RIVER PROTECTION PROJECT – WASTE TREATMENT PLANT

ENGINEERING SPECIFICATION

FOR

LAW Thermal Catalytic Oxidizer/Reducer

Content applicable to ALARA? ☒ Yes ☐ No

ADR No.
24590-LAW-ADR-M-02-023

Rev
4

Specification changes retroactive? ☐ Yes ☒ No
☐ N/A (alpha revision or revision 0)

NOTE: Contents of this document are Dangerous Waste Permit affecting.

Quality Level
Q
DOE Contract No. DE-AC27-01RV14136

REV	DATE	BY	CHECK	REVIEW	E&NS	DPEM/EM
		Darryl Nelson		Grant Goolsby	Dwight Kruh for Dick Carlstrom	Janet Roth
1	4/26/10	Darryl Nelson	Nathan Whitcomb	Grant Goolsby	Dick Carlstrom	Janet Roth
0	3/1/10	Darryl Nelson	Nathan Whitcomb	Grant Goolsby	Dick Carlstrom	Janet Roth

SPECIFICATION No.
24590-LAW-3PS-MBTV-T0001

Rev
1

Revision History

Revision	Reason for Revision
1	This revision removes the full complement of NQA-1 requirements and substitutes a Quality Requirements Specification customized specifically for the LAW TCO procurement. This revision also reflects the removal of IEEE-323 environmental qualification requirements for LAW SS equipment. No revision bars were used for this revision. Issued for purchase.
0	Issued for purchase.

Notice

Please note that source, special nuclear, and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the US Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

Contents

Attachments

Attachment JQ07 - *Instrumentation for Packaged Systems*
Attachment EKP0 - *Electrical Requirements for Packaged Systems*
Attachment NN00 - *Thermal Insulation for Mechanical Systems*
Attachment PS02 - *Shop Fabrication of Piping*
Attachment AFPS - *Shop Applied Special Protective Coatings for Steel Items and Equipment*
Attachment EEQ - *LAW TCO EEQ Guidance*

1. 24590-WTP-SRD-ESH-01-001-02, pages C.34-1 thru C.34-5, tailoring of ANSI-K61.1
2. 24590-WTP-SRD-ESH-01-001-02, pages C.26-1 thru C.26-7, tailoring of ASME-B31.3
3. 24590-WTP-SRD-ESH-01-001-02, pages C.19-1 thru C.19-3, tailoring of IEEE-384
4. LAW Skid Interface Connections
5. Connection For Non-Routine Sample Extraction
6. Connection For Sample Extraction-Permanent Typical
7. Certificate of Analysis for BASF Catalysts, LLC (VOCat 300S)
8. LAW TCO & Ammonia/Air Dilution Skid Embed As-Built Elevations
9. 24590-WTP-SRD-ESH-01-001-02, page C.9-1, tailoring of AISC M016
10. 24590-WTP-SRD-ESH-01-001-02, page C.22-1 thru C.22-2, tailoring of IEEE-344
11. Sample Certificate of Conformance

1 Scope

1.1 Project Description and Location

The Hanford Tank Waste Treatment and Immobilization Plant (WTP) is a complex of waste treatment facilities where the Department of Energy's (DOE) Hanford site tank waste will be pretreated and immobilized into stable glass form via vitrification. The WTP Contractor will design, build, and start up the WTP pretreatment and vitrification facilities for the US Department of Energy's (DOE) Office of River Protection (ORP). The waste treatment facilities will pre-treat and immobilize the Low-Activity Waste (LAW) and High-Level Waste (HLW) currently stored in underground storage tanks at the Hanford Site.

The Hanford Site occupies an area of about 560 square miles and is located along the Columbia River, north of the city of Richland. The WTP Facility will be constructed at the East End of the 200 East Area of the Hanford Site. Benton, Franklin, and Grant counties surround the Hanford Site.

1.2 Equipment, Material, and Services Required

This specification provides the requirements for the design, analysis, materials selection, appurtenances selection, project management, quality control, quality assurance, inspection, fabrication, testing and labeling of an LAW Thermal Catalytic Oxidizer/Reducer (TCO) and the associated Ammonia/Air Dilution Skid.

The scope of work for the SELLER includes all work specifically defined in this specification and its addenda and attachments. Work shall include, but is not limited to, the following:

1.2.1 Low-Activity Waste Off-Gas Equipment: To include a Thermal Catalytic Oxidizer/Reducer Skid, LVP-SKID-00002, Ammonia/Air Dilution Skid, LVP-SKID-00003, and a TCO Heater / Ammonia-Air Dilution Fan control panel (LVP-PNL-00003) to utilize the ABB control system equipment (if vendor panel is provided). Components are Seismic Category III and IV as denoted on the Mechanical Data Sheet (MDS) in Section 2 of the MR.

1.2.2 Provide an analysis of the design from a Thermal Catalytic Oxidizer/Reducer expert to determine expected catalyst changeout frequency.

1.2.3 Provide Material Test Reports (MTRs), welding procedures, insulation installation procedures, surface preparation and coating procedures, testing procedures, testing results, quality assurance procedures, quality assurance inspection results, and all other procedures and documentation required per this specification and its addenda and attachments.

1.2.4 Provide transportation, storage, and installation instructions for the Thermal Catalytic Oxidizer/Reducer and the Ammonia/Air Dilution Skid per manufacturer's recommendation and this specification.

1.2.5 Provide packaging and prepare the Thermal Catalytic Oxidizer/Reducers Skid, the Ammonia/Air Dilution Skid, control panels, shim pack, gaskets, special tools (if required), and catalyst bed for shipment to the WTP site. Packaging shall be sufficient to allow outdoor storage for a period of up to 12 months at the WTP site, without BUYER action except routine inspection. Environmental conditions for storage are found in Section 3.6 of this specification. SELLER shall provide specific guidelines for storage beyond 12 months.

1.2.6 Provide special tools required for installation and maintenance.

1.2.7 Provide Material Safety Data Sheets (MSDSs) for the catalyst cartridges and any other potentially hazardous chemicals or materials which will be delivered to the BUYER.

1.2.8 Provide a thermal analysis of the Thermal Catalytic Oxidizer/Reducer, and support frame in accordance with the requirements of this specification and Mechanical Data Sheets (MDSs) in Section 2 of the Material Requisition (MR). Select insulation material (i.e. calcium silicate, refractory brick, mineral wool) to meet thermal requirements of this specification.

1.2.9 Procure, install and test thermal insulation to meet the thermal requirements of this specification. Provide detailed installation procedure for insulation, complete with design drawings and insulation map.

1.2.10 Provide a seismic analysis of the Thermal Catalytic Oxidizer/Reducer and ammonia supply/dilution skids in accordance with the requirements of this specification.

1.2.11 Provide shop painting of carbon steel surfaces.

1.2.12 Provide an equipment reliability assessment for all major components and subcomponents including expected catalyst life of the Thermal Catalytic Oxidizer/Reducer. The definition of components and sub-components is at SELLER's discretion. See Attachment 11 for a sample Certificate of Conformance.

1.2.13 Provide junction boxes to accommodate wiring to remote-mounted SELLER control panel. SELLER shall provide wiring schedule, diagrams, and documentation to facilitate installation of wiring from equipment to remote control panel.

1.2.14 Provide ASME Section VIII and B31.3 analyses of the Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution supply piping in accordance with the requirements of this specification.

1.3 Work by Others

Specific activities and materials excluded from the scope of this specification include:

1.3.1 Shipping to WTP jobsite

1.3.2 Material unloading and storage at jobsite

1.3.3 Installation labor

1.3.4 Foundation embeds

1.3.5 Ammonia vapor supply to skid connection

1.3.6 Electric power supply

1.3.7 Off skid external wiring

1.3.8 External connection to BUYER's instrumentation and controls

1.3.9 Containment Tent, portable High Efficiency Particulate Air (HEPA) filter exhauster

1.3.10 Grounding cable

1.4 Acronyms and Abbreviations

AHJ	Authority Having Jurisdiction
AI	Analog Input
AISC	American Institute of Steel Construction
AO	Analog Output
ANSI	American National Standards Institute

ASD	Adjustable Speed Drive
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWS	American Welding Society
C&I	Control & Instrumentation
CM	Commercial
MTR	Material Test Report
COA	Certificate of Analysis
COTS	Commercial-Off-The-Shelf
DBE	Design Basis Event
DCS	Distributed Control System
DD	Device Description
DO	Digital Output
DRE	Destruction and Removal Efficiency
FAT	Factory Acceptance Test
FF	Foundation® Fieldbus
FMEA	Failure Mode and Effects Analysis
GFE	Government Furnished Equipment
HEPA	High Efficiency Particulate Air
HLW	High Level Waste
ICN	Integrated Control Network
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input / Output
ISA	Instrument Service Air
LAW	Low Activity Waste
MACT	Maximum Achievable Control Technology
MDS	Mechanical Data Sheet
MR	Material Requisition
MSDS	Material Safety Data Sheet
MTBF	Mean-Time Between Failure
NACE	National Association of Corrosion Engineers
NDE	Non-Destructive Examination
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NMCF	Non-Modifiable Configurable Firmware
NOx	Oxides of Nitrogen
NRTL	Nationally Recognized Testing Laboratory
P&ID	Piping and Instrumentation Diagram
PCJ	Process Control System
PLC	Programmable Logic controller
PMI	Positive Material Identification
PPE	Personnel Protection Equipment
PPJ	Programmable Protection System
PQR	Procedure Qualification Record
PSA	Process Service Air
QAP	Quality Assurance Program
Q	Quality
QL	Quality Level

RFQ	Request for Quote
RPP	River Protection Project
RTD	Resistance Temperature Device
SC	Seismic Category
SCO	Selective Catalytic Oxidation
SCR	Selective Catalytic Reduction
SDDR	Supplier Deviation Disposition Request
SIS	Safety Instrumented System
SS	Safety Significant
SSCs	Systems, Structures, and Components
SVOCs	Semi-Volatile Organic Compounds
TCO	Thermal Catalytic Oxidizer/Reducer
UL	Underwriters Laboratories, Inc.
VOCs	Volatile Organic Compounds
VSL	Vitreous State Laboratory
WAC	Washington Administrative Code
WPS	Welding Procedure Specification
WTP	Hanford Tank Waste Treatment and Immobilization Plant

1.5 Definitions

The equipment covered by this specification will be used in the WTP, where the following definitions are applicable:

Quality Level (QL): The quality level identifies the quality requirements to be applied to the equipment. The identified quality levels are Q (Quality), and CM (Commercial). Quality requirements are specifically defined on the associated MDSs and SELLER Quality Assurance Program (QAP) requirements data sheets.

