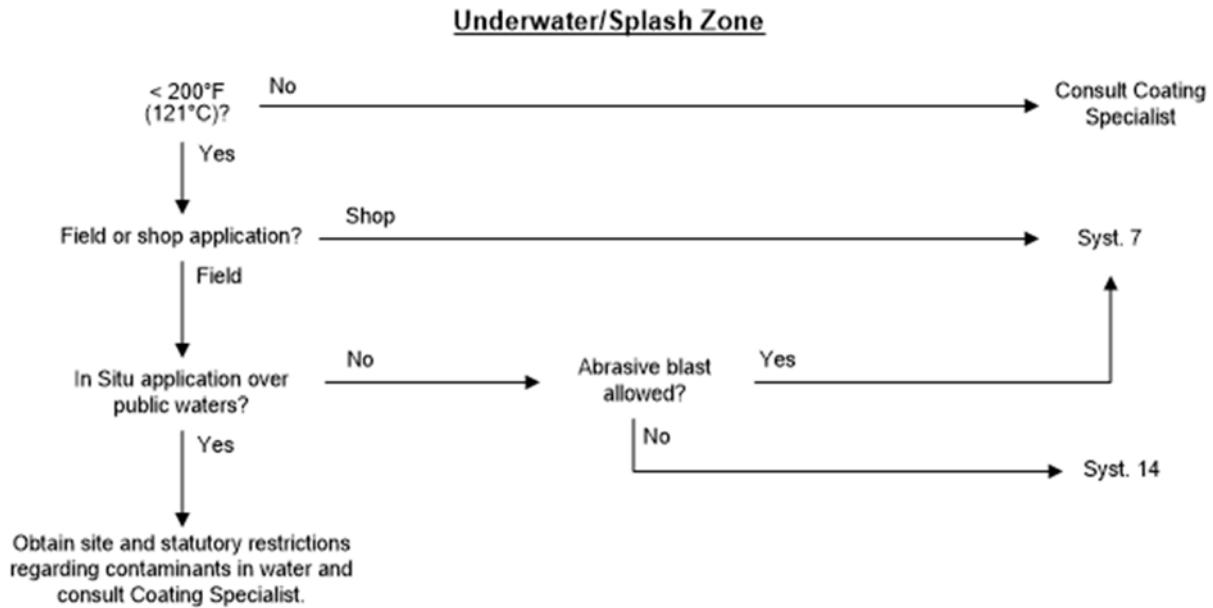
NOTES:

- 1) **[A]** Hot-dip galvanizing is the preferred coating for structural steel which is not at very high elevated temperature due to long-term economics for most sites. Galvanizing lasts longer than organic coatings. With approval from the Owner's Engineer, Coating System 1 or 2 is an acceptable alternative.
- 2) Vessel skirts and supports are not considered structural steel for the purposes of coating requirements.
- 3) **[*]** Hot-dip galvanizing shall be according to ASTM A 123/A 123M. Unless otherwise specified by Owner's Engineer, zinc used in galvanizing shall be "High Grade Zinc," Z15001 (less than 0.03% lead) in accordance with ASTM B 6.
- 4) Zinc thickness shall be in accordance with Table 1 in ASTM A123/A 123M.
- 5) Per GP 04-06-01, ASTM A354 Grade BC high strength bolts may be hot-dip galvanized. High strength bolting which should not be galvanized may be coated by mechanical galvanizing or with an inorganic zinc rich primer.
- 6) Galvanized structural steel shall not be welded or in direct contact with stainless steel equipment. These systems shall be bolted and isolated with a solid nonmetallic strip or sheet.
- 7) **[A]** When approved by the Material's Engineer:
 - Syst. 1A or 1B may be substituted for Syst. 1.
 - Syst. 2A or 2B may be substituted for Syst. 2.

Table Category D: Underground Piping and Fittings and Field Welds and Repair

| Pipe Coating System Options | Max Temp. Limit for Underground Service (Note 4) | Field Weld/Joint Coating Options | Comments |
|---|--|----------------------------------|--|
| Syst. 7 100% solids epoxy | 200 °F (93 °C) | Syst. 7, Syst. 12 | Syst. 7 requires abrasive blast. |
| Syst. 8 Coal tar enamel-TGF3 | 120 °F (49 °C) | Syst. 12 or 14 | 1) Both field joint coating options (Syst. 12 and 14) are compatible with coal tar enamel. 2) See Note 3. |
| Syst. 12 Wax tape | 120 °F (49 °C) | Syst. 12 | 1) Protective overwrap is required. 2) Prone to damage during shipment. Intended for field application. |
| Syst. 14 Viscoelastic tape | Varies per product grade. Max. is 185 °F (85 °C) | Syst. 14 | 1) Requires abrasive blast for underground service. 2) Protective overwrap is required for underground use. |
| Syst. 18 Bredero Shaw's YJ2K 3 layer | 185 °F (85 °C) | Syst. 18A | Available only from Shaw Canada in Edmonton, Alberta. |
| Notes: | | | |
| (1) [I] Each of the coating systems listed has advantages and disadvantages regarding application scenario, treatment of field joints, and suitability for the type of underground exposure. | | | |
| (2) [E] [R] Selection of underground coatings shall be made with the assistance of a Materials Engineer or Nonmetallic Materials Engineer. | | | |
| (3) [I] Coal tar enamel contains coal tar, which is sensitizing to skin and lungs. It is not typically approved by site Industrial Hygiene for application at the site, but automated shop application to straight lengths has been historically economically attractive for very large scope underground installations. | | | |

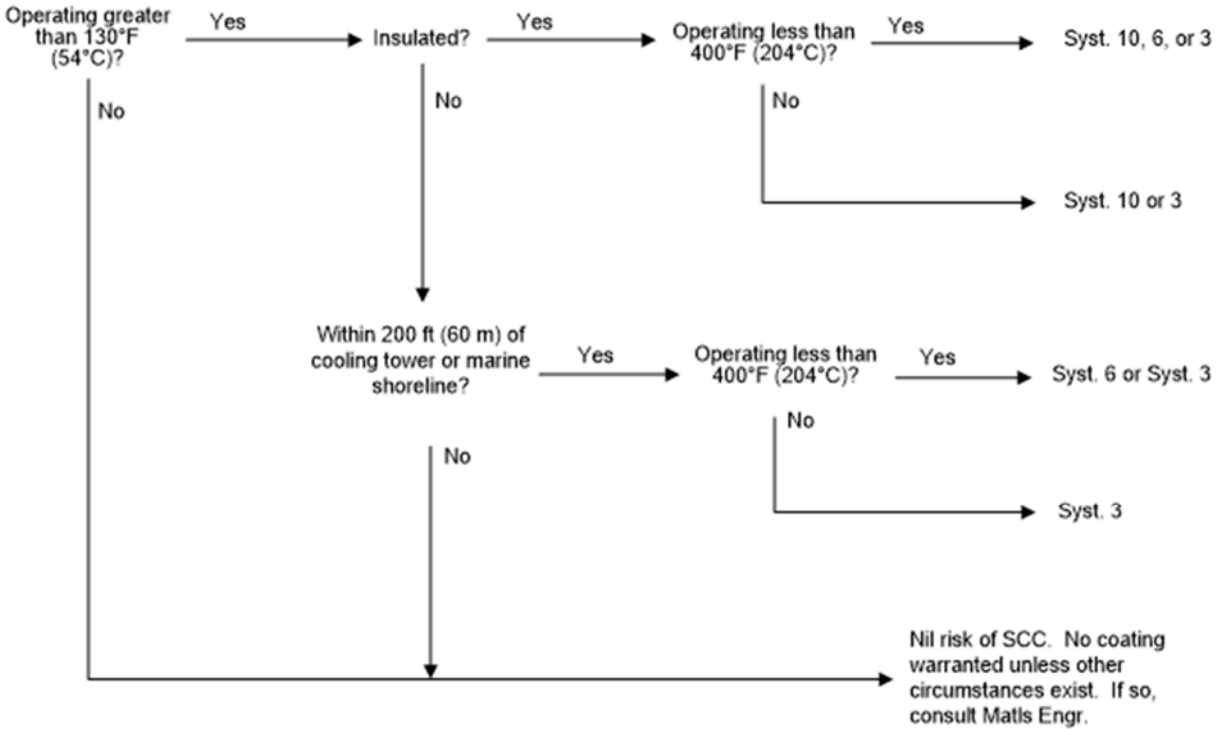
Figure Category E: Underwater/Splash Zone and Marine and Land Piles and Sheet Piling



NOTE:

- 1) The groove at sheet piling interlocks shall not be coated.

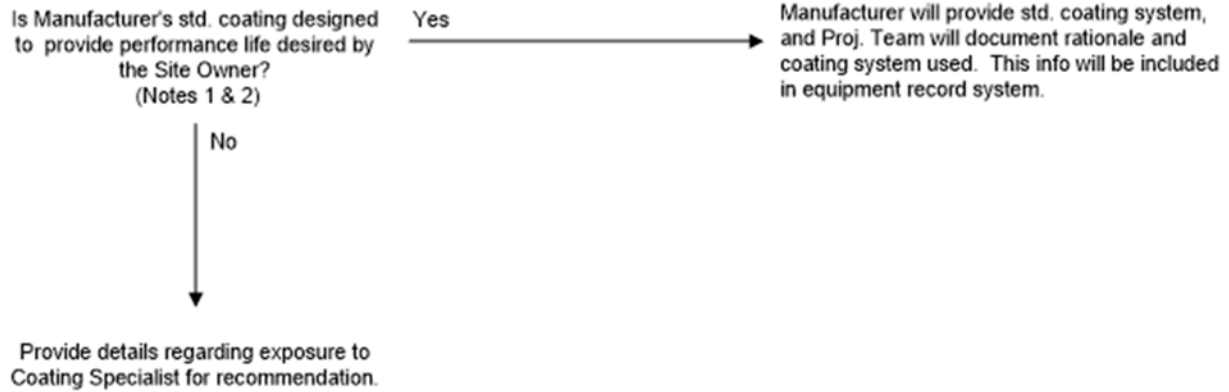
Figure Category F: Stainless Steel



ALL NOTES APPLY:

- 1) **[*]** This coating approach defines the minimum requirements for stainless steel in marine and coastal atmosphere. Company sites in rural areas may enforce less stringent requirements regarding the protection of stainless steel from stress corrosion cracking (SCC). The decision whether or not to protect austenitic stainless steel from chloride SCC shall be made by Owner's Engineer.
- 2) **[R]** Steam tracing made of copper shall not be used on stainless equipment and not in conjunction with aluminum foil.
- 3) **[R]** When heat tracing is used, organic coatings must have long-term resistance to the tracer temperature, or a spacer must be utilized.
- 4) **[*] [R]** If surfaces will operate in temperature range which would allow sweating, Syst. 3 shall be the means of protection if protection is specified by Owner's Engineer.

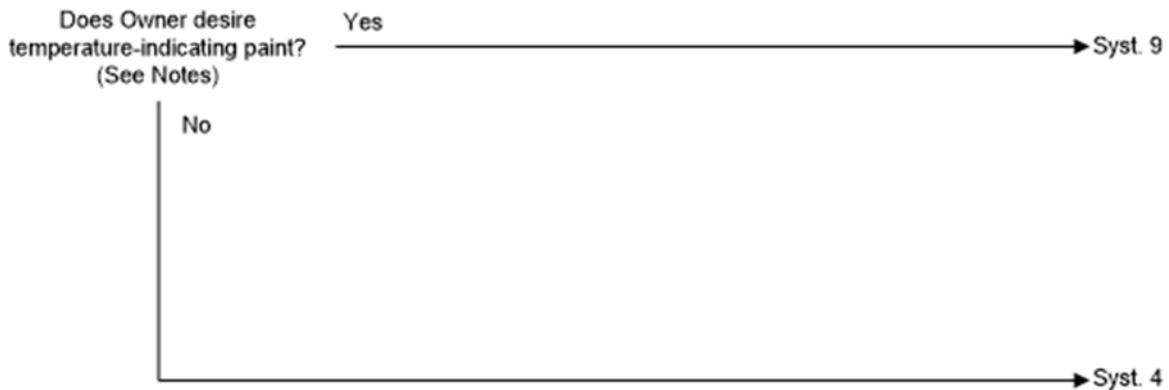
Figure Category G: Purchased Equipment (OEM) – Machinery, Motors, Instruments, Transformers, Valves, etc.



NOTES:

- 1) Assuming proper surface preparation and coating application, coating performance life is dependent on the atmospheric exposure of the equipment.
- 2) Exposure to chemical spills, splash, fumes, or routine testing of salt water deluge systems will severely limit performance life of "standard coating systems." Consult Coating Specialist to determine suitability of the proposed coating system.

Figure Category H: Refractory-Lined Equipment

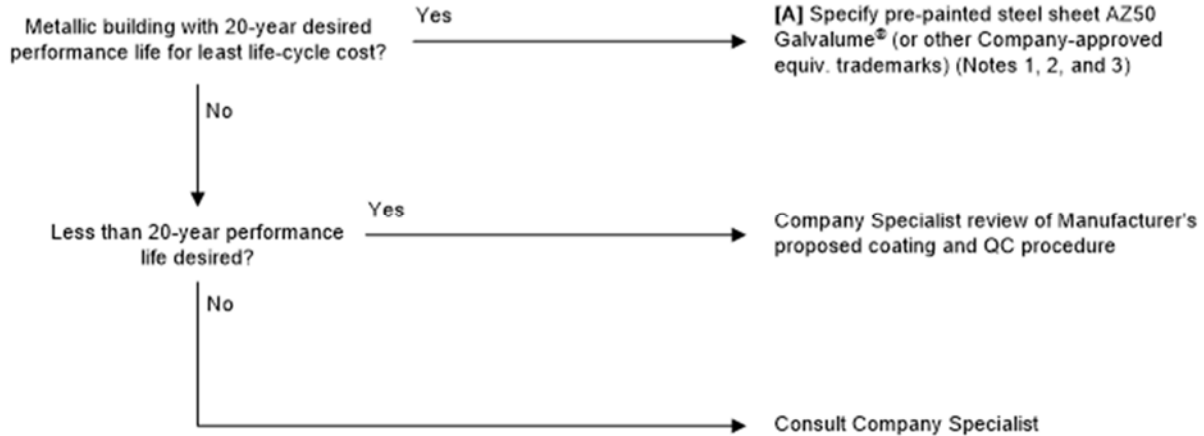


ALL NOTES APPLY:

- 1) Coatings applied to refractory-lined equipment shall have a surface emissivity not less than 0.85. Coatings which do not contain aluminum usually meet this requirement.
- 2) Color change of paint which indicates steel temperatures above the trigger temperature is a one-time occurrence.
- 3) The original color of temperature-indicating coatings fades with time and temperature. Depending on the normal operating temperature of the steel, the coating will usually fade and become a much lighter shade of the original coating within 3 to 5 years.

Figure Category I: Remote Instrument Enclosures (RIEs), Substation Enclosures, and Small Metallic Buildings

(See Note 4)

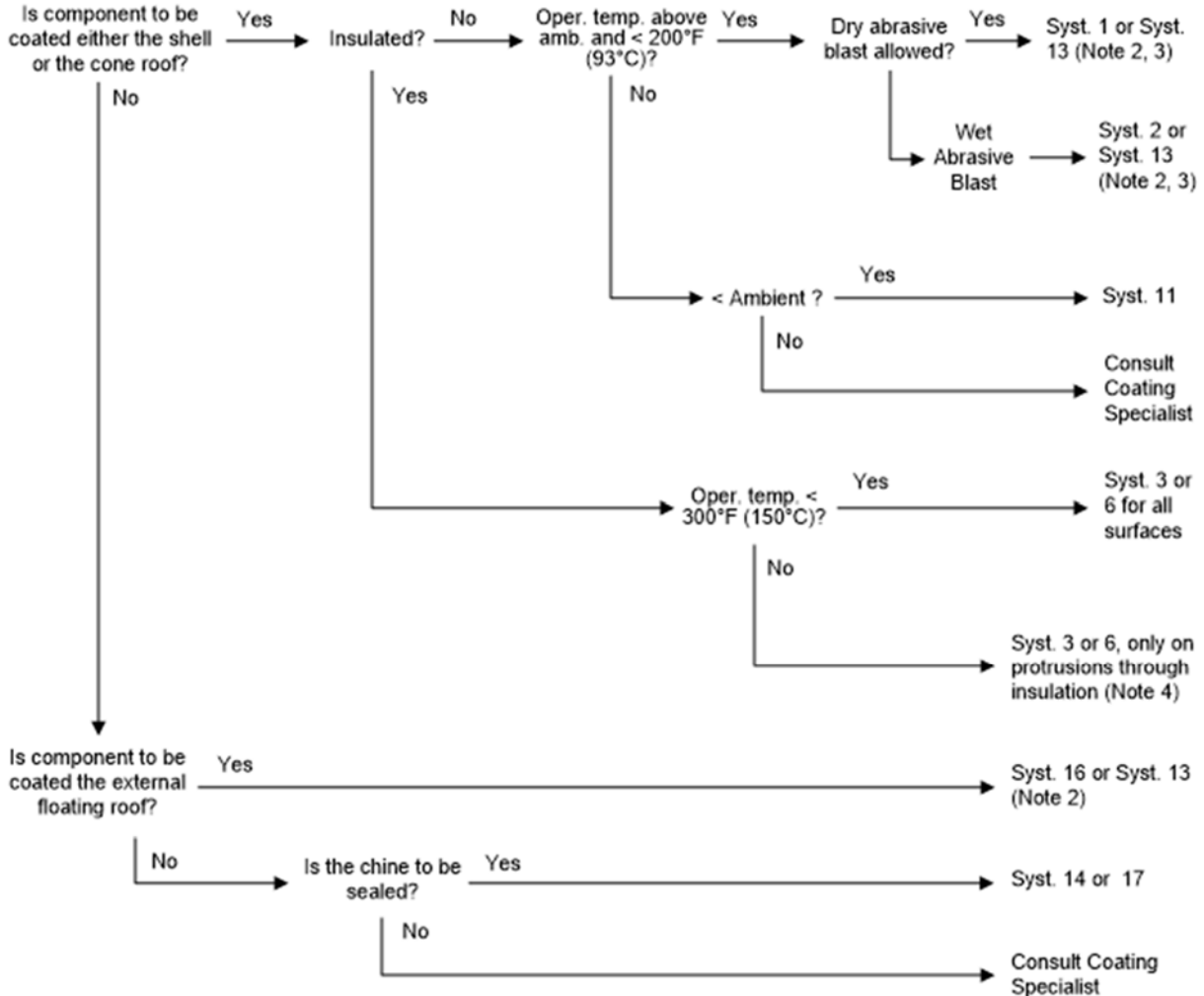


NOTES:

- 1) Galvalume is available globally under various equivalent trademarks. See www.steelroofing.com. ASTM A792/A792M is the industry standard for this 55% aluminum/45% zinc hot-dip process.
- 2) Manufacturer's proposal should include the following:
 - a) Type of external coating to be provided and associated warranty.
 - b) Whether a full coating film will be provided on internal surfaces or whether only a "backer" coating is to be provided.
- 3) Application of sprayed foam insulation to uncoated Galvalume may damage the aluminum/zinc coating.
- 4) [*] Other Company and/or local building standards and design practices regarding personnel safety associated with buildings or enclosures may apply.

Figure Category J: Aboveground Atmospheric Storage Tanks –External Steel Surfaces

(See Note 1)



NOTES:

- 1) Chart assumes new steel or complete removal of old coating. Tightly adhered coating that is in good condition and that resists abrasive blasting may be allowed to remain if the type of coating is known and confirmed to be compatible with the new coating. This does not apply to external floating roof coatings.
- 2) Syst. 13 (Moisture-cured urethane system) is recommended when coating work must occur during periods of cold and/or damp weather. Consult Manufacturer’s product data and application instructions.
- 3) [*] When recommended by Owner’s Engineer, tanks storing hydrocarbons shall be coated with light-colored, reflective coating.
- 4) System 3 or 6 are recommended as these can withstand temperatures above 300°F (150°C). They can also perform in cases where protrusions act as cooling fins, thereby creating operating conditions over the metal surface with temperatures under 300°F (150°C).

Appendix B: Inspection Methods and Acceptance Criteria

B-1

Note: This appendix is a required part of this Practice.

| Test Type | Method | Frequency | Acceptance Criteria | Consequence/ Corrective Action |
|---|--|---|---|---|
| Environmental Conditions | Ambient and steel temperature Relative humidity: ASTM E 337 Dew point spread | Before start of each shift, plus a minimum twice per shift | In accordance with specified requirements | No blasting or coating |
| Verification of Abrasive Materials | SSPC AB 1 | Each 16 tons (15,000 kg), or manufacturing batch, whichever is less | Qualification and conformance testing per Section 5 of SSPC AB 1 | No blasting or coating |
| | SSPC AB 3 | | Qualification (i.e., "preliminary acceptance") testing per Section 4 of SSPC AB 3 and conformance testing per Sections 4.1.1, 4.2.2, and 4.2.3 of SSPC AB 3 | |
| Compressed Air Quality | ASTM D 4285 | Before start of each shift or change in compressed air source and at 4 hour intervals thereafter | Per the Standard (No visible contamination) | Service, clean, and replace hoses, filters, KO pots, aftercoolers. Pressure wash with cleanser, rinse, then reblast contaminated surfaces |
| Visual Examination of Substrate | Visually, for sharp edges, weld spatter, slivers, rust grade, etc. | 100% of all surfaces prior to surface preparation | No defects, refer to specified requirements | Defects to be repaired |
| Surface Cleanliness a) Visual b) For dust | (a) SSPC VIS 1 or ISO 8501-1 | (a) 100% visual of all surfaces | (a) In accordance with specified requirements | (a) Re-blast |
| | (b) ISO 8502-3 pressure sensitive tape method | (b) Spot checks, but not less than 1 per 100 ft ² (10 m ²). Specific location to be determined by Company Inspector | (b) Maximum quantity and size rating of 2 | (b) Re-clean and retest until acceptable |

| Test Type | Method | Frequency | Acceptance Criteria | Consequence/ Corrective Action |
|--|---|--|--|---|
| <p>[*] Soluble Salts</p> <p><i>Only if specified or requested by Inspector because of seating service.</i></p> | <p>Extraction: ISO 8502-6 (Bresle) ISO 8502-9 (Conductometric) Or Extraction: SSPC GUIDE 15, Section 4.6 (Elcometer 130 SC 400) Assessment: SSPC GUIDE 15, Section 5.3</p> | <p>4 samples per 22,000 ft² (2000 m²) of surface to be coated Specific location to be determined by Company Inspector</p> | <p>Average conductivity corresponding to $\leq 30 \text{ mg/m}^2$ and maximum conductivity corresponding to $\leq 40 \text{ mg/m}^2$ water soluble salt(s).</p> | <p>Steam or clean water washing and retesting until entire 22,000 ft² (2000 m²) test area is acceptable</p> |
| <p>Anchor profile</p> | <p>Per ASTM D 4417</p> <p>Perform at beginning of shift, then at prescribed frequency.</p> | <p>a) Power tool cleaning: Every 4 hours</p> <p>b) Recycled abrasive: Every 4 hours</p> <p>c) For non-recycled abrasive: Minimum once per shift...or...after any change of equipment conditions, abrasive material, or abrasive size</p> | <p>As specified</p> | <p>Re-blasting, using appropriate grit size or enhanced nozzle pressure. OR Repeat power tool surface preparation.</p> |
| <p>Extent of Intercoat Cure</p> | <p>Perform solvent rub test to ensure:</p> <p>(a) IOZ is fully cured per ASTM D 4752</p> <p>(b) Confirm epoxy for splash zone exposure, or under insulation has not exceeded its recoat interval per ASTM D 5402. Unless otherwise instructed, in writing, by the Coating Manufacturer, perform 50 double rubs using MEK.</p> | <p>Perform 3 tests per 5000 ft² (500 m²) of surface to be coated</p> | <p>(a) Average resistance rating not less than 4</p> <p>(b) Discoloration must be visible on the rub cloth, or... Thumbnail indentation at the center of the rub path must be possible, or Reduction in gloss must be visually discernable</p> | <p>(a) Inadequately cured IOZ: Take action to enhance level of cure (e.g., water misting). If ineffective, remove and reapply inadequately cured IOZ.</p> <p>(b) Overcured Epoxy: Sweep blast using reduced nozzle pressure and fine abrasive. Remove all dust.</p> |

| Test Type | Method | Frequency | Acceptance Criteria | Consequence/ Corrective Action |
|--|---|---|---|---|
| Compatibility with color topcoats (With Vendor Standard Coating on Purchased Equipment) | Apply test patch and test per ASTM D 3359 , Method A or ASTM D 6677 . Patch may be as small as 30 in. ² (200 cm ²). Apply first coat of overcoat system only. | One for each component coated with Vendor standard, except one in 25 for identical components | As established by the Coating Manufacturer of the overcoat(s) | Remove incompatible coating before applying specified system. Use liquid stripper or SSPC SP 11 . |
| Visual Examination of Coating | Visual to confirm absence of contamination, pinholes, sagging, or other surface defects | 100% of surface after each coat | According to specified requirements | Repair of defects |
| Dry Film Thickness | For vessels: SSPC PA 2 | | | Repair, apply additional coats, or recoat as appropriate. |
| | For piping: Per Table 1: Instructions for Measurement of Dry Film Thickness . | | | |

Appendix C: Requirements for Application of Aluminum Foil to Stainless Steel Vessels and Piping

C-1

Note: This appendix is a required part of this Practice.

Appendix C.1: General

C.1-1

[A] The decision to protect austenitic stainless steel from chloride stress corrosion cracking shall be made by the Company Owner's Engineer. See Coating System Selection Flowchart for stainless steel, Category F.

C.1-2

[I] Installation of aluminum foil wrap is typically part of the work scope of the Insulation Subcontractor. Additional details may be found in the [CINI Handbook](#).

C.1-3

[R] Aluminum foil shall not be used on stainless steel in sweating service.

C.1-4

[R] Aluminum foil shall not be used on equipment that is heated by panel coils or is routinely heated by steam lances inserted through the insulation to clear process blocks.

Appendix C.2: Safety and Industrial Hygiene Concerns

C.2-1

[I] Aluminum foil introduces no additional safety or industrial hygiene concerns.

Appendix C.3: Foil Composition and Thickness

C.3-1

[R] The aluminum foil chemical composition shall be a minimum of 98% aluminum and shall meet the general requirements of [ASTM B 479](#).

C.3-2

[R] The aluminum foil thickness shall be between 1.6 mils (0.04 mm) to 6 mils (0.15 mm) and shall not have an adhesive backing.

C.3-3

[R] Close contact between the aluminum foil and the pipe or vessel must be achieved. Neither aluminum sheet nor rigid aluminum materials shall be used.

Appendix C.4: Surface Preparation

C.4-1

[R] The stainless steel surface shall be dry and free of all chlorides, lubricants, dirt, markings, tags, etc. before the aluminum foil is applied. Power water washing with fresh water will acceptably remove chlorides.

Appendix C.5: Installation

C.5-1

[R] The aluminum foil shall be applied tightly so that physical contact with the pipe or vessel is maintained. An overlap of approximately 2 in. (50 mm) shall be provided at joints.

C.5-2

[R] The foil overlaps shall be arranged to shed water at all times.

C.5-3

[R] Aluminum foil shall be molded to flanges and fittings so that physical contact is maintained.

C.5-4

[R] If the piping or vessel will be steam traced, then the first layer of foil shall be applied directly to the pipe or vessel prior to installing the steam tracer and maintain physical contact between the foil and the steel. A second layer of aluminum foil shall be applied over the top of the stainless steel steam tracing.

C.5-5

[R] On gusset supports or branch connections, apply a layer of aluminum foil to each of the sections with a foil joint at the connection. A second layer of aluminum foil shall be applied to fully encapsulate the attachment weld.

C.5-6

[R] Torn, damaged, or contaminated foil shall not be used, but limited "punctures" of the aluminum foil during application are acceptable.

C.5-7

[R] The applicator will use clean work practices to prevent chloride contamination of the piping or vessel. Use of clean gloves, changed at least daily, is required.

C.5-8

[R] Aluminum foil shall be applied to clean, dry surfaces.

Appendix C.6: Inspection

C.6-1

[A] [R] Company's Inspector shall verify the following:

- a. Thickness of the aluminum foil before installation is as specified.
- b. Pipe or vessel surface meets the requirements in Section C-4 of this Appendix.
- c. Aluminum foil is not torn, damaged, or contaminated after installation.

C.6-2


[R] The Company's Inspector will conduct additional inspections at his or her discretion. These inspections or lack of Company's inspections do not relieve Subcontractor of its responsibility for quality and performance of the coating.


Record of Change


Purpose Code Definitions


16-1


| Code | Description |
|---|--|
| * | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |
| A | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| C | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| CS | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| E | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| I | Obsolete as per 2019 CIG - Assigned to paragraphs that provide only clarifying information, such as Scope statements, definitions of terms, etc. |
| M | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| O | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| R | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| S | Assigned to paragraphs that contain design, fabrication and construction requirements that, if not met, can directly result in or significantly increase the risks of either: <ol style="list-style-type: none"> 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). <p>Safety designation shall not be applied to paragraphs with Risk Matrix Category 4 when the incident probability and risk can be determined by the appropriate SME.</p> |
| Purpose Code Hierarchy: Purpose Codes assigned to a numbered item apply to all associated subitems. Purpose codes assigned to an individual subitem apply only to that subitem. | |

|  | | Client: | ExxonMobil | CENTRIFUGAL PUMP SUMMARY SHEET | | | Rev. | |
|---|--|-----------------------|---------------------------|--------------------------------|----------------------|------------------|----------------|--|
| | | Project: | BAYTOWN GOLD | | | | DATE | |
| | | Project No.: | 216119C | | | | | |
| | | MR No.: | | | | | | |
| | | Equipment Tag: | | | | | | |
| | | Equipment Service: | | | | | | |
| | | Doc. No. | | | | | | |
| Sl. No. | Description | Purchaser requirement | Purchaser requirement UOM | Supplier offered value | Supplier offered UOM | Additional notes | | |
| 1 | General | | | | | | | |
| 2 | Conformity assessment system (CAS) level : | D | | D | | | | |
| 3 | Tag number : | input data | | input data | | | | |
| 4 | Tag description : | input data | | input data | | | | |
| 5 | Applicable to : | purchase | | select | | | | |
| 6 | Units : | select | | select | | | | |
| 7 | Manufacturer : | input data | | input data | | | | |
| 8 | Manufacturing Location : | input data | | input data | | | | |
| 9 | Pump model and size : | input data | | input data | | | | |
| 10 | Number of stages : | input data | | input data | | | | |
| 11 | Number of pump units : | input data | | input data | | | | |
| 12 | Service type : | select | | select | | | | |
| 13 | Number of starts : | input data | select | input data | select | | | |
| 14 | Instantaneous start-up : | select | | select | | | | |
| 15 | Pump operational mode : | select | | select | | | | |
| 16 | Pump start-up mode : | select | | select | | | | |
| 17 | Individual pump flow control : | select | | select | | | | |
| 18 | Site data | | | | | | | |
| 19 | Project country : | input data | | input data | | | | |
| 20 | Project region : | input data | | input data | | | | |
| 21 | Plant environmental location : | select | | select | | | | |
| 22 | Equipment location : | outdoors | | select | | | | |
| 23 | Location climate : | unheated | | select | | | | |
| 24 | Location sunlight protection : | direct sunlight | | select | | | | |
| 25 | Mounting : | grade | | select | | | | |
| 26 | Special weather protection : | select | | select | | | | |
| 27 | Elevation : | input data | select | input data | select | | Per GP03-09-01 | |
| 28 | Barometer : | input data | select | input data | select | | | |
| 29 | Maximum ambient temperature : | input data | select | input data | select | | | |
| 30 | Minimum ambient temperature : | input data | select | input data | select | | | |
| 31 | Maximum relative humidity : | input data | % | input data | % | | | |
| 32 | Minimum relative humidity : | input data | % | input data | % | | | |
| 33 | Unusual conditions : | select | | select | | | | |
| 34 | Floating applications motion design criteria : | input data | | input data | | | | |
| 35 | Hazardous area certification standard : | select | | select | | | | |
| 36 | Explosion hazard classification (IEC) : | select | | select | | | | |
| 37 | Explosion gas group (IEC) : | select | | select | | | | |
| 38 | Temperature class (IEC) : | select | | select | | | | |
| 39 | Explosion hazard classification (NFPA) : | select | | select | | | | |
| 40 | Explosion gas group (NFPA) : | select | | select | | | | |
| 41 | Temperature class (NFPA) : | select | | select | | | | |
| 42 | Ignition hazard assessment : | select | | select | | | | |
| 43 | Utility conditions | | | | | | | |
| 44 | Drivers voltage : | input data | V | input data | V | | | |
| 45 | Drivers phase : | 3 | | select | | | | |
| 46 | Driver frequency : | select | Hz | select | Hz | | | |
| 47 | Heating medium : | select | | select | | | | |
| 48 | Heating voltage : | input data | V | input data | V | | | |
| 49 | Heating phase : | 1 | | select | | | | |
| 50 | Heating frequency : | select | Hz | select | Hz | | | |
| 51 | Heating steam minimum temperature : | input data | select | input data | select | | | |
| 52 | Heating steam maximum temperature : | input data | select | input data | select | | | |
| 53 | Heating steam minimum pressure : | input data | select | input data | select | | | |
| 54 | Heating steam maximum pressure : | input data | select | input data | select | | | |
| 55 | Cooling water maximum inlet temperature : | input data | select | input data | select | | | |
| 56 | Cooling water design temperature : | input data | select | input data | select | | | |
| 57 | Cooling water maximum inlet pressure : | input data | select | input data | select | | | |
| 58 | Cooling water design pressure : | input data | select | input data | select | | | |
| 59 | Cooling water type : | input data | | input data | | | | |
| 60 | Fouling factor : | input data | select | input data | select | | | |
| 61 | Cooling water chloride concentration : | input data | ppm | input data | ppm | | | |
| 62 | Instrument air minimum pressure : | input data | select | input data | select | | | |
| 63 | Instrument air maximum pressure : | input data | select | input data | select | | | |
| 64 | Liquid characteristics | | | | | | | |
| 65 | Liquid name : | input data | | input data | | | | |
| 66 | Liquid type : | select | | select | | | | |
| 67 | Liquid respiratory exposure class: | | | | | | | |
| 68 | Vapor pressure at rated temperature : | input data | select | input data | select | | | |
| 69 | Vapor pressure maximum : | input data | select | input data | select | | | |
| 70 | Vapor pressure minimum : | input data | select | input data | select | | | |
| 71 | Relative density rated : | input data | | input data | | | | |
| 72 | Relative density maximum : | input data | | input data | | | | |
| 73 | Relative density minimum : | input data | | input data | | | | |
| 74 | Specific heat rated : | input data | select | input data | select | | | |
| 75 | Specific heat maximum : | input data | select | input data | select | | | |
| 76 | Specific heat minimum : | input data | select | input data | select | | | |
| 77 | Viscosity rated : | input data | select | input data | select | | | |
| 78 | Viscosity maximum : | input data | select | input data | select | | | |
| 79 | Viscosity minimum : | input data | select | input data | select | | | |
| 80 | Corrosive constituents : | input data | | input data | | | | |
| 81 | Erosive constituents : | input data | | input data | | | | |
| 82 | H2S concentration : | input data | ppm | input data | ppm | | | |
| 83 | Chloride concentration : | input data | ppm | input data | ppm | | | |
| 84 | Total dissolved salts : | input data | ppm | input data | ppm | | | |
| 85 | Particulate size : | input data | um | input data | um | | | |
| 86 | Particulate concentration : | input data | ppm | input data | ppm | | | |
| 87 | Dissolved Gases (Yes/No) | input data | | input data | | | | |
| 88 | Operating conditions | | | | | | | |
| 89 | NPSHA datum : | select | | select | | | | |
| 90 | Flow rated : | input data | select | input data | select | | | |
| 91 | Flow normal : | input data | select | input data | select | | | |

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| | | MR No.: | | | | |
| | | Equipment Tag: | | | | |
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| 92 | Flow maximum : | input data | select | input data | select | |
| 93 | Flow minimum : | input data | select | input data | select | |
| 94 | Flow alternative condition : | input data | select | input data | select | |
| 95 | NPSHA rated : | input data | select | input data | select | |
| 96 | NPSHA normal : | input data | select | input data | select | |
| 97 | NPSHA maximum : | input data | select | input data | select | |
| 98 | NPSHA minimum : | input data | select | input data | select | |
| 99 | NPSHA alternative condition : | input data | select | input data | select | |
| 100 | NPSHA at 120 % of rated flow : | input data | select | input data | select | |
| 101 | Pumping temperature rated : | input data | select | input data | select | |
| 102 | Pumping temperature normal : | input data | select | input data | select | |
| 103 | Pumping temperature maximum : | input data | select | input data | select | |
| 104 | Pumping temperature minimum : | input data | select | input data | select | |
| 105 | Pumping temperature alternative condition : | input data | select | input data | select | |
| 106 | MDMT (Deg F) | input data | select | input data | select | |
| 107 | Discharge pressure rated : | input data | select | input data | select | |
| 108 | Discharge pressure maximum : | input data | select | input data | select | |
| 109 | Discharge pressure alternative condition : | input data | select | input data | select | |
| 110 | Estimated Shutoff pressure | input data | select | input data | select | |
| 111 | Suction pressure rated : | input data | select | input data | select | |
| 112 | Suction pressure normal : | input data | select | input data | select | |
| 113 | Suction pressure maximum : | input data | select | input data | select | |
| 114 | Suction pressure minimum : | input data | select | input data | select | |
| 115 | Suction pressure alternative condition : | input data | select | input data | select | |
| 116 | Differential pressure rated : | input data | select | input data | select | |
| 117 | Differential pressure alternative condition : | input data | select | input data | select | |
| 118 | Differential head rated : | input data | select | input data | select | |
| 119 | Differential head alternative condition : | input data | select | input data | select | |
| 120 | Hydraulic power : | input data | select | input data | select | |
| 121 | Performance | | | | | |
| 122 | Proposal curve number : | input data | | input data | | |
| 123 | Impeller diameter rated : | input data | select | input data | select | |
| 124 | Impeller diameter maximum : | input data | select | input data | select | |
| 125 | Impeller diameter minimum : | input data | select | input data | select | |
| 126 | Rated speed : | input data | rpm | input data | rpm | |
| 127 | Rated power : | input data | select | input data | select | |
| 128 | Efficiency : | input data | % | input data | % | |
| 129 | Proposal curve BEP flow (at rated impeller diameter) : | input data | select | input data | select | |
| 130 | Capacity Ratio (Rated Flow as % of BEP Flow) | input data | % | input data | % | |
| 131 | Minimum flow thermal : | input data | select | input data | select | |
| 132 | Minimum flow stable : | input data | select | input data | select | |
| 133 | Start of preferred operating region : | input data | select | input data | select | |
| 134 | End of preferred operating region : | input data | select | input data | select | |
| 135 | Start of allowable operating region : | input data | select | input data | select | |
| 136 | End of allowable operating region : | input data | select | input data | select | |
| 137 | Maximum head at rated impeller : | input data | select | input data | select | |
| 138 | Head rise to Shut off | input data | % | input data | % | |
| 139 | Shut off Pressure at rated impeller dia | input data | select | input data | select | |
| 140 | Maximum power at rated impeller : | input data | select | input data | select | |
| 141 | Head increase due to impeller change | input data | % | input data | % | |
| 142 | NPSH3 at rated flow : | input data | select | input data | select | |
| 143 | NPSH3 at EOC | input data | select | input data | select | |
| 144 | NPSHA-NPSH3 margin at rated flow : | ≥ 3 | ft | input data | select | |
| 145 | NPSHA-NPSH3 margin at EOC : | ≥ 0 | ft | input data | select | |
| 146 | Specific speed : | input data | select | input data | select | |
| 147 | Suction-specific speed : | input data | select | input data | select | |
| 148 | Maximum allowable sound pressure level : | input data | dB(A) | input data | dB(A) | Per GP 02-01-01 |
| 149 | Maximum allowable sound power level : | input data | dB(A) | input data | dB(A) | Per GP 02-01-01 |
| 150 | Construction | | | | | |
| 151 | API pump type : | select | | select | | |
| 152 | Mounting : | select | | select | | |
| 153 | Casing type : | select | | select | | |
| 154 | Casing Split (Axial / Radial) | select | | select | | |
| 155 | Impeller type : | select | | select | | |
| 156 | Rotation (viewed from coupling end) : | select | | select | | |
| 157 | Component balance to ISO 21940-11, Grade G1.0 : | not required | | select | | |
| 158 | Impeller number of vanes : | input data | | input data | | |
| 159 | Suction size : | input data | in. | input data | in. | |
| 160 | Suction facing : | select | | select | | |
| 161 | Suction rating : | select | | select | | |
| 162 | Suction position : | select | | select | | |
| 163 | Discharge size : | input data | in. | input data | in. | |
| 164 | Discharge facing : | select | | select | | |
| 165 | Discharge rating : | select | | select | | |
| 166 | Discharge position : | select | | select | | |
| 167 | Nozzle loads : | as per API | | select | | |
| 168 | Auxiliary process-liquid piping construction : | socket welded | | select | | |
| 169 | Connection design approval prior to fabrication : | not required | | select | | |
| 170 | Pressure casing drain size : | input data | in. | input data | in. | |
| 171 | Pressure casing vent size : | input data | in. | input data | in. | |
| 172 | Drain valve supplied by : | vendor | | select | | |
| 173 | Vent valve supplied by : | vendor | | select | | |
| 174 | Pump warm-up or cooldown line : | select | | select | | |
| 175 | Machined and studded connections : | select | | select | | |
| 176 | Pipe threads specification : | select | | select | | |
| 177 | Case pressure rating maximum allowable working temperature : | input data | select | input data | select | |
| 178 | Case pressure rating maximum allowable working pressure : | input data | select | input data | select | |

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| | | Equipment Service: | | | | | | |
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| 179 | Bearing housing cooling method : | fan | | fan | | | | |
| 180 | Cooling water piping plan : | not applicable | | select | | | | |
| 181 | Heat tracing and/or insulation : | not required | | select | | | | |
| 182 | Purpose of insulation : | select | | select | | | | |
| 183 | Extent of heat tracing and insulation : | None by Vendor. By Purchaser only. | | input data | | | | |
| 184 | Heat tracing and/or insulation supplied and installed by : | purchaser | | select | | | | |
| 185 | Heating tracing and/or insulation specification : | not applicable | | select | | | | |
| 186 | Total package estimated mass : | input data | select | input data | select | | | |
| 187 | Shaft flexibility index reported by vendor : | select | | select | | | | |
| 188 | Shaft flexibility index (OH2 pumps only) : | input data | | input data | | | | |
| 189 | OH3 back-pullout lifting device : | select | | select | | | | |
| 190 | Shrink fit limited movement impellers : | select | | select | | | | |
| 191 | Vertical pump construction | | | | | | | |
| 192 | Head maximum allowable working pressure : | input data | select | input data | select | | | |
| 193 | Column maximum allowable working pressure : | input data | select | input data | select | | | |
| 194 | Bowl maximum allowable working pressure : | input data | select | input data | select | | | |
| 195 | Suction barrel or can maximum allowable working pressure : | input data | select | input data | select | | | |
| 196 | Pump thrust bearing location : | in pump | | select | | | | |
| 197 | Suction strainer type : | input data | | input data | | | | |
| 198 | Level control by : | select | | select | | | | |
| 199 | Line shaft connection : | select | | select | | | | |
| 200 | Line shaft configuration : | select | | select | | | | |
| 201 | Line shaft bearing lube : | pumpage | | select | | | | |
| 202 | Line shaft bearing quantity : | input data | | input data | | | | |
| 203 | Hardened sleeves under line shaft bearings : | select | | select | | | | |
| 204 | Vertical pump sump dimensions | | | | | | | |
| 205 | Grade (underside of pump mounting plate or top of foundation) elevation : | input data | select | input data | select | | | |
| 206 | Low liquid level elevation : | input data | select | input data | select | | | |
| 207 | Sump floor elevation : | input data | select | input data | select | | | |
| 208 | Sump diameter : | input data | select | input data | select | | | |
| 209 | Grade to top of pump discharge connection dimension : | input data | select | input data | select | | | |
| 210 | Pump length (grade to underside of pump inlet bell or strainer dimension) : | input data | select | input data | select | | | |
| 211 | Grade to first stage impeller centerline dimension : | input data | select | input data | select | | | |
| 212 | Grade to liquid minimum submergence level dimension : | input data | select | input data | select | | | |
| 213 | Bearings and lubrication | | | | | | | |
| 214 | Radial bearing type : | rolling element | | select | | | | |
| 215 | Thrust type bearing : | rolling element | | select | | | | |
| 216 | Review and acceptance of thrust bearing size : | not required | | select | | | | |
| 217 | Rolling element bearing life calculations : | required | | select | | | | |
| 218 | Lubrication : | select | | select | | | | |
| 219 | Oil viscosity ISO grade : | input data | ISO VG | input data | ISO VG | | | |
| 220 | Oil type : | select | | select | | | | |
| 221 | Grease type : | not applicable | | input data | | | | |
| 222 | Grease grade : | not applicable | | input data | | | | |
| 223 | Bearing housing sealing type/model : | Inpro seals | | input data | | | | |
| 224 | Oil mist reclassifiers supplied by : | select | | select | | | | |
| 225 | Materials | | | | | | | |
| 226 | Annex H class : | select | | select | | | | |
| 227 | Minimum design metal temperature : | input data | select | input data | select | | | |
| 228 | Reduced-hardness materials : | select | | select | | | | |
| 229 | Applicable hardness standard : | select | | select | | | | |
| 230 | Special coating for impellers and other wetted parts : | select | | select | | | | |
| 231 | Case and case cover material : | input data | | input data | | | | |
| 232 | Nonwetted pressure-retaining fasteners material : | input data | | input data | | | | |
| 233 | Diffuser material : | input data | | input data | | | | |
| 234 | Impeller material : | input data | | input data | | | | |
| 235 | Inducer material : | input data | | input data | | | | |
| 236 | Impeller wear component type : | select | | select | | | | |
| 237 | Impeller wear component material : | input data | | input data | | | | |
| 238 | Impeller wear component hardness : | input data | select | input data | select | | | |
| 239 | Case wear ring material : | input data | | input data | | | | |
| 240 | Wear parts hardnesses : | input data | select | input data | select | | | |
| 241 | Shaft material : | input data | | input data | | | | |
| 242 | Auxiliary process-liquid lines, fittings and other connections to casing, including seal plans material : | select | | select | | | | |
| 243 | Materials (additional for vertical pumps) | | | | | | | |
| 244 | Suction barrel/can material : | input data | | input data | | | | |
| 245 | Discharge head material : | input data | | input data | | | | |
| 246 | Discharge column material : | input data | | input data | | | | |
| 247 | Head column material : | input data | | input data | | | | |
| 248 | Discharge elbow and pipe material : | input data | | input data | | | | |
| 249 | Bowl/casing material : | input data | | input data | | | | |
| 250 | Bellmouth/suction cover material : | input data | | input data | | | | |
| 251 | Strainer material : | input data | | input data | | | | |
| 252 | Line shaft material : | input data | | input data | | | | |
| 253 | Shaft enclosing tube material : | input data | | input data | | | | |
| 254 | Bowl shaft material : | input data | | input data | | | | |
| 255 | Process wetted fasteners material : | input data | | input data | | | | |
| 256 | Bearing retainer or spider material : | input data | | input data | | | | |
| 257 | Line shaft bearing material : | input data | | input data | | | | |
| 258 | Line shaft hard facing material : | input data | | input data | | | | |
| 259 | Line shaft sleeves material : | input data | | input data | | | | |
| 260 | Bearing lubrication lines material : | input data | | input data | | | | |
| 261 | Bowl bearing material : | input data | | input data | | | | |
| 262 | Material inspection | | | | | | | |
| 263 | Material inspection requirements : | select | | select | | | | |
| 264 | Impact test as per : | other | | select | | | GP 18-10-01 | |

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| 265 | Hardness testing of parts, welds and heat-affected zones : | select | | select | | | |
| 266 | Additional surface/sub-surface examination : | select | | select | | | |
| 267 | Additional surface/sub-surface examination for : | input data | | input data | | | |
| 268 | Additional surface magnetic particle or liquid penetrant examination : | select | | select | | | |
| 269 | Additional sub-surface ultrasonic or radiographic examination : | select | | select | | | |
| 270 | Additional components PMI tested : | input data | | input data | | | |
| 271 | Repair and heat treatment records : | required | | select | | | |
| 272 | Baseplate | | | | | | |
| 273 | API baseplate number : | select | | select | | | |
| 274 | Sized to accommodate seal piping systems : | required | | select | | | |
| 275 | Baseplate type : | full sloped deck plate inside base plate / grouted | | select | | | |
| 276 | Mounting : | four point mount | | select | | | |
| 277 | Stainless steel plate, thickness 0.2 in. (5 mm) minimum, under all pump feet : | select | | select | | | |
| 278 | Foundation/ Anchor bolts, Nuts & Gaskets | input data | | input data | | | |
| 279 | Earthing bosses located diagonally opposite each other on baseplate and lifting lugs | input data | | input data | | | |
| 280 | Mechanical seal | | | | | | |
| 281 | API Standard 682 mechanical seal code : | input data | | input data | | | |
| 282 | Mechanical Seal Make | input data | | input data | | | |
| 283 | API Standard 682 data sheet attached : | select | | select | | | |
| 284 | Mechanical seal primary plan : | select | | select | | | |
| 285 | Mechanical seal primary plan construction : | select | | select | | | |
| 286 | Mechanical seal secondary plan : | select | | select | | | |
| 287 | Cooling Water Piping Plan | input data | | input data | | | |
| 288 | Tubing fittings manufacturer : | input data | | input data | | | |
| 289 | Additional central flush port : | select | | select | | | |
| 290 | Heating jacket required : | select | | select | | | |
| 291 | Static sealing pressure maximum : | input data | select | input data | select | | |
| 292 | Static sealing pressure minimum : | input data | select | input data | select | | |
| 293 | Dynamic sealing pressure maximum : | input data | select | input data | select | | |
| 294 | Dynamic sealing pressure minimum : | input data | select | input data | select | | |
| 295 | Seal design temperature maximum : | input data | select | input data | select | | |
| 296 | Seal design temperature minimum : | input data | select | input data | select | | |
| 297 | Coupling | | | | | | |
| 298 | Coupling specification : | API Standard 610 | | API Standard 610 | | | |
| 299 | Coupling manufacturer : | input data | | input data | | | |
| 300 | Coupling type/model/size : | input data | | input data | | | |
| 301 | Coupling rating (power/100 rpm) : | input data | select | input data | select | | |
| 302 | Service Factor / Spacer Length | input data | | input data | | | |
| 303 | Coupling components balance grade : | select | | select | | | |
| 304 | Coupling with hydraulic fit : | not required | | select | | | |
| 305 | Coupling with proprietary clamping device : | not required | | not required | | | |
| 306 | Coupling guard specification : | input data | | input data | | | |
| 307 | Coupling and exposed shaft guard material : | sparking-resistance material | | input data | | | |
| 308 | Driver and gear | | | | | | |
| 309 | Driver type : | electric motor | | select | | | |
| 310 | Driver specification : | input data | | input data | | | |
| 311 | Driver manufacturer : | input data | | input data | | | |
| 312 | Area Classification | input data | | input data | | | |
| 313 | Driver rating : | Table 12 (motor) | | select | | | |
| 314 | Driver sized for testing on water : | yes - full curve | | select | | | |
| 315 | Driver frame or model : | input data | | input data | | | |
| 316 | Canopy for motors | input data | | input data | | | |
| 317 | Motor Terminal Box with suitable cable entry | input data | | input data | | | |
| 318 | Space heater | input data | | input data | | | |
| 319 | Driver nameplate power : | input data | select | input data | select | | |
| 320 | Driver nominal speed : | input data | rpm | input data | rpm | | |
| 321 | Driver rated load speed : | input data | rpm | input data | rpm | | |
| 322 | Driver lubrication method : | flood | | select | | | |
| 323 | Driver radial bearing type : | select | | select | | | |
| 324 | Driver thrust bearing type : | select | | select | | | |
| 325 | Motor starting method : | direct-on-line | | select | | | |
| 326 | Adjustable speed drive : | not required | | select | | | |
| 327 | Source of adjustable speed drive : | select | | select | | | |
| 328 | Required trip speed : | input data | rpm | input data | rpm | | |
| 329 | Gear : | not required | | select | | | |
| 330 | Gear specification : | input data | | input data | | | |
| 331 | Gear/adjustable speed drive manufacturer : | input data | | input data | | | |
| 332 | Instrumentation | | | | | | |
| 333 | Accelerometers : | select | | select | | | |
| 334 | Number of accelerometers : | 1 per bearing housing | | input data | | | |
| 335 | Accelerometers mounting location : | input data | | input data | | | |
| 336 | Threaded provision for mounting accelerometers only : | select | | select | | | |
| 337 | Flat surface provision for mounting accelerometers only : | select | | select | | | |
| 338 | Vibration probes : | select | | select | | | |
| 339 | Number of vibration probes per radial bearing : | input data | | input data | | | |
| 340 | Vibration probes mounting location : | input data | | input data | | | |
| 341 | Threaded provision for mounting vibration probe only : | select | | select | | | |
| 342 | Flat surface provision for mounting vibration probes only : | select | | select | | | |
| 343 | One-event-per-revolution probe (key phasor) : | not required | | select | | | |
| 344 | Temperature probes : | select | | select | | | |
| 345 | Number of temperature probes per radial bearing : | 1 per radial bearing | | input data | | | |
| 346 | Temperature probes mounting location : | input data | | input data | | | |
| 347 | Provision for mounting temperature probes only : | select | | select | | | |
| 348 | Temperature gauges (with thermowells) : | select | | select | | | |
| 349 | Monitors and cables supplied by : | purchaser | | select | | | |

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| | | MR No.: | | | | | | |
| | | Equipment Tag: | | | | | | |
| | | Equipment Service: | | | | | | |
| | | Doc. No. | | | | | | |
| Sl. No. | Description | Purchaser requirement | Purchaser requirement UOM | Supplier offered value | Supplier offered UOM | Additional notes | | |
| 350 | Testing | | | | | | | |
| 351 | Hydrostatic test of VS6/VS7 bowls and column : | select | | select | | | | |
| 352 | Residual unbalance test method : | select | | select | | | | |
| 353 | Cleanliness prior to final assembly : | select | | select | | | | |
| 354 | Nozzle load test : | select | | select | | | | |
| 355 | Structural resonance test : | not required | | select | | | | |
| 356 | Driver to be used for testing : | shop | | select | | | | |
| 357 | Notification of successful shop performance test : | required | | select | | | | |
| 358 | Performance test NPSHA limited to 110 % site NPSHA : | select | | select | | | | |
| 359 | Performance test at minimum submergence for vertical submerged pumps : | required | | select | | | | |
| 360 | Vibration test measurement locations : | select | | select | | | | |
| 361 | Retest after final head adjustment : | required | | select | | | | |
| 362 | NPSH test : | select | | select | | | | |
| 363 | NPSH test type : | valve suppression | | select | | | | |
| 364 | NPSH test specification : | select | | select | | | | |
| 365 | Complete unit test : | no | | select | | | | |
| 366 | Duration of complete unit test : | input data | hours | input data | hours | | | |
| 367 | Sound level test : | required | | select | | | | |
| 368 | Auxiliary equipment test : | required | | select | | | | |
| 369 | Auxiliary equipment included in test : | input data | | input data | | | | |
| 370 | Bearing housing resonance test : | not required | | select | | | | |
| 371 | Disassembly after test : | not required | | not required | | | | |
| 372 | Hydrodynamic bearings removal and inspection after test : | select | | select | | | | |
| 373 | Surface preparation and painting | | | | | | | |
| 374 | Surface preparation and painting specification : | Manufacturer's Standard | | input data | | | | |
| 375 | Other purchaser requirements | | | | | | | |
| 376 | VFD steady state forced response analysis : | not required | | select | | | | |
| 377 | Transient forced response analysis : | not required | | select | | | | |
| 378 | Torsional analysis report : | not required | | select | | | | |
| 379 | Lateral analysis : | not required | | select | | | | |
| 380 | Spare parts | | | | | | | |
| 381 | Commissioning and start-up spares quotation : | required | | required | | | | |
| 382 | Normal maintenance spares quotation : | required | | not required | | | | |
| 383 | Two-year operating spares quotation : | not required | | not required | | | | |
| 384 | Capital spares quotation : | not required | | select | | | | |
| 385 | Spare rotor storage orientation : | select | | select | | | | |
| 386 | Shipping and storage container for vertical storage of spare rotor : | select | | select | | | | |
| 387 | Inert gas purge for spare rotor container : | select | | select | | | | |
| 388 | Shipment | | | | | | | |
| 389 | Preservation and packing specification : | Manufacturer's Standard | | input data | | | | |
| 390 | Preservation and packing suitable for : | select | | select | | | | |
| 391 | Export boxing : | select | | select | | | | |
| 392 | Outdoor storage : | required - for 6 months | | select | | | | |
| 393 | Guarantee | | | | | | | |
| 394 | Pump Test tolerances : | input data | | input data | | | | |
| 395 | Mechanical warranty and workmanship | input data | | input data | | | | |
| 396 | Noise level for complete package | input data | | input data | | | | |
| 397 | Utility & Power consumption | input data | | input data | | | | |
| 398 | Miscellaneous | | | | | | | |
| 399 | Supervision for Erection at per-diem rate with number of days | input data | | input data | | | | |
| 400 | Supervision for Pre Commissioning and Commissioning at per-diem rate with number of days | input data | | input data | | | | |
| 401 | Proven Track Record (PTR) | | | | | | | |
| 402 | Proven Track Record (PTR) | input data | | input data | | | | |
| 403 | Dimensions | | | | | | | |
| 404 | Skid Dimensions (LxWxH) | input data | | input data | | | | |
| 405 | Complete Package weight (lb) | input data | | input data | | | | |
| 406 | Maintenance weight (lb) | input data | | input data | | | | |



Client: ExxonMobil
Project: BAYTOWN GOLD, Texas
Document: Spare Part List

Rev: 0

Spare Parts also include parts and assemblies normally used or consumed during installation of equipment, cleaning, flushing, and inspection.

Spare part philosophy:

The vendor is required to propose innovative means to reduce the necessity for OWNER to maintain quantities of spare parts inventory during the operational life of the equipment.

All Erection & Commissioning Spares shall be in vendor scope of supply. Capital Spares and Insurance spares shall be quoted as Optional with standard lead time (Not project lead time) as per below philosophy.

Vendor to note that below spares philosophy include minimum spares and vendor can recommend additional spares which are necessary for the optimal functioning of Pump package:

| ITEM | SPARE PART | Quantity Required | | | | | | | Notes |
|--|--|--|---|---|---|---|---|---|-------|
| | | (BASED ON THE NUMBER OF INSTALLED ITEMS) | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Section B: Mechanical – Rotary | | | | | | | | | |
| B1 | Centrifugal Pump (Horizontal / Inline – API 610 / General Purpose Process) | | | | | | | | |
| | MECHANICAL | | | | | | | | |
| | PUMP (Single Pump Stage) | | | | | | | | |
| 1 | Set of Impellers (Full Dia) | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 2 | Seat of Wear Plate (For Semi-open / open impellers) | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 3 | Set of Case wearing rings | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 4 | Set of Impeller wearing rings | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 5 | Set of Shaft with keys | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 6 | Impeller Nut with washer | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 7 | Set of Interstage Bushings | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 8 | Set of Interstage Shaft sleeves | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 9 | Set of Gaskets, O-rings | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 10 | Set of Mechanical Seals along with Shaft Sleeves under seals with gland plates for Cartridge seals / without gland plate for other seals | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 11 | Set of Mech. Seal Parts (as Mech. Seal Repair Kit) | 1 | 1 | 2 | 2 | 2 | 2 | 2 | |
| 12 | Set of gland packings | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 13 | Set of Labyrinths / Isolators for bearing housing | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 14 | Set of Oil Seals for bearing housing | 1 | 2 | 3 | 4 | 4 | 4 | 4 | |
| 15 | Throat Bush | 1 | 1 | 1 | 2 | 2 | 2 | 2 | |
| 16 | Set of bearings (Non drive end side) | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 17 | Set of bearings (Drive end side) | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 18 | Set of Bearing Lock Washer | 1 | 1 | 2 | 2 | 2 | 2 | 2 | |
| 19 | Bearing Nut | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 20 | Deflector | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 21 | Set of flexible element of coupling [#] | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 22 | Coupling Complete Set (including Fasteners) [#] | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 23 | Constant Oil Levellers / Pressure- compensated (or balanced) Constant Level Lubricator | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| Mandatory Spares required for other equipment / items within package (e.g. Electrical, Steam Turbine, Gear box, Lube oil system, Instrumentation, piping etc.) refer to respective section/document for details. | | | | | | | | | |

ANNEXURE E: SPARE PART LIST

| ITEM | SPARE PART | Quantity Required | | | | | | | Notes |
|-----------|---|--|---|---|---|---|---|---|-------|
| | | (BASED ON THE NUMBER OF INSTALLED ITEMS) | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| B2 | Centrifugal Horizontal Pumps (Multistage) | | | | | | | | |
| | MECHANICAL | | | | | | | | |
| | Pump | | | | | | | | |
| 1 | Set of impellers | 1 | 1 | 2 | 2 | 2 | 2 | 2 | |
| 2 | Set of case wearing rings | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 3 | Set of Impeller wearing rings | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 4 | Set of Intermediate bushings | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 5 | Set of Balance Drum Sleeve (Bushing) | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 6 | Set of Gaskets, O-rings | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 7 | Set of Shaft with keys | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 8 | Set of Mechanical Seals along with Shaft Sleeves under seals with gland plates for Cartridge seals without gland plate for other seals | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 9 | Set of Mech. Seal Parts (as Mech. Seal Repair Kit) | 1 | 1 | 2 | 2 | 2 | 2 | 2 | |
| 10 | Set of Labyrinths / Isolators for bearing housing | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 11 | Set of Oil Seals for bearing housing | 1 | 2 | 3 | 4 | 4 | 4 | 4 | |
| 12 | Throat Bush | 1 | 1 | 1 | 2 | 2 | 2 | 2 | |
| 13 | Set of Bearings, NDE | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 14 | Set of Bearings, DE | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 15 | Lock Nut | 1 | 1 | 1 | 2 | 2 | 2 | 2 | |
| 16 | Deflector | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 17 | Set of Flexible elements of Coupling [#] | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 18 | Coupling Elements- Complete Set (including Fasteners) [#] | 1 | 2 | 2 | 2 | 2 | 2 | 2 | |
| 19 | Constant Oil Levellers / Pressure- compensated (or balanced) Constant Level Lubricator | 2 | 2 | 2 | 2 | 2 | 4 | 4 | |
| | Additional Spares for Axially Split Pumps | | | | | | | | |
| 1 | Complete Rotor assembly dynamically balanced (including balance drum) | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| | Additional Spares for Radially Split Double Case Pumps | | | | | | | | |
| 1 | Complete replaceable inner case element consisting of all rotating & stationary hydraulic elements (with permanent storage container including necessary fixture to store the rotor in vertical position) | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| B3 | High Speed Pump, OH6 | | | | | | | | |
| | MECHANICAL | | | | | | | | |
| | Pumps | | | | | | | | |
| 1 | Impeller (Rated Dia.) | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 2 | Impeller Tab Washer | 1 | 2 | 3 | 4 | 5 | 7 | 7 | |
| 3 | Set of High Speed Shaft Assy. with keys | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 4 | Low Speed Shaft Assembly (Intermediate/Idler) with keys | 1 | 1 | 1 | 1 | 2 | 2 | 2 | |
| 5 | Shaft Spacer | 1 | 1 | 1 | 1 | 2 | 2 | 2 | |
| 6 | Set of Gaskets | 2 | 2 | 2 | 2 | 3 | 3 | 3 | |
| 7 | Sets of O-ring repair kit | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 8 | Gearbox oil seals | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 9 | Mechanical Seal for Gear Box Side (Complete seal with sleeve and gland plate) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 10 | Seal Rotating Face for Gear Box Side | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 11 | Mechanical Seal for Process Side | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 12 | Seal rotating Face for process Side | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 13 | Ball bearing for Low Speed Shaft (lower) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 14 | Ball bearing for Low Speed Shaft (upper) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 15 | Journal bearing for High Speed Shaft (lower) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 16 | Journal bearing for High Speed Shaft (upper) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 17 | Coupling Complete Set (including Fasteners) when applicable [#] | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 18 | Oil Filter cartridge | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 19 | Complete gearbox (fully assembled with coupling) | 1 | 1 | 1 | 1 | 2 | 2 | 2 | |

ANNEXURE E: SPARE PART LIST

| ITEM | SPARE PART | Quantity Required | | | | | | | Notes |
|-----------|--|--|---|---|---|---|---|---|-------|
| | | (BASED ON THE NUMBER OF INSTALLED ITEMS) | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 20 | Constant Oil Levellers / Pressure- compensated (or balanced) Constant Level Lubricator | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| | Addnl. Spares with SINGLE Seal | | | | | | | | |
| 1 | Set of throttle bushing | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 2 | Shaft sleeve | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 3 | Set of Mech. Seal (Complete Assy., Process Side only) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 4 | Set of Mech. Seal Parts (as Mech. Seal Repair Kit for Process Side Only) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| | Addnl. Spares with DOUBLE/TANDEM Seal | | | | | | | | |
| 1 | Shaft sleeve (lower) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 2 | Shaft sleeve (upper) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 3 | Set of Mech. Seal (Complete Assy., Process Lower Side) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 4 | Set of Mech. Seal (Complete Assy., Process Upper Side) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 5 | Seal Rotating Face Process Lower side | 1 | 1 | 1 | 2 | 2 | 3 | 3 | |
| 6 | Seal Rotating Face Process Upper side | 1 | 1 | 1 | 2 | 2 | 3 | 3 | |
| 7 | Set of Mechanical Seal Parts (as Mech. Seal Repair Kit for Process Lower Side Only) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 8 | Set of Mechanical Seal Parts (as Mech. Seal Repair Kit for Process Upper Side Only) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| B4 | Rotary Pump | | | | | | | | |
| | MECHANICAL | | | | | | | | |
| | Pumps | | | | | | | | |
| 1 | Set of Rotors | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 2 | Casing Insert (Stator) [only for screw pump] | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 3 | Set of Bearings (Drive End) - Each Screw | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 4 | Set of Bearings (Non Drive End) - Each Screw | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 5 | Set of Gaskets, O - rings | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 6 | Set of Labyrinths | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 7 | Set of Oil Seals | 1 | 2 | 3 | 4 | 4 | 4 | 4 | |
| 8 | Set of Mechanical Seals along with Shaft Sleeves under seals with gland plates for Cartridge seals / without gland plate for other seals | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 9 | Set of Mech. Seal Parts (as Mech. Seal Repair Kit) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 10 | Set of Gland Packings (Where Applicable) | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 11 | Coupling Complete Set (including Fasteners) [#] | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| B5 | Gear Box (Special / General Purpose): | | | | | | | | |
| | MECHANICAL | | | | | | | | |
| 1 | Set of High Speed/Low Speed Gears & Shaft Assembly with keys | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 2 | Set of Radial Bearings | 1 | 2 | 3 | 4 | 4 | 4 | 4 | |
| 3 | Set of Thrust Bearings | 1 | 2 | 3 | 4 | 4 | 4 | 4 | |
| 4 | Set of Labyrinths, Oil Seals | 1 | 2 | 3 | 4 | 4 | 4 | 4 | |
| 5 | Set of all Gaskets, O-rings | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 6 | Complete bare lube oil pump (if integral with gear box) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| B6 | Lube Oil / Seal Oil System, Cooling Water System | | | | | | | | |
| | Lube Oil Pump / Cooling Water Pump Centrifugal (Main + Stand By + Emergency) | | | | | | | | |
| 1 | Complete bare pump assembly excluding driver couplings & base plate | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 2 | Set of bearings | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 3 | Set of Mechanical Seals | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 4 | Set of Impeller Wear Rings | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 5 | Set of Casing Wear Rings | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 6 | Set of Gaskets, O - rings | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 7 | Complete set of coupling of each type [#] | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 8 | Constant Oil Levellers / Pressure- compensated (or balanced) Constant Level Lubricator | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |

ANNEXURE E: SPARE PART LIST

| ITEM | SPARE PART | Quantity Required | | | | | | | Notes |
|-----------|--|--|---|---|---|---|---|---|-------|
| | | (BASED ON THE NUMBER OF INSTALLED ITEMS) | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| | Lube Oil Pump / Cooling water pump Rotary (Main + Stand By + Emergency) | | | | | | | | |
| 1 | Complete Shaft driven Main oil pump w/gear coupling | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 2 | Complete bare pump assembly excluding driver couplings & base plate | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| 3 | Set of bearings | 1 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 4 | Set of Mechanical Seals | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 5 | Set of Gaskets, O - rings | 2 | 4 | 6 | 8 | 8 | 8 | 8 | |
| 6 | Constant Oil Levellers / Pressure- compensated (or balanced) Constant Level Lubricator | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| B7 | Electrical Spares | | | | | | | | |
| | LV Motors | | | | | | | | |
| 1 | Set of Bearings (NDE + DE) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 2 | Set of bearing housings with inner & outer cover(NDE+DE) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 3 | Terminal Block (including Terminal Box Cover with Screws) / bushing | 1 | 1 | 1 | 1 | 2 | 2 | 2 | |
| 4 | Set of Cooling Fans | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| | MV Motors | | | | | | | | |
| 1 | Set of Bearings (NDE + DE) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 2 | Set of bearing housings with inner & outer cover(NDE+DE) | 1 | 1 | 2 | 2 | 3 | 3 | 3 | |
| 3 | Terminal Block / HT bushing | 1 | 1 | 1 | 1 | 2 | 2 | 2 | |
| 4 | Set of Cooling Fans | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |

- Note:** #1. In case of special purpose coupling, the following shall also be included:
- Complete set of spacer coupling with hardware (fastners)
 - Set of shims/flexible elements
 - Distance piece, hubs & keys (If applicable)
2. Instrument spares list to be provided as per vendor standard which will be reviewed by Technip and Company.
3. List of Spares shall be confirmed by Purchaser before PO placement

Welding Procedures

GP 18-07-01D

Scope

0-1

This Global Practice (GP) governs welding and welding qualifications.

0-2

API Recommended Practice 582, Third Edition, May 2016 ([API RP 582-3](#)), as modified by this GP, defines the minimum requirements and practices for welding and welding qualification.

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1. References

1.1. Required References

1.1-1

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.1.1. Global Practices

1.1.1-1

| GP Reference | Reference Title |
|--|--|
| GP 03-18-01D | Piping Fabrication Shop or Field |
| GP 06-01-01D | TEMA Type Shell-and-Tube Heat Exchangers |
| GP 09-04-01D | Atmospheric Storage Tanks |
| GP 18-04-01D | Postweld Heat Treatment of Equipment Handling Alkaline Solutions |
| GP 18-10-01D | Additional Requirements for Materials |
| GP 18-10-01D Sec.8 | Additional Requirements for Cr-Mo Steels |
| GP 18-12-01D | Positive Material Identification |

1.1.2. Industry Standards

1.1.2-1

| Industry Standard Number | Industry Standard Title |
|------------------------------------|---|
| API RP 582 | Welding Guidelines for the Chemical, Oil, and Gas Industries; Fourth Edition |
| API STD 650 | Welded Steel Tanks for Oil Storage |
| ASME B31.3 | Process Piping |
| ASME/BPVC SEC IX | Section IX - Welding, Brazing, and Fusing Qualifications |
| ASME/BPVC SEC II C | Section II-C Specifications for Welding Rods, Electrodes, and Filler Metals - Materials |

| Industry Standard Number | Industry Standard Title |
|---------------------------------------|---|
| ASME/BPVC SEC IX | Section IX Qualification Standard For Welding, Brazing, And Fuzing Procedures; Welders; Brazers; And Welding, Brazing, And Fusing Operators - Welding, Brazing And Fusing Operators |
| ASME/BPVC SEC VIII D1 | BPVC Section VIII - Rules for Construction of Pressure Vessels - Division 1 |
| AWS A4.2M | Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic and Duplex Ferritic-Austenitic Stainless Steel Weld Metal |
| AWS A5.17/A5.17M | Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding |
| AWS A5.23/A5.23M | Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding |
| BSI BS EN 14015 | Specification for the Design and Manufacture of Site Built, Vertical, Cylindrical, Flat-Bottomed, Above Ground, Welded, Steel Tanks for the Storage of Liquids at Ambient Temperature and Above |
| NACE MR0103/ISO 17945 | Petroleum, Petrochemical, and Natural Gas Industries - Metallic Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments |

1.2. Additional References

1.2-1

[*] This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

2. Acronyms and Definitions

2.1. Acronyms

2.1-1

| Acronym | Description |
|---------|---|
| AWS | American Welding Society |
| DHT | Dehydrogenation Heat Treatment |
| FCAW | Flux Cored Arc Welding |
| FN | Ferrite Number |
| GMAW-S | Gas Metal Arc Welding-Short Circuiting Transfer |

| Acronym | Description |
|------------------|----------------------------------|
| GTAW | Gas Tungsten Arc Welding |
| H ₂ S | Hydrogen Sulfide |
| HF | High Frequency |
| MT | Magnetic Particle Testing |
| MTR | Material Test Report |
| PMI | Positive Material Identification |
| PQR | Procedure Qualification Record |
| PT | Liquid Penetrant Examination |
| PWHT | Post Weld Heat Treatment |
| SAW | Submerged Arc Welded |
| SMAW | Shielded Metal Arc Welding |
| TIG | Tungsten Inert Gas |
| WPS | Welding Procedure Specification |

2.2. Definitions

2.2-1

| Term | Definition |
|--------------------------|---|
| Back Cladding | A localized weld overlay operation between two integrally clad or weld overlaid sections. This process is also known as 'clad restoration.' |
| Effective Depth | The thickness of weld overlay or back cladding having the specified chemical composition. |
| Total Depth | The total thickness of weld overlay or back cladding. |
| Weld Overlay (Surfacing) | A deposition of one or more layers of a dissimilar weld metal to the surface of a base material in an effort to improve the corrosion or wear resistance properties of the surface. |

3. Revisions to API Recommended Practice 582, Third Edition, May 2016

3-1

All headings contained herein correspond to paragraph numbering within [API RP 582](#) and reflect additions and exceptions to the recommended practice.

3-2

All provisions not modified or deleted remain in force and shall be considered mandatory.

3-3

Only the paragraphs that are modified are listed in this GP. For convenience, the nature of the modification is noted in the beginning of each paragraph as follows:

- a. **Addition:** Denotes modifications to the corresponding [API RP 582](#) paragraph.
- b. **Exception:** Denotes paragraphs that completely replace the corresponding [API RP 582](#) paragraph.
- c. **New:** Denotes paragraphs that do not appear in the [API RP 582](#) document.

Modifications to Section 4: General Welding Requirements

4.2 Addition: Rationale: General Welding Requirements

4.3 Addition: General Welding Requirements

[R] The basis for rejection of WPSs shall be noncompliance with this GP, failure to meet applicable codes, or violation of industry practice.

4.6 New: General Welding Requirements

[R] The supplementary essential variables in [ASME/BPVC SEC IX](#) shall apply to all impact-tested WPSs, when required by the code or [GP 18-10-01D](#).

4.7 New: General Welding Requirements

[R] Each base metal within a given P-Number or Group Number (as designated in [ASME/BPVC SEC IX](#), Table QW/QB-422) having nominally different chemical or mechanical properties shall require a separate WPS. This requirement does not apply to different grades of P-No. 8, Group 1 and Group 2 base metal, provided the WPS specifies the filler metal required for each different base metal type.

4.8 New: General Welding Requirements

[A] [R] Prior to weld repairing mill defects found in pressure-containing components during shop or field inspections, a separate WPS with supporting PQRs shall be submitted to Owner's Engineer for approval.

Modifications to Section 5: Welding Processes

5.2.1 Addition: Limitations of Fusion Welding Processes—General

[R] Single-pass butt-welding of pressure-containing joints in ferritic steel pressure vessels exceeding 6 mm (¹/₄ in.) thickness shall be acceptable only when the joint receives a subsequent grain refining (austenitizing) heat treatment.

5.2.3.f New: Limitations of Fusion Welding Processes—Gas Metal Arc Welding—Short Circuit Transfer

[C] [R] Complete butt or fillet welds may be welded with this process, provided that the wall thickness of no member exceeds 25 mm (1 in.) and either of the following conditions is met:

- i. Welding is done in any position except vertical-down, and the current is not less than 170 A.
- ii. Welding is done in the vertical-up position (i.e., 3G), and the heat input is not less than 14 kJ/cm (35 kJ/in.). Heat input is defined as:

$$\frac{\text{amperage} \times \text{voltage} \times 60}{\text{travel speed (in. or cm per minute)}}$$

5.2.8 New: Limitations of Fusion Welding Processes—Gas Tungsten Arc Welding

- a. [R] Manual GTAW (TIG) welding shall only be used with the addition of filler metal.
- b. [A] [R] GTAW shall be done using HF starting equipment or lift start (e.g., Lift-Arc) or Company-approved equal to avoid contacting the tungsten electrode with the work piece.

Modifications to Section 6: Welding Consumables (Filler Metal and Flux)

6.1.3.a Addition: General

[C] The use of E7024-1 welding consumables shall be acceptable for making fillet welds to join floor plates of [API STD 650](#) or [BSI BS EN 14015](#) storage tanks, provided that the qualification requirements of [GP 09-04-01D](#) are met.

6.1.8 Addition: General

[A] [C] Base metal and filler metal combinations not meeting the recommendations of [API RP 582](#), Annex A, Table A.1 "Carbon and Low-Alloy Steel" shall be submitted for approval by Owner's Engineer.

6.1.9 New: General

- a. [R] When joining similar metals, the deposited weld metal shall match the chemistry and the mechanical properties of the base metal as closely as possible.
- b. [A] Whenever the minimum mechanical properties of the deposited weld metal fail to meet the minimum mechanical properties of the base metal, or whenever the nominal chemistry of the deposited weld metal differs from the nominal chemistry of the base metal, Vendor's proposal to use such weld metal shall be submitted to Purchaser for Owner's Engineer approval.

6.1.10 New: General

[R] Requalification shall be required whenever any of the following occurs:

- a. The wire chemistry for ferritic steels is changed from one AWS classification to any other classification or to a chemical composition not covered by the AWS filler metal specifications.
- b. Flux-cored electrodes are changed from one AWS classification to another, electrodes are not classified by AWS, or electrodes are specified with supplementary requirements. Requalification is not required for a change in the position designator from EX0T-X to EX1T-X and vice versa.
- c. The chemical composition of the weld deposit is changed from one A-Number to any other A-Number in [ASME SEC IX](#), Table QW/QB-442 "Ferrous/Nonferrous P-Numbers -Grouping of Base Metals for Qualification," including a change from A-1 to A-2 and vice versa.

6.2.3 New: Dissimilar Welding

[R] The use of nickel-based consumables containing niobium, such as ERNiCrMo-3 and ERNiCr-3, shall not be used for welding the following materials:

- a. Duplex stainless steels (e.g., S32750, S32760, and S32101) having a nitrogen content > 0.20%
- b. Alloy 20 (N08020)

6.4.1 Addition: Stainless Steel Welding (P-No. 6, P-No. 7, and P-No. 8)

[A] Base metal and filler metal combinations not meeting the recommendations of [API RP 582](#), Annex A, Table A.2 "Stainless Steel Alloys" shall be submitted for Owner's Engineer approval.