Seismic Category (SC): Specific requirements for each seismic category are defined in reference documents listed in Sections 2.3.13 of this specification and the MDS in Section 2 of the MR.

Thermal Catalytic Oxidizer/Reducer Expert: One who has extensive knowledge regarding the characteristics and application of Thermal Catalytic Oxidizer/Reducer. Must have a minimum of five (5) years experience.

Cabinet: It is used interchangeably with the word "enclosure" within this specification.

Enclosure: A surrounding case constructed to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection to the enclosed equipment against specific environmental conditions. An enclosure generally does not have any operational interface accessible from the exterior.

Panel: A type of enclosure that provides some kind of operational interface accessible from the exterior, without having to open the enclosure.

Rack: An open frame construction of angle, strut, channel, pipe, etc., designed to support the mounting of four or more instruments.

Non-Modifiable Configurable Firmware: The combination of commercial off the shelf hardware device, computer instructions, and data that resides as read-only software on that device. Non-Modifiable Configurable Firmware precludes modifications by WTP staff, but can accept configuration parameters, via a set up process, to achieve specific functionality to meet WTP requirements, provided features or capabilities such as advanced "scripting" or "coding" are not utilized. Non-modifiable configurable firmware can be adequately verified by testing the component of which it is an integral part.

1.6 Safety/Quality Classifications

1.6.1 Refer to the MDS in Section 2 of the MR for Safety Class, Quality Level and Seismic Category classifications related to the LAW Thermal Catalytic Oxidizer/Reducer and the Ammonia/Air Dilution skid.

2 Applicable Documents

2.1 General

2.1.1 Work shall be done in accordance with the referenced codes, standards, and documents listed below, which are an integral part of this specification.

2.1.2 When specific chapters, sections, parts, or paragraphs are listed following a code, industry standard, or reference document, only those chapters, sections, parts, or paragraphs of the document are applicable and shall be applied. For the codes and standards listed in Section 2, the specific revision or effective date identified shall be followed. If a date or revision is not identified, the latest issue, including addenda, at the time of quotation, shall apply.

2.2 Industry Standards

2.2.1 AISC M016 - 9th Edition, *Manual of Steel Construction, Allowable Stress Design*, as tailored in Appendix C of 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Vol. II* (see Attachment 9)

2.2.2 ASME B31.3 – 1996, *Process Piping Code*, as tailored in Appendix C of 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Vol. II* (see Attachment 2)

2.2.3 ASME B & PVC, Section VIII-2004, Division 1: *Rules for Construction of Pressure Vessels*

2.2.4 ASME Y14.100-2004, *Engineering Drawing Practices*

2.2.5 ASTM – E84-08, *Surface Burning Characteristics of Building Materials*

2.2.6 ASTM - A240-07, *Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels*

2.2.7 AWS D1.6-1999, *Structural Welding Code, Stainless Steel*

2.2.8 NEMA 250-2003, *Enclosures for Electrical Equipment (1,000 Volts Maximum)*

2.2.9 NFPA 70 – 1999, *National Electrical Code*

2.2.10 NFPA 497-1997, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*

2.2.11 UL 467-2007, *Standard for Safety Grounding and Bonding Equipment*

2.2.12 UL 508-2007, *Standard for Safety Electric Industrial Control Equipment*

2.2.13 UL 508A-2007, *Standard for Industrial Control Panels*

2.2.14 ANSI K61.1 - 1999, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia*, as tailored in Appendix C of 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Vol. II* (see Attachment 1)

2.2.15 IEEE 384-1992, *Standard Criteria for Independence of Class 1E Equipment and Circuits,* as tailored in Appendix C of 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Vol. II* (see Attachment 3)

2.2.16 IEEE 344-1993, *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power generating Stations,* as tailored in Appendix C of 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Vol. II* (see Attachment 10)

2.2.17 ASME PTC-10-1997, Performance Test Codes on Compressors and Exhausters

2.2.18 ABMA 9-1990, Load Ratings and Fatigue Life for Ball Bearings

2.2.19 ABMA 11-1990, Load Ratings and Fatigue Life for Roller Bearings

2.2.20 ISO 3744-1995, Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Engineering Method in an Essentially Free Field over a Reflecting Plane

2.2.21 ISO 1940-1:2003, Mechanical Vibration - Balance Quality Requirements for Rotors In a Constant (Rigid) State-Part 1: Specification and Verification of Balance Tolerances

2.2.22 NEMA MG 1-1998, Motors and Generators

2.2.23 AMCA-210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

2.2.24 AWS D1.1-2000, *Structural Welding Code – Steel*

2.2.25 29 CFR 1910, *Occupational Safety and Health Standards for General Industry*

2.2.26 1997 UBC, *Uniform Building Code*

2.3 Reference Documents/Drawings

2.3.1 24590-WTP-3PS-EVV1-T0001, *Engineering Specification for Low Voltage Adjustable Speed Drives*

2.3.2 24590-WTP-3PS-FB01-T0001, *Engineering Specification for Structural Design Loads for Seismic Category III & IV Equipment and Tanks*

2.3.3 24590-WTP-3PS-G000-T0001, *Engineering Specification for Supplier Quality Assurance Program Requirements*

2.3.4 24590-WTP-3PS-G000-T0002, *Engineering Specification for Positive Material Identification (PMI) for Shop Fabrication*

2.3.5 24590-WTP-3PS-G000-T0003, *Engineering Specification for Packaging, Handling and Storage Requirements*

2.3.6 24590-WTP-3PS-G000-T0014, *Engineering Specification for Supplier Design Analyses*

2.3.7 24590-LAW-3PS-MBT0-T0001, *Quality Requirements Specification for the LAW TCO Procurement*

2.3.8 24590-WTP-3PS-JQ00-T0004, *Engineering Specification for Management of Supplier Software*

2.3.9 24590-WTP-3PS-JXXE-T0003, *Engineering Specification for Commercial C&I Enclosures, Panels, Cabinets, and Racks*

2.3.10 24590-WTP-3PS-MKH0-T0007, *Engineering Specification for Axial Flow High Efficiency Particulate Air (HEPA) Filter Housings*

2.3.11 24590-WTP-3PS-MKH0-T0009, *Engineering Specification for Standard Nuclear Grade High Efficiency Particulate Air (HEPA) Filters (For ASME AG-1 Compliant Filters)*

2.3.12 24590-WTP-3PS-MV00-T0001, *Engineering Specification for Pressure Vessel Design and Fabrication*

2.3.13 24590-WTP-3PS-MV00-T0002, *Engineering Specification for Seismic Qualification Criteria for Pressure Vessels*

2.3.14 24590-WTP-3PS-MVB2-T0001, *Engineering Specification for Welding of Pressure Vessel, Heat Exchangers and Boilers*

2.3.15 24590-WTP-3PS-NWP0-T0001, *Engineering Specification for General Welding and NDE Requirements for Supplier Fabricated Piping*

2.3.16 24590-WTP-3PS-SS00-T0001, *Engineering Specification for Welding of Structural Carbon Steel*

2.3.17 24590-WTP-3PS-SS00-T0002, *Engineering Specification for Welding of Structural Stainless Steel and Welding of Structural Carbon Steel to Structural Stainless Steel*

2.3.18 24590-101-TSA-W000-0009-195-00002, *Report - Small Scale Melter Testing for Allyl Alcohol Method Verification*

2.3.19 24590-WTP-LIST-CON-08-0001, *Restricted Materials List WTP Safety Assurance*

2.3.20 24590-LAW-M6-LVP-00005, *P&ID - LAW Melters Secondary Offgas Vessel Vent Process System SCR, VOC & Ammonia Dilution Packages*

2.3.21 24590-LAW-MKD-LVP-00012, *24590-LAW-MX-LVP-SKID-00002 and 24590-LAW-MX-LVP-SKID-00003 - LAW Catalytic Oxidizer / Reducer*

2.3.22 24590-WTP-3PS-PB01-T0001, *Technical Supply Conditions for Pipe, Fittings, and Flanges*

2.3.23 24590-WTP-3PS-G000-T0019, *Acquisition of Commercial Items and Services for Use in Safety Applications at WTP*

3 Design Requirements

3.1 General

3.1.1 The Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution unit is designed to selectively and primarily remove Volatile Organic Compounds (VOCs) and Oxides of Nitrogen (NO_X) from the offgas generated by the LAW melters.

3.1.2 The Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution unit shall be designed per this specification, the applicable documents listed in Section 2 of this specification, and the MDSs in Section 2 of the MR.

3.1.3 The WTP facility is designed for a minimum service life of 40 years. Structural and pressure boundary components related to the Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution units shall be engineered with a design life of 40 years. Catalyst used in the Thermal Catalytic Oxidizer/Reducer shall have a minimum design life of one year. Other key mechanical components, such as the Recuperative Heat Exchanger, Electric Heater, Catalyst Module, Exhaust Fans, and Mixing Chamber shall have a minimum service life of five years with periodic maintenance.
Components that cannot be guaranteed for a minimum service life of five years shall be identified in accordance with the following requirements:

- Failure rate or Mean-Time Between Failure (MTBF), whichever is available, and the basis for the rate including specific references to any sources.
- Estimated modes of failure (example, dielectric breakdown, element overheat, etc.). This may be delineated in a Failure Mode and Effects Analysis (FMEA). The method used to perform the FMEA (Example, MIL-STD-1629) and the year shall be specified. All assumptions used to perform the FMEA shall be clearly stated.
- Recommended maintenance and frequency, as applicable.
- Estimated time to perform the recommended maintenance, as applicable.

The data above shall be based on the physical and environmental conditions delineated in this specification and MDSs. Where possible, the SELLER shall compare the figures for the equipment in this specification to similar equipment sold and serviced by the SELLER. The source for all estimates and any underlying assumptions shall be stated. If software is used to perform the FMEA, the SELLER shall specify the software used and the version (example software, Relex, Isogen, Reliasoft, etc.).

3.1.4 Operation of the Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution units shall be continuous for one year. Refer to MDSs in Section 2 of the MR for thermal cyclic conditions.

3.1.5 The thermal and seismic analyses to be provided per this specification must verify that the final detailed design of the Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution units meet the requirements set forth in this specification and its attachments.

3.1.6 The maximum pressure drops across the Thermal Catalytic Oxidizer/Reducer shall be in accordance with the requirements of the MDSs.

3.1.7 The following requirements shall be met:

- Pressure boundary shall be designed in accordance with the requirements of ASME B&PVC, Section VIII, Div. 1 and BUYER specification 24590-WTP-3PS-MV00-T0001, *Engineering Specification for Pressure Vessel Design and Fabrication*. Code stamp is not required
- Non-Destructive Examination (NDE) requirements for the pressure boundary shall be in accordance with BUYER specification 24590-WTP-3PS-MV00-T0001, *Engineering Specification for Pressure Vessel Design and Fabrication*. See additional requirements for Design Level 2 (L-2) Vessels, Section 6.3
- Seismic analysis shall be per BUYER specification 24590-WTP-3PS-MV00-T0002, *Engineering Specification for Seismic qualification Criteria for Pressure Vessels*

- The structure supporting the pressure boundary shall be designed per BUYER specification 24590-WTP-3PS-MV00-T0002, Section 7.2.2, *Engineering Specification for Seismic Qualification Criteria for Pressure Vessels*

3.1.8 Penetrations in the pressure boundary (i.e. access doors, sample ports, etc.) shall be designed and reinforced in accordance with the requirements of ASME B&PVC, Section VIII, Div. 1, and BUYER specification 24590-WTP-3PS-MV00-T0001, *Engineering Specification for Pressure Vessel Design and Fabrication*. In addition, access doors shall be designed for ease of operation by one person.

3.1.9 If determined necessary by thermal analysis, SELLER shall design the Thermal Catalytic Oxidizer/Reducer to be externally insulated so the external surface temperature does not exceed 140°F. Insulation shall meet applicable requirements of Attachment NN00.

3.1.10 Internal bracing shall be minimized. Where internal bracing is required, bracing members of circular cross section are preferred.

3.1.11 The LAW Thermal Catalytic Oxidizer/Reducer shall be provided with a recuperative heat exchanger bypass (refer to Piping and Instrumentation Diagram (P&ID) 24590-LAW-M6-LVP-00005 attached to the MR).

3.1.12 The SELLER shall select insulation and design the Thermal Catalytic Oxidizer/Reducer and support frame to prevent the BUYER's concrete foundation from reaching a maximum temperature of 150°F.

3.1.13 SELLER shall design and supply necessary outlet piping for sample nozzles located downstream of the recuperative heat exchanger required for ammonia control. SELLER shall include pipe supports and Tied Expansion joints for both the offgas process inlet and outlet connections. Tied Expansion joints shall be 2 ply or greater.

3.1.14 The following are the Safety Significant functions of the LAW Thermal Catalytic Oxidizer/Reducer and the Ammonia/Air Dilution units. An instrument has a "Z" suffix if it serves an active safety function. (Note: Only root components are listed below. See P&ID 24590-LAW-M6-LVP-00005 for the remaining components):

a) Confinement of Melter Offgas (by SELLER): TCO housing, piping, and appurtenances shall be designed to maintain melter offgas confinement during normal operation, and during and after a seismic category III DBE. Structural failure of internals shall not breach confinement boundary.

b) Confinement of Ammonia (by SELLER): The ammonia and air dilution supply piping, valves, and appurtenances shall maintain confinement of ammonia during normal operation, and during and after a seismic category III DBE.

c) Electric Heater Shutdown Safety Scenarios to safely shut down electric heater before, during and after a seismic category III DBE:

- Electric Heater shall shut down upon detection of high heater temperature (TE 0509(Z))
- Electric Heater shall shut down upon detection of high temperature at outlet of SCO/SCR skid (by others)
- Electric Heater shall shut down upon detection of Caustic Scrubber bypass valve opening (by others)
- Electric Heater shall shut down upon detection of high temperature at outlet of the Caustic Scrubber (by others)

d) Ammonia Supply Safety Scenarios to safely control the supply of ammonia before, during and after a seismic category III DBE:

- Close YV 0528(Z) upon detection of low dilution-air flow
- Close YV 0528(Z) upon detection of low LVP header vacuum (by others)
- Close YV 0528(Z) upon detection of high LVP header vacuum (by others)
- Close YV 0528(Z) upon detection of high ammonia flow
- Close YV 0528(Z) upon detection of low offgas temperature at the SCO/SCR skid outlet (by others)
- Close YV 0528(Z) upon detection of high offgas temperature exiting the SCO/ SCR skid outlet (by others)
- Close YV 0528(Z) upon detection of high temperature exiting the Caustic Scrubber (by others)
- Close YV 0528(Z) upon detection of the Caustic Scrubber bypass valve not closed (by others)
- Fail-Safe valve YV 0528(Z) fail closed on loss of power or control signal

e) Ammonia/Air Dilution Safety Scenarios to safely dilute and maintain the SCO/ SCR ammonia concentration below the Lower Flammable Limits (LFL) before, during and after a seismic category III DBE:

- Close YV 0538(Z) upon detection of low LVP header vacuum (by others) below a predetermined setpoint
- Close YV 0538(Z) upon detection of high LVP header vacuum (by others) above a predetermined setpoint
- Fail-Safe valve (YV 0538(Z)) fails closed on Loss of power or control signal

f) SCO/SCR Skid Bypass Valve YV 0501(Z) (by others) Actuation Safety Scenarios to safely handle melter offgas before, during and after a seismic category III DBE:

- Open YV 0501(Z) upon detection of high SCO/SCR differential pressure (by others)
- Open YV 0501(Z) upon detection of high LVP header vacuum (by others)
- Open YV 0501(Z) upon detection of low LVP header vacuum (by others)
- Open YV 0501(Z) upon detection of Caustic Scrubber bypass valve not closed (by others)
- Open YV 0501(Z) upon detection of high temperature exiting the Caustic Scrubber
- Open YV 0501(Z) upon detection of a loss of normal facility power (by others)
- Fail-safe valve YV 0501(Z) fails open upon loss of power or control signal

3.2 Offgas Treatment Functional Description of Major Components

Offgas is generated from the vitrification of radioactive waste in Joule heated ceramic melters.

3.2.1 LAW Thermal Catalytic Oxidizer/Selective Catalytic Reduction Unit:

The feed to the LAW Thermal Catalytic Oxidizer/Reducer is primarily melter offgas that has been treated by a Submerged Bed Scrubber (SBS), Wet Electrostatic Precipitator (WESP), HEPA Filters, and an Activated Carbon Bed Adsorber.

3.3 Basic Function

The Thermal Catalytic Oxidizer/Reducer unit shall consist of four primary components; a recuperative heat exchanger, electric heater, VOC selective catalytic oxidation (SCO) bed, and a NO_X selective catalytic reduction (SCR) bed. The power supply shall be as specified in Section 3.9. The rating of each component shall be determined by the SELLER to meet the performance requirements specified in Section 3.4 of this specification. SELLER shall also include ammonia dilution and mixing appurtenances necessary to meet performance requirements of this specification.

3.3.1 Recuperative Heat Exchanger

The recuperative heat exchanger is primarily employed to recover heat from the SCR hot exhaust gas for the Thermal Catalytic Oxidation/Reducer unit. The heat exchanger shall cool down the hot SCR exhaust gas and heat the incoming offgas.

3.3.2 Electric Heater

The electric heater is downstream of the recuperative heat exchanger and is employed to heat the offgas feed to the final desired oxidation and reduction temperatures. After startup, the electric heater shall function as a trim control to raise the offgas temperature to the required oxidizing temperature. Required oxidizing and reduction temperatures shall be per performance criteria specified in Section 3.4 of this specification.

3.3.3 VOC Selective Catalytic Oxidation Unit

The SCO unit, containing oxidation catalyst, is downstream of the Electric Heater and will oxidize volatile and semi-volatile organic compounds creating water and carbon dioxide. The residence time and number of catalyst beds shall be as specified in Section 3.4 of this specification.

3.3.4 NO_X Selective Catalytic Reduction Unit

The SCR unit, containing reduction catalyst, is downstream of the SCO and shall use ammonia injection to reduce the NO_X to Nitrogen, Oxygen, and water through catalytic reaction with ammonia.

3.3.5 Ammonia/Air Dilution System

The BUYER will supply ammonia gas to the LAW Ammonia/Air Dilution System. SELLER shall specify dilution air flow rates and pressures if required for the Ammonia/Air Dilution skid. SELLER shall supply necessary equipment required to meet performance requirements.

3.4 Performance

3.4.1 Refer to the Thermal Catalytic Oxidizer/Reducer MDSs for design data and gas stream properties.

3.4.2 The organic Destruction and Removal Efficiency (DRE) performance shall be based on inlet loadings specified in the MDSs.

3.4.3 The Thermal Catalytic Oxidizer/Reducer shall meet the DRE for Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs) as required in the MDSs as well as residence time and minimum oxidizing temperatures specified.

3.4.4 The NOx SCR unit shall meet the reduction efficiency at less than the specified ammonia slip concentration required in the MDSs.

3.4.5 Detection limits used to verify the Thermal Catalytic Oxidizer/Reducer guaranteed performance shall be based on BUYER information (MDS General Note 9).

3.4.6 SELLER shall provide curves plotting efficiency versus inlet operating temperature for the Thermal Catalytic Oxidizer and Selective Catalytic Reducer catalysts.

3.4.7 SELLER shall provide ammonia slip curves for SCR performance.

3.4.8 The ammonia slip exiting the LAW systems shall be specified by the SELLER to meet the NOx reduction efficiencies specified in Section 3.4.4 of this specification.

3.4.9 BUYER's residence time, specified in the MDSs, is the minimum for VOC and SVOC destruction and therefore shall be used by SELLER if it exceeds the SELLER's calculated required residence time.

3.4.10 As specified in the MDSs, concentrations of certain chemical compounds are subject to large step increases and spikes. The SELLER's calculation shall account for these increases and spikes.

3.4.11 SELLER shall identify if additional NOx analyzers are required outside the boundaries of the SELLER's equipment to meet the specified NO_X reduction efficiency and ammonia slip MDS requirements. SELLER shall obtain BUYER's approval for additional NO_X analyzers.

3.5 Design Conditions

3.5.1 Refer to the Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution MDSs in Section 2 of the MR.

3.5.2 The embed plate design location and elevation for the two skids are shown on drawing 24590-LAW-DB-S13T-00135, drawing coordinate (F-6.5 for the TCO skid, G-7.5 for the Ammonia/Air Dilution skid). The design elevation for the top of the embed plates is 48 feet - 0 inches, in plant elevation. The existing embed elevations vary slightly from plate to plate. Attachment 8 lists the embed As-Built elevations.

3.5.3 As required, shim plates will be placed on the BUYERS foundation embed plates for leveling the two skids. To account for embed elevations and variability of the concrete floor, the bottom elevation for the two skids shall be set at +48 feet, +1/4 inch in plant elevation. The SELLER shall provide the shim plates (plus 6 spares) necessary to set the skids at +48 feet, +1/4 inch. The SELLER shall provide the design detailing how the shims are welded to the BUYERS embed plates and how the equipment is connected to the shim plates.