6.4.3 New: Stainless Steel Welding (P-No. 6, P-No. 7, and P-No. 8)

[R] When ferrite testing is specified for production welds, Fabricator shall demonstrate prior to the beginning of fabrication that the FN of the deposited weld metal will be within the specified range. Testing shall be done using one of the two methods described in [Paragraph B.3.3](#) (b), second paragraph. The test coupon shall be produced using the same welding procedure, the same grade of base material, and the same filler metal classification that will be used in production. The FN may be demonstrated by testing the welding procedure qualification coupon or a production mock-up. Alternatively, the FN can be demonstrated by testing the first production weld.

6.4.4 New: Stainless Steel Welding (P-No. 6, P-No. 7, and P-No. 8)

[R] Autogenous welding of superaustenitic stainless steels without a subsequent solution annealing heat treatment shall not be permitted.

6.5.5.1 Addition: Duplex and Super Duplex Stainless Steel Welding

[R] SAW flux shall have a basicity (Boniszweski) index between 1.7 and 2.3.

6.5.5.4 New: Duplex and Super Duplex Stainless Steel Welding

[R] FCAW filler metals shall contain the alloying elements in the sheath and a basic-type flux.

6.6.4 Exception: Submerged Arc Welded

[R] Reprocessed flux or re-crushed slag shall not be used for SAW of pressure-containing parts, such as pressure vessels, piping, and atmospheric storage tanks. Use of such materials is permitted for SAW of structural and non-code components, provided that all of the following requirements are met:

- a. [A] Approval by Owner's Engineer
- b. Separate and distinct markings identifying the re-crusher and the trade designation
- c. Separate WPS(s) and PQR(s)
- d. [A] Testing per [AWS A5.17/A5.17M](#), [AWS A5.23/A5.23M](#), or Company-approved equivalent specification

6.6.6 New: Submerged Arc Welded

[R] Active submerged arc fluxes may be used for carbon steel (P-1 material) welding within all the following limitations:

- a. Material wall thickness shall not exceed 25 mm (1 in.).
- b. Voltage ranges are established and equipment is available to monitor that these limits will not be exceeded.
- c. Welding procedure qualification results indicate that the impact and hardness requirements have been met.

6.9 Addition: Alloy Consumable Controls

[R] Additional requirements for the control and PMI of welding consumables are specified in [GP 18-12-01D](#).

Modifications to Section 7: Shielding and Purging Gases

7.4 New: Shielding and Purging Gases

[R] Deletion of a back purging gas for a butt joint welded from one side only without backing strip shall require a separate PQR.

7.5 New: Shielding and Purging Gases

[R] The following are additional requirements for the shielding and back purging of duplex stainless steel welds:

- a. Welding procedures shall be qualified using the same gases for arc shielding and back purging that will be used in production.
- b. The shielding gas for the GTAW process shall be 99.99% argon or a mixture of argon and nitrogen, with the maximum nitrogen content not exceeding 2%.
- c. [A] The use of nitrogen for back purging of shop or field welds shall be approved by Owner's Engineer.
- d. The use of gas mixtures containing hydrogen for shielding, orifice, or purging gases is not permitted.

Modifications to Section 8: Preheating and Interpass Temperature

8.1 Addition: Preheating and Interpass Temperature

- a. [R] Mn-Mo steels (e.g., SA 302 or SA 533) less than or equal to 50 mm (2 in.) thick shall be preheated to 150 °C (300 °F) minimum. Mn-Mo steels greater than 50 mm (2 in.) thick shall be preheated to 250 °C (480 °F) minimum.
- b. [C] For P-No. 9 group materials, the guidance provided in [ASME/BPVC SEC VIII D1](#), Nonmandatory Appendix R "Preheating" shall remain nonmandatory.

8.6 Exception: Preheating and Interpass Temperature

[R] The maximum interpass temperature for duplex of [API RP 582](#), Table 5 "Maximum Recommended Interpass Temperatures for Duplex and Super Duplex Stainless Steels" shall not apply to tube-to-tubesheet welding.

8.8 New: Preheating and Interpass Temperature

[R] For heavy-wall (> 50 mm [2 in.]) pressure vessels, the retention of preheat, outgassing (dehydrogenation), and/or intermediate stress relief, if necessary, shall be specified in the WPS or on a supplemental data sheet.

Modifications to Section 9: Post-Weld Heat Treatment (PWHT)

9.2 Addition: Post-Weld Heat Treatment (PWHT)

[R] The WPS shall specify whether PWHT shall be performed and in the temperature range. (A statement such as "PWHT, if required by ASME Code" is not acceptable.)

9.4 Addition: Post-Weld Heat Treatment (PWHT)

[R] Hardness testing of the PQR shall be performed when welding steels that are or are not subjected to PWHT are exposed to wet H₂S service or HF acid service conditions as defined in [GP 18-10-01D](#). Testing shall be done per [API RP 582](#), Paragraph 12.6 "Hardness Testing—Weld Procedure Qualification and Production Testing."

9.5 Exception: Post-Weld Heat Treatment (PWHT)

[R] Production hardness testing shall be performed per [GP 18-10-01D](#).

9.8 Addition: Post-Weld Heat Treatment (PWHT)

[A] Repairing stress-relieved components without subsequent PWHT may be proposed for Owner's Engineer approval, provided the repair meets all requirements of [ASME/BPVC SEC VIII D1](#), UCS-56 "Requirements for Postweld Heat Treatment," Paragraph (f) and the following:

- a. All repair procedures employ a temper bead welding technique.
- b. The welding procedure specification has been qualified per [ASME/BPVC SEC IX](#), QW-290 "Temper Bead Welding."
- c. All P-No. 3, P-No. 4, and P-No. 5A materials are inspected with MT or PT after the material has been at ambient temperature for not less than 48 hours. The holding time can be reduced to 24 hours when approved by Owner's Engineer.
- d. Equipment is not exposed to conditions that are prone to environmental cracking (i.e., deaerators and hydrogen or alkaline environments that require PWHT for stress relief).

9.10 Exception: Post-Weld Heat Treatment (PWHT)

[R] Seal welding for P-1, P-3, P-4, P-5A, and P-9 materials is acceptable without PWHT per [GP 03-18-01D](#), Section 11 "Seal Welding Threaded Connections," Item (2).

9.11 Exception: Post-Weld Heat Treatment (PWHT)

[R] PWHT for P-4 and P-5A piping and tubing shall be per [GP 18-10-01D Sec.8: Additional Requirements for Cr-Mo Steels](#).

9.12 Addition: Post-Weld Heat Treatment (PWHT)

[*] For dissimilar metal welds that require PWHT at a temperature beyond the specified range of [API RP 582](#), Table 6 "PWHT Temperatures and Holding Times" for one of the materials, Owner's Engineer or Purchaser shall specify the holding temperature and time.

9.13 Addition: Post-Weld Heat Treatment (PWHT)

[R] Unless otherwise specified by the fabrication code, the thermal gradient controls specified in [API RP 582](#), Section 9 "Post-Weld Heat Treatment (PWHT)," as modified by this GP, are applicable to all pressure vessels. The gradient controls are also applicable to piping in alkaline service as defined in [GP 18-04-01D](#).

9.14 Addition: Post-Weld Heat Treatment (PWHT)

Local spot PWHT is permitted on spherical shapes, such as hemispherical heads and spheres.

9.15 New: Post-Weld Heat Treatment (PWHT)

[R] Welds on 9Cr-1Mo-V steel (P-15E) shall be cooled after welding and subsequent DHT in still air below 95 °C (200 °F) to get a complete martensitic transition before PWHT at 750–760 °C (1,380–1,400 °F).

Modifications to Section 10: Cleaning and Surface Preparation

10.10 New: Cleaning and Surface Preparation

[R] All slag shall be removed from the outside of each completed weld.

Modifications to Section 11: Special Procedure Qualification Requirements/Testing

11.2.1 Addition: Tube-to-Tubesheet Welding

[R] All tube-to-tubesheet welding procedures shall be qualified in accordance to [GP 06-01-01D](#).

11.2.3 New: Tube-to-Tubesheet Welding

Duplex stainless steel weld overlay is not typically recommended as an alternative to cladding due to reduced corrosion resistance. It may be considered acceptable as a last resort but would not be recommended during material selection.

11.3.1 Addition: General

[A] [C] If approved by Owner, then this GP and [API RP 582](#) are not mandatory for duplex stainless steel equipment and piping in Category D service, as defined in [ASME B31.3](#).

11.3.2.2 Addition: Thickness and Heat Input

- a) [R] The heat input used during qualification shall be based on the highest heat input used in production, and it shall not be greater than 25 kJ/cm (63.5 kJ/in.) nor less than 5.0 kJ/cm (13 kJ/in.). The heat input for tube-to-tubesheet welding may exceed this maximum limit, but shall not exceed 35 kJ/cm (90 kJ/in.). The WPS and PQR shall list the heat input for each weld pass.
- b) [R] For single-sided duplex stainless steel weldments, the first and second weld passes shall be made using the GTAW process. The second pass shall be "cold" pass or "cold" pass with 75% heat input of root pass.
- c) [R] For highly restrained SAW welds, the maximum heat input shall not exceed 12 kJ/cm (30 kJ/in.).

11.3.3 Exception: Welding Position

The procedure shall be qualified in the vertical-up position (3G). If welding is to be performed only in the flat (1G) position, then only qualification in the 1G position is required.

11.3.5 Addition: Hardness Testing

For wet H₂S service as described in [GP 18-10-01D](#), hardness testing shall meet the requirements of [NACE MR0103/ISO 17945](#).

11.3.6.3 Addition: Impact Test

- a. For duplex weldments with a wall thickness over 25 mm (1 in.), the impact test—using full-size specimens—and the corrosion test are required.
- b. For duplex weldments with a wall thickness over 50 mm (2 in.), full-size impact specimens shall be removed for testing at the location of the first weld pass and at the $1/4T$ position.

Modifications to Section 12: Other Items

12.5.1 Addition: Stud Welding

[R] For load-carrying welds, destructive tests of at least 10 consecutively welded studs shall be used to demonstrate the suitability of the WPS, including the specified percent fusion. The PQR shall include a record of all welding variables and equipment settings used during qualification. The welding qualifications shall be performed on materials having the same nominal chemistries and thicknesses as the production welds.

12.5.2 Addition: Stud Welding

[R] For non-load-carrying studs, the welding qualifications shall be performed on materials having the same nominal chemistries and thicknesses as the production welds.

12.5.3 Exception: Stud Welding

[R] Production welds shall be 100% visually inspected. Additionally, 5% of the remaining production welds that were not already inspected per the requirements of [Paragraph 12.5.1](#) or [Paragraph 12.5.2](#), as modified by this GP, shall be inspected by hammer testing (1 kg [2 lb] hammer and 500 mm to 750 mm [20 in. to 30 in.] stroke) or 15 degree bend tests. If any of the stud welds fail, then 100% of the welds shall be inspected.

12.8.1 Addition: Additional Production Requirements for Welding Duplex and Super Duplex Stainless Steel

[R] Requirements for welder and welding operator qualification shall be as follows:

- a. Welder and welding operator performance qualification tests shall be made using the same welding procedure, base material UNS grade, thickness range, and brand of filler metal to be used in production.
- b. The ferrite-to-austenite ratio shall be determined as required in [API RP 582](#), Paragraph 11.3.4.3 for all performance qualification tests.
- c. Impact testing as required in [Paragraph 11.3.6.3](#), as modified by this GP, shall be done for all performance qualification tests.

Modifications to Annex A: Welding Consumables for Shielded Metal Arc Welding (SMAW)

- a. [A] [R] Welding fillers for Cr-Mo-V steels shall require approval by Owner. The same brand and type used in WPS/PQR shall be used in production. For SMAW, only EXX15-type or EXX16-type fillers shall be used.
- b. [R] For P15E (P91) steels, the nickel content of the filler shall be limited to $Ni < 0.8 \text{ wt\%}$ and the sum of $Ni + Mn$ shall be limited to $Ni + Mn < 1.5 \text{ wt\%}$ and documented in the MTR.

Modifications to Annex B: Weld Overlay and Clad Restoration (Back Cladding)

B.1.1 Exception: General

- a. [R] Weld overlay or back cladding may be deposited in one or more layers. The number of weld layers in production shall not be less than the number of layers deposited for weld overlay procedure qualification tests.
- b. [R] The total depth (as defined in [GP 18-07-01D Sec.2.2: Definitions](#)) of overlay and back cladding shall be 3 mm ($1/8$ in.) or greater in thickness.
- c. [R] The effective depth (as defined in [GP 18-07-01D Sec.2.2: Definitions](#)) of overlay and back cladding shall be the uppermost 1.5 mm ($1/16$ in.) of the top layer, as a minimum. This material shall meet the specified chemical composition where chemical analysis of the production overlay or back cladding is required.
- d. [R] If multiple-layer overlay or back cladding is required to meet the specified chemistry, and subsequent machining or grinding is necessary to satisfy dimensional requirements, then the final machined or ground surface shall retain the specified effective depth. Examples include machining of gasket grooves in flanges and tubesheets and grinding of heat exchanger shell inside diameter to permit insertion of tube bundle.
- e. [R] Weld overlay thickness shall be verified by actual measurement of the exposed edge at weld joint preparations. Questions regarding overlay thickness shall be resolved by ultrasonic thickness measurements, if necessary.

B.1.4 Addition: General

[R] The chemical composition at the effective depth of the overlay or back cladding shall be reported for welding procedure qualification tests.

B.1.6 Addition: General

[*] [R] The chemical composition at the effective depth of the overlay or back cladding shall be reported for production welding, when specified by Owner's Engineer. The acceptance requirements for production overlay and back cladding are found for the particular alloy(s) in [API RP 582](#), Sections B.3 "Austenitic (300 Series) Stainless Steel Overlay" through Section B.6 "Nickel-base Alloys (Other Than Ni-Cu Alloy 400)," as modified by this GP.

B.1.7 Addition: General

- a. [R] Test samples shall be removed, or in-situ tests shall be conducted, prior to final PWHT at locations selected by Inspector. The number of samples for chemical analysis for all types of weld overlay and back cladding, and number of ferrite measurements for austenitic stainless steel deposits, shall be as follows:
 - i. Automatic weld overlay—One sample shall be taken from (or test conducted on) each girth section and equipment component (e.g., head, shell course, tubesheet, nozzle bore, etc.), and each back clad seam, except as provided in Item (c) below.
 - ii. Manual weld overlay—Two samples shall be taken from (or tests conducted on) each girth section and equipment component (e.g., head, shell course, tubesheet, nozzle bore, flange face, etc.), and each back clad seam, except as provided in Item (c) below.

- iii. Back cladding of nozzle weld seams— For nozzles > 300 mm (12 in.) in diameter, one sample shall be taken for each 900 diametrical mm (36 diametrical inch), or part thereof. For nozzles ≤ 300 mm (12 in.) in diameter, one sample shall be taken for each weld seam.
- b. [R] For repetitive manual and automatic weld overlay operations on components > 600 mm (24 in.) in diameter, two tests per welder per week may be substituted for the requirements of the paragraph above (including its lettered subitems). However, there shall be no change in welding procedure, filler metal classification, batch number of submerged arc or electroslag flux, or welding position. Authorization shall be at the discretion of Inspector.

B.1.9 Exception: General

- a. [R] For multiple-layer weld overlay or back cladding, liquid penetrant examination shall be performed on the first layer surface as follows:
 - i. Automatic welding: 5% minimum
 - ii. Manual welding: 12% minimum
- b. Examination methods and acceptance standards shall be in accordance with [ASME/BPVC SEC VIII D1](#), Mandatory Appendix 8 "Methods for Liquid Penetrant Examination (PT)." Any unacceptable indications shall be a cause for liquid penetrant examination of the entire surface of the overlay or back cladding.
- c. [R] For overlays of Type 347 or 309Cb, the final surface of weld overlays, back cladding, and welds joining attachments to weld overlays or integral cladding shall be 100% liquid penetrant examined with a water-soluble penetrant following hydrostatic testing. However, for heat exchangers and overlays of all other alloys, 100% liquid penetrant examination may be performed prior to hydrostatic testing. Additionally, the following shall apply:
 - i. Examination and acceptance standards shall be per [ASME/BPVC SEC VIII D1](#), Mandatory Appendix 8 "Methods for Liquid Penetrant Examination (PT)."
 - ii. Defective areas shall be repaired and reexamined. If more than 5% of the surface area needs to be repaired, then Owner's Engineer shall be informed.

B.2.1 Addition: Clad Restoration (Back Cladding)

[R] Prior to back cladding butt joints, the weld groove in the backing material shall be filled approximately flush with, but not more than 1.5 mm (¹/₁₆ in.) below, the weld overlay fusion line or the clad bond line adjacent to the weld groove. Care shall be taken to avoid cross-contaminating the cladding and backing material weld metal. Any suspected areas of cross-contamination shall be etched with either a nitric acid or copper sulfate solution to confirm the integrity of the clad surface.

B.3.2 Addition: Austenitic (300 Series) Stainless Steel Overlay

[R] The content of individual elements reported in the chemical analysis shall be within the range specified in [API RP 582](#), Table B.2, "Chemical Composition Requirements for Austenitic Stainless Steel Overlays," except for the following:

- a. For austenitic stainless steel deposits containing Cb (Nb) (e.g., Type 347 or Type 309Cb), the Cb (Nb) ratio (Cb/C [Nb/C]) shall not exceed 16:1.
- b. For Type 316 and 316L deposits, the Mo content shall not be less than 2.25%.

B.3.3 Addition: Austenitic (300 Series) Stainless Steel Overlay

- a. [R] The ferrite content of the first layer as well as the final layer shall be measured.
- b. [R] The ferrite content shall be determined by one of the following:
 - i. The actual, as-deposited chemical composition and the WRC-1992 diagram for stainless steel weld metal (per [ASME SEC II C](#) SFA-5.9/SFA-5.9M, Figure A.1 "WRC-1992 Diagram for Stainless Steel Weld Metal")
 - ii. Magnetic instrument as listed in [AWS A4.2M](#)

B.3.5 Exception: Austenitic (300 Series) Stainless Steel Overlay

- a. [R] Magnetic gauges shall be calibrated and certified per [AWS A4.2M](#). An annual calibration certification shall be available to Inspector. Prior to use in production, instrument calibration shall be verified on at least two standards (calibration test blocks) with a minimum ferrite spread of 5 FN. At least one of these standards shall have an FN of 3–10.
- b. These standards shall be one of the following:
 - i. Primary or secondary weld metal standards described in [AWS A4.2M](#)
 - ii. Samples with certified chemical analyses referenced to the WRC-1992 (FN) diagram
 - iii. Samples with ferrite content measured by metallographic techniques

B.5.1 Addition: Monel Alloy 400 (67Ni-30Cu)

[R] In addition to HF acid service, the iron content shall not exceed 5% for Alloy 400 overlays exposed to sulfuric acid or sea or brackish water and for other service environments when specified by Purchaser.

B.5.2 Addition: Monel Alloy 400 (67Ni-30Cu)

[R] Ferricyanide testing is required for all nickel-copper (Alloy 400 [Monel], 67Ni-30Cu) and copper-nickel (70Cu-30Ni, 90Cu-10Ni) alloy overlays and back cladding.

Ferricyanide tests shall be performed on 100% of finished nickel-copper or copper-nickel overlays and back cladding deposits. The results shall not indicate the presence of free iron.

The test procedure shall be as follows:

- a. The surface to be examined shall be prepared by a method that does not cause contamination by free iron. A solvent or detergent solution shall remove oil, grease, and dirt. A pickling solution may be used to remove oxides. The surface shall be thoroughly rinsed after pickling or detergent cleaning, using distilled or deionized water. If mechanical surface preparation is required, then new emery paper or grinding wheels, and non-ferritic buffing wheels and brushes, shall be used.
- b. The composition of the test solution shall be as follows:
 - i. 90% by volume potassium ferricyanide (4% solution)
 - ii. 10% by volume solution consisting of one part concentrated hydrochloric acid (36–38% by weight HCl) and nine parts distilled water
- c. Fresh test solution shall be prepared immediately before application.
- d. The testing solution's reaction shall be checked on samples of nickel-copper or copper-nickel and carbon steel. A blue color should appear immediately on carbon steel. No color should appear on nickel-copper or copper-nickel within 10 minutes. If color does appear, then the solution is too acidic, and new solution shall be formulated.
- e. The solution shall be applied to the tested surface by spraying (using an atomizer) or drop by drop (using an eyedropper). Appearance of a definite blue color within 2 minutes indicates the presence of free iron. A light blue tint shall be considered insignificant.

- f. Questions regarding determination of iron content based on the degree of blueness shall be resolved by spot chemical analysis. The iron content shall not exceed 5% for services specified in B.5.1 of this GP or 6% for all other services.

GP History Prior to Migration

| Version 1.0.0 | | Date: 12/01 |
|----------------------|---------------|--|
| Location | Action | Description |
| | | Initial Publish. |
| Version 1.1.0 | | Date: 09/02 |
| Section 5.1 | Modification | Item b Rationale: move the last sentence in the paragraph to Item c. Renumber the remaining items in the list. |
| Version 2.0.0 | | Date: 08/03 |
| Entire GP | Replacement | Entire document revised; earlier GP replaced with revisions to API RP 582. |
| Version 2.0.0 | | Date: 11/03 |
| | | Global Practice version number and format updated to comply with new process; however, original publish date remains, and no content was modified. |
| Version 3.0.0 | | Date: 01/10 |
| Scope, Item (2) | Modification | Changed API RP 582 reference from the 1st edition to the 2nd edition. Most changes to this version of the GP were to done to align with the new edition of API RP 582. |
| Scope, Item (3) | Modification | Changed the definitions of what an Addition means and added the designation New to denote paragraphs that do not appear in API. |
| Section 1 | Modification | Added references to GP 18-04-01, GP 18-12-01, GP 09-04-01, BSI BS EN ISO 15614-8, and other references cited in the GP. |
| General | Modification | Renumbered sections and changed designations to align with the second edition of API RP 582. |
| Section 5.1 | Deletion | Item 5.1.i was deleted because API now allows the usage of ESW for weld overlay. |
| Section 5.2.8 | Modification | Split into two separate paragraphs. No technical changes were made. |
| Section 5.2.9 | New | Added section regarding the heat input limits for duplex stainless steel. |
| Section 6.1.3.a | New | Added to reflect the use of rutile electrodes for tank floor fabrication, which is overlooked by the API document. |
| Section 6.1.6 | Deletion | Deleted requirement as now covered in Par 6.1.7 of API. Kept rationale and renumbered as Section 6.1.7. |

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| Section 6.1.8 | Modification | Old paragraph was deleted since this requirement is now covered in Par 6.1.3 of API. Rationale was renumbered to Section 6.1.3. New Par. 6.1.8 was added to require approval for filler and base metal combinations that are not covered by Table A.1. |
| Section 6.2.2 | Modification | Deleted old text as requirement is now fully covered in Par. 6.2.2 of API. Added new requirement that all dissimilar welding applications are considered to be exposed to a sulfur environment since fabricators do not normally know if sulfur is present. Also added a limitation on the use of nickel based filler metals for welding super duplex stainless steels. |
| Section 6.4.2.4 | New | Added rationale. |
| Section 6.4.3 | New | Added section requiring the testing of consumables for ferrite number prior to the start of production welding. |
| Section 6.4.4 | New | Added section prohibiting the autogenous welding of superaustenitic stainless steel without the Purchaser's approval. |
| Section 6.5.1 | New | Added exception paragraph that ferrite testing of the PQR shall be per Section 11.3. |
| Section 6.5.4 | New | Added to list additional welding consumable requirements for duplex stainless steels. |
| Section 6.9 | New | Added a section that the control and PMI of welding consumables will be per GP 18-12-01 in addition to the API RP. |
| Section 7.5.1 | Deletion | Item 7.5.1 is now covered by Par. 7.6 of the API RP. Renumbered rationale. Item 7.5.2 was renumbered to Section 7.7. |
| Section 7.8 | New | Added section addressing shielding and purging gases for welding duplex stainless steels. |
| Section 8.1.1 | Deletion | Item 8.1.1 was removed because it is now covered by Par. 6.1.3b in API. |
| Section 8.2 | New | Added rationale. |
| Section 8.4 | New | Added maximum interpass requirements for the welding of duplex stainless steels. |
| Section 9.4 | New | Added a requirement to do hardness testing of the PQR when steels are to be stress relieved due to exposure to Wet H ₂ S Service. |
| Section 9.4.1 | Deletion | Deleted requirement that referred to GP 18-10-01 for hardness testing of PQRs. |
| Section 9.4.2 | Deletion | Deleted requirement that referred to GP 18-10-01 for hardness testing of PQRs. Added rationale to designate when testing may be required. |

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| Section 9.8 | Modification | Added a requirement that temperbead welding shall be done with a WPS qualified to ASME SEC IX. Also added that the holding time prior to inspection of low alloy steels can be reduced to 24 hours when approved by the Owner's Engineer. |
| Section 9.10 | Modification | Changed GP 03-18-01 reference to Section 12, Item (2). |
| Section 9.12 | New | Added a paragraph and rationale regarding the PWHT of dissimilar welds. |
| Section 9.13 | New | Added a paragraph and rationale specifying when the thermal gradient controls are necessary. |
| Section 9.14 | New | Added a paragraph allowing the usage of spot PWHT on spherical shapes. |
| Section 11.2 | Deletion | Deleted rationale since tube-to-tubesheet welding qualifications are now covered in ASME SEC IX. |
| Section 11.2.1 | New | Added requirements regarding compliance with ASME SEC IX for tube to tubesheet welding. |
| Section 11.3 | New | Added qualification test requirements for welding duplex stainless steel. |
| Section 12.5.3 | Modification | Renumbered first paragraph to Section 12.5.2. Kept second paragraph numbered as Section 12.5.3 and clarified the amount of testing required for production welds. |
| Section 12.8 | New | Added welder qualification requirements and production test plate testing requirements for duplex stainless steel. |
| Section 12.9 | New | Added inspection and testing requirements for duplex stainless steel welds. |
| Annex A | Modification | Changed requirement to require the tables in the annex to be followed unless approved by the Owner's Engineer. |
| Section B.1.7 | Modification | Changed the requirements for the inspection of weld overlays at nozzles as a way to simplify the amount of testing that is required. Old system was cumbersome. |
| Section B.3.2.1 | Deletion | Deleted the requirement in Item B.3.2.1 since this is now covered in Table B-2. |
| Section B.3.3.1 | Deletion | Deleted the requirement in Item B3.3.1.a since this requirement is now covered in Section B3.3 of the API RP. |
| Section B.3.3 | Modification | In item B3.3.2.a, updated the reference from WRC 1988 to WRC 1992 and deleted the reference to the DeLong Diagram. |
| Section B.3.5 | Modification | In item B3.5.2.b, updated the reference from WRC 1988 to WRC 1992 and deleted the reference to the DeLong Diagram. |

| | | |
|-----------------------------|---------------|--|
| Section B.5.1 | New | Added new requirement and rationale for restricting the iron content of Alloy 400 weld overlays in sea and brackish waters and for other services defined by the Purchaser. |
| All Global Practices | Modifications | <p>To standardize the format of the Global Practices and to meet other requirements, the following changes have been implemented:</p> <p>"For ExxonMobil Use Only" has been replaced with "For Company Use Only."</p> <p>A copyright waiver has been added in the first page Footer.</p> <p>The definition of asterisks in the Scope has been deleted. The asterisk is now defined in the Purpose Code attachment and is used within brackets as other Purpose Codes.</p> <p>Multiple paragraphs within a Section have been numbered.</p> <p>The standard text for Required References has been modified.</p> <p>The standard text for Additional Requirements has been modified.</p> <p>The Safety Purpose Code has been modified.</p> <p>The following Purpose Codes have been added:</p> <p>[*] for additional information or decision required of Owner's Engineer.</p> <p>[A] for approval requirements before beginning work or finalizing design.</p> |
| Version 4.0.0 | | Date: 10/16 |
| General | Modification | Updated Purpose Codes, Rationales, references, and unit conversions and clarified content throughout GP. Updated entire document as needed to align with API RP 582, Third Edition, May 2016 (versus Second Edition, December 2009). |
| Section 2 | Addition | Added Section 2 by moving existing definitions to this section. |
| Section 3 | Modification | Modified previous API modifications as follows: |
| API Section 4 | Modification | Added new Section 4.9. |
| API Section 6 | Modification | <p>Modified Section 6.1.3.a to add reference to BSI BS EN 14015 storage tanks.</p> <p>Modified Section 6.2.2 to delete indication that environment shall be considered to contain sulfur.</p> <p>Modified Section 6.5.5 to remove indication of revised procedure qualification requirements (including ferrite testing), to remove filler metal and flux requirements, and to remove chemical composition requirements table. These requirements have been added to API 582-3.</p> |
| API Section 8 | Modification | Deleted the Addition to Section 8.6 and its table specifying interpass temperatures, and added an Exception to Section 8.6. |

| | | |
|----------------|--------------|---|
| API Section 9 | Modification | Modified Section 9.8, Item (d) to encompass any condition prone to environmental cracking. Added Section 9.15. |
| API Section 11 | Modification | Modified Section 11.2.3, Item (a) to apply only if tubesheet is constructed of super austenitic or duplex stainless steel. Added Section 11.2.3, Item (c). Deleted Section 11.3 requirement for base metal of same UNS number, requirements for ferrite to austenitic ratio, and requirements for corrosion and impact testing. These requirements have been added to API 582-3. Added Section 11.3.1. Modified Section 11.3.3 to reclassify from Addition to Exception. Modified Section 11.3.5 to specify testing per NACE MR0103/ISO 17945 and delete all other added requirements. |
| API Section 12 | Modification | Added modification to Section 12.5.1 for load-carrying welds. Deleted Exception to Section 12.5.2 and replaced with an Addition. Modified Section 12.8 to delete requirements for production test plates and requirements for pressure boundary welds. |
| API Annex A | Modification | Deleted item discussing filler metals with chemistries not listed in Tables A.1, A.2, A.3, and A.4 of API RP 582-2, and added two paragraphs. |
| API Annex B | Modification | Modified Section B.1.1 to reclassify from Addition to Exception. Modified Section B.1.9, Item (b) to distinguish requirements for overlays of Type 347 or 309Cb versus overlays of other alloys. |

Record of Change

| Version 5.0 | | |
|----------------|--------------|--|
| Location | Action | Description |
| Section 6.1.11 | Modification | Requalification conditions are added. |
| Section 6.4.3 | Addition | Added rationale. |
| Section 8.1 | Modification | Preheating and interpass temperature requirements modified |
| Section 11.2.1 | Modification | Tube-to-tubesheet welding procedure content modified. |
| Section 11.2.3 | Addition | Requirements for weld overlay updated. |
| Section 12.8.5 | Deletion | Section 12.8.5 deleted. |

Purpose Code Definitions

| Code | Description |
|---|--|
| * | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |
| A | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| C | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| CS | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| E | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| I | Obsolete as per 2019 CIG - Assigned to paragraphs that provide only clarifying information, such as Scope statements, definitions of terms, etc. |
| M | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| O | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| R | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| S | Assigned to paragraphs that contain design, fabrication and construction requirements that, if not met, can directly result in or significantly increase the risks of either: <ol style="list-style-type: none"> 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). <p>Safety designation shall not be applied to paragraphs with Risk Matrix Category 4 when the incident probability and risk can be determined by the appropriate SME.</p> |
| Purpose Code Hierarchy: Purpose Codes assigned to a numbered item apply to all associated subitems. Purpose codes assigned to an individual subitem apply only to that subitem. | |

Pressure Casting Quality and Inspection

GP 18-03-04D

Scope

0-1

This Global Practice (GP) covers the minimum quality and inspection level for iron, steel (carbon, alloy or stainless), and nickel-based alloy pressure-retaining castings used for pumps, steam turbines, compressors, valves and pipe fittings, double-pipe and multi-tube heat exchanger return bends, or other equipment, when specified by Owner's Engineer.

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1. References

1.1. Required References

1.1-1

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply. Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.1.1. Global Practices

1.1.1-1

| GP Reference | Reference Title |
|------------------------------|---|
| GP 18-03-02D | Statically Cast Steel and Alloy Pressure-Containing Parts and Tube Supports for Fired Heaters |
| GP 18-03-03D | Centrifugally Cast High-Alloy Tubes and Headers for Catalytic Steam Reforming Headers |
| GP 18-10-01D | Additional Requirements for Materials |
| GP 20-01-01D | Inspection of Equipment and Materials |

1.1.2. Industry Standards

1.1.2-1

| Industry Standard Number | Industry Standard Title |
|---------------------------------------|--|
| API RP 941 | Recommended Practice for Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants |
| ASME B16.34 | Valves - Flanged, Threaded, and Welding End |
| ASME B31.3 | Process Piping |
| ASME/BPVC SEC VIII D1 | Section VIII - Division 1 Rules for Construction of Pressure Vessels |
| ASTM A 395/A 395M | Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures |
| ASTM A 487/A 487M | Standard Specification for Steel Castings Suitable for Pressure Service |
| ASTM A 494/A 494M | Standard Specification for Castings, Nickel and Nickel Alloy |

| Industry Standard Number | Industry Standard Title |
|--|--|
| ASTM A 703/A 703M | Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts |
| ASTM A 990/A 990M | Standard Specification for Castings, Iron-Nickel-Chromium and Nickel Alloys, Specially Controlled for Pressure Retaining Parts for Corrosive Service |
| ASTM E 165/E 165M | Standard Practice for Liquid Penetrant Examination for General Industry |
| MSS SP-53 | Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components - Magnetic Particle Examination Method |
| MSS SP-54 | Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components - Radiographic Examination Method |
| MSS SP-55 | Quality Standard for Steel Castings for Valves, Flanges, Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities |
| NS CD3MN | Niyama Simulation CD3MN Benchmark |
| NS CD4MCuN | Niyama Simulation CD4MCuN Benchmark |
| NS CF8M | Niyama Simulation CF8M Benchmark |
| NS CN3MN | Niyama Simulation CN3MN Benchmark |
| NS CN7M | Niyama Simulation CN7M Benchmark |
| NS CW12MW | Niyama Simulation CW12MW Benchmark |
| NS CW6MC | Niyama Simulation CW6MC Benchmark |
| NS M30C | Niyama Simulation M30C Benchmark |
| NS M35-1 | Niyama Simulation M35-1 Benchmark |
| NS N3M | Niyama Simulation N3M Benchmark |
| NS Qualification Form | Niyama Simulation Qualification Form |
| NS Qualification Procedure | Niyama Simulation Qualification Procedure |
| NS WCB | Niyama Simulation WCB Benchmark |

1.2. Additional References

1.2-1

[*]This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is

referenced, any requirements from underlying industry standards apply. Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

2. Acronyms and Definitions

3. General

3-1

[*] Owner's Engineer shall specify inspection requirements for nonferrous castings other than nickel-based castings.

3-2

[GP 18-03-02D](#) and [GP 18-03-03D](#) cover static cast furnace components and centrifugal cast high alloy furnace tubes, respectively.

3-3

[GP 20-01-01D](#) lists the equipment and materials requiring inspection by Owner's Representative and the general requirements related to the inspection activities.

3-4

[*] The qualification of castings by use of the Niyama criterion shall be specified by Owner's Engineer. Guidance on use of this criterion and a practitioner qualification procedure are included in Appendix A of this GP.

4. Definitions

4-1

The term Inspector, as used in this GP, refers to Owner's Representative.

4-2

[*] Casting Quality Levels—a quality level shall be assigned to the casting as defined in [Table 1: Casting Quality Levels](#) or by Owner's Engineer.

Table 1: Casting Quality Levels

| Quality Level | Casting Type |
|---------------|--|
| I | <ol style="list-style-type: none"> All alloy steel and stainless steel castings in continuous cyclic hot hydrogen service where the design temperature exceeds the carbon steel curve in API RP 941. All castings in hydrofluoric (HF) acid service. [*] Castings in other services or applications as specified by Owner's Engineer. |
| II | <ol style="list-style-type: none"> All castings in non-cyclic hot hydrogen service where the design temperature exceeds the carbon steel curve in API RP 941. All castings in high-pressure steam and hydrocarbon (Class 1500 and higher) service. Pump castings in: |

| Quality Level | Casting Type |
|---------------|---|
| | <ol style="list-style-type: none"> a. Hydrocarbon or boiler feedwater service where the design pressure is ≥ 750 psig (5170 kPa) or design temperature is ≥ 750 °F (400 °C) b. Chemical service (e.g., sulfuric acid, phenol, peroxide) c. Low-temperature or cryogenic hydrocarbon and petrochemical service where the design temperature is ≤ -20 °F (-30 °C) d. Service where Cr-Mo steels, CA-15, CA6NM, CN7M, stainless steel, alloy 20, and all nickel-based alloys, except those covered by Quality Level I or III, are specified <ol style="list-style-type: none"> 4. Cast steel reciprocating compressor and reciprocating pump pressure-retaining castings (cylinders and cylinder heads). 5. Centrifugal and rotary compressor pressure-retaining castings. 6. [*] Castings in other services or applications as specified by Owner's Engineer. |
| III | <ol style="list-style-type: none"> 1. Pump castings in amine and sour water services. 2. Carbon steel castings in high-pressure hydrogen (Class 600 and higher) service. 3. [*] Castings in other services or applications as specified by Owner's Engineer. |
| IV | <ol style="list-style-type: none"> 1. Ductile iron pressure-retaining castings for reciprocating compressors and pumps (cylinders and cylinder heads). 2. Hydrocarbon and water services not covered in Quality Levels I–III. 3. All commercial-grade castings. |

4-3

Major casting repairs are repairs to defects that meet the following criteria:

- a. Cause a casting to leak during hydrotest.
- b. Result in repair cavities exceeding 20% of the casting wall thickness or 1 in. (25 mm), whichever is less.
- c. Result in a repair area >10 in.² (6500 mm²).

4-4

[*] Critical areas are those defined by Owner's Engineer and/or based on the results of examination of initial casting(s), including those listed in [Table 2: Critical Areas for Inspection](#).

Table 2: Critical Areas for Inspection

| Component | Critical Area |
|-----------|--|
| Valves | <ol style="list-style-type: none"> 1. End flange to body transition area 2. Body transition area to the bonnet 3. Small integral nozzle/bleed connections |

| Component | Critical Area |
|--|--|
| | 4. Both ends of butt welding end valves |
| Pumps | <ol style="list-style-type: none"> 1. Transition between the volute and casing flanges 2. Transition between the suction nozzle and casing 3. Transition between the discharge nozzle and casing 4. Transition between the casing and feet (pressure boundary only) 5. Junction between the casing and stuffing box |
| Steam Turbines | <ol style="list-style-type: none"> 1. Nozzle block 2. Steam chest 3. Transition between the casing and nozzle 4. Transition between the casing and joint flange |
| Reciprocating Compressors and Pumps ⁽¹⁾ | <ol style="list-style-type: none"> 1. Valve pockets 2. The bore and box packing area |
| Centrifugal and Rotary Compressors | <ol style="list-style-type: none"> 1. Transition between the nozzles and casing 2. Transition between the casing and horizontal joint 3. Areas with radii less than 1 in. (25 mm) |
| Double-Pipe and Multi-Tube Heat Exchangers | <ol style="list-style-type: none"> 1. Cast return bend housings (or bonnets) |
| Other Equipment | <ol style="list-style-type: none"> 1. Abrupt changes in casting section thickness or shape 2. Locations where risers, gates, and feeders are attached 3. Locations that may be subject to high-stress service loadings 4. Ends of butt welding connections 5. [*] Other areas so designated by Owner's Engineer |
| <p>Note to Table 2: Critical Areas for Inspection:</p> <p>(1) Refers to cast steel reciprocating compressors only. Ductile iron reciprocating compressors shall be inspected in accordance with Quality Level IV. The final machined valve pocket and packing box surfaces of cylinders and heads shall be free of porosity on the sealing surfaces, unless Supplier can demonstrate that this condition will not result in leakage around the valve or packing.</p> | |

5. Materials

5-1

[R] For ductile iron reciprocating compressors and pumps, all castings shall meet the following criteria:

- a. Be given a ferritizing anneal.
- b. Have a microstructure containing a minimum of 90% of the Graphite as Type I and Type II Graphite as defined in [ASTM A 395/A 395M](#).

5-2

[R] Alloy 400 castings for use in HF acid service shall be grade M-35-1 as defined in [ASTM A 494/A 494M](#) or [ASTM A 990/A 990M](#) except that (Si + 5 x C) shall be less than 2.5% and Cb shall be less than 0.5%. Castings ordered to [ASTM A 990/A 990M](#) shall be inspected per the inspection class that meets the minimum requirements of Section 5 of this GP.

5-3

[R] Castings of CA6NM shall be provided per [ASTM A 487/A 487M](#) Class B heat treatment.

6. Examinations and Acceptance Criteria

6-1

Mill test reports of chemical composition and mechanical properties of castings shall be submitted to the Inspector.

6-2

[R] For castings requiring Post-Weld Heat Treatment (PWHT) (except carbon steel), final radiographic inspection shall be performed after heat treatment.

6-3

[*] [R] [Table 3: Required Examinations and Acceptance Criteria for Valves](#) specifies the nondestructive examinations and acceptance criteria required for valves. Owner's Engineer may specify additional requirements not listed in [Table 3: Required Examinations and Acceptance Criteria for Valves](#). Purchaser may specify a greater frequency of examination than what is listed in [Table 3: Required Examinations and Acceptance Criteria for Valves](#).

6-4

[*] [Table 3: Required Examinations and Acceptance Criteria for Valves](#) shall cover batch-type castings other than valves and piping components when specified by Owner's Engineer.

Table 3: Required Examinations and Acceptance Criteria for Valves

| Quality Level | Exam Type ⁽¹⁾ | Exam Frequency (No. of Castings) | Extent of Exam ⁽⁵⁾ | Acceptance Standards |
|---------------|--------------------------|--|---|--------------------------|
| I | VT | All | 100% | VT-1 |
| | MT/PT ⁽⁴⁾ | All | 100% ⁽²⁾ | MT-1/PT-1 ⁽⁴⁾ |
| | RT | All | 100% | RT-1 |
| II | VT | All | 100% | VT-1 |
| | MT/PT ⁽⁴⁾ | All | 100% ⁽²⁾ | MT-2/PT-2 ⁽⁴⁾ |
| | RT | Initial: F1 Balance: F2 (see below) | Critical areas (see Table 2: Critical Areas for Inspection of this GP) | RT-2 ⁽³⁾ |
| III | VT | All | 100% | VT-1 |
| | MT/PT ⁽⁴⁾ | Initial: F1 Balance: F2 (see below) | Critical areas (see Table 2: Critical Areas for Inspection of this GP) | MT-2/PT-2 ⁽⁴⁾ |

| Quality Level | Exam Type ⁽¹⁾ | Exam Frequency (No. of Castings) | Extent of Exam ⁽⁵⁾ | Acceptance Standards |
|---------------------------|--------------------------|--|-------------------------------|----------------------|
| IV | VT | All | 100% | VT-1 |
| Legend: | | | | |
| Frequency of Examination: | F1 | Inspect the first casting of each size and ANSI Class rating. | | |
| | F2 | Minimum of 10% of the order as selected by the Inspector. | | |
| Acceptance Standards: | VT-1 | MSS SP-55 | | |
| | MT-1 | ASME/BPVC SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | | |
| | PT-1 | ASME/BPVC SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | | |
| | RT-1 | ASME/BPVC SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | | |
| | MT-2 | ASME B16.34 Mandatory Appendix II, Section II-2.1, "Castings" | | |
| | PT-2 | ASME B16.34 Mandatory Appendix III, Section III-2.1, "Castings" | | |
| | RT-2 | ASME B16.34 Section 8 "Requirements for Special Class Valves," and Mandatory Appendix I, Section I-2, "Acceptance Standards" | | |

Notes to [Table 3: Required Examinations and Acceptance Criteria for Valves](#):

- (1) Examination techniques:
 - (a) Visual Examination (VT) per [MSS SP-55](#).
 - (b) Magnetic Particle Testing (MT), Liquid Penetrant Testing (PT), and Radiographic Testing (RT) per [ASME/BPVC SEC VIII D1](#) Mandatory Appendix 7, "Examination of Steel Castings."
 - (c) [A] When approved by Owner's Engineer, Ultrasonic Testing (UT) examination per [ASME/BPVC SEC VIII D1](#) Mandatory Appendix 7, "Examination of Steel Castings," may be used in lieu of RT where casting configurations do not allow RT.
- (2) Including machined gasket surfaces and weld bevels.
- (3) If a defective casting is found by radiography, then two additional castings of the same material and type shall be examined. If either of these is defective, then all remaining castings of the same material and type shall be examined.
- (4) PT shall be substituted for MT for all non-magnetic alloys and low-alloy nickel steels.
- (5) When 100% inspection is specified for critical areas or for the entire casting, it shall mean inspection of all accessible areas.

6-5

[R] Casting wall thickness shall be measured and dimensional checks shall be performed on all Quality Level I, II, and III castings. Results shall meet the requirements of Manufacturer's approved drawings.

6-6

[*] [R] [Table 4: Required Examinations and Acceptance Criteria for Piping Components](#) specifies the nondestructive examinations and acceptance criteria required for piping components. Owner's Engineer may specify additional requirements not listed below.

Table 4: Required Examinations and Acceptance Criteria for Piping Components

| Quality Level | Exam Type ⁽¹⁾ | Exam Frequency (No. of Castings) | Extent of Exam | Acceptance Standards |
|---------------------------|--------------------------|---|---|--------------------------|
| I | VT | All | 100% | VT-1 |
| | MT/PT ⁽⁴⁾ | All | 100% ⁽²⁾ | MT-1/PT-1 ⁽⁴⁾ |
| | RT | All | 100% | RT-1 |
| II | VT | All | 100% | VT-1 |
| | MT/PT ⁽⁴⁾ | All | 100% ⁽²⁾ | MT-3/PT-3 ⁽⁴⁾ |
| | RT | Initial: F1 Balance: F2 (see below) | Critical areas (see Table 2: Critical Areas for Inspection of this GP) | RT-3 ⁽³⁾ |
| III | VT | All | 100% | VT-1 |
| | MT/PT ⁽⁴⁾ | Initial: F1 Balance: F2 (see below) | Critical areas (see Table 2: Critical Areas for Inspection of this GP) | MT-3/PT-3 ⁽⁴⁾ |
| IV | VT | All | 100% | VT-1 |
| Legend: | | | | |
| Frequency of Examination: | F1 | Inspect the first casting of each size and ANSI Class rating. | | |
| | F2 | Minimum of 10% of the order as selected by the Inspector. | | |
| Acceptance Standards: | VT-1 | MSS SP-55 | | |
| | MT-1 | ASME/BPVC SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | | |

| Quality Level | Exam Type ⁽¹⁾ | Exam Frequency (No. of Castings) | Extent of Exam | Acceptance Standards |
|---------------|--------------------------|---------------------------------------|---|----------------------|
| | PT-1 | ASME/BPVC SEC VIII D1 | Mandatory Appendix 7, "Examination of Steel Castings" | |
| | RT-1 | ASME/BPVC SEC VIII D1 | Mandatory Appendix 7, "Examination of Steel Castings" | |
| | MT-3 | MSS SP-53 | | |
| | PT-3 | MSS SP-53 | Table 1, "Acceptance Standards" | |
| | RT-3 | MSS SP-54 | | |

Notes to [Table 4: Required Examinations and Acceptance Criteria for Piping Components](#):

- (1) Examination techniques:
 - (a) VT per [MSS SP-55](#).
 - (b) MT per [MSS SP-53](#), PT per [ASTM E 165/E 165M](#), and RT per [MSS SP-54](#)
 - (c) [A] When approved by Owner's Engineer, UT examination per [ASME/BPVC SEC VIII D1](#) Mandatory Appendix 7, "Examination of Steel Castings," may be used in lieu of RT where casting configurations do not allow RT.
- (2) Including machined gasket surfaces and weld bevels.
- (3) If a defective casting is found by radiography, then two additional castings of the same material and type shall be examined. If either of these is defective, then all remaining castings of the same material and type shall be examined.
- (4) PT shall be substituted for MT for all non-magnetic alloys and low-alloy nickel steels.

6-7

[*] [R] [Table 5: Required Examinations and Acceptance Criteria for Rotating Equipment Pressure-Retaining Components and Double Pipe and Multipipe Heat Exchanger Return Bends](#) specifies the nondestructive examinations and acceptance criteria required for rotating equipment components. Owner's Engineer may specify additional requirements not listed therein.

6-8

[*] [Table 5: Required Examinations and Acceptance Criteria for Rotating Equipment Pressure-Retaining Components and Double Pipe and Multipipe Heat Exchanger Return Bends](#) shall cover small quantity, non-batch-type castings other than rotating equipment pressure-retaining parts when specified by Owner's Engineer.

Table 5: Required Examinations and Acceptance Criteria for Rotating Equipment Pressure-Retaining Components and Double Pipe and Multiple Heat Exchanger Return Bends

| Quality Level | Exam Type ⁽¹⁾ | Exam Frequency (No. of Castings) | Extent of Exam | Acceptance Standards |
|-----------------------|--------------------------|---|---|--------------------------|
| I | VT | All | 100% | VT-1 |
| | MT/PT ⁽³⁾ | All | 100% ⁽²⁾ | MT-1/PT-1 ⁽³⁾ |
| | RT | All | 100% | RT-1 |
| II | VT | All | 100% | VT-1 |
| | MT/PT ⁽³⁾ | All | 100% ⁽²⁾ | MT-2/PT-2 ⁽³⁾ |
| | RT | All | Critical areas (see Table 2: Critical Areas for Inspection of this GP) | RT-2 |
| III | VT | All | 100% | VT-1 |
| | MT/PT ⁽³⁾ | All | Critical areas (see Table 2: Critical Areas for Inspection of this GP) | MT-2/PT-2 ⁽³⁾ |
| IV | VT | All | 100% | VT-1 |
| Legend: | | | | |
| Acceptance Standards: | VT-1 | MSS SP-55 | | |
| | MT-1 | ASME/BPVC SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | | |
| | PT-1 | ASME/BPVC SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | | |
| | RT-1 | ASME/BPVC SEC VIII D1 Mandatory Appendix 7, "Examination of Steel Castings" | | |
| | MT-2 | ASME B16.34 Mandatory Appendix II, Section II-2.1, Castings" | | |
| | PT-2 | ASME B16.34 Mandatory Appendix III, Section III-2.1, "Castings" | | |
| | RT-2 | ASME B16.34 Mandatory Appendix I, Section I-2, "Acceptance Standards" | | |

Notes to [Table 5: Required Examinations and Acceptance Criteria for Rotating Equipment Pressure-Retaining Components and Double Pipe and Multipipe Heat Exchanger Return Bends](#):

- (1) Examination techniques:
 - (a) VT per [MSS SP-55](#).
 - (b) MT, PT, and RT per [ASME/BPVC SEC VIII D1](#) Mandatory Appendix 7, "Examination of Steel Castings."
 - (c) [A] When approved by Owner's Engineer, UT examination per [ASME/BPVC SEC VIII D1](#) Mandatory Appendix 7, "Examination of Steel Castings," may be used in lieu of RT where casting configurations do not allow RT.
- (2) Including machined gasket surfaces and weld bevels.
- (3) PT shall be substituted for MT for all non-magnetic alloys and low-alloy nickel steels.

7. Repairs

7-1

[A] [R] Owner's Engineer shall approve weld repair procedures for Quality Level I, II, and III castings prior to performance of such repairs. Repair procedures may be submitted for approval prior to casting.

7-2

[R] Repair and re-examination of castings shall be in accordance with the applicable ASTM standard or other standard referenced in the Purchase Order. Repair welds in carbon and low-alloy steel shall be postweld heat treated in accordance with the requirements of [ASME/BPVC SEC VIII D1](#) Subsection C, Part UCS, "Requirements for Pressure Vessels Constructed of Carbon and Low Alloy Steels," or [ASME B31.3](#). Where the requirements of the applicable standard exceed those of [ASME/BPVC SEC VIII D1](#) Subsection C, Part UCS, "Requirements for Pressure Vessels Constructed of Carbon and Low Alloy Steels," or [ASME B31.3](#), they shall govern. Welds shall meet the hardness requirements in [GP 18-10-01D](#), except that the hardness of Grade CA6NM castings shall not exceed 255 HB or Rc23. Repairs shall also be in accordance with the following:

- a. Repair welds in austenitic stainless steel shall be solution annealed.
- b. [A] Repair procedures for other materials shall require approval by Owner's Engineer.

7-3

[R] Weld repairs shall not be carried out on cast iron.

7-4

[R] All repair welds shall be reinspected to the same standard required for the original casting.

7-5

[R] Records of all major repairs shall be provided with the final equipment documentation for Quality Level I, II, and III castings.

Appendix A: Use of Niyama Criterion

A-1

This Appendix covers use of the [NS Qualification Procedure](#), which can be used to ensure quality and consistency of castings through the qualification of practitioners using casting simulation software.

Appendix A.1: General

A.1-1

Casting simulation software using the Niyama criterion shall be used during design to improve quality control. The use of the Niyama criterion shall be limited to grades CD3MN, CD4MCuN, CF8M, CN3MN, CN7M, CW6MC, CW12MW, M30C, M35-1, N3M, and WCB.

Appendix A.2: Qualification Procedure

A.2-1

Supplier shall develop a qualification procedure (as shown in the [NS Qualification Procedure](#)) that will allow practitioners to demonstrate their competent use of casting simulation using the Niyama criterion and to ensure that the final casting will be free of defects. Once the procedure is successfully completed, the practitioners are considered qualified to submit Niyama criterion results for that material.

A.2-2

The geometry for the standard casting simulation consists of a valve with a riser in a rectangular mold box. The standard casting simulation used in qualification shall employ the following parameters and guidelines:

- a. Qualification may be requested for any alloy (benchmark results are currently available for only a limited number of alloys).
- b. The mold material in the standard casting simulation is specified to be furan (resin-bonded silica) sand. It is understood that a different mold material may be used for a production casting.
- c. Mold/metal interfacial heat transfer coefficient is specified as a constant value of 800 W/(m²K) to eliminate variability resulting from the difference in selection of coefficient values. It is understood that different values may be appropriate when simulating production castings.
- d. Variability due to a filling simulation is eliminated by simulating solidification only. A prescribed initial superheat of the melt in the mold and a prescribed initial mold temperature are specified. It is understood that a filling simulation is typically needed to accurately predict temperatures and that the initial melt and mold temperatures depend on a foundry's practice.
- e. The choice of thermophysical properties (metal and mold) for this qualification is made by the person conducting the simulation. One purpose of the qualification is to establish that sufficiently accurate properties are used.
- f. A sufficiently fine numerical grid shall be used by the person conducting the simulation, such that the Niyama results are reasonably grid-independent. The time step is typically determined automatically by the simulation software and depends on the grid size, among other factors.
- g. The Niyama criterion shall always be evaluated at a temperature that is 10% of the solidification range above solidus [i.e., $T_{Ny} = T_{sol} + 0.10 \cdot (T_{liq} - T_{sol})$].
- h. Minimum Niyama values shall **always** be reported in units of (°C-sec)^{1/2}/mm.

A.2-3

Supplier shall complete the following steps to qualify its software practitioner per the defined qualification procedure below:

- a. Set up and run a standardized casting simulation.
- b. Create the Niyama contour plot and record the minimum Niyama value.

- c. Obtain the benchmark Niyama value to be used as acceptance criteria for the alloy for which qualification is requested. See the Benchmark Results for the following alloys per the procedures listed below:
- i. [NS CD3MN](#)
 - ii. [NS CD4MCuN](#)
 - iii. [NS CF8M](#)
 - iv. [NS CN3MN](#)
 - v. [NS CN7M](#)
 - vi. [NS CW6MC](#)
 - vii. [NS CW12MW](#)
 - viii. [NS M30C](#)
 - ix. [NS M35-1](#)
 - x. [NS N3M](#)
 - xi. [NS WCB](#)
- d. Compare results to the benchmark Niyama value.

Appendix A.3: Acceptance Criteria

A.3-1

If the minimum Niyama value obtained in the qualification simulation is lower than or equal to the benchmark value, then the practitioner is QUALIFIED for that alloy.

A.3-2

If the minimum Niyama value obtained in the qualification simulation is higher than the benchmark value, then the practitioner is NOT QUALIFIED for that alloy.

Appendix A.4: Documentation

A.4-1

[A] Results, including benchmark values, shall be documented on the [NS Qualification Form](#) and submitted to Purchaser for approval.

8. GP History Prior to Migration

8-1

| | | Version 1.0.0 | Date: 01/02 |
|-----------|---------------|--|-------------|
| Location | Action | Description | |
| | | Initial Publish. | |
| | | Version 1.0.0 | Date: 07/03 |
| | | Global Practice version number and format updated to comply with new process; however, original publish date remains, and no content was modified. | |
| | | Version 1.1.0 | Date: 12/04 |
| Section 3 | Modification | Table 1: Quality Level II - Item (3) was deleted. Level III: Item (2) was inserted. | |
| Section 5 | Modifications | Table 3: Quality Level II & III - Extent of Exam was modified. Table 4: Quality Level II & III - Extent of Exam was modified. Table 5: Quality Level II & III - Extent of Exam was modified. | |

| Version 1.2.0 | | Date: 12/07 |
|-----------------------------|---------------|--|
| Section 4 | Addition | Item (3) was inserted to clarify the heat treatment for Grade CA6NM. |
| Section 5 | Modification | <p>Modified Acceptance Standards for MT-2, PT-2 and RT-2 in Table 3 to read as follows:</p> <p>ASME B16.34 Annex C became ASME B16.34 Mandatory Appendix II, Section II-2.1</p> <p>ASME B16.34 Annex D became ASME B16.34 Mandatory Appendix III, Section III-2.1</p> <p>ASME B16.34 Section 8 and Annex B became ASME B16.34 Section 8 and Mandatory Appendix I, Section I-2</p> |
| Section 5 | Modification | <p>Modified Acceptance Standards for MT-2, PT-2 and RT-2 in Table 5 to read as follows:</p> <p>ASME B16.34 Annex C became ASME B16.34 Mandatory Appendix II, Section II-2.1</p> <p>ASME B16.34 Annex D became ASME B16.34 Mandatory Appendix III, Section III-2.1</p> <p>ASME B16.34 Annex B became ASME B16.34 Mandatory Appendix I, Section I-2</p> |
| Section 6 | Modification | In item (2), weld hardness requirements for Grade CA6NM were clarified. Modified Rationale. |
| All Global Practices | Modifications | <p>To standardize the format of the Global Practices and to meet other requirements, the following changes have been implemented:</p> <p>"For ExxonMobil Use Only" has been replaced with "For Company Use Only."</p> <p>A copyright waiver has been added in the first page Footer.</p> <p>The definition of asterisks in the Scope has been deleted. The asterisk is now defined in the Purpose Code attachment and is used within brackets as other Purpose Codes.</p> <p>Multiple paragraphs within a Section have been numbered. The standard text for Required References has been modified. The standard text for Additional Requirements has been modified. The Safety Purpose Code has been modified.</p> <p>The following Purpose Codes have been added:</p> <p>[*] [A] for additional information or decision required of Owner's Engineer. for approval requirements before beginning work or finalizing design.</p> |

| Version 2.0.0 | | Date: 07/14 |
|----------------------|--------------|---|
| General | | Updated Purpose Codes, Rationales, references, and unit conversions and clarified content throughout GP. |
| Scope | Modification | Updated to include double-pipe and multi-tube heat exchanger return bends. |
| Section 2 | Addition | Item (3): Added to reference the general requirements of GP 20-01-01. Item (4): Added to allow for use of Niyama criterion. |
| Table 2 | Addition | Added double-pipe and multi-tube heat exchangers to "Components." |
| Section 4 | Modification | Item (2): Modified and expanded to include ASTM A 990/A 990M, which is near equivalent to ASTM A 494/A 494M. Specified that C _b shall be less than 0.5%. |
| Section 5 | Modification | Item (3): Modified to allow greater examination frequency based on feedback from projects. Items (4) and (8): Added items based on previous table notes. |
| Tables 3, 4, 5 | Modification | Note (1): Modified. Includes allowance for UT in lieu of RT when specified by Owner's Engineer and RT is not possible. Added based on project examples where UT has successfully been used under a controlled inspection plan. Moved notes applying to entire table into items outside of the tables. |
| Section 6 | Modification | Items (1) and (2b): Updated to specify approval. Item (5): Modified to exclude requirement for Level IV castings. |
| Appendix A | Addition | Added appendix to detail a procedure for qualifying practitioners of casting simulation software for the purpose of applying the Niyama criterion. Appendix includes references to Niyama Simulation documents. |
| | | |

Record of Change

Purpose Code Definitions

10-1

| Code | Description |
|------|--|
| * | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |
| A | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| C | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| CS | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| E | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| I | Obsolete as per 2019 CIG - Assigned to paragraphs that provide only clarifying information, such as Scope statements, definitions of terms, etc. |
| M | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| O | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| R | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |

| Code | Description |
|--|---|
| S | <p>Assigned to paragraphs that contain design, fabrication and construction requirements that, if not met, can directly result in or significantly increase the risks of either:</p> <ol style="list-style-type: none"> 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). <p>Safety designation shall not be applied to paragraphs with Risk Matrix Category 4 when the incident probability and risk can be determined by the appropriate SME.</p> |
| <p>Purpose Code Hierarchy: Purpose Codes assigned to a numbered item apply to all associated subitems. Purpose codes assigned to an individual subitem apply only to that subitem.</p> | |

Positive Material Identification

GP 18-12-01D

Scope

0-1

[I] This Global Practice (GP) applies to metallic alloy materials purchased for use either directly by Owner or indirectly through Vendors, Fabricators, or Subcontractors. It includes the supply, fabrication, and erection of these materials.

0-2

[I] This GP covers the procedures and methods to ensure that the nominal chemical composition of alloy materials is in accordance with purchase specifications, and that such materials are properly analyzed and marked to indicate the alloy.

0-3

[I] Carbon steels are not within the Scope of this GP.

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1. References

1.1. Required References

1.1-1

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

1.1.1. Global Practices

1.1.1-1

1.1. Global Practices–ExxonMobil Engineering Practices

| | |
|-----------------------------|--------------------|
| GP 18-07-01 | Welding Procedures |
|-----------------------------|--------------------|

1.1.2. Industry Standards

1.1.2-1

1.3. API–American Petroleum Institute

| | |
|----------------------------|---|
| API RP 578 | Material Verification Program for New and Existing Alloy Piping Systems |
|----------------------------|---|

1.4. ASME–American Society of Mechanical Engineers

| | |
|-------------------------------|---|
| ASME SEC II A | BPVC Section II A - Materials Part A - Ferrous Material Specifications |
| ASME SEC II B | BPVC Section II B - Materials Part B - Nonferrous Material Specifications |
| ASME SEC II C | BPVC Section II C - Materials Part C - Specifications for Welding Rods, Electrodes, and Filler Metals |
| ASME SEC V | BPVC Section V - Nondestructive Examination |

1.5. ASTM–American Society for Testing and Materials

| | |
|-----------------------------------|---|
| ASTM A 193/A 193M | Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications |
| ASTM A 751 | Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products |
| ASTM E 353 | Standard Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys |
| ASTM E 354 | Standard Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys |
| | Other ASTM and National Standards, as applicable |

1.1.3. Data Sheets

1.1.3-1

1.2. ExxonMobil Data Sheets

| | |
|----------------------------|---|
| T181201C01 | Positive Material Identification - Analysis Mode Data Sheet |
|----------------------------|---|

1.1.4. Tutorials

1.1.5. Other Publications

1.2. Additional References

1.2-1

[*] This Section lists the additional Practices, codes, standards, specifications, and publications that shall be used with this document only where specified. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

1.2.1. Global Practices**1.2.2. Industry Standards****1.2.3. Tutorials****1.2.4. Other Publications****2. Acronyms and Definitions****2.1. Acronyms****2.2. Definitions****2.2-1**

| Term | [I] Definition |
|--|--|
| 100% Positive Material Identification | Each individual component and weld is tested. |
| Check (Instrument Performance) | A test carried out on a known standard alloy to verify the performance of the instrument. RATIONALE: The definition of a "check" on the accuracy of an instrument is provided to clarify that a calibration is not intended by Section 5, Item (2). |
| Inspection Lot | With the exception of bolting, an inspection lot is a group of components from the same heat number or heat treatment batch, from which a sample is drawn. For bolting, a lot is a group of similar components in terms of alloy type and size. |
| PMI Procedure | A procedure is defined as a specified series of actions, acts, or operations that have to be implemented in a specific order to continuously obtain the same Positive Material Identification (PMI) results under the same circumstances. It shall include a sequence of activities, tasks, steps, decisions, calculations and processes, that when undertaken in the sequence prescribed will produce the desired PMI analysis. |
| PMI Program | A detailed set of instructions defining the order of precedence to be followed for the successful execution of a Positive Material Identification (PMI) Plan. The program shall include the structure, process, and procedure to control operations, manage change, and define how, when and where Positive Material Identification (PMI) is to be employed for compliance with the program objectives. |
| PMIV (PMI Verified) AV (Alloy Verified) | Markings used to identify components which have been tested and confirmed to be acceptable. |
| Positive Materials Identification (PMI) | A procedure used to ensure that specified metallic alloy materials are: properly identified as to alloy type, marked according to Owner's procedures, installed as intended. |

| Term | [I] Definition |
|-----------------------------------|--|
| Representative Sampling | <p>PMI testing of a sample, which consists of one or more pieces (components), selected at random from an inspection lot, which will be examined to determine acceptability of the inspection lot.</p> <p>The size of the representative sample, and the maximum number of defective parts allowed, shall provide 90% confidence that not more than 5% of the entire lot is defective, with the following minimum sample sizes satisfying this requirement if no defective parts are found:</p> <p>100% for a lot of 28 pieces or less; 28 pieces for a lot of 50 pieces or less, 38 pieces for a lot of 150 pieces or less, and 45 pieces for a lot of 3,000 or less.</p> |
| Traceable Mill Certificate | A document that permits each component to be identified according to the original heat or material from which it was produced. |

3. Specific Applicability

3-1

[S] [E] [R] The following metallic-alloy-material items require 100% Positive Material Identification (PMI):

- a. All pressure-containing welds. For double welded joints, both weld caps, inside and outside, when accessible. On internally clad or overlaid vessels, the inside weld cap shall be PMI'd before back cladding and the result recorded on an as built and mapped vessel drawing.
- b. All Pressure-containing piping components, including the following:
 - i. Thermowells
 - ii. Instrument manifolds
 - iii. [*] Braided alloy-reinforced hoses in the service of hazardous or corrosive materials as designated by the Owner's Engineer
- c. Pressure-containing components of heat exchangers (to include the plates for plate and frame heat exchangers, except components per Section 3, Item [2]) and other pressure vessels.
- d. Plate material used as Pressure-containing components.
- e. Pressure-containing machinery components (e.g., pump casings, compressors, and process expansion drivers).
- f. Pressure-containing instrument housings in alloy piping circuits that cannot be isolated from the process environment, or housings with a design pressure above 900 psig (e.g., gauge glass housings, orifice meter tubes).
- g. External valve components (body, flanges, bonnet, plugs, and vents, and associated welds).
- h. Expansion joints and bellows in Pressure-containing service.
- i. Pressure-containing tubing which cannot be isolated from the process environment (except as excluded in Section 3, Items [2] and [4]).
- j. Fired heater coils including all welds on alloy tubes and air-cooled heat exchanger tubes (air fin tubes).
- k. Except for tubular products covered by Section 3, Item (2a) and bolting covered by Section 3, Item (2c), items designated for representative sampling PMI but which have no alloy type identification (i.e., permanent marking) shall be 100% PMI verified.
- l. Any other components or materials specifically designated for PMI on the Purchase Specification.

3-2

[E] [*] [R] The following items require PMI on a representative sampling basis, as a minimum, unless specifically exempted on the Purchase Specification:

- a. Tubular products used in the fabrication of equipment, such as heat exchangers and boilers, provided that traceable mill certification is available.
- b. Fired heater, heat exchanger, and boiler internals (tube hangers, tube supports, and tubesheets).
- c. All [ASTM A 193/A 193M](#) Grade B16 and alloy stud bolting, except as excluded in Section 3, Item (4j).
- d. Ring joint flange and clamp type (e.g., Grayloc) connector flange gaskets.
- e. Sheet products used in the fabrication of equipment, such as welded plate and frame, provided that traceable mill certification is available.

3-3

[E] [R] Internal metallic lining/cladding and weld overlay used for protection against corrosive environments shall be tested as follows:

- a. Integral cladding: 100%. One inspection for each clad component.
- b. Weld overlay, backcladding, and applied linings as specified in [GP 18-07-01](#) shall be tested before postweld heat treatment.

3-4

[C] The following items are exempt, unless specifically designated for PMI on the Purchase Order:

- a. Alloy components, where the alloy is installed for product purity consideration only. Owner shall specify PMI requirements if special alloy requirements are needed for environmental concerns.
- b. Internal machinery parts.
- c. Internal instrument parts, including orifice plates.
- d. Electrical components.
- e. Non-pressure-containing welds.
- f. Stainless steel instrument tubing and copper tubing with an outside diameter of $3/4$ in. and less, when properly identified by paint stencil (exchanger tubing is not included in this exemption).
- g. Stainless steel instruments installed in carbon steel piping circuits.
- h. Compression-type ferrules fittings and components (e.g., valves, filters, etc.) for use with $3/4$ in. outside diameter and smaller tubing.
- i. Steam tracing, instrument air, and hydraulic tubing.
- j. All [ASTM A 193/A 193M](#) Grade B7 bolting.
- k. [*] All gaskets, except as required by Section 3, Item (2d), or Owner's Representative, based on criticality of service.

3-5

[R] Supplier shall provide a documented PMI program to ensure conformance of components to the specified composition for the following items listed. This program may include segregation procedures for tested material, marking, and/or random sampling. Owner shall approve (in writing) acceptance of the supplier's PMI program for internal non-pressure-containing components (as listed in this paragraph).

- a. Internal non-pressure-containing parts.
- b. Metallic alloy components for refractory linings (e.g., refractory anchors and hex mesh) shall be covered under this requirement.

4. General Requirements

4-1

[*] [R] Fabricator or Vendor shall provide a PMI program (including a detailed PMI procedure) to comply with the requirements of this Practice and/or as specified by Owner's Engineer.

4-2

[A] [R] Owner's Engineer approval of the PMI program/procedure shall be obtained prior to the start of fabrication. Owner's Inspector shall witness tests and perform audits to ensure that PMI program requirements are met. It is the Contractor's responsibility to ensure that implementation of the PMI program is in accordance with this Practice. Owner's Engineer approval of the PMI program shall be obtained prior to the start of fabrication. The Owner's Inspector shall witness the first article and 10% random sampling of all remaining PMI testing thereafter. It is the Contractor's responsibility to ensure that implementation of the PMI program is in accordance with this Practice.

4-3

[E] [R] Records of PMI results shall be provided to Owner's Engineer as part of the As-Built documentation.

- a. For fabricated or assembled equipment, these records shall include an itemized list of all components and welds on Data Sheet [T181201C01](#), or its equivalent.
- b. Tabulation of tested items shall be keyed to As-Built drawings through the use of reference numbers.
- c. Positively identified materials shall be traceable to any required material documentation, such as mill test reports.
- d. [A] Shop fabricated equipment or assemblies that have been PMI tested in the Supplier's shop need not be verified again in the field. The Supplier's report of alloy verification shall be submitted to Owner's Engineer for review upon completion of the equipment.

4-4

[R] Materials requiring PMI (per Section 3, Items [1–3]) shall be analyzed using an acceptable method as defined in this Practice.

- a. Instruments shall be used in an analysis mode. The accuracy of the instrument shall be checked by measurement against a known standard of each alloy type. Measured values shall meet acceptance criteria per Section 5.
- b. [A] Instruments may be used in an alloy identification or alloy matching mode, when approved by Owner's Engineer. Follow-up analysis is required when alloy identification does not comply with the specified alloy.

4-5

[R] When 100% PMI is required per Section 3, Item (1), PMI testing shall be performed according to one of the following:

- a. On all components and welds, when the equipment (e.g., pipe spool, vessel, heat exchanger or heater) has been completely fabricated, but may be performed prior to PWHT.
- b. On individual components prior to fabrication, if physical access is no longer possible during final construction, provided that they are both PMI and alloy type marked. Following fabrication, all welds shall be PMI inspected per Section 4, Item (7). Alloy type marking shall meet the same requirements as described for PMIV marking in Section 6.
- c. On each individual section of reinforced hose requiring PMI (Section 3, Item [1biii]) prior to installation. Sections will be marked AV.

4-6

[R] Where representative sampling is allowed, pieces may be tested upon receipt. Such pieces shall be marked PMIV (Positive Materials Identification Verified) or AV (or Alloy Verified). Items from the same lot that are not tested shall be marked PMI.

- a. If any piece from the representative sample is unacceptable, each piece of the lot shall be examined.
- b. When a lot is found to contain unacceptable pieces, 100% of the next two lots from the same Supplier shall be examined. If both lots are acceptable, or when two successive lots are acceptable, the sampling procedure defined in Section 2 may be resumed.

4-7

[A] [R] All welds requiring PMI shall be PMI inspected, identified in the records, and marked PMIV or AV. Prior to heat treatment, painting, or insulating, Owner's Engineer shall verify that materials have been installed in accordance with the Specification. Welds requiring PMI shall be inspected according to the following:

- a. Automated welding—one sample from each girth or long seam.
- b. Manual welding—two samples from each girth section ≥ 24 in. diameter.
- c. Manual welding—one sample from each girth seam < 24 in. diameter.
- d. Autogenous welded pipe and fitting—PMI verification of only the base metal is required.
- e. Weld repair—one sample PMI testing per 24 in. of length for each weld repair.

4-8

[E] Weld Consumables:

- a. [*] Prior to use in fabrication, sample buttons shall be welded using each heat of bare wire and lot of covered or flux-cored electrodes, and PMI tested based on the approved Seller's PMI Program and Procedures. A button of bare wire is not necessary if the PMI instrument can examine wire. Button size shall be a minimum 1.0 in. diameter (25.4 mm) with a minimum $\frac{3}{8}$ in. (.375 in./9.5 mm) thickness of deposited weld metal.
- b. After successful PMI qualification, all welding consumables used for fabrication shall be segregated and uniquely identified from all other welding materials in the Seller's shop.
- c. A list of acceptable material heat, lot, and batch numbers shall be developed and clearly identified on the documentation accompanying each vessel in the Seller's shop.
- d. If the alloy is incorrect, the entire heat or lot shall be rejected.

4-9

[*] [R] Owner's Engineer shall specify the material composition of bimetallic or duplex stainless steel welds.

5. Acceptance Criteria

5-

[R] For all materials requiring PMI, acceptance criteria shall be as follows:

5-1

Analysis Mode Examination: the measured value of alloying elements shall be within 10% of the specified level or range in the applicable materials standards (example: for 5 Cr, where the allowable range is 4–6%, the measured value shall fall within the range 3.6 to 6.6%). Requirements for minor alloying elements are defined in [Table 1: Identification Elements \(1\)](#) notes.

5-2

Alloy Identification or Alloy Matching Mode Examination: the instrument shall confirm that alloys comply with the specified standard, within the accuracy given in Section 5, Item (1).

5-3

Test results shall conform to purchase documents and be properly identified to the applicable materials specifications. Materials shall be color coded in accordance with Owner's Specification, and marked per Section 6 of this Practice.

5-4

For weld metal PMI testing, or joints of similar base metals with matching filler, the acceptance criteria are based on the requirements of [ASME SEC II C](#).

5-5

[R] If PMI test results indicate that the component is not the specified material, the item shall be rejected.

- a. Whenever materials are identified as incorrect, a rejection note shall be issued indicating unacceptable materials have been supplied.
- b. Vendor or Fabricator shall be responsible for replacing the material with the correct specified material and for performing PMI on all replacement materials.
- c. Material rejected by PMI shall be marked to designate rejection using indelible ink or paint. The rejected items shall be held in a designated area to prohibit their re-use.
- d. If the PMI test results fall outside the acceptable range, using the standard instruments described in this Practice, Vendor may obtain a quantitative check analysis performed by an independent testing laboratory. If no method is referenced in the applicable materials standard, an appropriate method of chemical analysis, as specified in this Practice, shall be used. Results of this analysis shall govern.

6. Marking

6-1

[R] Each component (or weld) shall be marked immediately after PMI inspection and acceptance. Markings shall be permanent and readily visible. These markings shall be in addition to markings required by applicable Codes.

6-2

[A] Each component or weld analyzed shall be marked with the "PMIV" or "AV" code letter symbol, using a low stress stamp or other marking approved by Owner. A permanent dye or paint may be used to mark bolts and tubing. The marking shall be placed as follows:

- a. Pipe shall have two marks, 180 degrees apart, 3 in. (75 mm) from each end of each length on the outer surface of the pipe.
- b. Weld marks shall be placed adjacent to the welder's mark, directly on the weld. Welds on tubes in heat transfer shall not be stamped, but marked by either stenciling or vibro-etching.
- c. Weld overlay and backclad material may have Positive Materials Identification noted on As-Built drawings. Marking of vessel equipment is not required.
- d. Fittings and forgings shall be marked adjacent to the Supplier's markings.
- e. Valves shall be marked adjacent to the Supplier's markings on bodies and other pressure parts.
- f. Plates shall be marked adjacent to the heat numbers.
- g. Castings shall be marked adjacent to the Supplier's markings and heat numbers.
- h. Tubes for Heat Transfer Service shall be stenciled—not stamped—12 in. (300 mm) from each end.
 - i. The marking shall be done with a water-insoluble material that contains no harmful substance, such as metallic pigments (aluminum [Al], lead [Pb] and zinc [Zn], sulfur or

chlorides), that would attack or harmfully affect austenitic or nickel alloy steels at ambient or elevated temperatures.

- ii. The chloride and sulfur content of water insoluble materials shall be limited to 1% or less as determined by [ASME SEC V B SD-808](#) "Standard Test Method for Chlorine in New and Used Petroleum Products (Bomb Method)" and [ASME SEC V B SD-129](#) "Standard Test Method for Sulfur in Petroleum Products (General Bomb Method)," or equivalent.
- iii. Supplier shall submit an analysis of the marking material to the purchaser to demonstrate, by chemical analysis and history of use, that the marking material meets the requirements.
 - i. Bolting shall be marked on one end.
 - j. Nuts shall be marked on one flat.

6-3

If the material or item is too light, too small, or cannot otherwise be stamped, vibro-etching or color-coding shall be applied in conjunction with the Supplier's standard. Such shall be noted on the Alloy Verification Reports.

6-4

When heat treatment is performed after material verification, the identification marking shall be recognizable after such heat treatments. If the marking is unrecognizable, PMI testing shall be repeated.

6-5

When an alloy pipe or plate is cut after PMI testing and marking, the marking shall be transferred onto the unmarked section as described in this Section.

7. Acceptable Methods for PMI

7-1

[*] [R] Positive Materials Identification (PMI) shall verify that the alloy is as specified. When elemental analysis is carried out, minimum elements to be tested for each alloy type are listed in [Table 1: Identification Elements \(1\)](#). For alloys not included in [Table 1: Identification Elements \(1\)](#), Owner shall submit proposed elements. The instrument employed shall be used to verify the major alloy constituents of the material.