3.5.4 The BUYER'S existing embed plates for the TCO skid are coated carbon steel plates, stock code: EBPNS02CD, shown on drawing 24590-BOF-DD-S13T-00001. The BUYER'S existing embed plates for the NH3/Air Dilution skid are coated carbon steel plates, stock code: EBPST19CA, shown on drawing 24590-LAW-DD-S13T-00019. The carbon steel embed plates are coated with one layer of inorganic zinc primer. When attachments are welded to the existing embed plates, WTP site welding procedures require inorganic zinc primer to be removed within 2- 4 inches of the weld area. Only carbon steel can be welded to the carbon steel embed plates where the inorganic zinc primer has been removed. It is acceptable to weld a carbon steel vibration pad retainer or stainless steel vibration pad retainer to the top of the carbon shim welded to the BUYER'S embed.

3.5.5 All shim material shall be carbon steel, ASTM A36 bare steel, no coating required. Shim thickness is nominal.

3.6 Environmental Conditions

3.6.1 The Thermal Catalytic Oxidizer/Reducer Skid and Ammonia/Air Dilution Skid will be located indoors. Refer to MDSs for specific room environmental design conditions.

3.6.2 Thermal Catalytic Oxidizer/Reducer and components, except catalysts, and the Ammonia/Air Dilution Skid may be stored outdoors prior to installation at ambient extreme temperatures ranging from minus 23°F dry-bulb to 113°F dry-bulb and a relative humidity of 0 to 100%.

3.6.3 Refer to Sections 3.7, 3.9 and 3.10 of this engineering specification for enclosure, instrumentation and electrical requirements.

3.7 Mechanical Requirements

3.7.1 General

3.7.1.1 Due to access restrictions for installation, the Thermal Catalytic Oxidizer/Reducer units shall be fabricated in such a manner that will allow delivery in three to five sections that comply with the bounding dimensions specified in MDSs. Each section of the Thermal Catalytic Oxidizer/Reducer shall be skid mounted.

3.7.1.2 The catalyst bed shall be designed for manual removal and replacement. The catalyst bed shall be designed to meet service life requirements outlined in Section 3.1.2 of this specification. The weight of a catalyst module shall not exceed 50 pounds for lifting manually. BUYER prefers side access for replacing the catalysts. If weights exceed 50 pounds, lifting beams or rigs shall be designed and supplied by the SELLER.

3.7.1.3 SELLER shall provide transitions for connection to BUYER's piping and gas analyzer instrumentation. All flanges required for connection to BUYER's piping and gas analyzers shall be raised face flanges and shall be welded to the pipe (no threaded connections allowed). See Attachment 4 (LAW Skid Interface Connections). See also Attachments 5 and 6 (Connection for Non-Routine Sample Extraction and Connection for Sample Extraction - Permanent Typical, respectively) for non-routine and permanent analyzer connection details.

3.7.1.4 SELLER shall provide TCO drain lines. Drain lines shall be welded to the housing at low points. Penetrations by drains shall be arranged and individually sealed so that catalysis beds cannot be bypassed. Drain lines shall be piped to skid edge and flanged.

3.7.1.5 NOT USED

3.7.1.6 SELLER shall design and supply recuperative heat exchanger outlet piping as specified in the MDSs. Pipe fabrication and supports shall be designed in accordance with ASME B31.3 and Attachment PS02 *Engineering Specification for Shop Fabrication of Piping*, and be included in the SELLER's scope of supply. SELLER shall include pipe supports and tied expansion joints for both offgas process inlet and outlet connections.

3.7.1.7 NOT USED

3.7.1.8 A containment tent or series of containments tents will be erected by the BUYER to control the work area for catalyst removal and replacement after permanent installation of the TCO units. The BUYER will supply and set up a portable HEPA filtered exhauster for containment tent ventilation with discharge port monitoring. The TCO unit will be ventilated using the BUYER's permanently installed process fans. Prior to opening the catalyst access doors on the TCO unit, the TCO unit air will be sampled using an up stream, 1/4 inch pre-installed sample tap. The air sample will be used to determine the level of airborne radioactive material inside the TCO unit. After the air samples are taken and deemed acceptable, opening the catalyst access doors will take place inside the containment tent once stable air flow conditions are established.

3.7.1.9 The SELLER shall supply the following for each TCO unit:

3.7.1.9.1 One 1-inch air sample tap per TCO unit. Include one 1-inch full port ball valve. The sample tap shall extend 12 inches inside the TCO unit. The accessible end of the 1-inch ball valve shall include a cap. There shall be at least 3 inches of clearance, for tightening bolts, between the insulating jacketing and the underside of the flange.

3.7.1.10 Catalyst removal / installation:

3.7.1.10.1 The catalyst bed (s) shall be designed for manual removal and replacement without entering the TCO unit for contact maintenance. It is acceptable for hands and arms to break the plane of the catalyst access door to reach inside the TCO to operate jack bolts with hand tools or use tools with extended handles to remove /replace catalyst modules. It is acceptable to split the movable catalyst frame to minimize the weight of the frame being moved for catalyst module removal / replacement. Pulling the Catalyst module forward to unsnap the tongue and groove connection is not desirable. A jack bolt system that applies pressure to the movable frame to hold the catalyst modules in place is desired.

3.7.1.11 To facilitate process troubleshooting and to obtain additional data during testing and operations, the SELLER shall supply the following for each TCO unit:

3.7.1.11.1 One thermowell between each of the VOC catalyst beds to be provided to take temperature readings during non-routine evolutions. Thermowells shall be located to minimize flow disturbance and not interfere with the manipulation of the catalyst access doors. The location shall consider optimum accessibility. However, it is acceptable to locate the thermowell on the top of the TCO. Include ball valve, blind flange, gaskets and bolts for each well assembly. See Attachment 5 (Connection for Non-Routine Sample Extraction) for temporary connection details.

3.7.1.11.2 One sample port between each of the VOC catalyst beds to be used to measure offgas concentrations during non-routine evolutions. Sample ports shall be located to minimize flow disturbance and not interfere with the manipulation of the catalyst access doors. The location shall consider optimum accessibility. However, it is acceptable to locate the sample ports on the top of the TCO. Include ball valve, blind flange, gaskets and bolts for each sample port. See Attachment 5 (Connection for Non-Routine Sample Extraction) for temporary connection details.

3.7.2 Recuperative Heat Exchanger

3.7.2.1 Unless otherwise specified, the heat exchanger pressure boundary shall be designed in accordance with ASME B&PVC, Section VIII, Div. 1.

3.7.2.2 The recuperative heat exchangers in the Thermal Catalytic Oxidizer/Reducer units are expected to have a design life of 40 years. If the design life is less than 40 years, the SELLER shall provide provisions for cleaning, maintenance, repair or unit replacement. The SELLER shall submit options for cleaning, maintenance, repair or provisions for total unit replacement of the recuperative heat exchanger. Options to be considered, but not limited to, include:

3.7.2.3 Body flanges that allow for total unit replacement

3.7.2.4 Clean out doors for maintenance access

3.7.2.5 Automatic wash systems/particulate collection hoppers

3.7.2.6 Bolted connection to skid support frame

3.7.2.7 Heat exchangers shall be designed for full differential pressure, with one side at the design pressure and the other side at atmospheric pressure.

3.7.3 Ammonia/Air Dilution Equipment

3.7.3.1 Design and fabrication of ammonia piping and valves shall be in accordance with ANSI K61.1 and ASME B31.3 (as tailored in Attachment 1 & 2, respectively), and Attachment PS02 *LAW TCO Customized PS02*.

3.7.3.2 Piping and components required for the LAW Ammonia/Air Dilution shall be located on a separate skid away from the Thermal Catalytic Oxidizer/Reducer skid. Refer to MDS for space envelope and equipment layout requirements. SELLER shall include necessary equipment to meet performance requirements of this specification.

3.7.3.3 SELLER shall supply, test, and deliver HEPA filters and housings for the LAW ammonia dilution system in accordance with MDSs.

3.7.3.4 HEPA filters shall be designed and fabricated in accordance with specification 24590-WTP-3PS-MKH0-T0009, *Engineering Specification for Standard Nuclear Grade High Efficiency Particulate Air (HEPA) Filters (For ASME AG-1 Compliant Filters)*, and MDS listed in Section 2.1 of the Material Requisition.

3.7.3.5 HEPA filter housings shall be designed and fabricated in accordance with specification 24590-WTP-3PS-MKH0-T0007, *Engineering Specification for Axial Flow High Efficiency Particulate Air (HEPA) Filter Housings*, and MDS listed in Section 2.1 of the Material Requisition.

3.7.3.6 SELLER shall supply commercially available (quality level CM) centrifugal fans for the LAW ammonia/air dilution system. If SELLER determines airflow cannot be adequately controlled using control valves and that adjustable speed drives (ASD) are required, then the ASDs shall be in accordance with 24590-WTP-3PS-EVV1-T0001, *Engineering Specification for Low Voltage Adjustable Speed Drives*. Centrifugal Fan Data Sheets shall not be supplied by the BUYER. SELLER shall create and submit Centrifugal Fan Data Sheets outlining performance requirements as specified by the SELLER. Applicable design conditions and mechanical requirements shall be outlined on the Centrifugal Fan Data Sheets.

3.7.3.7 Fans shall be capable of performing at the conditions shown on the fan data sheets. Fan performance ratings shall be based on AMCA-210 standard air conditions. Multi-stage fan performance rating may be based on testing in accordance with ASME PTC-10-1997. Capacity and air stream properties are shown in SELLER supplied fan data sheets. Materials of construction used shall be compatible with the effluent being handled.

3.7.3.8 Fan/motor assemblies shall be complete with all components and accessories fully assembled, wired, and skid mounted requiring only connection to the BUYER's electrical power and control systems, and interconnecting piping. Fan/motor assemblies shall be self-supporting, capable of carrying the static loads of the fan components and the stress imposed during shipment, installation, and operation.

3.7.3.9 Fans shall be provided with machined rotary shaft seals. Multi-stage fans may be provided with low leakage, carbon ring seal. Shaft seals shall be fully capable of withstanding the required test pressures before, during, and after fan operation. Allowable leakage shall be equal to or less than 0.01 % of normal airflow, per inch of fan operating pressure, or 0.5 SCFM, whichever is greater.