See below [Table 1: Identification Elements \(1\)](#)(1)

Table 1: Identification Elements (1)

| Materials | Identification Elements | Materials | Identification Elements |
|-------------------|-------------------------|------------------|---------------------------------------|
| C - 1/2 Mo | Mo | Alloy 20Cb-3 | C ⁽²⁾ , Cr, Ni, Mo, Cb, Cu |
| 1 Cr - 1/2 Mo | Cr, Mo | Brass, Admiralty | Sn |
| 1 1/4 Cr - 1/2 Mo | Cr, Mo | Brass, Naval | Sn |
| 2 1/4 Cr - Mo | Cr, Mo | Brass, Aluminum | Zn, Al |

| Materials | Identification Elements | Materials | Identification Elements |
|-----------------------|-------------------------------|------------------------------|---|
| 5 Cr - 1/2 Mo | Cr, Mo | 90/10 Cu/Ni | Cu, Ni |
| 7 Cr - 1/2 Mo | Cr, Mo | 70/30 Cu/Ni | Cu, Ni |
| 9 Cr - 1 Mo | Cr, Mo | Alloy 400 | Ni, Cu |
| 12 Cr (Type 405/410S) | C ⁽²⁾ , Cr | Titanium Grades 1 and 2 | Ti |
| 12 Cr (Type 410) | Cr | Grade 12 Ti | Ti, Mo ⁽²⁾ , Ni ⁽²⁾ |
| 17 Cr (Type 430) | Cr | Grade 16 Ti | Ti, Pd ⁽²⁾ |
| 25 Cr (Type 446) | Cr | Grade 26 Ti | Ti, Ru |
| 304 | Cr, Ni | Alloy 182 | Ni, Cr |
| 304L | C ⁽²⁾ , Cr, Ni | Alloy 600 | Ni, Cr |
| 304H | C ⁽²⁾ , Cr, Ni | Alloy 625 | Ni, Cr, Mo, Cb, Ti |
| 309L | C ⁽²⁾ , Cr, Ni | Alloy 800 | Ni, Cr, Al, Ti |
| 309 CbL | C ⁽²⁾ , Cr, Ni, Cb | Alloy 825 | Ni, Cr, Mo, Cu, Ti |
| 310 | Cr, Ni | AISI 4140 | C ⁽²⁾ , Cr |
| 316/317 | Cr, Ni, Mo | AISI 4340 | C ⁽²⁾ , Cr, Ni |
| 316L/317L | C ⁽²⁾ , Cr, Ni, Mo | Alloy 2205 | Cr, Ni, Mo |
| 321 | Cr, Ni, Ti | Alloy 2507 | Cr, Ni, Mo |
| 347 | Cr, Ni, Cb | 3.5, 5 and 9 Ni | Ni |
| | | Alloy C-276 | Ni, Cr, Mo, W |
| | | ASTM A533 Grades B, C, and D | Ni, Mo |

Notes to [Table 1: Identification Elements \(1\)](#):

(1) Acceptance criteria for Identification Elements shall be per Section 5, Item (1).

| Materials | Identification Elements | Materials | Identification Elements |
|---|-------------------------|-----------|-------------------------|
| <p>(2) Owner's Engineer shall specify requirements for minor alloying elements (e.g., low carbon in Type 304L SS or Type 410S SS, minor alloying elements in various grades of titanium) using guidance in Section 7, Item (4f).</p> <p>RATIONALE: The specified alloy elements listed in Table 1: Identification Elements (1) were chosen based on their contribution to the performance of the alloy. Only elements that play a substantial role in corrosion resistance or strength are identified.</p> | | | |

7-2

[R] Instruments or methods used for examination when used in either the element analysis or alloy identification mode shall include:

- a. **[A]** Testing shall be performed according to the alloy analyzer Manufacturer's procedures. Owner's Engineer shall approve any modification of such procedures.
- b. Each analyzer shall be calibrated according to Manufacturer requirements. At the beginning and end of each shift, the instrument shall be checked at least three times against a known standard for each alloy type to be inspected during the shift, using the method to be used during the shift. This check shall be performed under environmental conditions similar to the test location.
- c. Accuracy as measured against the standard shall meet requirements in Section 5, Item (1).
- d. When confirming results of alloys not correctly identified in the alloy identification mode, instruments shall provide quantitative, recordable, elemental composition results for positive identification of the alloy elements present.

7-3

[A] [R] Persons performing the PMI shall demonstrate their capabilities to the satisfaction of Owner's Engineer. Qualifications of the tester, including training and experience, shall be included in the PMI program required by Section 4, Item (1).

7-4

[A] [R] PMI shall be conducted using equipment approved by Owner's Engineer. The following are requirements to obtain approval.

- a. Equipment shall be one of the following devices suitable for the elements to be determined as required in [Table 1: Identification Elements \(1\)](#).
 - i. Use of quantitative, portable X-ray fluorescence analyzers per [API RP 578](#) paragraph 5.21
 - ii. Use of portable optical emission analyzers per [API RP 578](#) paragraph 5.22
- b. The specific device (manufacturer, model number) shall be identified within the submitted PMI procedure.
- c. Equipment shall have demonstrated as per Section 5, Item (1), $\pm 10\%$ accuracy of the actual value for all elements analyzed. This shall be documented within the submitted procedure with example data results for alloy element combinations required for the proposed job.

- d. [*] If the Owner's Engineer is not satisfied with the submitted device information for approval. A procedure for further qualification of instruments may be provided by the Owner's Engineer.
- e. Care shall be taken to not damage critical surfaces (e.g., bearings) when using optical emission analyzers.
- f. Analytical laboratories using X-ray fluorescence spectrometry, optical spectroscopy, or wet chemical analysis may be used for verification in cases where test results by other methods differ from Mill Certificate data.
- g. Suitable methods for identifying minor elements include: specialized laboratory instrumentation, suitable optical emission analyzers, traceable mill certificates, or a combination of traceable mill certificates and chemical analysis using lower measurement sensitivity.

7-5

[A] Owner's Engineer may approve PMI methods other than those listed in Section 7, Item (4) (e.g., magnetic) for austenitic stainless steel (e.g., 304SS or 316SS) base metal in cryogenic (and non-corrosive) service.

Record of Change

| Version 1.0.0 | | Date: 07/01 |
|------------------------|--------------|--|
| Location | Action | Description |
| | | Initial Publish. |
| Version 1.1.0 | | Date: 12/03 |
| Section 1.1 | Deletion | Deleted reference to GP 19-02-01. |
| Section 1.1 | Addition | Added references to GP 05-01-01 and GP 18-07-01. |
| Version 1.1.0 | | Date: 12/03 |
| | | Global Practice version number and format updated to comply with new process; however, original publish date remains, and no content was modified. |
| Version 2.0.0 | | Date: 06/05 |
| Section 3, Item (1b) | Addition | [*] Added requirement for material identification of braided hosing in critical services as specified. |
| Section 3, Item (2e) | Addition | Added requirement for PMI testing on sampling basis for refractory supports. |
| Section 4, Item (8) | Addition | Added requirement for weld consumable qualification pre-fabrication. |
| Section 7, Item (1) | Modification | Table 1: Identification Elements (1) : some material identification was modified. |
| Section 7, Item (4) | Addition | [*] Added option to permit alternative instruments to be qualified for PMI testing with an approved testing protocol. |
| Section 7, Item (4iii) | Addition | [*] Added Niton XL 800 to approved instruments list. |
| Section 7, Item (4) | Deletion | [*] Removed Niton XL 818, 2XL800 and XL 808 from approved instruments list. |
| Version 3.0.0 | | Date: 03/09 |
| Section 2 | Modification | Redefined Representative Sampling to be based on statistical confidence. Added PMI Program and PMI Procedure definitions. |
| Section 3, Item (1) | Addition | Addition of [S] Purpose Code. |
| Section 3, Item (2e) | Addition | Added requirement of representative sampling for sheet products. |

| | | |
|---|---------------|---|
| Section 3, Item (5) | Modification | Revised wording to clarify intent. |
| Section 4, Item (1) | Deletion | Removed [S] purpose code. |
| Section 4, Item (2) | Addition | Added requirements regarding witness of PMI by Owner's Inspector. Added [A]. |
| Section 4, Item (5b) | Modification | Specified requirements on final construction verification. |
| Section 4, Item (8a) | Addition | Added button size requirements. |
| Section 7, Table 1: Identification Elements (1) | Addition | Added Alloy C-276 and ASTM A533 to Table 1: Identification Elements (1) . |
| Section 7, Item (4) | Deletion | Removed approved instruments list. |
| Section 7, Item (4) | Addition | Added guidance for qualified PMI instruments. |
| All Global Practices | Modifications | <p>To standardize the format of the Global Practices and to meet other requirements, the following changes have been implemented:</p> <p>"For ExxonMobil Use Only" has been replaced with "For Company Use Only."</p> <p>A copyright waiver has been added in the first page Footer.</p> <p>The definition of asterisks in the Scope has been deleted. The asterisk is now defined in the Purpose Code attachment and is used within brackets as other Purpose Codes.</p> <p>Multiple paragraphs within a Section have been numbered.</p> <p>The standard text for Required References has been modified.</p> <p>The standard text for Additional Requirements has been modified.</p> <p>The [S] Purpose Code has been modified.</p> <p>The following Purpose Codes have been added:</p> <p>[*] for additional information or decision required of Owner's Engineer.</p> <p>[A] for approval requirements before beginning work or finalizing design.</p> |
| Version 3.1.0 | | Date: 11/13 |
| General | Modification | Updated references throughout GP. |
| Section 3, Items (1), (2), & (3) and Section 4, Items (3) & (8) | Modification | Added [E] Purpose Code. |

Purpose Code Definitions

| Code | Description |
|------|--|
| * | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |
| A | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| C | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| CS | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control Security Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS Risk Assessment for the installation. |
| E | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| M | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| O | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| R | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| S | Assigned to paragraphs that contain design, fabrication and construction requirements that, if not met, can directly result in or significantly increase the risks of either: <ol style="list-style-type: none"> A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). <p>Safety designation shall not be applied to paragraphs with Risk Matrix Category 4 when the incident probability and risk can be determined by the appropriate SME.</p> |

Purpose Code Hierarchy: Purpose Codes assigned to a numbered item apply to all associated subitems.
Purpose codes assigned to an individual subitem apply only to that subitem.

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PIPING SHOP FABRICATION, TESTING, FLUSHING, CLEANING AND FIELD ERECTION

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1. GENERAL

1.1 Scope

This Specification covers the requirements for the fabrication, heat treatment, inspection, testing, flushing, and cleaning of shop and field fabricated piping within the scope of ASME Codes listed below.

1.2 Statutory Requirements

The Purchaser and Supplier shall mutually determine the measures that must be taken to comply with all applicable governmental codes, regulations, ordinances, and rules which shall be applied as first precedence.

1.3 Documents, Codes, and Industry Standards

The following documents are referenced herein and form part of the Order. Editions of the codes and industry standards shall be as defined in the PIPING DESIGN AND LAYOUT USBT-000-TE-MP-PSP-0001.

DOCUMENTS

| | |
|--------------------------|---|
| USBT-000-TE-MP-PSP-0001, | "Piping Design and Layout" |
| USBT-000-TE-MP-SPC-0002, | "Project Addendum to General ExxonMobil Material Spec - GEMS" |
| USBT-000-TE-MP-PSP-0003, | "Pipe Support Standard" |
| USBT-000-TE-MP-PSP-0006, | "Piping Engineering Criteria" |
| USBT-000-TE-MP-SPC-0001, | "Index of Piping Material Classes" |
| USBT-000-TE-MP-PSP-0004, | "Pipe Fittings Flanges Bolting and Gaskets-Technical Notes" |
| USBT-000-TE-MP-PSP-0005, | "Piping Manual Valves-Technical Notes" |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME Boiler and Pressure Vessel Code

| | |
|---------------|--|
| Section V, | "Nondestructive Examination" |
| ASME B1.20.1, | "Pipe Threads, General Purpose (Inch)" |
| ASME B31.3, | "Process Piping" |
| ASME PCC-1 | "Pressure Boundary Bolted Flange Joint Assembly" |

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

| | |
|------------------|---|
| ASTM A36/A36M, | "Carbon Structural Steel" |
| ASTM A105/A105M, | "Carbon Steel Forgings for Piping Applications" |
| ASTM A385/385M, | "Providing High-Quality Zinc Coatings (Hot-Dip)" |
| ASTM B6, | "Zinc" |
| ASTM F1545, | "Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges" |

PIPE FABRICATION INSTITUTE (PFI)

| | |
|-----------|--------------------------|
| PFI ES-3, | "Fabricating Tolerances" |
|-----------|--------------------------|

1.4 Purpose Code Definition

This section contains purpose code definition for design requirements that shall be incorporated into Project detailed design by the FEED/EPC Contractor. These requirements may affect design, fabrication, construction, commissioning, or any combination.

- [*]: Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision.
- [A]: Assigned to paragraphs that require approval from the Owner's Engineer before the work may proceed or the design is finalized.
- [C]: Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes.
- [E]: Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil.
- [I]: Assigned to paragraphs that provide only clarifying information, such as Scope statements, definitions of terms, etc.
- [M]: Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations.
- [O]: Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design, such as during start-ups, process swings, subcomponent malfunction, etc.
- [R]: Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions.
- [S]: Assigned to paragraphs containing specifications/guidance where the primary purpose is the avoidance of incidents impacting personnel safety, process safety, and the public in general and/or involving responses to emergency situations. Any deviation from the specifications contained in such designated paragraphs requires formal review and approval according to local safety policy.

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2. MATERIALS

2.1 General

- 2.1.1. [I] Components for shop fabricated piping shall be supplied by the Purchaser (Free Issue), or purchased by the fabricator, as specified in the Purchase Order. All materials and spools through all phases of storage and fabrication shall be segregated from other Orders.
- 2.1.2. [I] Where the fabricator is designated to purchase piping materials, the material requirements of Technical Specifications USBT-000-TE-MP-PSP-0004 shall apply.
- a. [R] All materials of construction shall be new, as specified in the Order, and in accordance with all codes, standards, and specifications specified in the Order.
- 2.1.3. [R] [A] Piping components with ratings or wall thicknesses higher or lower than specified on the drawings shall not be substituted without the Purchaser's written approval.
- 2.1.4. Positive Material Identification (PMI) and Low Temperature Carbon Steel (LTCS) Traceability
- [R] Materials shall be positive material identified as specified on the USBT-000-TE-MP-SPC-0001. "Index of Piping Material Classes" and the relevant Piping Material Classes (PMC's). PMI testing requirements as defined in Technical specification.
- a. [S] LTCS Traceability
1. Each length of LTCS pipe and each LTCS nipple are required to be supplied with MTR's and die stamped with the heat number (see Section 6).
 2. Every time a pipe length is cut, the heat number must be transferred by die stamping on the cut piece.
 3. Any bulk lengths of pipe or bulk nipples shipped from the fabrication shop to the job site shall be color coded with continuous longitudinal stripes. The preferred color for LTCS is Yellow.

2.2 Welding Materials and Miscellaneous Materials

- 2.2.1. [I] The fabricator shall be responsible for purchasing welding electrodes and welding rods, which shall be in accordance with Technical Standard.
- 2.2.2. [I] In addition to consumables, the fabricator shall be responsible for purchasing and installing welded pipe supports (trunnions, shoes) and miscellaneous materials such as lugs, trunnion base plates, end plates, and insulation supports, which are not defined on the isometric bill of materials.
- a. [R] All parts requiring welding shall be of weldable quality. Carbon steel shall contain no more than 0.35% carbon. Free machining steel shall not be used.

b. [S] All parts welded to impact tested materials shall be impact tested.

2.2.3. Pipe Support Welded Attachment Materials

[A, R] Unless otherwise specified or approved by Owner's Engineer, lugs, brackets, insulation supports, or other attachments that must be welded to piping shall be of similar nominal chemical composition as the piping component to which they are attached. P1 material may be used for attachments to P3 through P5 materials that are not in hydrogen service.

3. FABRICATION

3.1 General

3.1.1. Tolerances

- a. [I] The tolerances on fabricated piping shall be in accordance with PFI Standard ES-3.
- b. [R] The maximum allowable gap between reinforcing pads and the curvature of the pipe shall not exceed 2.4 mm (3/32 in.).
- c. [R] Radial misalignment at the joining ends of piping components shall be limited to 1/8 in. (3 mm) or 1/4 of the pipe wall thickness, whichever is less.

3.1.2. Cutting Processes

[R] Nickel and nickel-copper alloy materials shall not be cut by oxygen or electric arc processes without prior written approval from the Purchaser.

3.1.3. Backing Rings

[R] Backing rings are prohibited unless specified by the Purchaser.

3.1.4. Branch Connection

Piping branch connections shall be per USBT-000-TE-MP-SPC-0002, Piping Branch Connection Details.

- 3.1.5. [R] Slip-on flanges shall be double-welded. The inside weld shall not protrude past the flange face or past the pipe inside surface. The pipe shall be set back from the flange face a distance equal to pipe wall thickness plus 3 mm (1/8 in.). In addition, the pipe-flange annulus between the welds shall be vented to the outside by a 3 mm (1/8 in.) diameter hole.

3.1.6. Field Welds

- a. [A] Changes in location or additions to any field welds specified in the Order shall not be made without prior written approval of the Purchaser.
- b. [M] Fabricator Located Field Welds: When locating field welds which cross from one area

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to another, the fabricator shall not be governed by the separation of the line into sections as shown in the Purchaser's drawings. When field welds are added in lines which pass through building walls and roofs, column lines of structures, foundations, platforms, or grade elevation, the welds shall be located at least 305 mm (12 in.) outside of or above such structural items.

- c. [M] Termination of spools where branch lines connect to headers shall be as defined in the isometrics.
- 3.1.7. [R] Longitudinal seams shall be located to clear large openings and external attachments. The longitudinal joints in adjoining components shall be staggered. For NPS 6 and above, the stagger shall not be less than 75 mm (3 in).
- 3.1.8. [M] Flange Orientation and Bolt Hole Alignment
- a. The orientation of bolt holes in pipe flanges to be connected to flanged nozzles on vessels and tanks shall be as follows:
1. When the nozzle axis lies in a plane perpendicular to the vessel axis, the bolt hole shall straddle the flange center line parallel to the vessel axis.
 2. When the nozzle axis is parallel to or coincides with the vessel axis, the bolt holes shall straddle the descriptive north-south flange center line on vertical vessels or shall straddle the vertical flange center line on horizontal vessels.
 3. When the nozzle axis is radial to the vessel head surface, the bolt holes shall straddle the flange center line lying in the plane containing the vessel axis.
 4. The orientation of nozzles not specified above shall be as specified in the Purchaser's drawings.
- b. Bolt holes in pipe flanges to be connected to flanged nozzles on exchangers shall straddle the natural center lines of the exchanger nozzles.
- c. Bolt holes in pipe flanges to be connected to flanges on piping or piping equipment shall straddle the descriptive north-south flange center line when the flange is horizontal or shall straddle the vertical center line when the flange face is vertical or inclined.
- 3.1.9. Adjacent Weld Spacing
- a. [R] The minimum distance between the edges of welds at adjacent branch connections, pipes, pads, or fittings shall be four (4) times the header nominal wall thickness or 25 mm



(1 in), whichever is greater, refer to Figure 1.

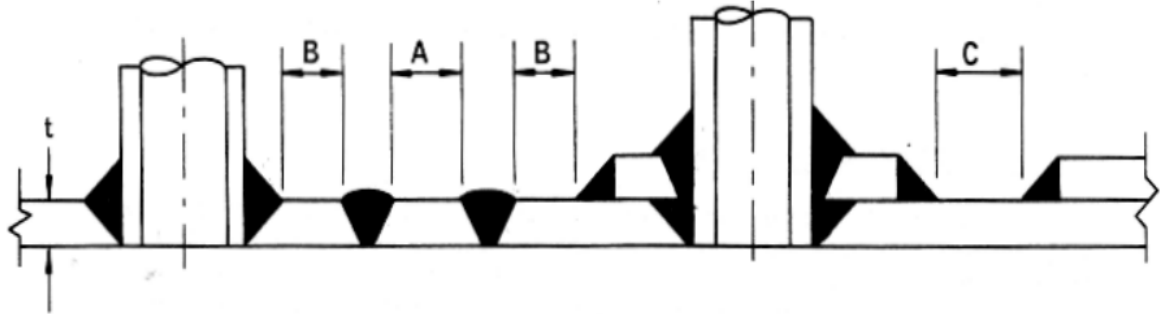


FIGURE 1: Welds Minimum Distance

- 3.1.10. [S] For girth-butt, miter, and longitudinal welds in piping, which is to be pneumatically field tested, the following requirements shall be met:
- [S] Inspection shall meet the acceptance criteria specified by ASME B31.3 for Severe Cyclic Conditions.
 - [S] All welded longitudinal joints not previously hydrotested or radiographed shall be radiographed along the entire length of the weld. Ultrasonic examination or eddy current examination may be substituted for radiography.
 - [S] All field girth-butt and miter welds shall be 100% radiographed. Welds that cannot be radiographed shall be inspected by the liquid penetrant or magnetic particle method.
- 3.1.11. [M] Piping shall be fabricated to form assemblies of the largest practicable sizes economically suitable for transportation to the job site.
- 3.1.12. [R] Stub-ends for lap-joint flanges, if fabricated by welding, shall be made with complete penetration welds.

3.2 Threading

- 3.2.1. [R] Threading of pipe shall preferably be done after bending, forging, or heat treatment operations. When this is impracticable, threading may be done prior to these operations, but precautions shall be taken to properly protect pipe threads from damage.
- 3.2.2. [I] Threads shall be concentric with the outside barrel of the pipe and shall conform to ASME B1.20.1.
- 3.2.3. [R] Taper-pipe threads (NPT) per ASME B1.20.1 shall be used for all threaded pipe joints,



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including thermowell nozzles.

3.3 Welding

3.3.1. [R] All welding shall be performed in accordance with qualified procedures approved by the Purchaser prior to fabrication. Qualified procedures shall meet the requirements of Technical Standard. The Welding Procedure Specifications (WPS) shall include the permitted internal misalignment which shall not exceed 1.6 mm (1/16 in).

3.3.2. Socket welds

[R] A gap shall be set between the pipe and the socket base prior to welding in accordance with ASME B31.3. All socket-welds shall be made using the GTAW and/or SMAW processes only and shall be made with at least two (2) passes.

3.3.3. Weldolets

[R] Installation and welding of weldolets shall be in accordance with the manufacturer's recommendations. Particular care shall be taken to assure welding to the bevel portion (weld line) of the fitting.

3.3.4. Seal Welding Threaded Connections

- a. [S][E] All threaded piping connections including threaded thermowells shall be seal welded. However, seal welding is not necessary for the following:
1. Category D fluid services as defined in ASME B31.3.
 2. Instruments or piping components that require periodic removal for maintenance.
 3. Union ring threads.
 4. Plugs and caps for drain and vent valves. Plugs and caps for drain and vent valves that are used only for hydrostatic testing and are in dangerous materials service shall be seal welded.
- b. [S] Connections requiring seal welding shall be made without the use of sealing (anti-size) compound or Polytetrafluoroethylene (PTFE) tape. All cutting oil shall be removed prior to assembly. After the joint has been tightened to normal thread engagement per ASME B1.20.1 (hand-tightened to 4 1/2 -5 threads), seal welding shall cover all exposed threads. A minimum of two weld passes is required.

3.3.5. Soft Seat Valves

[R] Welding is not permitted on valves equipped with soft seats, unless the seats have been removed or precautions recommended by Valve Manufacturer have been taken to prevent damage to the soft seats.

3.4 Pipe Bends

3.4.1. [R] Pipe bends shall comply with the following requirements:

- a. Bending shall be in accordance with PFI ES-24.
- b. The centerline radius of pipe bends shall be equal to at least three times the nominal pipe diameter. Proposals to use smaller radius pipe bends shall be submitted to the Purchaser for approval by Owner's Engineer.

3.5 Non-Metallic Piping

3.5.1. [S] Non-metallic piping (e.g., PVC, CPVC, HDPE) shall be fabricated in accordance with ASME B31.3, this specification, and the manufacturer's recommendations.

3.5.2. [R] All materials shall be new.

3.5.3. [R] Bonding shall be performed by qualified bonders using qualified Bonding Procedure Specifications (BPS). The fabricator shall be responsible for qualifying bonding procedure specifications and bonders or bonding operators in accordance with ASME B31.3.

3.5.4. [R] Joining methods such as solvent cementing, heat fusion bonding and electrofusion shall be in accordance with ASME B31.3.

3.6 Hot-Dip Galvanizing After Fabrication (HDGAF)

Where Hot Dip Galvanizing After Fabrication (HDGAF) is specified in a Piping Material Class (PMC), the following requirements shall apply.

3.6.1. [R] Piping specified to be hot-dip galvanized after fabrication shall be flanged spools without field welds. Piping NPS 2 and smaller is normally pre-galvanized, threaded construction, and field assembled. The following requirements shall apply to piping NPS 3 and larger unless specified otherwise in the PMC.

3.6.2. [R] Refer to ASTM A385/A385M for general guidelines for preparation, fabrication, and welding.

3.6.3. [R] [A] The minimum inside dimensions of the galvanizing vat shall be 12.2 m x 1.22 m x 1.22 m (40 ft. x 4 ft. x 4 ft. x 4 ft.). Any exceptions to the minimum dimensions shall be approved in writing by the Purchaser prior to award.

3.6.4. [S] Socketweld components and construction, and slip-on flanges are prohibited.

- 3.6.5. [R] [A] Welding electrodes shall be low in silicon content (approximately 0.40% or less). Weld electrode brand and chemistry and the Welding Procedure Specification (WPS) shall be submitted to the Purchaser for approval prior to any welding (see Article 3.3 above).
- 3.6.6. [R] Spools shall be limited to a single plane and terminated by flanges or by a fitting with a flange (fitting make-up). Branch connections are permitted provided they are fitting make-up terminated with a flange, except that a forged threaded branch outlet fitting (“Thredolet”) shall be used for NPS 2 and smaller branches.
- 3.6.7. [R] All welding shall be completed prior to galvanizing.
- 3.6.8. [S] Completed spools shall be hot-dip galvanized inside and outside using zinc conforming to ASTM B6, “High Grade” (i.e., 0.03% lead maximum and 0.01% cadmium maximum).
- 3.6.9. [R] The weight per unit area of coating shall be not less than 0.55 kg/m² (1.8 oz./ft²) as determined from the average of 2 test specimens, and not less than 0.49 kg/m² (1.6 oz./ft²) for each specimen. Test specimens shall be 100 mm (4 in.) long sections of pipe, 2 specimens for each pipe size being galvanized.
- 3.6.10. [R] The gasket surfaces of flanges shall be galvanized. After the galvanizing process is complete, inspect the gasket surfaces, and clean up surface irregularities by wire brushing or other suitable method. Wire brushing shall be with circular motions such that there are no radial scratches across the gasket surface.
- 3.6.11. [R] After galvanizing is completed, threads shall be cleaned of excess galvanizing or “chased” and plugged with an ASTM A105 galvanized forged steel plug.

3.7 Metallic Piping with Non-Metallic Liners

- 3.7.1. [S] Fabrication shall be in accordance with the relevant Piping Material Class(es) (PMC's) and ASTM F1545.
- 3.7.2. [R] Fabrication spools shall be shop hydrostatically pressure tested in accordance with ASTM F1545.
- 3.7.3. [R] Lined piping spools shall be shop electrostatically tested for holes (holidays) in the liner.

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3.8 Bracing of Pipe Connections Less Than NPS 2 (50 mm)

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[S] [R] Bracing requirements for piping connections $NPS \leq 1\frac{1}{2}$ (40 mm) that connect to a pipe two or more sizes larger are listed below and are summarized in Table 1: Bracing Requirements Summary.

- a. Bracing is not required for Category D fluid service.
- b. **[R]** All small piping connections that are ASME Class 900 and above shall be braced.
- c. Bracing is required for piping connections that are fabricated using a nipple, coupling (half or full), or other non-reinforced fitting welded directly to the run pipe (Figure 2: Pipe Connection Details, Detail A).
- d. For non-vibrating service, bracing is not required for piping connections fabricated with reinforced fittings (Figure 2: Pipe Connection Details, Details B-E).
- e. Bracing is required for the vibrating services listed in Table 2: Piping Connections in Vibrating Service below. However, where the valve centerline is located within 9 in. (225 mm) of the pipe wall, bracing is not required for connections that terminate at the valve, pressure gauge connections, or connections that continue as tubing $< 1/2$ in. (12 mm) in diameter for the following:
 - i. Integrally reinforced extended body valves (Figure 2: Pipe Connection Details, Detail B)
 - ii. [A] "Bridge" weld reinforced extended body valves (Figure 2: Pipe Connection Details, Detail C) – where "bridge" weld reinforcement is used to eliminate bracing, the welding requirements and procedures shall be approved by Owner's Engineer
 - iii. Integrally reinforced extended fittings ("nipolets") used with Class 800 valves (Figure 2: Pipe Connection Details, Detail D)

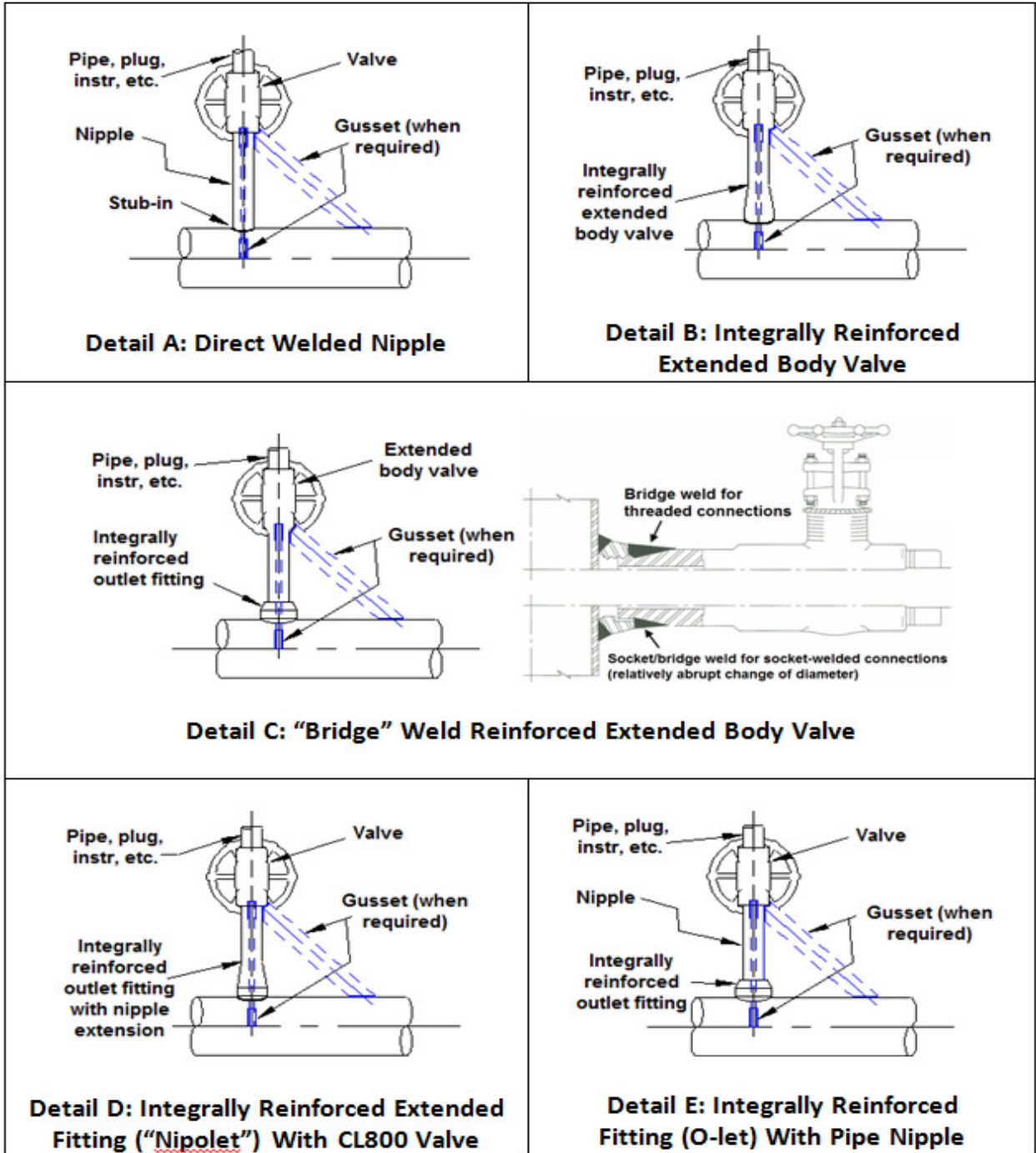


Table 1: Bracing Requirements Summary

| Fluid Service | Piping Class | Connection Type | Connection Use | Non-Vibrating | Vibrating |
|--|---|--|--|---------------|-----------|
| Cat D | All | All | All | No | No |
| Non-Cat D | < CL900 | Direct welded nipple ⁽¹⁾ | All | Yes | Yes |
| | | Integrally reinforced extended body valve ⁽²⁾ | Valve centerline within 9 in. (225 mm) of pipe wall and: Connections that terminate at valve Pressure gauge connections Connections that continue as tubing < 1/2 in. (12 mm) in dia. | No | No |
| | | "Bridge" weld reinforced extended body valve ⁽³⁾ | Valve centerline greater than 9 in. (225 mm) from pipe wall Piping or tubing ≥ 1/2 in. (12 mm) in dia. attached | No | Yes |
| | | Integrally reinforced extended fitting ("nipolet") with CL800 valve ⁽⁴⁾ | All | No | Yes |
| | Integrally reinforced fitting (o-let) with pipe nipple ⁽⁵⁾ | All | Yes | Yes | |
| | ≥ CL900 | All | All | Yes | Yes |
| Notes: | | | | | |
| (1) See Figure 2: Pipe Connection Details , Detail A | | | | | |
| (2) See Figure 2: Pipe Connection Details , Detail B | | | | | |
| (3) See Figure 2: Pipe Connection Details , Detail C | | | | | |
| (4) See Figure 2: Pipe Connection Details , Detail D | | | | | |
| (5) See Figure 2: Pipe Connection Details , Detail E | | | | | |



Figure 2: Pipe Connection Details



3.9 Clad or Weld Overlay Piping

- 3.9.1. [S] Where "Internally Clad" Piping is specified in the Piping Material Class(es) (PMC's), pipe, fittings, and flanges shall be manufactured from clad plate or by weld-overlay.
- 3.9.2. [R] [A] Clad materials and weld-overlay components shall be as specified in the PMC's, and shall meet the requirements of Technical Standard. Explosion clad material shall not be used without the prior written approval of the Purchaser.

3.10 Heat Treatment

3.10.1. [S] Required Post weld Heat Treatment (PWHT)

Unless otherwise noted, Post weld Heat Treatment (PWHT) of piping fabrication welds shall be in accordance with ASME B31.3 (or other specified code). When specified in the Piping Material Class (PMC) or on the Drawings, PWHT may be required for service for all piping wall thickness and all weld type.

- 3.10.2. [R] PWHT may be "local" or done in a furnace. However, socket weld and buttweld valves and piping with dissimilar metal welds shall not be furnace heat treated.
- 3.10.3. [R] Certain PMC's do not require mandatory PWHT, but rather they specify weld hardness control and special weld qualification procedures. If any tested weld exceeds the hardness limit specified, PWHT is required.
- 3.10.4. [R] If piping assemblies will be PWHT, seal welding shall be given the necessary heat treatment as well.
- 3.10.5. [A] [R] Heat treatment requirements for welded joints or bends of materials not covered by ASME B31.3 shall be submitted to Purchaser for approval by Owner's Engineer.
- 3.10.6. [A] [R] Proposals to weld or heat piping after final heat treatment shall be submitted to Purchaser for approval by Owner's Engineer.
- 3.10.7. [R] PWHT of welds on socket weld (SW) and buttweld (BW) valves shall be performed in accordance with Valve Manufacturer's recommendations, such that the valve internals are not damaged.

4. INSPECTION AND PRESSURE TESTING

4.1 Weld/Bond Inspection

- 4.1.1 [S] Unless specified otherwise, the inspection of pipe welds shall be in accordance with ASME B31.3 or ASME B31.1, as applicable. Purchaser shall provide a procedure for additional weld examinations when a pneumatic leak test is specified.
- 4.1.2. [R] When the liquid penetrant method is used to examine austenitic alloy steel or nickel-iron-chromium alloy materials having a design metal temperature above 399°C (750°F),

the liquid penetrant dye shall be removed with "Alconox" (manufactured by Alconox Incorporated) or other solvent or detergent cleaners provided the sulfur and chloride contents do not exceed the residue requirements of ASME Section V, Paragraph T-641. Optionally, the dye may be removed with the pre-cleaning PT agent, provided it contains no sulfur, chloride, lead, or zinc.

4.1.3. [R] All final inspection and testing shall be performed after any required PWHT per Para 341.3 ASME B31.3.

4.1.4. [R] Non-metallic piping

The acceptance criteria for bonds in non-metallic piping shall be in accordance with ASME B31.3.

4.2 Examination

4.2.1. Visual Examination

[M] Maximum allowable projections of weld metal into the pipe bore at welded butt joints shall be per ASME B31.3 and the following:

- a) The maximum internal projection shall be 1/16 in. (1.5 mm) for:
 - i. Piping NPS 2 (50 mm) and smaller
 - ii. "Pigged" lines.
 - iii. Plastic or elastomeric lined pipe
 - iv. Orifice flanges
 - v. Intake and interstage piping for reciprocating and rotary screw compressors.
- b) Internal welds for "meter tubes" shall be ground smooth and flush with the pipe inside diameter (ID).

[R] Undercutting of welds shall not be permitted in intake, recycle, interstage, and start-up bypass piping for reciprocating and rotary screw compressors.

4.2.2. Radiographic Examination

[R] All dissimilar welds (ferritic to austenitic alloys) shall be 100% shear wave ultrasonically tested UT. Radiography at the austenitic/ferritic weld prep bevel angle (multiple shots required) may be used as an alternative where shear wave UT is not possible.

4.2.3. Ultrasonic Examination

[A] [R] Ultrasonic examination may be substituted for radiographic examination when approved by Owner's Inspector. Such examination shall be in accordance with ASME B31.3

4.2.4. Magnetic Particle Examination

[A] [R] For non-magnetic materials, liquid penetrant examination may be substituted for magnetic particle examination. Such substitution may also be used for magnetic materials, with Owner's Engineer approval. This examination shall be in accordance with ASME B31.3.



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[R] Branch connection welds, not suitable for radiography, shall be in-process magnetic particle examined to the same percentages specified for radiographic examination. In-process inspection shall be performed as follows: the root pass, each 0.25 in. (6 mm) of weld deposit, and the final (cover) pass shall be magnetic particle examined.

[R] All double welded joints in magnetic materials shall be magnetic particle examined prior to back welding.

4.2.5. Liquid Penetrant Examination

[R] When liquid penetrant examination is substituted for the in-process magnetic particle examination of branch connection welds, testing shall be performed as follows: the root pass, each 0.25 in. (6 mm) of weld deposit, and final pass shall be examined by the liquid penetrant method. This examination shall be in accordance with ASME B31.3 Inspection and Testing.

[R] All double welded joints in non-magnetic materials shall be liquid penetrant examined prior to back welding.

[R] The final pass of fillet welds (non-magnetic materials only), such as socket welds, seal welds, and welds for slip-on flanges, shall be examined by the liquid penetrant method as follows:

- 100% of all welds joining Type 347 SS, duplex stainless steel, Alloy 800, Alloy 825, and Ni-based alloys
- 10% for all other non-magnetic materials
- 100% of all dissimilar welds, ferritic to austenitic alloys"

4.3 Chisel Marks, Dents, and Notches

[R] Chisel marks, clamp marks, and notches shall be blended to smooth contours with pointed or sharp corners or bottoms removed. Dents, notches, or marks which are deeper than 3 mm ($\frac{1}{8}$ in.), greater than 12 $\frac{1}{2}$ % of the nominal wall thickness, or which reduces wall thickness below the acceptable thickness shall not be accepted without prior written approval of the Purchaser.

4.4 Leak Testing

4.4.1. [R] Leak Testing Procedures

Test procedures and test schedules of lines or systems shall be approved by the Owner prior to the start of the test. Procedures shall include the following:

- Source and disposition of test fluid
- Provisions to prevent the creation of significant negative pressure (vacuum) during draining of the test fluid, etc.
- Specific lines to be included within a system test.



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- d. Provisions for temporary supports, vent, drain, fill connections, and gauge locations.
- e. Requirements for barricading of equipment that will be tested.
- f. [R] Piping containing soft-seated valves shall be flushed and drained before the valves are installed.
- g. [R] All restrictions that would interfere with filling, venting, draining, or flushing shall not be installed until after completion of the pressure test and line flushing operations. This includes orifice plates, flow nozzles, venturi tubes, variable area meters, positive displacement (PD) meters, turbine magnetic meters, strainers, and any other similar in-line equipment.
- h. [R] Instrument takeoff piping and sampling system piping, up to the first block valve, shall be leak tested with the piping or equipment to which it is connected.
- i. [R] Instrument lead lines, between the first block valve and the instruments to which they are connected, shall be leak tested to the test pressure of the associated piping/equipment. Testing may be performed separately or at the same time as the piping or equipment is tested, but the instruments shall be disconnected.

4.4.2. [R] Hydrotesting - Shop and Field

All joints, including all welds and bonds, may be primed, and painted prior to leak testing, except [*] [E] Joints located in areas identified as environmentally sensitive by Owner's Engineer.

- a. The shop fabricator shall pressure test piping only when noted in the Order as requiring a shop test. The assembler/erector shall pressure leak test all piping unless specifically excluded by the Purchaser. The test pressure and media shall be as specified by the Purchaser. Pressure testing shall be in accordance with ASME B31.3 and Purchaser Specifications. Unless specified otherwise, pressure testing of non-metallic piping shall be in accordance with ASME B31.3 and the manufacturer's recommendations.
- b. The test fluid used for hydrostatic testing shall not be detrimental to the piping or materials.
- c. When the test system includes fabricated items of austenitic materials, including austenitic stainless steel clad materials, the following shall apply:
 - 1. Only clean potable water with a maximum chloride content of 250 ppm shall be used. No salt or brackish water shall be used for cleaning or testing.
 - 2. The inside surface of pipe shall be cleaned before hydrostatic testing.
 - 3. After hydrostatic testing, all water shall be drained and removed by blowing with air. No heat or hot air shall be applied for drying.

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4. If there are portions of piping systems which cannot be completely drained or otherwise immediately removed, the system shall be flushed with demineralized water with 50 ppm maximum chloride content, or other chloride free solvent to remove the potable water.
5. All insulation in contact with austenitic stainless steel shall be kept dry at all times. Insulation, which may contact test water, shall be removed before the test, or an alternate test shall be used.
- d. All reinforcing pads and pad segments on pressure connections shall be tested with air at approximately 172 kPa (g) (25 psig). A 5 minute hold period is required after isolating the pressurized pad from the pressurizing source. During the hold period, the leak detection solution shall produce a film that does not break away from the area being tested, and the bubbles formed shall not break rapidly due to air drying or low surface tension. Soaps or detergent designed specifically for cleaning shall not be used. No pressure drop and no leaks are permitted. Test holes in pads shall not be plugged after testing.
- e. The following piping components and equipment shall not be subjected to piping system leak testing (Pressure testing):
 1. [R] Rotating machinery, such as pumps, turbines, and compressors
 2. [R] Pressure-relieving devices, such as rupture discs and pressure relief valves
 3. [R] Any equipment that does not have a specified test pressure at least as great as the piping test pressure.
 4. [R] Vessels that do not satisfy impact requirements at the piping test temperature.
 5. [R] Equipment lined with uncured phosphate or chemically bonded castable materials.
 6. [R] Locally mounted instruments and indicating pressure gauges, where the test pressure would exceed their scale range.
 7. [R] Other equipment as designated by Owner's Engineer.
 8. [R] Control valves shall be excluded from pressure testing and line flushing to protect the valves from dirt, scale, and foreign objects. The valves may be replaced with spool pieces, or the ends of the pipe blanked off, as appropriate.
 9. [R] The following shall not be tested with water:
 - a. Instrument air supply lines
 - b. Air lines to air motor operated valves
 - c. Hydraulic power piping and tubing
 - d. Lube, seal, and control oil piping



- f. [R] Underground Piping
- a. Underground pressure piping in water service and employing nonwelded girth joints (such as bell and spigot) shall be hydrostatically tested at 1.5 times the system design pressure. The test pressure shall be maintained for 2 hours while the leakage rate is measured, and the joints are inspected for leakage.
 - b. Underground non pressure sewer piping shall be tested full of water with a static head only, and the joints shall be inspected for leakage.
 - g. [R] Piping that is to be internally coated shall be hydrostatically tested prior to installation of the coating.
- 4.4.3. [S] Pneumatic Leak Testing
- a. Pneumatic testing of other than instrument air piping and tubing is acceptable only if Owner has approved the test procedure.
 - b. Pneumatic testing of spiral-welded pipe is not permissible.
- 4.5 Flushing and Cleaning**
- 4.5.1. [A] [S] The venting of drying gases utilized in the drying procedure has the potential to produce noise levels above 85 dBA. Areas with such noise levels present shall be barricaded to minimize personnel exposure. Expected noise levels shall be calculated as per directives (Noise control Design basis) to determine the areas requiring barricading. The timing and barricading of the drying procedure shall be approved by Owner's Engineer prior to venting of drying gases. Actual noise shall be measured after initiating venting of drying gases, and barricades shall be adjusted as appropriate.
- 4.5.2. [S] All chemicals used for cleaning shall have an onsite Material Safety Data Sheet (MSDS) and be approved by the Owner.
- 4.5.3. [S] If pigs are used for flushing or cleaning, then the procedures shall include a description of how personnel and equipment will be protected from the fluids or other material that may be expelled from the pipe.
- 4.5.4. [R] Static Commissioning Cleaning
- Static commissioning cleaning by chemical or mechanical means shall be performed for the following piping serving steam-generating equipment and rotating machinery:
- a. Boiler feedwater piping downstream of the deaerator.
 - b. Piping systems for machinery (carbon and low-alloy steels < 5 Cr):
 - i. Lube and seal oil systems (field fabricated piping only).
 - ii. Centrifugal and axial compressor suction piping, from the outlet of the first major vessel

upstream of the compressor to the compressor. Recycle and start-up bypass piping shall be included.

- iii. Reciprocating and rotary compressor suction and interstage piping (including vessels, exchangers, and pulsation suppression devices).
 - iv. PD pumps suction piping.
 - v. [C] Steam turbine inlet piping. For General Purpose Turbines, only the portion of the piping downstream of the Y-strainer needs to be cleaned.
- 4.5.5. [A, R] Owner shall approve procedures and schedules for piping protection after testing, flushing, draining, drying, and static commissioning cleaning until start-up.

5. PAINTING, COATING, AND INSULATION

5.1 General

- 5.1.1. [R] Following completion of inspection and testing, piping shall be coated or painted in accordance with Project Design Specification (Protective Coating Philosophy)
- 5.1.2. [R] Welded attachments to piping (supports, lugs, insulation supports) shall have the same coating as the piping.
- 5.1.3. [I] Insulation is normally done at the job site by a Subcontractor using Project Issued Specifications.

6. MARKING AND IDENTIFICATION

- 6.1 [R] When stamping is used, the stamps shall be "low-stress" steel stamps having round or "U" shaped cross sections or with "interrupted-dot" die stamps.
- 6.2 [R] Marking with paint or ink on all austenitic steels, nickel, and nickel alloys, shall be with a water insoluble material that contains no harmful substance, e.g., metallic pigments, sulfur, or chlorides, which would harmfully affect these materials at ambient or elevated temperatures. The following marking materials are acceptable to the Purchaser:
 - John P. Nissen - Low Chloride Metal Markers.
 - Carboline - 3359 Acrylic.
 - Others - Purchaser's written approval prior to use is required. Submit chemical analysis for approval. (Note: MSDS sheets are not acceptable for this purpose.)
- 6.3 [M] Fabricated parts requiring trial shop assembly shall be match-marked to facilitate erection as follows:
 - a. Match marking of piping fabricated from materials other than stainless steel shall be by means of steel dies with the markings ringed by white paint.



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| Client | USBT-000-TE-MP-PSP-0002 | | | | | | |
| Doc. No. | ExxonMobil | | | | | | |
| Client | BAYTOWN GOLD | | | | | | |
| Project | Baytown, Texas | | | | | | |
| Location | 000-General | | | | | | |
| Unit info | | | | | | | |

b. Match marking of piping fabricated from stainless steel shall be by scribing and center punch on the bevel. The location of the marks shall be indicated by a circle of water insoluble ink on the pipe 25 mm (1 in) from the bevel.

- 6.4 [M] Each spool shall be piece marked and color coded with circumferential band(s) for field sorting.
- 6.5 [M] Bulk lengths of LTCS pipe and bulk nipples shipped from the fabrication shop to the job site shall be die stamped with the heat number and color coded with continuous longitudinal stripes for material traceability. The preferred color for LTCS is Yellow.

7. ERECTION

7.1 Flange Jointing Practice

- 7.1.1. [R] Alignment Shop Pressure Testing of mating flanges shall be per the applicable code (ASME B31.1 or ASME B31.3) and ASME PCC-1 Nonmandatory Appendix E.
- 7.1.2. [R] Flange "makeup" shall be done without the use of gasket sealing compounds.
- 7.1.3. [R] All flange bolting shall be assembled with thread lubricating compound.
- 7.1.4. [R] Flange "bolt-up" procedures shall be in general alignment with ASME PCC-1 and shall be approved by Owner's Engineer.

7.2 Erection and Alignment at Rotating Machinery, Piping Larger than NPS 3

- 7.2.1. [R] [A] A detailed piping erection and alignment procedure shall be prepared for each rotating equipment machinery category and for each special purpose machinery train. Each procedure shall include the following and shall be submitted to Owner's Engineer for review and approval:
- Piping erection sequence
 - Flange alignment techniques
 - Flange bolt-up and driver(s)-to-driven machine(s) alignment pipe strain checks
- 7.2.2. [R] Flange alignment tolerances and driver-to-driven machine alignment change tolerances shall be satisfied both with and without temporary strainers installed. Where these criteria cannot be met, Contractor and Machinery Vendor shall develop a suitable resolution, such as installation of piping spools of different length to accommodate temporary strainers.
- 7.2.3. [R] The following considerations shall be addressed as part of final flange alignment and bolt-up:
- Prior to final flange alignment, all hydrostatic leak testing and line cleaning (including chemical cleaning, hydroblasting, steam blowing, and rupture disc blowdowns) shall be complete. The system shall be clean and dry. Hydrotesting blinds shall be removed.



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| Client | BAYTOWN GOLD | | | | | | |
| Project | Baytown, Texas | | | | | | |
| Location | 000-General | | | | | | |
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- b. Permanent spring supports shall be locked in the "cold load" position during piping erection, leak testing, piping alignment to machinery, and piping bolt-up.
- c. All fixed supports shall be checked with feeler gauges to ensure full contact with piping. All guides shall be checked to verify that design piping movement is not restricted.
- d. No unsupported piping shall be connected to the equipment nozzles.
- e. For field-fabricated piping, the makeup of flanged or field-welded joints shall be done progressively towards the machinery (e.g., the last flange bolted shall be the flange to the machinery).
- f. If prefabricated piping sections are used, at least one weld shall be left near the nozzle flanges for final fitting and alignment.
- g. Piping shall be free of load-imposing temporary restraints that may cause unintentional "cold springing" of the piping. Use of mechanical restraint devices for flange alignment other than to support the weight of the piping spool are prohibited.
- h. Local heating to correct minor misalignment is permitted on piping that does not require post weld heat treatment (PWHT). Piping shall be allowed to cool below 150°F (65.6°C) before bolt-up.
- i. Machined pins furnished with mating flanges shall be used to align flange bolt holes during field erection of mating piping.
- j. Final alignment of the driver to driven machine(s) shall be achieved in accordance with the required tolerances specified in the alignment procedure. This includes offsets for thermal growth or movement of the casing prior to final pipe alignment and bolt-up.
- k. Final piping alignment and driver-to-driven casing alignment or web deflection and movement on bolt-up shall be witnessed by Owner's Engineer. Records of pipe flange misalignment shall be provided for the following:
 - i. All special purpose equipment trains
 - ii. All reciprocating compressors over 200 bhp (150 kW)
 - iii. All machinery bolted to flanges of NPS 10 (DN 250) and larger.
 - iv. When specified by the Owner's Engineer.

7.2.4. [R] Equipment nozzle and mating flange alignment tolerances shall be within the following maximum permissible limits:

- a. For steam turbines and compressors other than reciprocating types, 1/64 in. (0.4 mm) for all alignment categories listed in Item (b) below.
- b. For centrifugal pumps, reciprocating compressors and other rotating machinery, refer to



Table 1

Table 2: Equipment Flange Alignment Tolerances

| Alignment Category | Maximum Permissible Misalignment of Flanged Joints, in. | | |
|---|---|---------------|----------|
| | NPS ≤ 12 | 14 ≤ NPS ≤ 22 | NPS ≥ 24 |
| 1. Vertical bolt hole offset | 1/8 | 1/16 | 1/64 |
| 2. Horizontal bolt hole offset | 1/8 | 1/16 | 1/64 |
| 3. Rotational offset | 1/8 | 1/16 | 1/64 |
| 4. Flange face parallelism (across diameter) | 1/64 | 1/64 | 1/64 |
| 5. Flange face separation, plus space required for gasket | ±1/8 | ±1/16 | ±1/64 |
| Acceptable Metric Equivalents | | | |
| in. | 1/64 | 1/16 | 1/8 |
| mm | 0.4 | 1.6 | 3 |

- 7.2.5. [R] For liquid service, final adjustments of spring supports shall be performed with the piping full of process liquid.
- 7.2.6. [R] After piping alignment is achieved for all machinery except reciprocating compressors, flange bolt-up shall be performed as follows:
- Dial indicators shall be installed on brackets installed on coupling hubs or shafts to measure vertical and horizontal movement of the driven machine(s) relative to the driver(s).
 - Starting with the largest flange size to be connected to any casing in the train, bolts and the gasket shall be installed in the flange.
 - All bolts shall first be finger tightened. Then all bolts shall be tightened to approximately half the required torque level. Next, bolts shall be tightened to an intermediate torque level, followed by tightening to the full torque level required.
 - The maximum allowable vertical or horizontal movement of the shaft on the casing to which the piping is bolted as measured relative to the adjacent shaft is 0.002 in. (0.05 mm).
 - If the shaft movement exceeds 0.002 in. (0.05 mm), all bolts in the flange shall be loosened, the gasket shall be removed, corrections to the piping or supports shall be made, and the bolt-up procedure shall be repeated.



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| Project | Baytown, Texas | | | | | | |
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| Unit info | | | | | | | |

7.2.7. [R] For reciprocating compressors, flange bolt-up shall be performed as follows:

- a. Web deflections shall be within the Manufacturer's tolerance.
- b. Steps (a) through (c) of 7.2.6 shall be performed.
- c. After bolting, rod drop of the cylinder to which the piping is being installed shall be within the Manufacturer's tolerance.

7.2.8. [A, R] When specified, alignment of the driver to driven machine(s) shall be witnessed in the hot condition. Alignment records shall be provided to Owner's Engineer for review and approval.

7.2.9. [M] The following pipe flange misalignment data, showing the effect of the piping connections on the machinery shaft alignment, shall be provided to Owner:

- a. Ambient temperature at which flange misalignment is measured.
- b. Driver-to-driven machine(s) shaft alignment (readings before, during, and after flange bolt tightening) as follows:
 - i. Radial alignment (maximum dial gauge runout measured perpendicular to the shaft on the rim of the coupling hub)
 - ii. Axial alignment (maximum dial gauge runout measured parallel to the shaft on the face of the coupling hub near the rim)
- c. Flange misalignment (final "cold" alignment and "hot" alignment when specified):
 - i. Vertical bolt hole offset.
 - ii. Horizontal bolt hole offset.
 - iii. Rotational offset
 - iv. Flange face parallelism
 - v. Flange face separation
 - vi. Reciprocating compressor web deflections

Valve Selection

GP 03-12-01D

Scope

0-1

[I] This Global Practice (GP) covers requirements for valve selection excluding control valves and pressure relief valves. Design requirements for location, accessibility, and power operation of Emergency Block Valves (EBVs) in isolation services are excluded from the scope of this GP.

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1. References

1.1. Required References

1.1-1

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply. Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.1.1. Global Practices

1.1.1-1

| GP Reference | Reference Title |
|------------------------------|---------------------------------|
| GP 03-12-09D | General Requirements for Valves |

1.1.2. Industry Standards

1.1.2-1

| Industry Standard Number | Industry Standard Title |
|-----------------------------------|---|
| API STD 594 | Check Valves: Flanged, Lug, Wafer, and Butt-Welding |
| API STD 600 | Steel Gate Valves - Flanged and Butt-Welding Ends, Bolted Bonnets |
| API STD 602 | Gate, Globe, and Check Valves for Sizes DN 100 (NPS 4) and Smaller for the Petroleum and Natural Gas Industries |
| API STD 603 | Corrosion-Resistant, Bolted Bonnet Gate Valves - Flanged and Butt-Welding Ends |
| API STD 608 | Metal Ball Valves - Flanged, Threaded, and Welding Ends |
| API STD 609 | Butterfly Valves: Double Flanged, Lug- and Wafer-Type |
| ASME B16.34 | Valves - Flanged, Threaded, and Welding End |
| ASTM A 494/A 494M | Standard Specification for Castings, Nickel and Nickel Alloy |
| ASTM A 564/A 564M | Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes |
| AWWA C504 | Rubber-Seated Butterfly Valves |

1.2. Additional References

1.2-1

[*]This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply. Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.2.1. Global Practices

1.2.1-1

| GP Reference | Reference Title |
|------------------------------|--|
| GP 03-07-01D | Piping Layout, Supports, and Flexibility |

1.2.2. Industry Standards

1.2.2-1

| Industry Standard Number | Industry Standard Title |
|----------------------------------|--|
| API SPEC 6D | Specification for Pipeline and Piping Valves |
| API STD 598 | Valve Inspection and Testing |
| API STD 607 | Fire Test for Soft-Seated Quarter-Turn Valves |
| ASME B1.20.1 | Pipe Threads, General Purpose (Inch) |
| ASME B31.3 | Process Piping |
| ASTM B 584 | Standard Specification for Copper Alloy Sand Castings for General Applications |
| AWS A5.13/A5.13M | Specification for Surfacing Electrodes for Shielded Metal Arc Welding |
| MSS SP-25 | Standard Marking System for Valves, Fittings, Flanges, and Unions |

2. Acronyms and Definitions

2.1. Definitions

2.1-1

| Term | Definition |
|---------------------------------|---|
| Auto-Ignition Temperature (AIT) | The lowest temperature required to cause self-sustaining combustion, without initiation by spark or flame. |
| Block Valve | Refers to any valve used to stop flow, typically an on/off valve. |
| Combustible Liquids | High flash liquids (flash points 100°F [38°C] or higher) when handled at temperatures 15°F (8°C) below their flash point and lower. |
| Corrosion Inhibitor | An additive to inhibit corrosion. There are active and passive corrosion inhibitors. |

| Term | Definition |
|---|---|
| Dangerous Materials | As used in this GP, dangerous materials shall include the following: a. Highly corrosive materials such as acids, caustic, and other similar materials. b. Flammable materials (including light hydrocarbons lighter than 68 degrees API). c. Boiler feedwater and steam, in systems requiring ASME Class 300 and higher flange ratings. d. Oxygen in concentrations greater than 35%. |
| Double Block and Bleed Valve | A single block valve with two independent seating surfaces, each capable of providing positive isolation when subjected to a high pressure closure test from either side of the valve in accordance with the test requirements of API STD 598. a) Gate valves capable of meeting the above test criteria are typically equipped with a body bleed and hard faced seats, and may include special wedge designs. b) Commodity API STD 600 type gate valves equipped with a flexible wedge are typically not capable of passing this test. |
| Emergency Block Valves (EBV) | Block valves in emergency isolation service for which the Owner has specified additional requirements with regard to location, accessibility, and power operation, per GP 03-07-01. |
| Fire-Tested | As used in this GP, means valve complies with API STD 607. |
| Flammable Liquids | Low-flash liquids [flash point below 100°F (38°C)] and high-flash liquids [flash point 100°F (38°C) or higher] when handled at temperatures above or within 15°F (8°C) of their flash points. |
| Flammable Materials | Flammable liquids; hydrocarbon vapors; and other vapors, such as hydrogen and carbon disulfide, that are readily ignitable when released to atmosphere. |
| Line Service Classification | Defines design pressure, design temperature, material, and corrosion allowance of a piping system. |
| Non-Dangerous Materials | As used in this GP, shall include all materials not listed as dangerous per the definition for dangerous materials in this Section. |
| Onstream Equipment Isolation | As used in this GP, indicates the removal from service of equipment or a unit for the purpose of repair, cleaning, or inspection while the remainder of the plant continues in operation. Equipment includes but is not limited to exchangers, pumps, compressors, steam turbines, dryers, vessels, and fired heaters either provided with a spare or able to be bypassed. |
| Onstream Isolation with Safety Implications | The cutting, drilling into, or unbolting of processing equipment, piping and/or vessels that exposes the interior of the equipment to the atmosphere such that there is a possibility of a resulting spill or release of hydrocarbons, chemical agents, hot pressurized or hazardous materials, or the possibility of introducing air into the equipment containing flammable or pyrophoric material. Onstream isolation with safety implications criteria apply to pieces of equipment for which the expected time to failure is less than two turnaround cycles AND for which on-line maintenance can be performed. |

| Term | Definition |
|--|---|
| Product Segregation to Prevent Contamination | The prevention of fluid mixing that would result in unacceptable contamination of either fluid. |
| Releasable Valve | A valve is releasable if it can be isolated and removed from operation to be repaired without adversely affecting the operation of the unit. |
| Segregation for Safety | Segregation of fluids that could result in a reactive or explosive mixture (e.g., at cyclic power-forming unit reactor and regeneration block valves). |
| Severe Service | As used in this GP, severe service includes process conditions that result in cavitation, flashing, highly cyclic operations, erosive conditions, and/or high differential pressure. This term is typically applicable to valves. |
| Slurry Service | Streams having a solids content greater than 0.1 lb/gal (11.98 kg/m ³). |
| Soft Seals | Defined as resilient nonmetallic sealing elements located in the body seating and/or closure components. |
| Toxic Material | <p>1. Toxic Chemicals: Chemicals that cause damage to humans and for which an exposure limit (TLV or OEL) has been established by ACGIH, NIOSH, EMBSI, or other relevant regulatory agency (such as US EPA). These substances may cause significant negative impact (for example, severe inflammation, shock, collapse, or even sudden death) if humans are exposed to sufficiently high concentrations for a sufficiently long period of time. The concentrations of toxic chemical which would create a significant risk will vary by chemical and potential exposure time. Examples of toxic chemicals include but are not limited to the following: Benzene, Xylene, 1,3-Butadiene, Hexane, Chlorine, Bromine, Ammonia, Carbon Disulfide, Hydrogen Chloride, Hydrogen Sulfide, Sulfur Dioxide, and Hydrogen Fluoride.</p> <p>2. Toxic Gas/Vapor Service : Any gas or vapor stream containing a toxic chemical above a specific concentration defined by regulation or depending on the system under consideration. A stream shall be considered to be in toxic gas or vapor service if the material released could result in a concentration in air equal to or above the TLV (Threshold Limit Value) or OEL (Occupational Exposure Limit) for the toxic gas/vapor at the nearest location of exposure. The following are links to the TLV and OEL lists, respectively: http://emre.na.xom.com/info-ctr/ACGIH/index.htm, http://emre.na.xom.com/OEL/OEL/currentoel.htm</p> <p>3. Toxic Liquids: Liquids that can cause adverse health effects in humans as a result of exposure such as by inhalation of an aerosol, by ingestion, or by dermal absorption. Any liquid (product or process stream) containing a toxic chemical and which, if the material were to be released, would potentially result in a hazard. The concentration of toxic chemical needed to create a significant risk will vary by chemical and potential exposure time.</p> |

| Term | Definition |
|-----------------------|--|
| Valve End Connections | <p>Wafer or flangeless type: A flangeless valve body (exclusive of the valve bonnet area) that is centered within the pipe flange bolt circle, leaving the bolts exposed to the atmosphere. The valve is held in position only by the compressive forces from mating pipe flanges. Lug type: A flangeless valve body that is equipped with lugs (either through drilled or threaded) to allow for bolt-up and positioning between pipe flanges. Flanged type: A flanged valve intended for conventional bolt-up to mating pipe flanges. Such valves can be either single flange type or equipped with body end flanges. Welding end (buttweld end) type: A valve body intended for installation by full penetration welding. Threaded and/or socket weld type: A valve body intended for installation by threading or socket welding. Typically associated with small diameter valves per API STD 602.</p> |
| Wet H2S | Defined as greater than 50 wppm of H2S in a water phase (determined by using the total amount of sulfide in the water phase) or 0.05 psia (0.34 kPa abs) H2S partial pressure in the gas phase with liquid water present. |

3. Materials

3-1

[*] [R] Unless otherwise specified by Owner, trim material selection for carbon steel or low alloy (up to 9% chrome) gate valves shall be in accordance with [Table 1: Trim Requirements for Carbon Steel and Low Alloy Gate Valves](#).

Table 1: Trim Requirements for Carbon Steel and Low Alloy Gate Valves

| Service | Nominal Trim Material (per API STD 600) ⁽²⁾ ⁽³⁾ |
|--|---|
| Caustic | Trim #8 |
| Water, air, or inert gas | Trim #8 |
| Hydrocarbon service 68 deg API (0.709 relative density) and heavier and other lubricating type service | Trim #8 |
| Hydrocarbon service lighter than 68 deg API including vapor (non-lubricating service) | |
| Up to 900°F (480°C) maximum fluid design temperature | Trim #8 |
| Over 900°F (480°C) maximum fluid design temperature | Trim #5 |
| Isolation valves in powerformer reaction and regeneration service | Trim #5 |

| | |
|---|--------------------------|
| Steam, boiler feedwater, and condensate Class 150 and 300 Class 600 and higher | Trim #8 Trim #5 |
| Wet H ₂ S ⁽¹⁾ | Trim #2, #5, #8, #9, #12 |
| Process streams containing either amines or Flexsorb SE, plus H ₂ S ⁽¹⁾ | Trim #5 |
| Oxygen in concentrations greater than 35% | Trim #9 |
| Hydrofluoric Acid | Trim #9 |
| Single isolation valves used in double block and bleed applications per Table 6: Double Gate Valve Requirements | Trim #5 |
| Isolation valves used for highly corrosive materials (such as acids and caustics) at temperatures up to 200°F (95°C) | Trim #5 |
| Notes: | |
| (1) For wet H ₂ S services, see hardness requirements stipulated in GP 03-12-09D . | |
| (2) For hydrocarbon and general process services, API STD 600 Trim #5 is always an acceptable substitute (upgrade) for Trim #8. | |
| (3) Trim items include the valve stem, the gate and body (or seat ring) seat surfaces, and the backseat stem contact surface. | |

3-2

[*] [R] Austenitic stainless steel (Types 304, 316, 321, and 347), Duplex, Monel, and nickel alloy valves shall have trim, gland bolts and nuts, and yoke bolting of the same nominal chemistry as the body. In services where [Table 1: Trim Requirements for Carbon Steel and Low Alloy Gate Valves](#) of this GP requires Trim #5, [AWS A5.13/A5.13M](#) E/R CoCr-A hardfacing shall be provided for body and gate seats. Unless otherwise specified by the Owner, [AWS A5.13/A5.13M](#) E/R CoCr-A hardfacing is an acceptable alternative for seating surfaces.

3-3

[R] Material for valve stem packing and seals shall comply with the following:

- a. Materials shall be suitable for the fluid service and for the maximum and minimum fluid design temperatures to which these components will be exposed. As a minimum, stem packing for valves in hydrocarbon or steam service shall be suitable for 1000°F (538°C) process temperature.
- b. [*] For all non-oxidizing environments and for oxidizing environments ≤ 1000°F (538°C) process temperature, pure graphite (minimum 95% carbon content) packing and interlaced braided graphite end retainer rings shall be used unless otherwise specified. Density of graphite preformed rings shall be 70 to 90 lb/ft³ (1120 to 1440 kg/m³). All packing rings shall contain corrosion inhibitor.
- c. [*] Except for certain acid services and oxygen, fire-tested valve stem packing materials shall be used in flammable, combustible, or dangerous material services.

3-4

[*] [R] Cast Monel valve material shall be specified per [ASTM A 494/A 494M](#) Grade M-35-1 or Grade M-30C. Cast Monel valve materials for hydrofluoric acid service shall be Grade M-35-1 with additional requirements as specified by the Owner.

3-5

[S] [*] Limitations on the use of copper, and copper-based alloys, shall be as given below for the following services:

- a. Ammonia: Alloys with a copper content greater than 50% shall not be used in ammonia service or in aqueous solutions containing ammonia where the pH exceeds 8.5.
- b. Caustic and alkaline: Alloys with a copper content less than 85% shall not be used.
- c. Acetylene: Alloys with a copper content greater than 50% shall not be used in services where acetylene in a wet environment is present.

3-6

[R] 17-4PH stainless steel valve stems, shafts, hinge pins, and their integral components shall not be used for design temperatures greater than 750°F (400°C). 17-4PH stainless steel is an acceptable substitute for 13 Cr when the material and heat treatment comply with [ASTM A 564/A 564M](#), Type 630, condition H 1150M, double tempered.

3-7

[R] Monel shall not be used in any streams containing sulfur compounds above 400°F (204°C) or Catacarb service.

3-8

[R] For butterfly valves for water service, valve materials shall be per [AWWA C504](#) except as modified in [Table 2: Modifications to AWWA C504](#) of this GP.

Table 2: Modifications to AWWA C504

| [*] Service ⁽¹⁾ | | Body Lining | Shaft | Disc |
|----------------------------|----------------------------|---|---|--|
| Fresh Water | Not Throttled | Buna-N rubber seat (full lining not required) | Monel; or Austenitic Stainless Steel | Bronze; or Austenitic Stainless Steel |
| | Throttled | Buna-N rubber | | |
| Brackish Water | Not Throttled | Buna-N rubber | Monel; or Type 316 Stainless Steel; or Duplex Stainless Steel | Bronze per ASTM B 584 Alloy C90500; or Type 316 Stainless Steel ⁽²⁾ |
| | Throttled | | | Monel; or Type 316 Stainless Steel ⁽²⁾ |
| Sea Water | Throttled or not throttled | Buna-N rubber | Monel; or Super Duplex Stainless Steel | Monel, or Super Duplex Stainless Steel |

Notes:

- (1) A valve is considered to be in throttling service when the disc is at an angle greater than 10 degrees from the full open position during normal operation.
- (2) Type 316 stainless steel shall not be used in services where the fluid (line) velocity, with the disc in its normal operating position, is less than 3 ft/sec (0.9 m/s) or where the disc is normally closed.

4. Application and Limitations on Use

4.1. General

4.1-1

[S] All valves shall be suitable for the line service classification.

4.1-2

[S] Single or double valves at a classification change shall be suitable for the more severe line classification on either side of the valve(s) location.

4.1-3

[S] Valves around control valves (upstream, downstream, and bypass) shall be of the same Class rating as the most severe line classification.

4.1-4

[E] All valves shall be specified to meet any local regulatory requirements for fugitive emission leak limits.

4.1-5

[*] [O] [R] Gate and globe valves shall have flanged ends, bolted bonnet, and shall be OS&Y (outside screw and yoke). Deviations from these requirements, if any, shall be specified.

4.2. Compact and Extended Body Steel Valves

4.2-1

[R] Threaded and socket welding steel gate, globe and check valves per [API STD 602](#) may be used within the following limits:

- a. Gate valves shall be OS&Y.
- b. The specified line corrosion allowance is $\frac{1}{8}$ in. (3 mm) or less; or, if the specified valves have a thickness in excess of the minimum [API STD 602](#) specified thickness, the additional thickness may be considered as additional corrosion allowance.
- c. [*] Valves shall be bolted bonnet unless welded bonnet is specified. Bonnet welds shall be maximum 225 Brinell hardness.

4.2-2

[A] [R] If [API STD 602](#) flanged valves are used, the flanges shall be integrally forged, unless welded-on flanges are approved by the Owner's Engineer.

4.3. Nodular Iron, Cast Iron, Aluminum, and Copper-Based Alloy Valves

4.3-1

[S] [A] [R] Nodular (ductile) iron valves, either austenitic or ferritic, shall only be used within the limits of [ASME B31.3](#) provided the installation is approved by the Owner's Engineer. Usage in hydrocarbon or dangerous material services requires approval by the Owner's Engineer.

4.3-2

[S] [R] Cast iron valves may only be used in water service not subject to freezing.

4.3-3

[S] [R] Aluminum and copper-based alloy valves (e.g., brass or bronze) which experience significant loss of mechanical properties at elevated temperatures shall not be used in the following services:

- a. Services in which failure of the valve in a fire would increase the hazardous condition (Examples: Prevent steam flow to any process pump, steam header, or emergency steam line)
- b. In hydrocarbon service

4.4. Soft-Seated Valves

4.4-1

[*] [R] When specified, pressure relief for body cavities shall be provided for soft-seated valves in liquid service. The liquid shall be relieved to the upstream side, unless otherwise specified.

4.4-2

[R] The maximum design temperature for soft seal material shall be limited to the lesser of the following:

- a. The pressure-temperature rating specified by the valve manufacturer
- b. The temperature limits as given in [Table 3: Soft Seal Material Temperature Limits](#) of this GP.

Table 3: Soft Seal Material Temperature Limits

| Soft Seal Material | Temperature Limit | |
|--------------------|-------------------|-----|
| | °F | °C |
| BUNA N | 250 | 120 |
| EPDM | 300 | 150 |
| FEP | 400 | 200 |
| FKM [Viton (r)] | 400 | 200 |
| FFKM [Kalrez(r)] | 400 | 200 |
| NEOPRENE | 200 | 90 |
| PEEK | 480 | 250 |
| PTFE | 450 | 230 |

4.4-3

[S] [*] Non-fire-tested type ball, plug, or butterfly valves shall not be used in flammable material or other

dangerous material services regardless of operating temperature, except for certain acid services as specified by the Owner's Engineer.

4.4-4

[S] Fire-tested type ball, plug, and butterfly valves greater than NPS 4 shall not be used as the first block valve for the holdup of large volumes of dangerous liquid materials (> 10,000 gal [38,000 l] liquid holdup).

4.4-5

[S] Fire-tested butterfly valves per [API STD 609](#) Category B shall not be used in dangerous material services, and other process and general services unless the design is bi-directional or meets the design temperatures and pressures specified for both the preferred and non-preferred flow directions.

4.4-6

[S] Soft-seated ball, plug, and butterfly valves NPS 2 and larger shall not be used as block valves to the atmosphere.

4.5. Butterfly Valves—General

4.5-1

[R] Where butterfly valves are used as the first valve next to process equipment that requires depressurizing and removal for maintenance or other purposes, the valves shall be of the flanged type.

4.5-2

[R] Butterfly valves shall be limited to NPS 3 and larger.

4.6. Soft-Sealed Butterfly Valves—Fire-Tested

4.6-1

[*] [R] Unless otherwise specified, shaft material shall be as follows:

- a. 13Cr, except for valves with austenitic stainless steel bodies
- b. 18Cr 8Ni for valves with austenitic stainless steel bodies

4.6-2

[*] [R] Unless otherwise specified, disc material shall be as follows:

- a. 18Cr 8Ni
- b. Carbon steel, overlaid with 18Cr 8Ni, 0.060 in. (1.5 mm) minimum finished thickness
- c. Cr plated discs are not acceptable.

4.6-3

[*] [R] [AWS A5.13/A5.13M](#) E/R CoCr-A hardfacing shall be provided on seating surfaces when specified.

4.7. Butterfly Valves for Water Service

4.7-1

[R] Rubber lining of valve bodies shall be as follows:

- a. The wetted surfaces of valve bodies shall be fully lined, except that only a bonded rubber seat insert is required for non-throttling fresh water services.
- b. The lining shall extend across the full flange face and shall have a minimum thickness of $\frac{1}{4}$ in. (6 mm).
- c. The rubber lining shall be 100% bonded to the body, flange, and the metal seat insert, if any. The lining-to-seat bond shall be capable of withstanding a 160 psi (1100 kPa) tensile load.

- d. The minimum thickness of rubber at the body seating surface shall be as given in [Table 4: Minimum Rubber Thicknesses](#) of this GP.

Table 4: Minimum Rubber Thicknesses

| Valve Nominal Size | | Minimum Rubber Thickness | | | |
|--------------------|-----------|--------------------------|----|---------------|----|
| | | 90 Degree Seating | | Angle Seating | |
| in. | mm | in. | mm | in. | mm |
| 3–4 | 80–100 | 1/4 | 6 | 5/16 | 8 |
| 6 | 150 | 5/16 | 8 | 5/16 | 8 |
| 8–10 | 200–250 | 3/8 | 9 | 5/16 | 8 |
| 12–14 | 300–350 | 7/16 | 11 | 3/8 | 9 |
| 16–20 | 400–500 | 1/2 | 13 | 3/8 | 9 |
| 24 | 600 | 3/4 | 19 | 1/2 | 13 |
| 30–48 | 750–1200 | 1 | 25 | 1/2 | 13 |
| 54–72 | 1350–1800 | 1 | 25 | 5/8 | 16 |

4.8. Reduced Port Valves

4.8-1

[C] [R] Reduced port or smaller than line size valves (with reducers) may be used instead of full port valves, provided that:

- The increased pressure drop and reduced section modulus is considered in the design of the piping.
- Such valves are not used in horizontal lines sloped for continuous draining.
- [S] Drains are installed at all additional low points caused by the installation of such valves.
- They are not used in erosive applications such as slurries, fluidized solids, or severe fouling or coking services.
- [S] They are not used in pressure relief valve inlet or outlet piping, or in flare headers.
- They are not used in lines specified to be pigged.

4.9. Wafer and Lug Type Valves

4.9-1

[S] Wafer type valves shall not be used in hydrocarbon or dangerous materials service.

4.9-2

[S] Wafer or lug type valves shall not be used as the first block valve against storage tanks or vessels.

4.9-3

[S] Wafer (flangeless) and lug type valves shall not be used in any service with a design temperature above 600°F (315°C) or above the auto-ignition temperature of the fluid, whichever is lower.

4.9-4

[S] For design temperature exceeding 400°F (200°C) the body material of wafer or lug type valves shall have the same nominal coefficient of thermal expansion as the bolting material and adjacent flanges.

4.10. Check Valves**4.10-1**

[R] Dual and single plate check valves per [API STD 594](#) shall not be used in reciprocating compressor or reciprocating pump service.

4.10-2

[R] Union bonnet ball check and lift check valves (straight-through type) use shall be limited to portions of piping systems where pipe unions are permissible.

4.10-3

[R] Swing, ball and piston (lift) type check valves shall be of the self-closing type and shall not depend on flow reversal or a spring to effect closure.

4.10-4

[R] Check valves shall not be used in down-flow applications.

4.10-5

[R] Lift check valves shall not be used in services subject to fouling, coking deposits, or erosion.

4.10-6

[R] The need for and design of external assist or damping devices for the specified check valve type in a specific compressor discharge service shall be based on the full range of operating flow conditions.

4.10-7

[R] For design temperature > 600°F (315°C), threaded retainer plugs for hinge pins shall be seal-welded if valves are in flammable material service.

4.11. Knife Gate Valves**4.11-1**

[R] Knife gate valves shall not be used in dangerous material service.

4.12. Ball Valves**4.12-1**

[R] Ball valves shall be per [API STD 608](#) when applicable.

4.12-2

[A] [R] The use of balls and seats with hard-chromium, electroless nickel, tungsten-carbide, chromium-boride, or other similar hard coatings to improve erosion resistance shall be approved by the Owner's Engineer and be subject to the following limitations:

- a. Such coatings (plating) shall not be applied on a carbon steel base.
- b. Hard chrome plating shall have a minimum thickness of 0.002 in. (0.05 mm).
- c. The base material of the ball and seat shall be compatible with the fluid service.