3.7.3.10 Bearings shall be heavy-duty pillow block or pillow block type, self-aligning, grease-lubricated roller bearings with minimum L-10 service rating life noted on the SELLER supplied data sheets. Multi-stage centrifugal fan may be applied with radial type grease-lubricated radial ball bearings with L-10 service life of not less than 100,000 hours. Bearing rating life shall be established in accordance with ABMA 9 or 11, as applicable.

3.7.3.11 For single stage fans, the fan wheel/impeller and shaft shall be dynamically balanced in accordance SELLER's procedure. All balancing weights shall be welded in place. For single stage fans, all vibration tests shall be in accordance with SELLER's procedure. Multi-stage fans may be balanced to Quality Grade 2.5 of ISO 1940-1:2003, Mechanical Vibration-Balance Quality Requirements For Rotors In A Constant (Rigid) State- Part 1: Specification And Verification Of Balance Tolerances.

3.7.3.12 SELLER shall provide lifting lugs or slots to facilitate lifting and handling of the fans. If special lifting devices are required, they shall also be furnished.

3.7.3.13 Fan sound pressure level shall not exceed 85 dB(A) at 3-feet. If sound power exceeds 85 dB(A) at 3-feet, SELLER shall obtain BUYER permission to proceed in the form of an SDDR stating estimated sound power level.

3.7.3.14 Provisions shall be provided to measure the vibration of the fan bearings.

3.7.3.15 Electric motors shall be in accordance with NEMA MG-1. Motor drive combination shall be suitable for operation for the design conditions shown on the SELLER supplied fan data sheets.

3.7.3.16 For the fan, the following shall be submitted for BUYER's review and information:

3.7.3.16.1 SELLER's recommended accessibility and maintenance requirements.

3.7.3.16.2 Performance test procedure and test reports.

3.7.3.16.3 Sound test procedure and test reports.

3.7.3.16.4 Balancing and vibration test procedures and test results.

3.8 Loading

3.8.1 The Thermal Catalytic Oxidizer/Reducer (LVP-SKID-00002) and the associated Ammonia/Air Dilution assembly shall be self-supporting, capable of carrying the static loads of components and the stress imposed during shipment, installation, and operation.

3.8.2 The Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution skids shall be designed in accordance with the load and load combination requirements of specification 24590-WTP-3PS-FB01-T0001, *Engineering Specification for Structural Design Loads for Seismic Category III & IV Equipment and Tanks* and 24590-WTP-3PS-MV00-T0002, *Engineering Specification for Seismic Qualification Criteria for Pressure Vessels.*

3.8.3 The SELLER shall provide a seismic analysis in accordance with Section 3.8.2 of this specification and 24590-WTP-3PS-G000-T0014, *Engineering Specification for Design Analysis.*

3.8.4 The SELLER shall provide the documented results of the seismic analysis in report form to the BUYER.

3.8.5 The Thermal Catalytic Oxidizer/Reducer units shall be designed in accordance with the nozzle load requirements as specified in the MDSs in Section 2 of the MR.

3.9 Electrical Requirements

3.9.1 Electrical components and appurtenances furnished with the Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution units shall conform to the requirements of Attachment EKP0. Electrical components shall also meet applicable sections of NFPA 70-1999 and requirements outlined in NFPA 497-1997.

3.9.2 NOT USED

3.9.3 Electric heaters shall be of the element type and mounted on removable flanged plates for ease of maintenance. BUYER will supply a 480V 3-wire wye grounded power circuit. If SELLER's supplied heaters are rated for a lower voltage, SELLER shall supply the necessary components to step the electricity down to the necessary voltage.

3.9.4 Electrical enclosures shall be NEMA 4X rated.

3.9.5 The Thermal Catalytic Oxidizer/Reducer control panel (LVP-PNL-00003) components shall be UL 508 listed and certified. Control panels as a whole shall be UL 508A labeled.

3.9.6 NOT USED

3.9.7 SELLER shall provide a grounding lug or boss, in accordance with UL 467, on the equipment housing or frame to facilitate attachment of grounding cable by the BUYER.

3.9.8 SELLER shall provide total electric load for each Thermal Catalytic Oxidizer/Reducer.

3.9.9 SELLER shall provide a functional description of the electrical operation of the skids as well as single line, schematic, wiring, layout, and interconnection diagrams. In addition, catalog cut sheets, recommended spare parts, and electrical loads as detailed in Attachment EKP0, Section 9. *Documentation and Submittals.*

3.10 Instrumentation and Control Requirements

3.10.1 Instrumentation and controls furnished with the Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution units shall meet the instrumentation and control requirements as stated in Attachment JQ07. BUYER shall provide the appropriate ABB control system components (i.e. I/O modules, power supplies) to the SELLER for fabrication into the SELLER's control panel (LVP-PNL-00003) as described in Section 3.4.2 of Attachment JQ07. SELLER shall provide non-ABB manufactured equipment (fiber optic converters, fiber optic patch cables and plates, terminals, circuit breaker, wiring, etc.) and panel fabrication.

3.10.2 SELLER shall design the control panel (LVP-PNL-00003) to utilize the ABB control system equipment and provide a panel arrangement drawing with Bill of Material identifying all parts to be provided by the BUYER. SELLER shall provide an I/O list on the panel arrangement drawing for all instruments. Reference BUYER's P&IDs in Section 2 of the MR for additional information regarding instrument locations and types.

3.10.3 SELLER shall provide control narrative, logic drawings, termination drawings, and related items as specified in Attachment JQ07 for normal (PCJ) and safety control system (PPJ) operation. BUYER shall provide programming for normal operation (PCJ) via software included with BUYER supplied ABB components. For safety operations, the SELLER shall hardwire SS (Z) components to a NEMA 4X SS junction box for interface to buyer's safety control system (PPJ). BUYER shall provide controller, software, and attend and support the factory test of the equipment at the SELLER's facility.

3.10.4 In-line instruments shall be wired or tubed to the skid edge. Tubing shall terminate with a bulkhead connection. Wiring shall terminate in a junction box.

3.10.5 NOT USED

3.10.6 Management of SELLER software shall be governed by 24590-WTP-3PS-JQ00-T0004, *Engineering Specification for Management of Supplier Software.*

3.11 Lifting Requirements

3.11.1 Lifting lugs shall be installed on the Thermal Catalytic Oxidizer/Reducer and Ammonia/Air Dilution skid packages for balanced lifting and handling. SELLER shall identify the weight and center of gravity of each package. All lifting points shall be designed in accordance with the requirements of BUYER specification 24590-WTP-3PS-G000-T0003, *Engineering Specification for Packaging, Handling, and Storage Requirements.*

3.11.2 Lifting eyes or lugs shall be certified to be suitable for the safe, balanced lifting and handling of the equipment without distortion or damage to the components.

3.11.3 All lifting attachments shall have either a safety factor of three (3), based on material ultimate strength, or five (5), based on the material yield strength, whichever is more conservative. The lifting points and center of gravity shall have a label clearly identifying its safe working load.

3.11.4 Lifting lugs must accept standard commercial lifting equipment. Chain blocks or braiding shall not be permitted.

3.11.5 The lifting lugs for the packages must be accessible from the top, without removal of components or covers.

3.11.6 SELLER to provide calculations for the lift lug design.

3.12 Thermal Analysis Requirements

3.12.1 Method of thermal analysis shall be proposed by the SELLER.

3.12.2 Refer to MDS for thermal analysis technical information and heat loss requirements (i.e. thermal conductivity values, room temperatures, etc.).

3.12.3 The thermal analysis shall include the effects of stresses resulting from potential variations in temperatures due to startup, normal operation, shutdowns, and thermal cycling of the Thermal Catalytic Oxidizer/Reducer. Analysis shall show that the

Thermal Catalytic Oxidizer/Reducer are adequate for the design life specified in Section 3.1.2 of this specification. Analysis shall also establish design temperature of the TCOs.

3.12.4 The thermal analysis shall include thermal expansion of the Thermal Catalytic Oxidizer/Reducer and resulting nozzle loadings in X, Y, and Z planes with deflections at normal operating conditions and design conditions.

3.12.5 The thermal analysis shall determine the thickness and extent of insulation required on the sides, ends, top and bottom of the Thermal Catalytic Oxidizer/Reducer to ensure that the insulation jacket temperature and all exterior uninsulated portions with potential for personnel exposure, do not exceed 140 °F at maximum design temperature.

3.12.6 The thermal analysis shall determine the thickness and extent of insulation required on the bottom of the Thermal Catalytic Oxidizer/Reducer so that the temperature of the concrete does not exceed 150 °F.

3.12.7 The SELLER shall provide the documented results of the thermal analysis in report form to the BUYER. The thermal analysis report shall provide a complete thermal analysis of the Thermal Catalytic Oxidizer/Reducer and shall include 3-D graphical results of models and all calculations performed, as applicable to the analysis approach chosen.

3.12.8 All assumptions shall be plainly identified and data presented (including their uncertainty) with precise logic.

3.12.9 The final thermal analysis report shall be in accordance with 24590-WTP-3PS-G000-T0014 *Engineering Specification for Supplier Design Analysis* and shall convey information to several disciplines, many of whom may be less familiar with the general subject than the authors. Care shall be taken to use simple statements and expressions and to make statements as concise as possible. If highly technical terms are necessary, they shall be adequately explained and defined.

3.13 Thermal Catalytic Oxidizer/Reducer Design Analysis Requirements

3.13.1 The SELLER shall conduct and submit Thermal Catalytic Oxidizer/Reducer design analyses for the LAW unit. The design analysis of the Thermal Catalytic Oxidizer/Reducer shall be conducted by a Thermal Catalytic Oxidizer/Reducer expert to determine the expected catalyst changeout frequency for the final Thermal Catalytic Oxidizer/Reducer design. SELLER shall provide personnel qualifications to the BUYER for review.

3.13.2 Analysis shall be conducted considering operation of the Thermal Catalytic Oxidizer/Reducer at design conditions outlined in this specification and MDSs.

3.13.3 Analysis shall determine expected catalyst changeout frequency based on the gas composition and load information specified in the MDSs in Section 2 of the MR.

3.13.4 The design analysis for expected catalyst changeout shall assume that the offgas flow through the Thermal Catalytic Oxidizer/Reducer may vary as much as ±10% from the design flowrate specified in the MDSs in Section 2 of the MR.

3.13.5 The SELLER shall provide the documented results of the Thermal Catalytic Oxidizer/Reducer analysis with any graphical results, as applicable, in report form to the BUYER prior to fabrication.

3.14 Accessibility and Maintenance

3.14.1 BUYER's layout allows for necessary access and space requirements to facilitate maintenance during normal plant operation or scheduled shutdown.

3.14.2 SELLER's recommended accessibility and maintenance requirements for each piece of equipment shall be included in the SELLER's design and shown on layout drawings. Side access for replacement of the catalyst and related gaskets is required.

3.14.3 SELLER shall provide instructions and frequency of maintenance including lubrication, rotation, heating, and any other type of preventative maintenance that will preserve the equipment until the time it is put into operation, including:

- Up to 12 months outdoor storage prior to installation
- Outdoor preservation maintenance and inspection schedule
- Indoor (installed) but not operating preservation maintenance and inspection schedule
- Operating preservation maintenance and inspection schedule

Frequency of inspection and maintenance intervals during operation shall be in accordance with equipment SELLER's recommendations.

3.14.4 Equipment, instrumentation, and electrical components that are over six feet from ground level and require routine maintenance shall be provided with permanent work platforms with fixed ladders/stairs to perform maintenance.

3.14.5 Maintenance platforms, Handrails, and ladders, if applicable, shall be designed to meet the requirements set forth in 29 CFR 1910, *Occupational Safety and Health Standards for General Industry* and AISC 9th Edition (See attachment 9).

3.14.6 Maintenance platforms shall have a Minimum Uniform Load of 100 psf. Handrails, and ladders, if applicable, shall have a Minimum Uniform Load per Table 16B of UBC 1997.

3.14.7 The maintenance platforms, if applicable per 3.14.5, shall be attached without welding after the equipment is installed in the LAW facility.

3.15 Software Requirements

See Section 3.5 in Attachment JQ07 for specific software requirements.

3.16 Commercial Grade Dedication

See section 10.2.7.2 and 10.2.7.5 of this specification and 24590-LAW-3PS-MBT0-T0001, Rev 1 *Quality Requirements Specification for LAW TCO Procurement,* Section 6.5 for submittal requirements and protocol for the procurement of safety related components/functions.

In accordance with WTP specification 24590-LAW-3PS-MBT0-T0001, Rev 1 *Quality Requirements Specification for LAW TCO Procurement,* Section 6.5, the SELLER shall execute seismic design analyses for the safety components/functions (see Section 3.1.14 of this specification) in one of four ways:

1. Option #1. Design analysis results may be independently verified through testing or alternative calculation.
2. Option #2-The SELLER may elect to have design analyses performed by a sub-tier supplier approved by WTP.
3. Option # 3-SELLER performs design analyses using software which has been pre-qualified by the BUYER for use.

4. Option # 4-SELLER performs design analyses on BUYER's controlled software/platform.

3.16.1 The SELLER shall construct the pressure boundary components, including such items as plate, fasteners, weld material, etc., from material where the chemical and physical properties have been verified. See section 10.2.7.3 of this specification for a listing of WTP-Approved testing laboratories. This may be by the SELLER testing each piece of material or by testing one piece of material from each heat of material where material heat traceability to origin has been confirmed.

3.16.2 The SELLER shall perform a pressure confinement test of the assembly, or a series of tests that cumulatively verify the leak tightness of the assembly, at the test pressure specified by the WTP-approved Factory Acceptance Test.

3.16.3 For each instrument identified by a "Z" indicator in the item identification (see section 3.1.14 of this specification), the SELLER shall request WTP approval of the selected item(s) prior to procurement. Upon receipt of approval, WTP shall provide technical, quality, procurement and acceptance requirements for the item(s). The SELLER shall purchase two (2) additional sacrificial items for commercial grade dedication by WTP.

4 Materials

4.1 General

4.1.1 SELLER shall comply with specification 24590-WTP-3PS-G000-T0002, *Engineering Specification for Positive Material Identification (PMI) for Shop Fabrication.*

4.2 Construction

4.2.1 Materials of construction shall have properties suitable for the service conditions defined in the MDSs.

4.2.2 The ASME and/or ASTM material numbers and grades shall be identified and MTRs showing actual test report values shall be provided for the housing, ducts, weld filler metal, and support framing integral to the Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution assemblies. Material designations shall be indicated on the fabrication drawings and in the material lists.

4.2.3 Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution skids shall be fabricated from structural steel shapes and plates properly reinforced to be self-supporting, capable of carrying the static loads of components and the stresses imposed during shipment, installation, and operation.

4.2.4 Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution housings and outlet piping shall be fabricated from materials specified in the MDSs in Section 2 of the MR.

4.2.5 Where the BUYER has not specified material types, the SELLER shall select materials giving consideration to the design life of the equipment, compatibility with adjacent materials, compatibility with the process materials and conditions, environmental conditions, and coating requirements. BUYER shall review and approve materials selected by the SELLER.

4.3 Prohibited Materials

4.3.1 As applicable, mercury, zinc, cadmium, or other low melting point materials and halogens shall not be used in direct contact with stainless steel. This prohibition also applies to use of tools, fixtures, paints, coatings and sealing compounds, and any other equipment or materials used by the SELLER in handling, assembly and storage of stainless steel parts or components.

4.3.2 Asbestos shall not be used in any component of the Thermal Catalytic Oxidizer/Reducer, the associated Ammonia/Air Dilution units, and appurtenances.

4.3.3 The prohibited materials list excludes materials that might be used for bearings, brazed joints, or instruments.

4.3.4 The equipment provided to the BUYER shall not contain any of the materials listed in 24590-WTP-LIST-CON-08-0001, *Restricted Materials List WTP Safety Assurance* unless BUYER (Safety Assurance) approval is obtained.

4.4 Insulation

4.4.1 The SELLER shall provide detailed insulation installation procedures complete with drawings showing methods and details for applying and securing insulation. Installation procedures and drawings shall include details related to applying and securing metal jacketing (if externally insulated), to the Thermal Catalytic Oxidizer/Reducer. The insulation procedures shall be in accordance with Attachment NN00 *Thermal Insulation for Mechanical Systems*, and this specification. The insulation installation procedures shall be reviewed by the BUYER prior to commencement of work to install insulation on the Thermal Catalytic Oxidizer/Reducer.

4.4.2 SELLER shall recommend cements, mastics, and adhesives that will be suitable for the maximum design temperature of the Thermal Catalytic Oxidizer/Reducer. The mixing of cements, mastics, etc., shall be done with deionized water.

4.4.3 Provide for removable/replaceable insulation on flanges, manholes, doors, and access openings.

4.4.4 Insulation thickness greater than three (3) inches applied to the exterior of the Thermal Catalytic Oxidizer/Reducer shall be applied in multiple layers with staggered joints. Each layer of multiple layer and double insulation shall be held in place separately.

4.4.5 Exterior insulation shall be jacketed with 304 stainless steel. The stainless steel jacketing shall be 0.024 inch thick flat and smooth sheet, and conform to ASTM A240. The jacketing shall be furnished in the annealed or soft condition with a regular 2B mill finish and have a factory applied moisture barrier.

4.4.6 Design jacketing with an overlap of 2 inch minimum between sections. Standard process industry practices shall be followed.

4.4.7 Design stainless steel jacketing exposed edges to be machine-bent or rolled to eliminate sharp corners.

4.4.8 All insulation components, including facings, mastics, and adhesives, shall meet ASTM E84 fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed. Ratings used are determined by Underwriters Laboratories Inc. (UL).

5 Fabrication

5.1 General

5.1.1 Fabrication of the thermal catalytic oxidizer/reducer units shall be in accordance with the requirements of 24590-WTP-3PS-MV00-T0001, *Engineering Specification for Pressure Vessel Design and Fabrication.*

5.1.2 Fabrication of piping shall meet the requirements of BUYER specification 24590-WTP-3PS-NWP0-T0001 *Engineering Specification for General and NDE Requirements for Supplier Fabricated Piping*, Attachment PS02 *Engineering Specification for Shop Fabrication of Piping*, and ASME B31.3.

5.1.3 All stainless steel metal working, grinding, cutting, machining and welding shall use tools and consumables dedicated and segregated from all others to prevent cross contamination. A dedicated work area for tools, equipment storage, parts storage and raw materials must be established to control contamination. Welding consumables for stainless steel welding must be segregated from other consumables.

5.2 Welding

5.2.1 Design and fabrication of the TCO pressure boundary shall be in accordance with specification 24590-WTP-3PS-MV00-T0001, *Engineering Specification for Pressure Vessel Design and Fabrication*

5.2.2 Welding of the TCO pressure boundary shall be in accordance with specification 24590-WTP-3PS-MVB2-T0001, *Engineering Specification for Welding of Pressure Vessels, Heat Exchangers and Boilers.*

5.2.3 Fabrication of TCO piping shall be in accordance with Attachment PS02 *Engineering Specification for Shop Fabrication of Piping.*

5.2.4 Welding and NDE of TCO piping shall be in accordance with specification 24590-WTP-3PS-NWP0-T0001, *Engineering Specification for General Welding and NDE Requirements For Supplier Fabricated Piping.*

5.2.5 Welding of carbon structural steel shall be in accordance with AWS D1.1 and specification 24590-WTP-3PS-SS00-T0001, *Engineering Specification for Welding of Structural Carbon Steel.*

5.2.6 Welding of structural stainless steel shall be in accordance with AWS D1.6 and BUYER specification 24590-WTP-3PS-SS00-T0002, *Engineering Specification for Welding of Structural Stainless Steel and Welding of Structural Carbon Steel to Structural Stainless Steel.*

5.3 Coating

5.3.1 Shop coating shall be in accordance with Attachment AFPS *Engineering Specification for Shop Applied Special Protective Coatings for Steel Items and Equipment,* Appendix D, Number 8.20, System Code D.

5.3.2 A manufacturer's coating data sheet (see Attachment AFPS *Engineering Specification for Shop Applied Special Protective Coatings for Steel Items and Equipment*, Section 6.2.1.2) is required for each commercial off the shelf (COTS) item or component that is supplied with a manufacturer's standard coating.

5.3.3 The top coat shall be ANSI 70 grey in color.

5.4 Assembly

5.4.1 The Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution unit shall have edges that are both smooth and not sharp to the touch.

6 Tests and Inspections

6.1 General

6.1.1 The SELLER shall provide all instruments, cables, and facilities necessary to perform any shop tests, the Factory Acceptance Tests (FAT) and NDE.

6.1.2 SELLER shall provide the necessary hardware, fan, pre heater, power, controls, temporary insulation, piping, and ductwork for the LAW TCO and test equipment to set up and operate the LAW TCO at the design conditions specified in the LAW MDS at the SELLER's shop. The LAW TCO shall operate at a negative pressure so the test shall include a temporary fan(s) setup which meets the LAW MDS design conditions and a temporary pre-heater to simulate the hot gas from the melters (as specified in the MDS).