4.12-3

[S] [*] [A] All valves with hollow-ball construction in liquid service shall be provided with pressure relief

for the body cavity. Pressure shall relieve to the upstream side of the valve unless otherwise specified. The final design shall be approved by the Owner's Engineer.

4.12-4

[S] Valve handle shall be heat resistant and capable of withstanding direct exposure to fire without becoming unusable.

4.12-5

[S] Two piece ball valves with threaded body designs shall have the threaded body joint seal-welded to protect against disassembly under pressure.

4.13. Emergency Block Valves in Isolation Service (All Valve Types)

4.13-1

[S] [A] Valves shall be flanged, unless buttwelding end valves are approved by the Owner's Engineer.

4.13-2

[S] [A] Plug valves shall be lubricated fire-tested type, and require the Owner's Engineer approval, except that expanding seal fire-tested plug valves may be used in clean, non-corrosive services.

4.13-3

[S] Metal-seated ball valves, or metal-seated and fire-tested butterfly valves, shall have graphite packing and graphite body gaskets (when used).

4.13-4

[S] [*] Fire-tested soft-seated ball, plug, or butterfly valves may be used as EBVs in hydrocarbon service and in dangerous or flammable service, up to NPS 4.

4.13-5

[S] Chainwheel operation is not permitted.

4.14. Valves for Low Temperature Service

4.14-1

[R] Valves in low temperature service shall be equipped with extended bonnets as follows:

- a. [S] EBVs with a design temperature below -50°F (-46°C)
- b. Valves specified to be operable at or below -100°F (-73°C)
- c. [*] When specified by the Owner's Engineer

4.14-2

[R] Valves equipped with extended bonnets shall meet the following:

- a. Valves shall be oriented with the stem at or above horizontal.
- b. Valves specified to be in liquid service shall be oriented with the stem within 30 degrees of vertical.
- c. [*] [C] The bonnet extension and stem shall be the manufacturer's standard design for cold service unless a longer extension is specified.
- d. Extended bonnets shall not be insulated.

4.15. Pressure Relief for Valves in Liquid Service

4.15-1

[S] [*] Double-seated valves (excluding metal-seated flanged bonnet gate valves) that are specified to be in liquid service shall have adequate provision for pressure relief of the bonnet cavity.

4.15-2

[S] [*] All double-seated pressure seal valves and NPS 3 and larger welded bonnet valves shall have provision for pressure relief of the bonnet cavity, unless "vapor service only" has been specified.

4.15-3

[S] Metal-seated flanged bonnet gate valves shall have provision for pressure relief of the bonnet cavity when used in liquid cryogenic service or in applications where there is a significant risk of bonnet cavity overpressure due to rapid heat up and expansion of trapped liquid.

4.15-4

[S] When bonnet cavity pressure relief is required, it shall be provided for both the "valve closed" and "valve open" position.

4.15-5

[*] [R] Where bonnet cavity pressure relief is provided, the pressure shall relieve to the upstream side unless otherwise specified.

4.16. Pressure Seal Bonnet Valves**4.16-1**

[A] [R] The Owner's Engineer shall approve the use of pressure seal bonnet valves. Their use is limited to Class 900 and higher, and proposals shall address suitability in corrosive services.

4.17. End Connections**4.17-1**

[R] Threaded and socket welding end connections shall be limited to NPS 2 and smaller.

4.17-2

[R] Valves larger than NPS 2 shall be flanged except:

- a. Steam services requiring Class 600 and above may have buttweld ends.
- b. [A] Use of buttweld ends for services other than steam for Class 600 and above shall require Owner's Engineer approval.

4.17-3

[R] Surface finish on raised face flanges shall be 125 to 250 micro inches Ra.

4.17-4

[A] [R] Valves equipped with clamp type end connections shall have body face to face dimensions per [API SPEC 6D](#). The use of welded-on end connectors shall require Owner's Engineer's approval.

4.18. Threaded Openings and Plugs**4.18-1**

[E] [R] Threads shall be per [ASME B1.20.1](#).

4.18-2

[E] [A] [R] All threaded openings shall be plugged with solid, round or square head plugs of wrought material having the same nominal composition as the body or a comparable material approved by the Owner's Engineer. Plugs shall not be made from cast material.

4.19. Valve Position Indicators**4.19-1**

[R] For slurry service a valve indicator shall be provided that gives position indication of the fully closed position.

4.19-2

[A] [R] All quarter turn valves shall have an approved method for valve position indication. Manual

operators shall be designed so that they can only be installed one way on the valve stem. Its position shall indicate the status of open/close position.

5. Manual Gear Operators for Valves

5-1

[*] [O] Manual gear operators shall be supplied for valves per [Table 5: Size Requirements for Gear Operators](#) of this GP. Gate and globe valves shown in [Table 5: Size Requirements for Gear Operators](#) shall be supplied with gear operators only if they are operated more than four times a year or are designated as critical valves.

Table 5: Size Requirements for Gear Operators

| Class Rating | Valve Type and Minimum Size (NPS) | | | | | |
|---------------|-----------------------------------|-----|--------------|-----|-----------|----------|
| | Gate or Globe | | Ball or Plug | | Butterfly | |
| | in. | mm | in. | mm | in. | mm |
| 125, 150, 250 | 14 | 350 | 6 | 150 | 6 | 150 |
| 300 Note (1) | 10 | 250 | 6 | 150 | 6 | 150 |
| 400 | 8 | 200 | 6 | 150 | 4 | 100 |
| 600 | 8 | 200 | 6 | 150 | 4 | 100 |
| 900 | 6 | 150 | 4 | 100 | Note (2) | Note (2) |
| 1500 | 4 | 100 | 3 | 80 | Note (2) | Note (2) |
| 2500 | 3 | 80 | 3 | 80 | Note (2) | Note (2) |

Notes:

(1) Includes ASME Class 300 ductile iron.

(2) This valve type not generally available above ASME Class 600.

5-2

[O] A gear operator is required for quarter turn valves with a manufacturer's closing torque exceeding 80 ft-lbs (11 kg-m) and for all torque-seated (triple offset per [API STD 609](#) Category B) butterfly valves in all sizes.

5-3

[O] The rim pull for manual gear operators shall not exceed 80 lbs (36 kg).

5-4

[R] Use of valve chainwheels shall be minimized.

5-5

[S] Valve chainwheels shall be equipped with a suitable safety retaining device (such as a chain or cable) to prevent a failed chainwheel assembly from falling off the valve and striking an operator working directly beneath the valve.

6. Block and Bleed Valves

6-1

[I] This Section provides additional valve requirements for the following services and applications:

- a. Onstream equipment isolation (including instruments)
- b. Product segregation to prevent contamination
- c. Segregation for safety
- d. Slurry service
- e. General (other) service applications

6.1. Block Valves

6.1-1

[R] Double gate valves, or single gate valve alternatives (where permitted) shall be provided for "Onstream Equipment Isolation" in accordance with [Table 6: Double Gate Valve Requirements](#) and as follows:

- a. [*] [A] With Owner's approval, single gate valve alternatives may be used for line class 150 and line class 300 piping. Such valves shall be tested for double block and bleed capability per [API STD 598](#). The test medium shall be water unless an alternative test fluid is specified by the Owner's Engineer. The test duration shall be a minimum of 2 minutes.
- b. [A] A single gate valve without proven double block and bleed capability may be used when justified by a risk assessment conducted by the Owner for the specific application, or by successful experience with the specific service involved. In such cases, the double block and bleed closure test may be waived with Owner's approval.

6.1-2

[*] [A] [R] Use of other single or double block valve types as an alternative to the use of conventional gate valves for onstream equipment isolation applications per [Table 6: Double Gate Valve Requirements](#) shall be approved by the Owner. Single block valve alternatives may include special gate valves that are designed to exceed [API STD 600](#) or [API STD 602](#) minimum requirements, or ball and plug valve designs that are capable of providing double block and bleed isolation. These valves shall be closure tested for double block and bleed per [API STD 598](#) except that the Owner's Engineer shall specify the test pressure for the double block and bleed test.

6.1-3

[*] [A] [R] Where a single valve is used for "Product Segregation to Prevent Contamination" per [Table 6: Double Gate Valve Requirements](#), the valve shall be a special "double block and bleed" type gate, or alternatively, a soft-seated plug or ball type. A closure test for double block and bleed per [API STD 598](#) is required, with the test pressure equal to the valve design pressure specified by the Owner. Subject to Owner's approval, the use of a single resilient seated butterfly valve is permitted where zero leakage has been demonstrated by past experience or special testing and where leak detection facilities are provided. In this case a body bleed is not required.

6.1-4

[S] Requirements for valves used for "Segregation for Safety" or for "Onstream Isolation with Safety Implications" shall be per [Table 6: Double Gate Valve Requirements](#) for gate valves and as follows:

- a. All gate valve seat rings shall be seal-welded to the valve body.
- b. Gate valve backseat bushing shall be hardfaced with CoCr-A. Additionally, wedge guides shall be hardfaced with CoCr-A for valves cycling ten or more times per year.
- c. Both wedge gate and seats shall be hardfaced with CoCr-A for non-13 Cr trim materials selected in accordance with [Table 1: Trim Requirements for Carbon Steel and Low Alloy Gate Valves](#).
- d. The use of a single "double block and bleed" gate valve alternative is not permitted for [Table 6: Double Gate Valve Requirements](#) "Segregation for Safety" applications.
- e. [A] For services identified under "Segregation for Safety" in [Table 6: Double Gate Valve Requirements](#), double gate valves shall be provided with body bleeds. Where valves other than gate valves are used, the valve(s) shall have two independent seating surfaces and an intermediate pressurized buffer. The valve type and buffer arrangement shall be approved by the Owner's Engineer.

6.1-5

[S] Double block valves shall be used when a single block valve may be rendered inoperable due to autorefrigeration of a volatile liquid. The valves shall be separated by at least six inches of pipe. A bleeder is not required in this case.

6.1-6

[S] When double valves are required by [Table 6: Double Gate Valve Requirements](#), two valves separated by a short spool piece fitted with a bleeder shall be provided; alternatively, two valves bolted together with an intervening bleeder installed (on either valve) in position C or D per [ASME B16.34](#) is acceptable. No connection other than the bleeder shall be made between the valves.

6.1-7

[*] [M] When specified by the Owner's Engineer, double block valves shall be provided to isolate equipment that has a spare or may be bypassed temporarily if it is probable a single block valve will become corroded, eroded, or fouled such that the installation of a blind would be difficult due to excessive leakage.

6.2. Bleed Valves

6.2-1

[E] [*] [R] A single bleed valve, plugged, capped, blinded, or piped to a safe location when specified, shall be provided for all required applications. Bleed valves shall be NPS ³/₄ minimum and shall have threaded outlets. Except for the exclusions listed in Section 7.2, Item (5), bleed valves shall be located as follows:

6.2-1.1

[S] Between all double block valves required by [Table 6: Double Gate Valve Requirements](#) of this GP.

6.2-1.2

[S] For pressure-relieving (PR) devices:

- a. Between the PR device and the inlet block valve.
- b. Between the PR device and the outlet block valve unless the PR device discharges to atmosphere.

For all shell-and-tube and double pipe heat exchangers, when a manually operated bleeder valve is used for overpressure protection against liquid thermal expansion, the valve shall be installed on the cooler side.

6.2-1.3

[R] Where a body bleed is required, such as for double block valve testing and for "Segregation for Safety" applications:

- a. The bleed valve shall be located on the block valve body for valves NPS 4 (100 mm) and larger.
- b. Where it is not feasible to provide a bleed (due to size or other constraints), two block valves with an intervening bleeder shall be provided.
- c. [*] For gate valves, the bleed valve location shall be position G per [ASME B16.34](#) Figure 1 "Method of Designating Location of Auxiliary Connections When Specified" unless an alternative location is specified by the Owner's Engineer.

6.2-1.4

[S] Between the block valve and the associated equipment or isolation blind for all onstream isolation applications. A drain valve in this location that is not piped to a closed drain system or a body bleed in position C or D on the blinding side of the valve is sufficient to meet this requirement.

6.2-1.5

[C] Bleed valves are not required for:

- a. Single and double block valves at instrument takeoff connections.
- b. Double block at vents, drains, flushing, and cleaning connections.
- c. Where PR devices are installed for thermal liquid expansion protection.

6.3. Slurry Service**6.3-1**

[R] The specified bleed valve between double block valves shall be on the valve body (position C or D, [ASME B16.34](#), Figure 1 for gate valves).

6.4. Wedges**6.4-1**

[R] Wedges for gate valves NPS 3 or larger shall be flexible type except solid wedges, split wedges, or double disk gates may be used as follows:

- a. Class 150, any size or
- b. Single valves in double block and bleed applications with a specified design temperature $\leq 400^{\circ}\text{F}$ (204°C).

Table 6: Double Gate Valve Requirements

| Service | Fluid Design Temp (°F) | Fluid/Material | Line Class | NPS |
|--|------------------------|----------------|------------|-----|
| Onstream Equipment Isolation (including instruments) such as at: | ≤ 1000 | Any | ≥ 900 | Any |
| | > 1000 | Any | Any | Any |

| Service | Fluid Design Temp (°F) | Fluid/Material | Line Class | NPS |
|--|------------------------|---|------------|-----|
| a. Spared equipment and equipment capable of being bypassed b. Battery limits (process unit limits) c. Storage tanks and vessels d. Control valve stations (excluding bypass valves) e. Pressure-relieving systems | ≤ 1000 | Steam and Boiler Feedwater | ≥ 300 | > 2 |
| Product Segregation to Prevent Contamination such as at: | ≤ 400 | Any | > 300 | Any |
| a. Jump-over connections between product lines b. Unit bypasses such as around reactors | > 400 | Any | Any | Any |
| Segregation for Safety such as at: | Any | Any | Any | Any |
| a. Cyclic powerformer reaction and regeneration valves b. Steam cracker transfer line decoking isolation valves | Any | Any | Any | Any |
| Onstream Isolation with Safety Implications such as at ⁽¹⁾ : | ≥ 900 | Any | ≥ 900 | Any |
| a. Heat exchangers with on-line cleaning capability | Any | H ₂ S and Other Toxic Materials ⁽²⁾ | ≥ 300 | > 2 |
| b. Pumps | Any | Acids and Bases ⁽³⁾ | ≥ 600 | > 2 |
| c. Filters | Any | Hydrogen or Oxygen (H ₂ or O ₂ conc. ≥ 35%) | Any | > 2 |
| d. Control valves in severe service including FCCU slurry and angle control valves | Any | Flammable Liquids and Materials | ≥ 600 | > 2 |
| e. Parallel control valves installed for the purpose of on-line maintenance | Any | Combustible Liquids | ≥ 900 | > 2 |
| | Any | Material Operating Above AIT | Any | > 2 |
| Slurry Service | > 400 | Any | Any | Any |
| Other Services/Applications ⁽⁴⁾ such as at: | > 1000 | Any | Any | Any |
| a. Control valve bypasses b. Sample outlet piping, etc. | > 1000 | Any | Any | Any |
| Notes for Table 6: Double Gate Valve Requirements : | | | | |
| (1) Should consider where onstream isolation is expected frequently (e.g., between each turnaround). | | | | |

| Service | Fluid Design Temp (°F) | Fluid/Material | Line Class | NPS |
|---|------------------------|----------------|------------|-----|
| <p>(2) [*]" data-spacingafter="" data-spacingbefore="" style="text-align:left;font-size:10.5pt;font-family:Times New Roman;margin-top:3pt;margin-bottom:3pt;">[*] Stream may be considered "toxic" when: a) it meets the definition in Section 3 for toxic material; b) the (Industrial Hygiene) Respiratory Exposure Hazard Class is R-1, R-2, or R-3, as specified in the Environmental, Equipment, Exposure Review (EEER); or c) as otherwise specified by the Owner.</p> <p>(3) Includes liquids with a $\text{pH} \leq 3$ or $\text{pH} \geq 11$, which do not meet the Toxic Fluids criteria.</p> <p>(4) Including block valves not falling into other application categories, but excluding (plugged) vents and drains.</p> | | | | |

| Acceptable Metric Equivalents | |
|-------------------------------|-------|
| 200°F | 95°C |
| 400°F | 205°C |
| 1000°F | 538°C |

7. GP History Prior to Migration

7-1

| Version 1.0.0 | | | Date: 02/02 |
|---------------|---------------|--|-------------|
| Location | Action | Description | |
| | | Initial Publish. | |
| Version 1.0.0 | | | Date: 09/03 |
| | | Global Practice version number and format updated to comply with new process; however, original publish date remains, and no content was modified. | |
| Version 2.0.0 | | | Date: 03/04 |
| Section 3 | Modification | Clarified definition for "onstream equipment isolation." | |
| Table 1 | Addition | Added "Note 2." | |
| Section 4.1 | Modification | Revised to properly reference the revised scope of Table 6. | |
| Section 7 | Modifications | <p>Eliminated requirement for the use of double valves for most highly corrosive material services.</p> <p>No longer require double valves in Toxic material simply because the fluid contains some "toxic" materials.</p> | |

| | | |
|----------------------|-----------|---|
| Table 6 | Modified | Scope of Table 6 now limited to gate valves only. Reformatted Table 6 to help eliminate past confusion and incorrect interpretation of the GP requirements. |
| Version 3.0.0 | | Date: 08/04 |
| Scope | Clarified | Clarified to highlight that the intent of this GP is not to provide the design requirements for EBVs in isolation service and pointed to Design Practice XV-F. See comment at Section 2.3. |
| Definitions | Clarified | Clarified definition for valve end connections, emergency block valves (EBV) and fire-tested. Also alphabetized. |
| 4, Item (4) | Revised | Revised to include owners' approval for material specification for HF service. |
| 5.3 | Revised | Revised use more appropriate description for valve materials that lose mechanical strength at relatively low temperature. |
| 5.4 | Revised | Removed the gate valve exclusion. |
| 5.4, Item (4) | Revised | Added ball valve. |
| 5.4, Item (5) | Revised | Editorial. |
| 5.4, Item (6) | Revised | Added "2 NPS and larger." |
| 5.9 | Revised | Revised for clarity and added rationale. |
| 5.10, Item (7) | Revised | Revised to clarify and add temperature limit. |
| 5.12, Item (5) | Added | Addition to require sealwelding of two piece valve bodies. |
| 5.13, Item (6) | Removed | Outside of GP Scope. |
| 6, Item (4) | Replaced | Previous text is now in GP 03-12-09. Replaced it with a requirement to minimize the use of chainweheels. |
| 7.2, Item (2b) | Revised | Revised to include all device discharges that are not to atmosphere. |
| Version 4.0.0 | | Date: 12/07 |
| Scope | Revised | Deleted reference to DP XV-F. |
| 1.3 | Revised | Revised Title to API Std 594 and Std 602. |
| 2.1 | Added | Added reference to GP 03-07-01. |
| 2.2 | Revised | Revised Title to API Std 607. |
| 3 | New | Added definition for 'double block and bleed' valve. Added reference to threaded and socket weld type end connections. |

| | | |
|---------------|-----------|---|
| 3 | Revised | <p>Revised definition for wafer, or flangeless type valve end connection.</p> <p>Revised definition for soft seals.</p> <p>Revised definition for Emergency Block Valves.</p> <p>Revised definition for Segregation for Safety.</p> |
| 4.1 | Revised | Removed paragraph reference to globe and check valves. |
| 4.1 Table 1 | Revised | <p>Revised scope to limit to carbon steel and low alloy valves.</p> <p>Added additional service categories to Table 1.</p> <p>Eliminated reference to Trim #1. Also eliminated Trims #3, 10, 11, 13, and 14 for wet H₂S service.</p> <p>Revised scope of Note 2 to hydrocarbon and general process services.</p> <p>Added new note (3) on trim definition.</p> |
| 4.2 | Revised | Revised Table reference from Table 6 to Table 1. Added reference to Duplex material. Revised hard facing alternative to recognize owner specified hard facing. |
| 4.5 | Revised | Revised purpose code from R to S to be consistent with current GP 3-10-1, and added Rationale. |
| 4.6 | Revised | Revised heat treatment to 'condition H 1150 M, double tempered. |
| 4.7 | Revised | Revised to include any service containing sulfur compounds. |
| 4.8 Table 2 | Revised | Added new category for sea water, deleted reference to salt water |
| 5.2.1 | Revised | Added reference to globe and check valves per API 602. |
| 5.3 | Editorial | Revised RATIONALE for items 1, 2, and 3. |
| 5.4.2 | Revised | Added additional limitation on maximum temperature for soft seal materials to not exceed manufacturer pressure-temperature rating. |
| 5.4.2 Table 3 | Revised | Added generic reference to FKM, FFKM as well as PEEK and EPDM soft seal materials. |
| 5.4.3 | Revised | Added reference to Owner's engineer. |
| 5.4.6 | Clarified | Replaced 2 in. with NPS 2. |
| 5.5 | Clarified | Clarified valve to be the 1st valve next to process equipment. |
| 5.8c | Revised | Revised purpose code from 'R' to 'S.' Added Rationale. |
| 5.9.3 | Revised | Added auto-ignition temperature as additional limit. |
| 5.10.3 | Revised | Limited restriction on use of spring or flow reversal to effect closure to swing, ball and piston type check valves only. |

| | | |
|-------------|---------|---|
| 5.12.2 | Revised | Removed blanket restriction on chrome plating of balls by allowing the use of hard chromium and other similar hard coatings/plating when approved by the Owner's Engineer. Added minimum thickness requirement for hard chrome plating and restrictions on ball and seat materials. |
| 5.12.3 | Revised | Replaced Purchaser with Owner's Engineer. |
| 5.13.2 | Revised | Combined existing 5.13.2 with 5.13.3. |
| 5.13.3 | Removed | Information combined into 5.13.2. Remaining paragraphs renumbered. |
| 5.14 | Revised | Added temperature references, stem orientation limits, and additional requirements for bonnet extension length for valves in low temperature service. |
| 5.15 | Revised | Heading clarified to address Pressure Relief. |
| 5.15.1 | Revised | Excluded metal seated flanged bonnet gate valves. Deletes reference to 'closed' and 'open' position and upstream pressure relief direction which is covered in new 5.15.4 and 5.15.5. |
| 5.15.2 | New | Added pressure relief requirements for double seated pressure seal and welded bonnet valves. |
| 5.15.3 | New | Added pressure relief requirements for metal seated flanged bonnet gate valves in liquid cryogenic service and in applications with a significant risk of bonnet cavity overpressure. |
| 5.15.4 | New | Provides 'closed' and 'open' requirement as per previous 5.15.1. |
| 5.15.5 | New | Provides 'direction for pressure relief' requirement as per previous 5.15.1. |
| 5.17.4 | New | Added face to face requirements for clamp type end connections and Owner's Engineer approval for welded on end connections. |
| 6.5 | New | Added safety restraint requirement for valve chain wheels. Added rationale. |
| 7.1.1 | Revised | Revised for clarity. Added testing requirement for single gate valve alternatives. Added "R" purpose code. |
| 7.1.2 | Revised | Revised for clarity. Added clarification for "special" gate valves. |
| 7.1.4 | Revised | Revised paragraph purpose code from "R" to "S." Added prohibition on the use of a single 'double block and bleed' gate valve. Added rationale. |
| 7.2.3 | Revised | Removed reference to positions H, I, J, and K per ASME B16.34 Figure 1. Revised NPS 3 to NPS 4 for feasibility. |
| 7.2.4 (old) | Deleted | Requirement incorporated into revised 7.2.4 (previously 7.2.5). |
| 7.2.4 | Revised | Combined previous 7.2.4 and 7.2.5 into new 7.2.4 by adding reference to associated equipment. |

| | | |
|----------------------------------|---------------|---|
| Table 6 | Revised | <p>Deleted Trim column.</p> <p>For on stream equipment isolation, deleted reference to highly corrosive materials $\leq 200^{\circ}\text{F}$. This reference was added to Table 1 as an additional service category.</p> <p>Added steam cracker transfer line decoking isolation valves example for Isolation for Safety.</p> <p>Deleted notes 2 and 4. Remaining notes re-numbered.</p> <p>Revised re-numbered note 2 (previously note 3) to exclude plugged vents and drains.</p> |
| | | Endorsement by Chemical and DIOL. |
| All Global Practices | Modifications | <p>To standardize the format of the Global Practices and to meet other requirements, the following changes have been implemented:</p> <p>"For ExxonMobil Use Only" has been replaced with "For Company Use Only."</p> <p>A copyright waiver has been added in the first page Footer.</p> <p>The definition of asterisks in the Scope has been deleted. The asterisk is now defined in the Purpose Code attachment and is used within brackets as other Purpose Codes.</p> <p>Multiple paragraphs within a Section have been numbered. The standard text for Required References has been modified. The standard text for Additional Requirements has been modified. The [S] Purpose Code has been modified.</p> <p>The following Purpose Codes have been added:</p> <p>[*] for additional information or decision required of Owner's Engineer. [A] for approval requirements before beginning work or finalizing design.</p> |
| Version 4.1.0 | | Date: 04/08 |
| Section 7.1 | Modification | Moved previous Item (2) into the Item (1) rationale. |
| Version 4.2.0 | | Date: 10/10 |
| General | Modification | Updated reference titles and deleted references not cited in text. Added new [*] and [A] purpose codes. |
| Section 3 | Addition | Added Definitions for AIT, toxic material, onstream isolation with safety implications, releasable valve, and severe service. |
| Section 5.13, Item (4) Rationale | Modification | Modified rationale. |
| Section 7.1 Item (3) | Addition | Added one rationale paragraph. |

| | | |
|---------------------------|--------------|---|
| Section 7.1, Item (1a) | Modification | Clarified single gate valve option. |
| Section 7.1, Item (4) | Modification | Updated text for valves and gate valves. Added Item (e), specifying body bleed requirements. |
| Section 7.2, Item (3) | Modification | Made editorial change. |
| Table 6 | Modification | Made significant changes to table, including removal of "Number of Valves" and "Valve Body Bleed Required" columns and the addition of a Service section labeled "Onstream Isolation with Safety Implications." |
| Version 4.3.0 | | Date: 05/13 |
| Section 1.2 | Modification | Updated reference title. |
| Section 5.18, Item (1) | Modification | Added [E] Purpose Code. |
| Section 5.18, Item (2) | Modification | Added [E] Purpose Code. |
| Section 7.2 | Modification | Added [E] Purpose Code. |
| | | |

Record of Change

Purpose Code Definitions

9-1

| Code | Description |
|------|--|
| * | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |
| A | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| C | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| CS | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| E | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| I | Obsolete as per 2019 CIG - Assigned to paragraphs that provide only clarifying information, such as Scope statements, definitions of terms, etc. |
| M | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| O | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| R | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |

| Code | Description |
|--|---|
| S | <p>Assigned to paragraphs that contain design, fabrication and construction requirements that, if not met, can directly result in or significantly increase the risks of either:</p> <ol style="list-style-type: none"> 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). <p>Safety designation shall not be applied to paragraphs with Risk Matrix Category 4 when the incident probability and risk can be determined by the appropriate SME.</p> |
| <p>Purpose Code Hierarchy: Purpose Codes assigned to a numbered item apply to all associated subitems. Purpose codes assigned to an individual subitem apply only to that subitem.</p> | |

Piping Selection and Design Criteria

GP 03-10-01D

Scope

0-1

[I] This Global Practice (GP) specifies the criteria for metallic piping selection and design.

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1. References

1.1. Required References

1.1-1

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply. Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.1.1. Global Practices

1.1.1-1

| GP Reference | Reference Title |
|------------------------------|--|
| GP 03-18-01D | Piping Fabrication Shop or Field |
| GP 18-10-01D | Additional Requirements for Materials |
| GP 18-10-04D | Supplemental Requirements for Duplex Stainless Steel |

1.1.2. Industry Standards

1.1.2-1

| Industry Standard Number | Industry Standard Title |
|-----------------------------------|---|
| API SPEC 5L | Specification for Line Pipe |
| ASME B1.20.1 | Pipe Threads, General Purpose (Inch) |
| ASME B16.11 | Forged Fittings, Socket-Welding and Threaded |
| ASME B16.3 | Malleable Iron Threaded Fittings Classes 150 and 300 |
| ASME B16.47 | Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard |
| ASME B16.5 | Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard |
| ASME B16.9 | Factory-Made Wrought Buttwelding Fittings |
| ASME B31.3 | Process Piping |
| ASTM A 106/A 106M | Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A 312/A 312M | Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |

| Industry Standard Number | Industry Standard Title |
|-----------------------------------|--|
| ASTM A 333/A 333M | Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness |
| ASTM A 335/A 335M | Standard Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service |
| ASTM A 358/A 358M | Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications |
| ASTM A 426/A 426M | Standard Specification for Centrifugally Cast Ferritic Alloy Steel Pipe for High-Temperature Service |
| ASTM A 451/A 451M | Standard Specification for Centrifugally Cast Austenitic Steel Pipe for High-Temperature Service |
| ASTM A 53/A 53M | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 671/A 671M | Standard Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures |
| ASTM A 672/A 672M | Standard Specification for Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures |
| ASTM A 691/A 691M | Standard Specification for Carbon and Alloy Steel Pipe, Electric-Fusion-Welded for High-Pressure Service at High Temperatures |
| ASTM A 790/A 790M | Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe |
| ASTM A 928/A 928M | Standard Specification for Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal |
| ASTM B 165 | Standard Specification of Nickel-Copper Alloy (UNS N04400) Seamless Pipe and Tube |
| ASTM B 167 | Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696)* and Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617) Seamless Pipe and Tube |
| ASTM B 241/B 241M | Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube |
| ASTM B 407 | Standard Specification for Nickel-Iron-Chromium Alloy Seamless Pipe and Tube |
| ASTM B 423 | Standard Specification for Nickel-Iron-Chromium-Molybdenum-Copper Alloy (UNS N08825, N08221 and N06845) Seamless Pipe and Tube |

| Industry Standard Number | Industry Standard Title |
|----------------------------------|---|
| ASTM B 444 | Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloys (UNS N06625 and UNS N06852) and Nickel-Chromium-Molybdenum- Silicon Alloy (UNS N06219) Pipe and Tube |
| ASTM B 464 | Standard Specification for Welded UNS N08020 Alloy Pipe |
| ASTM B 517 | Standard Specification for Welded Nickel-Chromium-Iron-Alloy (UNS N06600, UNS N06603, UNS N06025, and UNS N06045) Pipe |
| ASTM B 705 | Standard Specification for Nickel-Alloy (UNS N06625, N06219 and N08825) Welded Pipe |
| AWWA C110/A21.10 | Ductile-Iron and Gray-Iron Fittings for Water |
| AWWA C111/A21.11 | Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C151/A21.51 | Ductile-Iron Pipe, Centrifugally Cast, for Water |

1.1.3. Other Publications

1.1.3-1

| Publication Number | Publication Title |
|-------------------------------|--|
| GEMS 3-49-1.0 | EMRE's Piping General ExxonMobil Material Specifications (GEMS) Document 3-49.1.0, "Mix/Injection Point Design and Fabrication Guidelines" (Document for internal Company use only - release to third parties requires Document Owner approval and compliance with Company MPI requirements) |
| TMEE-062 | ExxonMobil Maintenance Practices Manual (Document for internal Company use only - release to third parties requires Document Owner approval and compliance with Company MPI requirements) |

1.2. Additional References

1.2-1

[*]This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply. Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.2-2

[E] [*] All piping within the property limits of a plant site shall comply with [ASME B31.3](#), except that piping for steam boilers that come within the scope of [ASME SEC I](#) and [ASME B31.1](#) shall comply with those codes and applicable local requirements.

1.2-3

[*] The additional requirements for "Category M Fluid Service" (defined by [ASME B31.3](#)) shall not be used unless specified.

1.2.1. Industry Standards**1.2.1-1**

| Industry Standard Number | Industry Standard Title |
|-----------------------------|---|
| ASME B31.1 | Power Piping |
| ASME SEC I | BPVC Section I - Rules for Construction of Power Boilers |
| ASTM D 1869 | Standard Specification for Rubber Rings for Asbestos-Cement Pipe |
| NACE MR0103 | Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments |
| NACE TM0177 | Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H ₂ S Environments |
| NACE TM0284 | Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking |

1.2-4

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1.2-5

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2. Acronyms and Definitions**3. Materials****3-1**

[A] [R] Piping shall comply with [Table 1: Material Requirements](#). Owner's Engineer shall approve proposed specifications for materials not listed.

Table 1: Material Requirements

| Material | Requirements |
|--------------|--|
| Cast Iron | [A] Proposed material specifications shall be approved by Owner's Engineer in accordance with the additional requirements for cast iron materials in ASME B31.3 , Section 323.4.2 "Fluid Service Requirements for Materials, Specific Requirements." |
| Ductile Iron | AWWA C151/A21.51 |

| Material | Requirements |
|---|---|
| Carbon Steel | API SPEC 5L , ASTM A 53/A 53M , ASTM A 106/A 106M , ASTM A 333/A 333M , ASTM A 671/A 671M , ASTM A 672/A 672M , ASTM A 691/A 691M |
| Ferritic Alloy Steel | ASTM A 335/A 335M , ASTM A 671/A 671M , ASTM A 672/A 672M , or ASTM A 691/A 691M : Classes 12, 22, 32, or 42; ASTM A 426/A 426M |
| Austenitic Cr-Ni Steel | ASTM A 312/A 312M , ASTM A 358/A 358M , ASTM A 451/A 451M |
| Duplex | ASTM A 790/A 790M , ASTM A 928/A 928M |
| Alloy 20 | ASTM B 464 |
| Monel | ASTM B 165 |
| 3 ¹ / ₂ Ni or 9Ni | ASTM A 333/A 333M |
| Inconel | ASTM B 167 , ASTM B 517 , ASTM B 444 , ASTM B 705 |
| Aluminum | ASTM B 241/B 241M |
| Incoloy | ASTM B 407 , ASTM B 423 , ASTM B 705 |

3-2

[R] Welded pipe and fittings shall be as follows:

- a. All longitudinally or spiral welded pipe shall be leak tested by Manufacturer.
- b. The seams in Electric Resistance Welded (ERW) pipes shall be 100% examined by either ultrasonic or electromagnetic means by Manufacturer. The seams in Electric Fusion Welded (EFW) pipes shall be 100% examined by radiographic, ultrasonic, or electromagnetic means by Manufacturer. No Nondestructive Examination (NDE) is required for seams in welded pipes used in Category D fluid services (per [ASME B31.3](#)), except steam.
- c. Furnace butt welded pipe shall be limited to water service (Category D per [ASME B31.3](#)) and to a maximum size of NPS 4 (DN 100).
- d. Within process unit areas, spiral welded pipe shall be limited to water service. Spiral seams shall be double submerged arc butt welded.
- e. [A] Peaking for all carbon steel and low alloy ferritic longitudinally welded pipe and fittings designed for use in the creep range (i.e., greater than 750 °F [400 °C] for carbon steel and greater than 850 °F [455 °C] for C-¹/₂Mo and Cr-Mo alloys) or exposed to severe cyclic conditions (as determined using [ASME B31.3](#)) shall be limited to ¹/₈ in. (3 mm) maximum, as measured by a template technique approved by Owner's Engineer. Peaking is the deviation of a pipe's outside contour from a true circle at longitudinally welded joints.
- f. Carbon steel pipe with welded longitudinal seams shall not be used for design temperatures higher than those listed in [Table 2: Maximum Temperatures for Carbon Steel Pipe with Welded Longitudinal Seams](#).

Table 2: Maximum Temperatures for Carbon Steel Pipe with Welded Longitudinal Seams

| Pipe Type | Pipe Specification | Maximum Temperature | |
|--|--|--------------------------|------------------------|
| | | °F | °C |
| Furnace Buttwelded | — | 150 | 65 |
| ERW | — | 1,000 ^{(1) (2)} | 540 ^{(1) (2)} |
| EFW | ASTM A 671/A 671M , ASTM A 672/A 672M , or ASTM A 691/A 691M : Classes 22, 32, or 42 ; or API SPEC 5L submerged arc | 1,000 ^{(1) (2)} | 540 ^{(1) (2)} |
| EFW | ASTM A 671/A 671M , ASTM A 672/A 672M , or ASTM A 691/A 691M : Class 10 if < 3/4 in. (19 mm) thick; ASTM A 671/A 671M , ASTM A 672/A 672M , or ASTM A 691/A 691M : Classes 20, 30, or 40 if ≥ 3/4 in. (19 mm) thick | 750 ⁽¹⁾ | 400 ⁽¹⁾ |
| Spiral Welded | API SPEC 5L | 200 | 95 |
| Notes: | | | |
| (1) This temperature does not apply to fired heater decoking lines. | | | |
| (2) [A] Long-term temperature design conditions between 800 °F and 1,000 °F (427 °C and 540 °C) require Owner's Engineer approval. | | | |

3-3

[S] Cast iron and ductile iron pipe shall not be used in boiler feedwater service. Cast iron and ductile iron pipe may only be used in [ASME B31.3](#) Category D water service when not subject to freezing.

3-4

[R] Cast iron and ductile iron pipe used in fire water and cooling water services shall be centrifugally cast and suitable for a minimum working pressure of 250 psig (1,725 kPa-g).

3-5

[S] Low melting point alloys, such as aluminum, brass, and bronze, shall not be used in flammable material or combustible liquid services, except that aluminum alloys are permitted in cryogenic services.

3-6

[S] Limitations on the use of copper and copper-based alloys shall be as follows:

- a. Ammonia service: Alloys with a copper content greater than 50% shall not be used in ammonia service or in aqueous solutions containing ammonia where the pH exceeds 8.5.
- b. Caustic and alkaline service: Alloys with a copper content less than 85% shall not be used.
- c. Acetylene service: Alloys with copper content greater than 50% shall not be used in services where acetylene in a wet environment is present.

d. Copper shall not be used in an environment that contains sulfur or hydrogen sulfide.

3-7

[R] Carbon steel pipe with minimum yield strength exceeding 60,000 psi (415 MPa) shall not be used.

3-8

[R] [API SPEC 5L](#) pipe shall be of Product Specification Level (PSL) 2 unless otherwise approved by Owner's Engineer.

3-9

[S] [E] Hoses shall not be used for permanent process piping. The use of hoses constructed from crimped metal ribbons shall be prohibited.

3-10

[R] Seamless or welded 1¹/₄ Cr-1¹/₂ Mo pipe shall not be used for design temperatures above 900 °F (480 °C) in applications that have a design pressure greater than 200 psig (1,379 kPa-g).

3-11

[R] Carbon steel pipe shall not be used above 800 °F (427 °C) unless approved by Owner's Engineer.

3-12

[R] All materials shall be in compliance with the additional material requirements of [GP 18-10-01D](#).

3-13

[R] 22% Chromium duplex stainless steel shall be in compliance with the additional material requirements of [GP 18-10-04D](#).

4. Design

4-1

[S] Piping and components that are between double block valves shall be suitable for the more severe line service classification on either side of the double block valve installation.

4.1. Piping Size

4.1-1

[R] Minimum size of piping shall be NPS 1¹/₂ (DN 15). However, piping in hydrocarbon service, excluding instrument connections but including vents and drains, shall be a minimum of NPS 3³/₄ (DN 20).

4.1-2

[O] Minimum bore of piping shall be 0.250 in. (6.35 mm).

4.1-3

[M] Pipe sizes of NPS 1¹/₄, 2¹/₂, 3¹/₂, and 5 (DN 32, 65, 90, and 125) shall not be used. Mechanical equipment and instrument connections with these sizes shall be changed to a permissible piping size immediately adjacent to the equipment.

4.2. Line Joints and Pipe Bends

4.2-1

[E] Flanges and threaded connections shall not be used in underground piping in hydrocarbon service. Only welded joints (butt or socket) are permitted.

4.2-2

[R] Threaded and socket-welded joints shall be limited to pipe sizes NPS 2 (DN 50) and smaller, except for air, inert gas, or water below 250 °F (121 °C). Threaded joints in galvanized piping for water and instrument air are permitted for sizes up to NPS 4 (DN 100).

4.2-3

[M] Aboveground cast iron pipe shall have flanged joints, either cast integral with the pipe or threaded carbon steel flanges.