6.1.3 SELLER shall provide the necessary hardware, power, controls and test equipment to set up and operate the Instrument Service Air (ISA) supply on the Ammonia/Air Dilution Skid at the conditions prescribed in the MDS.

6.1.4 Any non-conforming work shall be redone by the SELLER at SELLER's cost.

6.2 Personnel Qualifications

6.2.1 NDE personnel performing NDE shall work in accordance with the following BUYER specifications:

- 24590-WTP-3PS-MV00-T0001, *Engineering Specification for Pressure Vessel Design and Fabrication*
- 24590-WTP-3PS-MVB2-T0001, *Engineering Specification for Welding of Pressure Vessels, Heat Exchangers and Boilers*
- 24590-WTP-3PS-SS00-T0001, *Engineering Specification for Welding of Structural Carbon Steel*
- 24590-WTP-3PS-SS00-T0002, *Engineering Specification for Welding of Structural Stainless Steel and Welding of Structural Carbon Steel to Structural Stainless Steel*
- 24590-WTP-3PS-NWP0-T0001, *Engineering Specification for General Welding and NDE Requirements for Supplier Fabricated Piping*
- Attachment PS02 *Shop Fabrication of Piping*

6.3 Non-Destructive Examinations

6.3.1 NDE shall be performed in accordance with the following BUYER specifications:

- 24590-WTP-3PS-MV00-T0001, *Engineering Specification for Pressure Vessel Design and Fabrication*
- 24590-WTP-3PS-MVB2-T0001, *Engineering Specification for Welding of Pressure Vessels, Heat Exchangers and Boilers*
- 24590-WTP-3PS-SS00-T0001, *Engineering Specification for the Welding of Structural Carbon Steel*

- 24590-WTP-3PS-SS00-T0002, *Engineering Specification for Welding of Structural Stainless Steel and Welding of Structural Carbon Steel to Structural Stainless Steel*
- 24590-WTP-3PS-NWP0-T0001, *Engineering Specification for General Welding and NDE Requirements for Supplier Fabricated Piping*
- Attachment PS02 *Shop Fabrication of Piping*

6.3.2 NDE procedures shall be submitted to BUYER for review and approval prior to use.

6.3.3 Submittal of exposed radiographs is required. Original set of exposed radiographic film must be sent, along with technique and reader sheets. Film must be packaged in such a manner as to preclude moisture and handling damage.

6.4 Shop Tests

6.4.1 Pre-Functional Acceptance Test

6.4.1.1 SELLER shall perform instrument testing, inspection and calibration required to verify compliance with this specification. When requested, procedures shall be submitted for the BUYER's review and approval, and reports provided for records in accordance with the RFP or Section 3 of Material Requisition to which this specification is attached.

6.4.1.2 BUYER's Engineering representative shall witness SELLER's functional tests. All defects in materials, wiring and tubing detected as a result of testing shall be repaired or replaced by the SELLER at no additional cost to the BUYER and prior to BUYER's arrival to witness the functional demonstration. SELLER shall allocate sufficient time in the project schedule to accommodate this requirement. BUYER will advise SELLER of any such witness tests.

6.4.2 Instrumentation and controls provided by the SELLER that contain solid state components shall be subjected to burn-in as required. Burn-in duration shall be 72 hours minimum. The SELLER shall provide advance notification of 10 business days to allow BUYER to witness this Test.

6.4.3 All wiring provided by the SELLER shall be verified 100 % point to point continuity test. Wiring errors detected shall be corrected and/or drawings corrected as appropriate prior to BUYER's inspection.

6.4.4 Software functional testing shall be governed by 24590-WTP-3PS-JQ00-T0004, *Engineering Specification for Management of Supplier Software.*

6.4.5 The SELLER shall perform Instrumentation functional testing to demonstrate to the BUYER the functionality of the system. A simulated input signal shall be injected, varied over the full range for each device, calibrated and checked for correct operation. Each control circuit or control logic element provided shall be checked for correct operation by simulating inputs, actuating switches and monitoring outputs, indicating lights, etc.

6.4.6 Failure to perform such tests or test failures shall be cause for rejection of part or all of the system components.

6.4.7 The SELLER's shop tests shall include the following:

a) Megger test before termination of all 480V wiring pulled into conduit. See Section 5 of the MR for Witness and Hold Point schedule. Record on FAT datasheet.

b) Continuity check of all wiring for conformance with drawings. See Section 5 of the MR for Witness and Hold Point schedule. Record on FAT datasheet.

6.4.8 Prior to notification by SELLER that a unit is ready for the BUYER to witness the Functional Test portion of the FAT, SELLER shall perform all other FAT mechanical and electrical inspections to ensure completed equipment is functioning and ready for the Functional Test. See Section 5 of the MR for Witness and Hold Point schedule.

6.4.9 SELLER shall have unit up and ready for Functional Testing prior to the BUYER's team arriving on the day the Functional Test is to commence.

6.4.10 SELLER shall submit FAT Inspection Plan and Functional Test Procedure for BUYER review prior to use by the SELLER. SELLER shall provide a signed copy of completed FAT inspection report to BUYER at time of notification that SELLER is ready for the Functional Test. See Section 5 of the MR for Witness and Hold Point schedule.

6.4.11 SELLER shall submit a report of FAT results.

6.4.12 Functional Test procedures shall be prepared by the SELLER in accordance with Attachment JQ07, Section 11.3.2.

6.4.13 The following is a list of preliminary BUYER expectations for the LAW TCO Functional Test. This list is subject to change by the BUYER during review of proposed test procedure. Changes to these expectations, agreed to during review of the proposed test procedure, do not need to be reflected in a revision to this specification.

a. Test setup shall simulate the melter operating conditions per the MDS.

i. Pressure testing shall be performed in accordance with required testing specified in ASME B31.3-1996 or ASME BPV Code Section VIII Division I as applicable. In addition to these codes required pressure tests, additional testing shall be performed to further demonstrate the pressure boundary integrity of equipment which will be subject to internal pressure above atmospheric during normal equipment operation. Record on FAT datasheet.

ii. Sensitive Leak Testing shall be performed on piping in accordance with ASME B31.3-1996 Section 345.8. Record on FAT datasheet.

iii. Bubble Testing shall be performed on equipment designed and fabricated in accordance with ASME BPV Code Section VIII, Division I in accordance with ASME BPV Code Section V, Article 10. Record on FAT datasheet.

iv. Obtain unit pressure drop measurements at ambient conditions and at heatup intervals specified by the BUYER. Record on FAT datasheet.

v. Obtain catalyst bed seal measurements at ambient conditions and at heatup interval specified by the BUYER. Record on FAT datasheet.

vi. Preheat the incoming air, prior to LVP-HTR-00002, to simulate the hot offgas from the melter.

vii. Provide power and temporary controls for heater LVP-HTR-00002.

viii. Run the LAW TCO for 24 hours under this setup, prior to test objective testing.

b. Test objectives:

i. Verify the TCO heater, LVP-HTR-00002 provides the required heat to maintain temperature within the operating range as specified on the MDS.

ii. Verify the JZ0510 loop controls LVP-HTR-00002 within the operating range.

iii. Verify the 2 melter nominal flowrate of approximately 4702 ACFM (or as specified in the MDS) can be achieved. The flowrate provided here is for information only and subject to change. Refer to the MDS for the actual flowrate.

iv. Verify the actual differential pressure drop is less than the allowable differential pressure drop of 9.1 inch water gauge. The pressure drop provided here is for information and subject to change. Refer to the MDS for the actual pressure drop. Record on FAT datasheet.

v. Verify the TCO outlet temperature at TE 0524 is less than 550 °F. The temperature provided here is for information and subject to change. Refer to the MDS for the actual temperature. Record on FAT datasheet.

vi. Verify the TCO bypass valve, TV 0508 will open and close 6 times while the unit is at normal operating temperature.

vii. Verify no leaks at the access doors under operating conditions. Ultrasonic leak detectors like AccuTrak VPE-1000, SON-TECTOR 123 or equal are acceptable for leak testing around the access door gaskets.

viii. Verify unit pressure drop is within acceptable limits as stated in BUYER-approved FAT. Record on FAT datasheet.

ix. Verify the floor temperature under the TCO is less than 150°F. Record on FAT datasheet.

c. After the TCO unit has cooled, verify unit pressure drop is within acceptable limits as stated in BUYER-approved FAT. Record on FAT datasheet.

d. After the TCO unit has cooled, verify no deformation or degradation to the housing and internal components. Document findings on FAT datasheet.

e. After the TCO unit has cooled, obtain catalyst bed seal measurements and compare to measurements taken in Section 6.4.13.a.v. Record on FAT datasheet.

f. After the TCO unit has cooled, demonstrate the catalyst can be removed and replaced without a person breaking the plane of the access doors. It is acceptable if arms break the access door plane during catalyst removal or installation.

i. SELLER to submit a catalyst installation and removal procedure.

6.4.14 The following is a list of requirements for the Ammonia/Air Dilution Skid Functional Test. This list is subject to change by the BUYER during review of proposed test procedure. Changes to these expectations, agreed to during review of the proposed test procedure, do not need to be reflected in a revision to this specification.

a. Test set up:

i. Pressure testing shall be performed in accordance with required testing specified in ASME B31.3-1996. In addition to these codes required pressure tests, additional testing shall be performed to further demonstrate the pressure boundary integrity of equipment which will be subject to internal pressure above atmospheric during normal equipment operation. Record on FAT datasheet.

ii. Sensitive Leak Testing shall be performed on piping in accordance with ASME B31.3-1996 Section 345.8. Record on FAT datasheet.

iii. It is acceptable to use temporary air and controls to open and close valves on the Ammonia/Air Dilution Skid.

b. The SELLER shall provide the following air source:

i. NOT USED

ii. Dry, oil and dust-free Instrument Service Air (ISA) at 90-150 psig and with a dew point value of -40°F at 100 psig based on ISA 7.0.01.

c. Test objectives:

i. Satisfactory results for 6.4.14.a criterion stated above.

ii. Actuated valves are full-cycled a minimum of 3 times and flow instrument loops respond per the design.

6.4.15 SELLER provided lifting equipment such as, but not limited to, spreader beams, strong backs, and yokes, shall be tested in accordance with Section 9.4 of 24590-WTP-3PS-G000-T0003, *Engineering Specification for Packaging, Handling and Storage Requirements*.

6.4.16 All overhead lifting points shall be proof tested. Test and examination certificates/documentation shall be provided to the BUYER for review. Lifts shall be conducted in accordance with a BUYER reviewed handling procedure.