4.2-4

[R] Underground cast iron and ductile iron pipe with bell and spigot joints may be made up with rubber rings. Rings shall be per [ASTM D 1869](#), synthetic rubber, oil-resistant type, or per [AWWA C111/A21.11](#).

4.2-5

[A] [R] For pipe bends made from cold pulled bends or by induction bending, a bending procedure and qualification is required, approved by Owner prior to fabrication.

4.3. Corrosion Allowance and Minimum Thickness**4.3-1**

[*] [R] Corrosion allowances and thread depth allowances shall not be less than the minimum values shown in [Table 3: Corrosion and Thread Depth Allowances](#). For threaded-end pipe, the thread depth allowance shown shall be added to the corrosion allowance.

Table 3: Corrosion and Thread Depth Allowances

| Pipe | NPS | Minimum Corrosion Allowance | |
|--|---|-----------------------------|--------------------|
| | | in. | mm |
| Cast Processes | | | |
| All Materials | All | 0.050 ⁽⁵⁾ | 1.3 ⁽⁵⁾ |
| Welding or Seamless Processes | | | |
| Carbon and Low Alloy Steels ⁽¹⁾ | All | 0.050 ⁽⁵⁾ | 1.3 ⁽⁵⁾ |
| Intermediate Alloy Steels ⁽²⁾ | All | 0.030 | 0.8 |
| High Alloy Steels ⁽³⁾ | All | 0.010 | 0.25 |
| Monel, Nickel, and Nickel Base Alloys ⁽⁴⁾ | All | 0.010 | 0.25 |
| All Other Nonferrous Materials | All | 0.030 | 0.8 |
| Threaded-End Pipe | NPS | Thread Depth Allowance | |
| | | in. | mm |
| All Materials | $\frac{1}{2}$ and $\frac{3}{4}$ (DN 15 and 20) | 0.057 | 1.4 |
| | 1 through 2 (DN 25 through 50) | 0.070 | 1.8 |
| Notes: | | | |
| (1) Includes all steels with an alloy content not exceeding 2 ¹ / ₄ Cr-1 Mo. | | | |

- (2) Includes all steels with an alloy content of 2¹/₂ to 9% Cr-1 Mo, and 3¹/₂ to 9 Ni steels.
- (3) Includes all stainless steels with an alloy content of 12 Cr and greater, Duplex Stainless Steels, Alloy 800, Alloy 825, and Alloy 20.
- (4) Includes materials such as Inconel and Hastelloy.
- (5) When a corrosion allowance of ¹/₁₆ in. (1.5 mm) is specified, a minimum value of 0.050 in. (1.3 mm) is acceptable.

4.3-2

[E] [R] The minimum wall thickness of piping shall not be less than any of the following:

- a. The thickness required for pressure or structural reasons, whichever is greater, plus corrosion allowance, and thread depth allowance (if any).
- b. The minimum schedule or thickness as determined from [Table 4: Piping Schedule or Minimum Wall Thickness](#).
- c. [A] The thickness required to maintain the pipe's ratio of nominal diameter to minimum wall thickness (D/t) at 150 or below for fully corroded condition. A ratio greater than 150 may be permitted if there is no probability of forming a vacuum and the higher ratio is approved by Owner's Engineer.

Table 4: Piping Schedule or Minimum Wall Thickness

| Material ⁽¹⁾ | NPS | mm | Sch. or Minimum Wall Thickness |
|---|---------------|-----------------|--------------------------------|
| Carbon, Low Alloy, and Intermediate Alloy Steels; Aluminum | ≤ 2 | ≤ 50 | Sch. XS |
| | 3 through 6 | 75 through 150 | Sch. STD |
| | 8 through 12 | 200 through 300 | Sch. 20 |
| | 14 through 18 | 350 through 450 | Sch. 10 |
| | 20 through 22 | 500 through 550 | Sch. 10 |
| | ≥ 24 | ≥ 600 | Sch. 10 |
| High Alloy Steels, Monel, Nickel and Nickel Base Alloys, All Other Nonferrous except Aluminum | ≤ 2 | ≤ 50 | 0.09 in. (2.25 mm) |
| | 3 and 4 | 75 and 100 | 0.09 in. (2.25 mm) |
| | ≥ 6 | ≥ 150 | 0.12 in. (3.0 mm) |

Notes:

- (1) [Table 4: Piping Schedule or Minimum Wall Thickness](#) does not apply to nipples used for branch connections or to piping for atmospheric vents and drains. See [GP 03-18-01D](#) for minimum wall thickness of nipples for branch connections.

4.4. Mixing/Injection Points

4.4-1

[R] The following mixing and injection points shall be designed in accordance with GEMS 3-49-1.0.

4.4-1.1

Mix/injection points subject to corrosion or thermal fatigue cracking in the mixing circuit.

4.4-1.2

Mix/injection points where the mixing or injection process is required to control corrosion in downstream equipment.

4.4-1.3

[S] Mix/injection points where the incoming streams differential temperatures are > 250 °F (140 °C).

5. Branch Connections \geq NPS 2 (DN 50) and Attachment Pads

5-1

[R] Integrally reinforced branch welding fittings that abut the outside surface of the run wall, in sizes NPS 4 (100 mm) and larger, shall not be used under any of the following conditions:

- The ratio of branch diameter to run diameter (d/D) exceeds 0.8.
- The run piping wall thickness is less than standard schedule.
- The run piping wall thickness is less than 0.75 in. (19 mm) where the outside diameter exceeds 36 in. (900 mm).

5-2

[R] Pad reinforced branch connections shall not be permitted whenever the piping design temperature is 800 °F (427 °C) or greater. This requirement shall also apply to other pad attachments (i.e., pad-reinforced lugs for spring hangers and lifting devices, wear pads, etc.).

5-3

[R] If a pad-type reinforcement is used for full size branch connections, it shall be of the complete encirclement type.

5-4

Reinforcing or attachment pad vent holes shall be minimum $\frac{1}{4}$ in. (6 mm) diameter and, for uninsulated lines, filled with grease or plastic sealant after leak testing.

6. Fittings

6-1

[R] Fittings shall be per [Table 5: Fittings Size Range with Applicable Standards](#) and the additional requirements of this GP:

Table 5: Fittings Size Range with Applicable Standards

| Fittings ⁽¹⁾ | Size Range | | Applicable Standards | | |
|--|-------------------------|---------------|-----------------------------|-----------------|----------------------------|
| | NPS | DN | | | |
| Steel Buttwelding Fittings | | | $\frac{1}{2}$ through 48 | 15 through 1200 | ASME B16.9 |
| Steel Socket Welding and Threaded Fittings | $\frac{1}{2}$ through 2 | 15 through 50 | ASME B16.11 | | |

| Fittings ⁽¹⁾ | Size Range | | Applicable Standards |
|--|----------------|------------------|----------------------------------|
| | NPS | DN | |
| Malleable-Iron Threaded Fittings ⁽²⁾ | 1/2 through 2 | 15 through 50 | ASME B16.3 |
| Gray-Iron and Ductile-Iron Fittings ⁽³⁾ | 2 through 48 | 50 through 1200 | AWWA C110/A21.10 |
| Flanged Fittings | 1/2 through 24 | 15 through 600 | ASME B16.5 |
| | 26 through 60 | 650 through 1500 | ASME B16.47 |

Notes:

(1) [A] Use of cast steel fittings requires approval of Owner's Engineer.

(2) Limited to air, inert gas, and water (below 212 °F [100 °C]).

(3) Gray-iron fittings limited to water service (below 212 °F [100 °C]). Ductile-iron fittings limited to nonhydrocarbon service (below 300 °F [149 °C]).

6-2

[R] Aluminum fittings shall be of either wrought or forged forms. Castings shall not be used.

6-3

[R] For reducing fittings, bar stock swages shall not be used without approval of Owner's Engineer. The allowable size reduction shall be per [ASME B16.9](#).

6-4

[R] Forged steel threaded and socket-welding unions shall be per [ASME B16.11](#), as applicable.

6-5

[A] [R] The use of proprietary weld-type transition fittings between stainless steel and aluminum shall be approved by Owner's Engineer.

7. GP History Prior to Migration

7-1

| Version 1.0.0 | | | Date: 07/01 |
|---------------|--------|------------------|-------------|
| Location | Action | Description | |
| | | Initial Publish. | |
| Version 1.1.0 | | | Date: 08/03 |

| | | |
|-------------------------|--------------------------------|---|
| Section 6, Table 5 | Modification | Row 1, column 3 was modified from "15 through 600" to "15 through 1200," per ASME B16.9, Section 3 for NPS>4, the equivalence is DNS=25. |
| Version 1.1.0 | | Date: 08/03 |
| | | Global Practice version number and format updated to comply with new process; however, original publish date remains, and no content was modified. |
| Version 2.0.0 | | Date: 12/04 |
| Section 2.4 | Addition | Added NACE MR0103. |
| Table 1 | Correction | Corrected Material classes to refer to class 12 rather than class 11. |
| Table 1 | Addition | Added ASTM B 517, ASTM B 444, and ASTM B 705 to the row for Inconel. |
| Section 3, Item 2 e) | Modification | Included fittings in item e) and paragraph heading. |
| Section 3, Item 2 f) | Moved/ Modification | Moved restriction of 1 ¹ / ₄ Cr - 1 ¹ / ₂ Mo use to Section 3, Item 10 and modified to include all welded and non-welded piping. Renamed item g) to be new item f). |
| Section 3, Item 3 | Clarification | Reworded for clarity. |
| Section 3, Item 5 | Clarification | Reworded for clarity. |
| Section 3, Item 8 | Addition | Added restriction of API SPEC 5L piping to product specification level (PSL) 2. |
| Section 3, Item 9 | Moved/ Modification | Previously Item 8. Reworded for clarity and removed approval of Owner's Engineer. |
| Section 3, Item 10 | Moved/ Modification | Moved restriction of 1 ¹ / ₄ Cr - 1 ¹ / ₂ Mo use to Section 3, Item 10 and modified to include all welded and non-welded piping. Renamed item g) to be new item f). |
| Section 3, Item 11 | Renumbered | Previously Item 9. |
| Section 4, Item 1 | Removed | Removed Owner Engineer's approval on design conditions. |
| Section 4, Item 2 | Renumbered/ Correction | Renumbered as Item 1, Changed to a [S] paragraph. |
| Section 4.1, Item 1 | Clarified | Reworded for clarity. |
| Section 4.3, Item 1 | Moved | Moved to Section 4.3, Item 2. |
| Section 4.3, Item 2 | Moved Clarification | Moved to Section 4.3, Item 1 and reworded for clarity. |
| Table 4 | Modification/ Clarified | Moved reference to Note 1 to the Table title and reworded Note 2 for clarity. |
| Section 5, Title | Modification | Added Attachment Pads. |
| Section 5, Item 2 | Modification | Modified to include pads attached for structural purposes. |
| Section 5, Item 3 | Modification/ Clarification | Removed duplication of code and rewrote for clarity. |

| | | |
|-----------------------------------|---------------|---|
| Section 5, Item 4 | Addition | Added requirement for vent holes on pads for structural purposes and filling the hole after leak testing. |
| Section 6, Item 4 | Clarification | Added "threaded" after "forged steel." |
| Version 2.1.0 | | Date: 10/05 |
| General | | From this version onward, revision bars in the right margin will be used to identify technical changes from the last version of the GP. |
| Section 1; Section 2 | Modification | Updated reference titles. Reorganized sections alphabetically. |
| Section 1; Table 1 | Modification | Updated ASTM A 106 mnemonic to ASTM A 106/A 106M. Updated ASTM A 426 mnemonic to ASTM A 426/A 426M. Updated ASTM A 451 mnemonic to ASTM A 451/A 451M. |
| Table 2; Section 3 (Item 7) | Addition | Added unit conversions. |
| Section 3 (Item 12) | Addition | Added Item 12: "[R] The use of A105 carbon steel flanges is limited to applications above the minimum design temperature specified for Curve A materials per ASME B31.3, Table 323.2.2A." |
| Version 2.2.0 | | Date: 10/08 |
| Table 2 | Modification | Added Note (2) references to 540 °C temperatures. |
| Version 2.3.0 | | Date: 06/13 |
| Section 2, Item (1) | Modification | Added [E] Purpose Code. |
| Section 3, Item (9) | Modification | Added [E] Purpose Code. |
| Section 3, Item 12 | Deletion | Removed Curve A requirement for A 105 material. |
| Section 4.2, Item (1) | Addition | Added [E] Purpose Code joint restrictions for underground piping. |
| Section 4.3, Item (1) | Modification | Added [E] Purpose Code. |
| Version 3.0.0 | | Date: 02/16 |
| General | Modification | Updated Purpose Codes, Rationales, references, and unit conversions and clarified content throughout GP. |
| Table 1 | Modification | Cast Iron: Referenced ASME B31.3 Section 323.4.2. Added Duplex and Alloy 20. |
| Table 2 | Modification | Changed title of table. |
| Section 3 | Modification | Item (2a): Modified leak testing requirement. Added Items (12) and (13) regarding reduction of nominal thickness. |
| Section 4.2 | Modification | Added Item (5) regarding pipe bends. |
| Table 3 | Modification | Made changes to Note (3) regarding stainless steels. |

| | | |
|-----------------------------|---------------|---|
| Table 4 | Modification | Modified title; removed Notes, Item (2) regarding wall thickness. |
| Section 4.4 | Addition | Added section about Mixing/Injection Points. |
| Section 5 | Modification | Removed "unless approved by Owner's Engineer" from Item (1). |
| All Global Practices | Modifications | <p>To standardize the format of the Global Practices and to meet other requirements, the following changes have been implemented:</p> <p>"For ExxonMobil Use Only" has been replaced with "For Company Use Only."</p> <p>A copyright waiver has been added in the first page Footer.</p> <p>The definition of asterisks in the Scope has been deleted. The asterisk is now defined in the Purpose Code attachment and is used within brackets as other Purpose Codes.</p> <p>Multiple paragraphs within a Section have been numbered. The standard text for Required References has been modified. The standard text for Additional Requirements has been modified. The [S] Purpose Code has been modified.</p> <p>The following Purpose Codes have been added:</p> <p>[*] for additional information or decision required of Owner's Engineer. [A] for approval requirements before beginning work or finalizing design.</p> |
| PL Only | | PL initial endorsement as of 08/18. |
| | | |

Record of Change

Purpose Code Definitions

9-1

| Code | Description |
|------|--|
| * | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |
| A | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| C | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| CS | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| E | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| I | Obsolete as per 2019 CIG - Assigned to paragraphs that provide only clarifying information, such as Scope statements, definitions of terms, etc. |
| M | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| O | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| R | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |

| Code | Description |
|--|---|
| S | <p>Assigned to paragraphs that contain design, fabrication and construction requirements that, if not met, can directly result in or significantly increase the risks of either:</p> <ol style="list-style-type: none"> 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). <p>Safety designation shall not be applied to paragraphs with Risk Matrix Category 4 when the incident probability and risk can be determined by the appropriate SME.</p> |
| <p>Purpose Code Hierarchy: Purpose Codes assigned to a numbered item apply to all associated subitems. Purpose codes assigned to an individual subitem apply only to that subitem.</p> | |

Winterizing Against Ambient Temperatures

GP 03-09-01D

Scope

0-1

This Global Practice (GP) covers the protection of equipment, piping, instruments, and machinery against the effects of ambient temperature. Such effects include hydrate formation, condensation, viscosity change, pour point suppression, and icing.

0-2

Winterization of fire water systems are excluded from this GP and are covered in [GP 03-02-03D](#).

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1. References

1.1. Required References

1.1-1

This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

1.1.1. Global Practices

1.1.1-1

| GP Reference | Reference Title |
|------------------------------|---|
| GP 15-07-03D | Alarm Systems |
| GP 17-03-01D | Emergency Shower and Eyewash Facilities |

1.2. Additional References

1.2-1

[*] This Section lists the Practices, codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition. If a specific section is referenced, any requirements from underlying industry standards apply.

Note: Referenced GP's/Specification's may be updated after this document has been published therefore the Section Name should be referred to over the Section Number.

2. Acronyms and Definitions

2.1. Acronyms

2.1-1

| Acronym | Description |
|---------|--------------------------------------|
| CSO | Car-Sealed Open |
| GII | General Information and Instructions |
| RTD | Resistance Temperature Detector |
| SHE | Safety, Health, and Environment |

2.2. Definitions

2.2-1

| Term | Definition |
|---|--|
| Car-Seal Open (CSO) | A method of adding a locking device or tag to a valve's handwheel or quarter turn lever to prevent accidental closure of the valve. |
| Dead Leg | Closed-ended piping which does not experience flow. Examples include piping which ends at a blind or pipe cap, small diameter piping to vents, drains, instrument connection, level bridles, or sample points, control valve bypasses, piping used only for startup and shutdown, or sections of pipe where the closure of a valve stops flow. |
| Lead Lines | Piping or tubing downstream of process root valve (i.e., between process root valve and instrument) |
| Lowest Mean Daily Temperature | The lowest daily average ambient temperature taken over a minimum time period of 10 years |
| Safety Critical (or SHE Critical) Equipment | Any device (mechanical, pneumatic, hydraulic, electrical, or electronic), system, or subsystem functioning as the last line of defense to prevent, or is vital in mitigating, one of the following scenarios: a. An uncontrolled major breach of containment of flammable or toxic materials b. A process related incident with the potential for severe injuries or death c. A release of materials that could have a serious environmental impact d. A breach of security access that has the potential for sabotage or other serious consequences (for example: failure of access control systems) This definition includes all protective equipment or systems, failures of which result in higher risks as defined by the Company risk matrix for SHE considerations (GMOP 2.1). This includes at a minimum all Category 1 risks and Category 2 risks resulting from Consequence Levels I or II events, as defined by the Company risk matrix for SHE considerations (GMOP 2.1). SHE CE also includes devices/systems to prevent or mitigate SHE risks that fall in the IE and IID cells in the Company risk matrix, since these typically may involve serious injuries or fatalities, albeit with low probability. Excluded from SHE critical equipment are those devices whose only consequence of failure is an environmental exception (reporting). This does not obviate the need for reporting environmental incidents. Also excluded from the SHE critical equipment category are business critical devices whose consequence of failure is purely economic (e.g., custody transfer). Reliable operation of such devices is covered by other appropriate equipment strategies. The term 'safety critical' is usually applied to instrumentation, but any device may qualify as SHE critical equipment (i.e., designated safety critical) if its failure could lead to serious consequences. For example, heat tracing systems (steam or electric) used to prevent plugging of pressure relief devices due to solidification of process fluids are considered safety critical and should be identified as such. |

| Term | Definition |
|---------------|--|
| Winterization | Measures taken to prepare components for operations in cold climates. Winterization is primarily focused on controlling and mitigating the adverse effects of freezing, icing, and wind chill in cold temperature. |

3. General

3-1

[R] Climatic zone classifications shall be per [Table 1: Climatic Zone Classifications](#) and shall be documented in the site GII. Where daily changes of approximately 17 °C (30 °F) are common and where the lowest mean daily temperature is not far above –1 °C (30 °F), classification as Zone A should be reviewed to ensure satisfactory unit safety and operability.

Table 1: Climatic Zone Classifications

| Climatic Zone Classification | Temperature Condition |
|---------------------------------|---|
| A | The lowest mean daily temperature is not below –1 °C (30 °F). |
| B | The lowest mean daily temperature is below –1 °C (30 °F) for no more than 24 consecutive hours. |
| C | The lowest mean daily temperature is below –1 °C (30 °F) for more than 24 hours but is above –18 °C (0 °F). |
| D | The lowest mean daily temperature is below –18 °C (0 °F). |

3-2

[R] The following are acceptable methods to winterize components as required within this GP. The selection of winterization shall consider operational factors such as sensible heat of the fluid, required operational flow rate, time between shutdown and draining of equipment, etc.

- a. Installation of protective external heating by tracing (e.g., steam, electric element, or hot water) or jacketing (e.g., steam, hot water, or hot oil)
- b. Installation of thermal insulation
- c. Elimination of dormant sections of piping
- d. Maintaining a partial flow in dormant sections of piping
- e. Draining and flushing
- f. Agitation
- g. Providing suitable housing/enclosure
- h. Antifreeze solutions

3-3

[O] [R] Components shall be winterized when the contained fluids exhibit any of the following conditions:

- a. High viscosity at the lowest ambient temperature where one-half of the normal flow rate cannot be obtained with the pressure available to start circulation.
- b. Ice or hydrate formation occurs due to pressure reduction of moisture-bearing gases

- c. Corrosive compounds form if condensation occurs.
- d. Undesirable separation or freezing occurs at the lowest ambient temperature.
- e. Pour point or freezing point is above the lowest ambient temperature.

3-4

[S] Winterization that is designated safety critical shall be protected by one of the following methods:

- a. Fully redundant steam tracing facilities from header to steam trap discharge. The two steam supplies may be taken from the same steam header or subheader. Independent CSO isolation valves shall be provided on each individual steam supply and condensate return. Where multiple parallel steam tracers are required to maintain process temperature, redundancy shall be in the form of one additional tracer.
- b. Fully redundant electric tracing facilities. Supply shall be from a dual power source. Where temperature control is employed, each facility shall be separately controlled, but the set points may be staggered to avoid overheating. Each tracing facility shall be configured with comprehensive alarms to alert of a failure. The design and classification/priority of these alarms shall be determined per [GP 15-07-03D](#). Where multiple parallel electric trace cables are required to maintain process temperature, redundancy shall be in the form of a complete additional set of trace cables from each power source.
- c. Installation of a single steam or electric tracing facility plus a SHE-critical low-temperature alarm. The SHE-critical alarm shall be from a skin thermocouple or RTD installed on the process line. For steam systems, the temperature instrument shall be placed on the process line, near the steam condensate outlet. A separate alarm shall be provided for each individual tracing section. Where multiple alarms are required in one locality, these may be routed to a local panel with a common SHE-critical alarm to the control room.

4. Equipment and Piping

4.1. Requirements for All Climatic Zones

4.1-1

[O] [R] Closed drain headers shall be winterized where piping may become plugged due to the following:

- a. Wax or other process deposits
- b. Congealed viscous fluids
- c. Auto-refrigerated releases to the system, such as flashing propane, which may cause freezing in the line

4.1-2

[O] Process vessels and heat exchangers containing fluids that may freeze or congeal during dormant periods shall be winterized.

4.1-3

[S] Dead legs and stagnant zones containing fluid that may freeze shall be winterized.

4.2. Additional Requirements for Zones B, C, and D

4.2-1

[O] [R] Water systems shall meet the following requirements:

- a. Underground water systems (including sewers) shall be installed at least 300 mm (1 ft) below the frost line.

- b. The portions of water systems located above ground shall be winterized.
- c. Emergency shower and eyewash facilities shall be winterized and meet the requirements in [GP 17-03-01D](#).

4.2-2

[S] Seal legs, seal drums, and lower portions of flare stacks shall be winterized.

4.3. Additional Requirements for Zones C and D**4.3-1**

[O] Aboveground sanitary sewer piping shall be winterized.

4.3-2

[R] Live and exhaust steam systems with low points where condensate can collect shall be winterized and provided with a steam trap.

4.3-3

[R] For utility air systems, drain valves shall be provided for filters and low points in the piping.

4.3-4

[S] Where hydrocarbons and water are separated within a vessel, those parts of the vessel containing water shall be winterized.

4.4. Additional Requirements for Zone D**4.4-1**

[R] Block valves in water service at branch connections shall be winterized.

4.4-2

[M] [O] Branch piping containing air, water, or steam from the header to the utility stations shall be winterized.

5. Instrumentation and Associated Piping**5.1. Requirements for All Climatic Zones****5.1-1**

[S] [O] [R] Instruments and instrument piping shall be winterized in accordance with [Table 2: Winterizing Against Ambient Temperature for Instruments](#). The instrument mechanism and indicator portions (e.g., an electronic capsule) of the transmitters shall be kept within Manufacturer's recommended temperature rating.

Table 2: Winterizing Against Ambient Temperature for Instruments

| Type of Fluid | Direct-Connected Pressure and Differential Pressure Instruments | Pressure Gauges | Externally Mounted Level Instruments and Gauge Glasses |
|---------------|---|-----------------|--|
| | | | |

| Type of Fluid | Direct-Connected Pressure and Differential Pressure Instruments | Pressure Gauges | Externally Mounted Level Instruments and Gauge Glasses |
|---|--|--|--|
| Water | Heat trace and insulate lead lines and instruments, including first process isolation valve(s) | Heat trace and insulate lead lines and instruments, including first process isolation valve | Heat trace and insulate vessel connections and chamber, including first process isolation valve(s) |
| Liquid (mixture) that could result in water accumulation in lead lines | | | |
| Liquid that forms ice or hydrates due to pressure reduction of moisture-bearing gases | | | |
| Liquid with a pour point or freezing point above the lowest ambient temperature | | | |
| Liquid that has high viscosity at the lowest ambient temperature | Use diaphragm seal and heat trace and insulate lead lines and instruments, including first process isolation valve | Use diaphragm seal and heat trace and insulate lead lines and instruments, including first process isolation valve | Use diaphragm seal and heat trace and insulate lead lines and instruments, including first process isolation valve |
| Steam | Heat trace and insulate lead lines and instruments, including first process isolation valve(s) | Insulate lead lines, including first process isolation valve, and use a siphon | N/A |
| Vapor, which could condense at operating pressure and at ambient temperature conditions | Insulate or heat trace and insulate lead lines and instruments, including first process isolation valve(s) | Insulate lead lines, including first process isolation valve | Insulate or heat trace and insulate vessel connections and chamber, including first process isolation valve(s) |

| Type of Fluid | Direct-Connected Pressure and Differential Pressure Instruments | Pressure Gauges | Externally Mounted Level Instruments and Gauge Glasses |
|--|--|----------------------|---|
| Corrosive liquid formed by condensation | Use diaphragm seal, liquid purge, or heat trace and insulate, including first process isolation valve(s) | Use a diaphragm seal | Use liquid purge or select corrosion-resistant metallurgy |
| Notes: | | | |
| (1) All valve and/or instrument manifold handles should not be insulated and should be left exposed to allow for proper operability. | | | |

5.1-2

[A] [O] Instrument piping shall not be winterized with an antifreeze solution, unless approved by Owner.

5.1-3

[R] Protective heating of lead lines shall be designed such that the liquid is not allowed to overheat and boil.

5.1-4

[O] Parallel and/or adjacent lead lines for differential pressure instruments that are heat traced shall use common heating and insulation so that a similar temperature is maintained between the lines.

5.2. Additional Requirements for Zones C and D**5.2-1**

[O] [R] Electronic instruments vulnerable to damage by freezing shall be installed in heated housings or located in buildings such that the temperature remains within Manufacturers' recommended ranges.

5.3. Additional Requirements for Zone D**5.3-1**

[O] Locally mounted instruments shall be winterized using insulated housings with steam coils or electric heating.

6. Machinery and Associated Piping**6.1. Requirements for All Climatic Zones****6.1-1**

[O] For pumps and associated piping, winterization shall also consider cooling; heating; flushing media for jackets, bearings, and seals; and the duration of anticipated nonoperational periods.

6.1-2

[O] [R] Compressor seal and flushing oil piping shall be heat traced, if the cooling of contained fluids to ambient temperatures causes seal oil quantity or pressure to fall below Equipment Manufacturer's recommended minimum, as measured at the point of consumption.

6.1-3

[S] Except for suction piping between knockout drums and centrifugal compressors, all compressor suction piping that contains hydrocarbon gas heavier than ethane or has a gas dew point less than the lowest mean daily temperature condition shall be heat traced and insulated.

6.1-4

[C] [R] Centrifugal compressor suction lines shall be evaluated for winterization to maintain liquid precipitation within Manufacturer's acceptable levels.

6.2. Additional Requirements for Zones C and D**6.2-1**

[S] [O] Compressors, turbines, engines, and other major machinery (including auxiliaries) not installed in heated buildings shall be winterized. Exposed components, such as cooling water lines, cooling jackets, lube and seal oil piping, filters, compressor suction lines, and knockout drums, shall be winterized for both normal operating and shutdown conditions.

6.2-2

[R] Compressors and auxiliaries enclosed in buildings shall be winterized to protect the equipment for shutdown conditions.

6.3. Additional Requirements for Zone D**6.3-1**

[R] Traps or surface seals for open-sight drains shall be winterized.

7. GP History Prior to Migration

7-1

| | | Version 1.0.0 | Date: 07/01 |
|-----------------------------|---------------|--|--------------------|
| Location | Action | Description | |
| | | Initial publish. | |
| | | Version 2.0.0 | Date: 08/03 |
| General | Revision | General review and revision of GP. | |
| Table 2 | Addition | Added reference to Note 1 from cells involving heat tracing. | |
| Section 4, Item 10 | Modification | Modified sentence to change "ambient temperature" to "the applicable temperature condition from Table 1." | |
| | | Version 2.0.0 | Date: 11/03 |
| | | Global Practice version number and format updated to comply with new process; however, original publish date remains, and no content was modified. | |
| | | Version 2.1.0 | Date: 08/09 |
| General | Modification | References added to text and editorial changes made to improve clarity. | |
| All Global Practices | Modification | <p>To standardize the format of the Global Practices and to meet other requirements, the following changes have been implemented:</p> <p>"For ExxonMobil Use Only" has been replaced with "For Company Use Only."</p> <p>A copyright waiver has been added in the first page Footer.</p> <p>The definition of asterisks in the Scope has been deleted. The asterisk is now defined in the Purpose Code attachment and is used within brackets as other Purpose Codes.</p> <p>Multiple paragraphs within a Section have been numbered.</p> <p>The standard text for Required References has been modified.</p> <p>The standard text for Additional Requirements has been modified.</p> <p>The Safety Purpose Code has been modified.</p> <p>The following Purpose Codes have been added:</p> <p>[*] [A] for additional information or decision required of Owner's Engineer.</p> <p>for approval requirements before beginning work or finalizing design.</p> | |
| | | Version 2.2.0 | Date: 08/16 |

| | | |
|-----------|--------------|--|
| General | Modification | Updated Purpose Codes, Rationales, and references, and clarified content throughout GP. |
| Table 2 | Deletion | Deleted Note 4 regarding heat tracing and insulation in Zones C and D. Note was redundant. |
| Section 4 | Additions | Item (3): Added information on hydrate suppression. Item (12): Added information on acceptable methods to protect safety critical heat tracing. |
| PL Only | | PL initial endorsement as of 07/18. |

Record of Change

8-1

| Version 3.0 | | |
|-------------|--------------|---|
| Location | Action | Description |
| General | Modification | Updated entire GP. Completely restructured and updated with latest standards and format, including Purpose Codes, Rationales, references, and unit conversions and clarified content throughout GP. |

Purpose Code Definitions

9-1

| Code | Description |
|---|--|
| * | Assigned to paragraphs that require Owner's Engineer to provide additional information or make a decision. |
| A | Assigned to paragraphs that require approval from Owner's Engineer before the work may proceed or the design is finalized. |
| C | Assigned to paragraphs whose primary purpose is reduced costs. Reduced cost in this context refers to initial investment cost and does not include life cycle cost considerations. Life cycle cost considerations are captured under reliability, maintainability, or operability purpose codes. |
| CS | Assigned to paragraphs containing specifications/guidance where the primary purpose is to meet the required practices for Computing and Network Security for Industrial Control Systems, as defined in the Company's "Industrial Control System Requirements" (ICSR). All proposed deviations from these paragraphs should be noted in the ICS System Security Risk Assessment for the installation. |
| E | Assigned to paragraphs whose primary purpose is driven by environmental considerations. Environmental considerations typically include specifications intended to protect against emissions/leakage to the air, water, and/or soil. Deviations from the specifications contained in such paragraphs require formal review and approval according to local environmental policy. |
| I | Obsolete as per 2019 CIG - Assigned to paragraphs that provide only clarifying information, such as Scope statements, definitions of terms, etc. |
| M | Assigned to paragraphs whose primary purpose is to provide for maintainability of equipment or systems. Maintainability provisions are those that facilitate the performance of maintenance on equipment/systems either during downtimes or during onstream operations. |
| O | Assigned to paragraphs whose primary purpose is to assure operability of equipment or systems. Operability is the ability of the equipment/system to perform satisfactorily even though conditions are off-design (e.g., during start-ups, process swings, subcomponent malfunction, etc.). |
| R | Assigned to paragraphs whose primary purpose is to improve or assure the reliability of equipment or systems. Reliability is a measure of the ability of equipment/systems to operate without malfunction or failure between planned maintenance interventions. |
| S | Assigned to paragraphs that contain design, fabrication and construction requirements that, if not met, can directly result in or significantly increase the risks of either: <ol style="list-style-type: none"> 1. A process or personnel safety incident that can be classified as a Consequence I, II or III as defined in the ExxonMobil Risk Matrix Application Guide (Risk Matrix) or 2. Escalation of a process safety event that can result in a Consequence I, II or III personnel safety or process safety incident. Escalation is defined as a secondary event caused by the initial event that could be predicted by a competent engineer (e.g., jet/pool fire effects on surrounding equipment or running pool fires in drainage pathways). <p>Safety designation shall not be applied to paragraphs with Risk Matrix Category 4 when the incident probability and risk can be determined by the appropriate SME.</p> |
| Purpose Code Hierarchy: Purpose Codes assigned to a numbered item apply to all associated subitems. Purpose codes assigned to an individual subitem apply only to that subitem. | |

CENTRIFUGAL PUMP EXPERIENCE SHEET

| | | | | |
|--|---------------|-------------------------|--------------------|--------------------|
| Project: | | | | |
| Service: | | | | |
| Date: | | | | |
| Tag Number: | | | | |
| Item | Units | Proposed Machine | Reference 1 | Reference 2 |
| Name Plate Information: | | | | |
| <i>Pump Manufacturer</i> | - | | | |
| <i>API Pump Type</i> | - | | | |
| <i>Pump Model</i> | - | | | |
| <i>Number of Stages</i> | - | | | |
| <i>Point of Manufacture</i> | - | | | |
| <i>Date of Manufacture</i> | - | | | |
| <i>Date of Commissioning</i> | - | | | |
| <i>End User</i> | - | | | |
| Process Conditions: | | | | |
| <i>Rated Suction Temperature</i> | deg F (deg C) | | | |
| <i>Rated Suction Pressure</i> | psig (barg) | | | |
| <i>Rated Discharge Pressure</i> | psig (barg) | | | |
| <i>Rated Differential Head</i> | ft (m) | | | |
| <i>Rated Flow</i> | GPM (m3/hr) | | | |
| <i>NPSH Available at Rated Flow</i> | ft (m) | | | |
| Pump Mechanical Design: | | | | |
| <i>Rated Speed</i> | RPM | | | |
| <i>Impeller Diameter (Rated / Max)</i> | in (mm) | | | |
| <i>NPSH3 at Rated Flow</i> | ft (m) | | | |
| <i>Suction Specific Speed</i> | - | | | |
| <i>Head Rise to Shutoff From Rated Flow</i> | % | | | |
| <i>Flow Ratio (Rated Flow / BEP Flow)</i> | % | | | |
| <i>Efficiency at Design Flow (1)</i> | % | | | |
| <i>Noise Levels (Reference GP 02-01-01D)</i> | dba | | | |
| <i>Number of Impeller Vanes</i> | - | | | |
| <i>Cooling Water Used?</i> | - | | | |
| <i>Double Volute / Diffuser?</i> | - | | | |
| <i>Hydrotest pressure (including inlet of double case, vertical and multi-stage pumps)</i> | psig (barg) | | | |
| <i>Nozzle Loads Meet API-610 Requirements?</i> | - | | | |
| <i>Wear Ring Clearance</i> | in (mm) | | | |
| <i>Minimum Continuous Stable Flow (Still Meeting Vibration Limits)</i> | GPM (m3/hr) | | | |
| <i>Minimum Thermal Flow</i> | GPM (m3/hr) | | | |
| <i>Journal Bearing Mfr. / Type</i> | - | | | |
| <i>Journal Bearing L10h at Rated and Max Load</i> | hours | | | |

ANNEXURE F: CENTRIFUGAL PUMP MECHANICAL SEAL EXPERIENCE SHEET FORMAT

| | | | | |
|---|----------|---|---|---|
| Journal Bearing Ndm Factor | - | | | |
| Thrust Bearing Mfr. / Type / Size | - | | | |
| Thrust Bearing L10h at Rated and Max Load | hours | | | |
| Thrust Bearing Ndm Factor | - | | | |
| API Material Code | - | | | |
| Casing Material | - | | | |
| Impeller Material | - | | | |
| Shaft Material | - | | | |
| Wear Ring Material | - | | | |
| Mechanical Seal (Reference Mechanical Seal Experience List Tab) | - | - | - | - |
| Coupling Design: | | | | |
| Coupling Mfr. / Type | | | | |
| Shaft and Coupling Safety Margin (Max Continuous and Max Transient) | % | | | |
| Driver Design: | | | | |
| Driver Type | - | | | |
| Driver Manufacturer | - | | | |
| Driver Speed | RPM | | | |
| Driver Power Rating | BHp (kW) | | | |

Note (1): 1. For sealless pumps, obtain efficiency of the pump hydraulic end only and of the pump hydraulic end and inefficiency due to the drive method (mag drive coupling inefficiency or canned motor transmission inefficiency). Overall power input for mag drive pumps should be stated at the pump to drive motor coupling. Power input for canned motor pumps should be stated at the electrical cable terminals. Make sure these factors are included in the vendor quoted efficiencies.

MECHANICAL SEAL EXPERIENCE SHEET

| | | | | |
|---|---------------|----------------------|--------------------|--------------------|
| Project: | | | | |
| Service: | | | | |
| Date: | | | | |
| Tag Number: | | | | |
| Item | Units | Proposed Seal | Reference 1 | Reference 2 |
| Name Plate Information: | | | | |
| Seal Manufacturer | - | | | |
| API Seal Type | - | | | |
| Seal Model | - | | | |
| Seal Type; Pusher / Bellows | - | | | |
| Seal Arrangement; Single / Dual | - | | | |
| API Flush / Quench Plan(s) | - | | | |
| Point of Manufacture | - | | | |
| Date of Manufacture | - | | | |
| Date of Commissioning | - | | | |
| End User | - | | | |
| Process Conditions: | | | | |
| Rated Suction Temperature | deg F (deg C) | | | |
| Rated Suction Pressure | psig (barg) | | | |
| Rated Discharge Pressure | psig (barg) | | | |
| Process Fluid Type | - | | | |
| Process Fluid Vapor Pressure | - | | | |
| Mechanical Seal Design: | | | | |
| Shat Speed | RPM | | | |
| Reverse Pressure Rating of Inner Seal (Dual Seals Only) | psig (barg) | | | |
| Dynamic Pressure Rating | psig (barg) | | | |
| Static Pressure Rating | psig (barg) | | | |
| Estimated Seal Chamber Pressure | psig (barg) | | | |
| Seal Chamber Pressure / Gland MAWP | psig (barg) | | | |
| Seal Generated Heat | BTU/hr (MW) | | | |
| Seal Heat Soak From Pump | BTU/hr (MW) | | | |
| Seal Chamber Margin to Vaporization | deg F (deg C) | | | |
| Gland Connections Available | - | | | |
| Throttle Bushing Type / Material | - | | | |
| Sleeve Fixation Method / Number of Set Screws | - | | | |
| Ratio, Torque / Fixation Method Capacity | % | | | |
| Ratio, Axial Force / Fixation Method Capacity | % | | | |
| Rotating Face Material | - | | | |
| Stationary Face Material | - | | | |
| Secondary Element Material | - | | | |

ANNEXURE F: CENTRIFUGAL PUMP MECHANICAL SEAL EXPERIENCE SHEET FORMAT

| | | | | |
|---|---|--|--|--|
| <i>Auxiliary Piping Type / Material; excluding Seal Reservoir</i> | - | | | |
| <i>Seal Reservoir Type / Material</i> | - | | | |
| <i>Barrier / Buffer Fluid</i> | - | | | |
| <i>Barrier / Buffer Fluid Circulation Rate</i> | - | | | |