6.4.17 Proof tests shall be conducted with at least the equipment weight.

6.4.18 After the proof tests, the lifting points shall be inspected:

6.4.19 The welds on fabricated lifting lugs shall be dye penetrant tested. Acceptance criteria shall be from the prevailing weld design code or standard.

6.4.20 Lift points shall be inspected for visual permanent plastic deformation of the material that may invalidate the design analyses for the lift point.

6.4.21 Environmental and seismic testing shall be performed as required per 24590-WTP-3PS-FB01-T0001. Tests, if required, shall be performed on sacrificial units.

6.5 Site Tests

6.5.1 The BUYER startup personnel shall perform acceptance tests after initial installation to confirm the Thermal Catalytic Oxidizer/Reducer and the associated Ammonia/Air Dilution unit meet the performance requirements specified in Section 3.4 of this specification.

7 Preparation for Shipment

7.1 General

The Thermal Catalytic Oxidizer/Reducer, catalysts, assemblies and the associated Ammonia/Air Dilution units shall be packaged, handled, and stored in accordance with BUYER specification 24590-WTP-3PS-G000-T0003, *Engineering Specification for Packaging, Handling, and Storage Requirements*.

7.2 Tagging

7.2.1 A stainless steel nameplate shall be attached in a visible location to each Thermal Catalytic Oxidizer/Reducer and Ammonia/Air Dilution unit showing the manufacturer's name, shop location, date of manufacture, serial number, equipment rating, equipment tag numbers, weight of assembly and purchase order number.

7.2.2 Electrical/Control panels shall be tagged with component identification numbers per Attachment JQ07, Section 3.6.8 and Section 8.

7.2.3 Mechanical subcomponents (valves, strainers, expansion/flex joints, filters, mixing chambers, etc) shall have component identification number engraved on a 1/16" minimum thick stainless steel tag with ¼" minimum character height, securely attached with 1/16" minimum diameter aircraft cable and ferrules.

7.2.4 Component identification numbers shall be as shown on BUYER's P&IDs or MDSs attached to the MR, or will be provided via BUYER mark up of SELLER submitted drawings.

7.3 Nameplates

7.3.1 Permanent nameplates or labels shall be provided to identify each meter, relay, control switch, indicating light, circuit breaker compartment, and to identify all devices and terminal blocks within the compartments.

7.3.2 Exterior nameplates shall be made of laminated, beveled plastic of manufacturer's standard, with black lettering or numbering on a white background and shall be permanently affixed on the exterior. The method of affixing shall not violate the NEMA rating of the enclosure.

7.3.3 Interior labels for all devices, parts and components shall be machine printed, permanent and self-adhesive labels.

7.4 Documentation

SELLER shall ensure that appropriate documentation is prepared and signed by the appropriate person(s), if required. The shipping documentation shall accurately reflect specific traceability to the items being shipped. Drawings (wiring diagrams), showing external terminations for BUYER use to connect to SELLER provided instrumentation, shall be marked with the BUYER's instrument tag numbers.

8 Quality Assurance

8.1 General Requirements

This section does not delete or revise (but is in addition to) those requirements defined by the procurement documents. If a supplier believes that an inconsistency exists between this section and the procurement documents and referenced codes and standards, the supplier shall immediately notify the River Protection Project-Waste Treatment Plant (RPP-WTP) requesting resolution.

8.1.1 SELLER is responsible to promulgate the requirements of this specification to sub-suppliers performing design analysis or providing items or services related to this procurement.

8.1.2 The SELLER's QAP Requirements are included in BUYER specification 24590-WTP-3PS-G000-T0001, *Engineering Specification for Supplier Quality Assurance Program Requirements*.

8.1.3 SELLER's QAP Manual shall be submitted to BUYER for review in accordance with BUYER specification 24590-WTP-3PS-G000-T0001, *Engineering Specification for Supplier Quality Assurance Program Requirements*.

8.1.4 For items designated quality level commercial (CM), no additional QA program requirements are mandated by BUYER beyond SELLER's commercial QA program.

8.2 Quality Program Requirements

8.2.1 SELLER shall have in place a QAP meeting the requirements of BUYER specification 24590-WTP-3PS-G000-T0001, *Engineering Specification for Supplier Quality Assurance Program Requirements*.

8.2.2 The successful bidder must pass a pre-award survey by the BUYER. SELLER shall demonstrate that its quality program is in compliance with the quality requirements stated in 24590-LAW-3PS-MBT0-T0001, *Quality Requirements Specification for the LAW TCO Procurement.*

8.2.3 The SELLER shall allow the BUYER, its agent, and DOE access to their facility and records pertaining to this purchase order for the purpose of Quality Assurance Audits and Surveillance at mutually agreed times.

8.2.4 SELLER shall submit their QAP and work plan to BUYER for review prior to commencement of work. The plan shall include documents and procedures to implement the work and include a matrix of essential Quality Assurance elements cross referenced with the documents/procedures.

8.3 Supplier Deviation

Each SELLER shall be required to identify and promptly document all deviations from the requirements of the procuring documents. In addition, the SELLER shall be required to describe the recommended disposition for BUYER's acceptance based on appropriate analysis. Submittals of request for deviations from lower-tier SELLERS shall be through the prime supplier to WTP. SELLER-proposed deviations from procurement documents shall be initiated by use of Supplier Deviation Disposition Request (SDDR) form in Section 2 of the MR.

9 Configuration Management

Equipment and/or components covered by this specification are identified with plant item numbers shown in the MDSs. Each item shall be identified in accordance with Tagging in Section 7.2 of this specification.

10 Documentation and Submittals

10.1 General

SELLER shall submit to BUYER Engineering and Quality Verification documents in the forms and quantities shown in Form G-321-E, *Engineering Document Requirement*, and Form G-321-V, *Quality Verification Document Requirements*, attached to the MR.

10.2 Submittals

The SELLER shall submit the following:

10.2.1 Drawings

Drawings shall be in accordance with ASME Y14.100 and show the following information:

10.2.1.1 The outline dimensions of each Thermal Catalytic Oxidizer/Reducer and Ammonia/Air Dilution units, including outline and detail drawings for each component. These drawings shall reflect the "as-shipped" configuration of the equipment and instrumentation.

10.2.1.2 Details of construction.

10.2.1.3 Mounting dimensions and information required for the design of supports and foundations.

10.2.1.4 Operating weight and center of gravity of each Thermal Catalytic Oxidizer/Reducer and Ammonia/Air Dilution unit.

10.2.1.5 The space required for the removal of components.

10.2.1.6 The location of access doors.

10.2.1.7 Thermal insulation and interface points with BUYER's foundation.

10.2.1.8 Wiring and schematic diagrams. Diagrams shall include wire gauges and fuse sizes applicable to the supplied units only.

10.2.1.9 The ASTM or equivalent designation for materials.

10.2.1.10 Nozzle locations for connections to BUYER's process and utility piping including electrical and instrumentation connections.

10.2.1.11 Piping and instrumentation diagrams (P&IDs).

10.2.2 Procedures

Procedures shall include but are not limited to:

10.2.2.1 SELLER's shipping preparation and storage procedures.

10.2.2.2 Startup, operation, shutdown and idle procedures/manual.

10.2.2.3 Catalyst changeout procedures.

10.2.2.4 Performance test procedures and acceptance criteria for shop tests.

10.2.2.5 Insulation installation procedures.

10.2.2.6 Surface preparation and coating procedures for components specifically fabricated for the TCOs/SCRs.

10.2.2.7 Inspection and Test Reports

10.2.2.8 Performance test reports for shop tests.

10.2.2.9 Reliability assessment.

10.2.3 Calculations

10.2.3.1 Seismic and Thermal analyses/calculations shall be submitted for BUYER's review and permission to proceed. Analyses shall include nozzle loadings and deflections for normal operation and design conditions.

10.2.3.2 Calculations shall be in accordance with 24590-WTP-3PS-G000-T0014, *Engineering Specification for Supplier Design Analysis.*

10.2.4 Manuals

Manuals and instructions shall include:

10.2.4.1 Erection and installation manuals which provide complete, detailed procedures for installing and placing equipment in initial operation. The manuals shall include all erection and installation drawings. Refer to BUYER specification 24590-WTP-3PS-G000-T0003 *Engineering Specification for Packaging, Handling and Storage Requirements*, for additional requirements.

10.2.4.2 Operation, accessibility and maintenance manuals which provide complete, detailed descriptions of components and appurtenances with data sheets showing design, construction and performance data for equipment. Manuals shall include drawings required

for operation, maintenance and repair, maintenance requirements, instructions and operational troubleshooting guides.

10.2.4.3 Instruction manuals shall cover items purchased, including materials that the SELLER has obtained from a subcontractor. The SELLER shall obtain such manuals and lists, and submit them to the BUYER.

10.2.4.4 The SELLER shall provide instructions regarding transportation, site storage and preparation, and protection of equipment after installation and prior to operation. Refer to BUYER specification 24590-WTP-3PS-G000-T0003 *Engineering Specification for Packaging, Handling and Storage Requirements*, for additional requirements.

10.2.5 Certificates of Conformance and Acceptance

10.2.5.1 SELLER shall provide Certificates of Conformance demonstrating compliance with all applicable standards, specifications, and drawings. See Attachment 11 for a sample Certificate of Conformance.

10.2.5.2 SELLER shall certify lifting eyes or lugs and/or spreader bars are suitable for the safe, balanced lifting, and handling of the equipment.

10.2.5.3 Attachment 7 provides the Certificate of Analysis (COA) for BASF Catalysts, LLC (VOCat 300S) used in Catholic University's Vitreous State Laboratory (VSL) testing. Prior to release for shipment SELLER shall provide the COA demonstrating the performance of the oxidation catalyst is equal to or better than the oxidation catalyst used in the reference VSL testing (Ref. MDS General Note 9) for BUYER's acceptance.

10.2.6 Schedules

Lists and schedules shall include:

10.2.6.1 Schedule of engineering and fabrication.

10.2.6.2 Parts list, and cost for parts and items subject to deterioration and replacement.

10.2.6.3 List of recommended spare parts. The spare parts list shall include names of the original equipment manufacturer with appropriate part numbers.

10.2.7 Materials Certificates/Statistics

10.2.7.1 If the SELLER so chooses, the BUYER shall supply, as Government Furnished Equipment (GFE), a certified bulk quantity of 347 stainless steel to be used for fabricating the TCO. See Section 4b, Special Conditions 17 of the MR for GFE details. The SELLER shall provide all GFE program procedures to the BUYER per Attachment B of said Special Conditions 17.

10.2.7.2 MTRs for those components serving a safety function to confine melter off-gas and confine ammonia gas/air shall be submitted for BUYER approval prior to use. MTRs shall include the component identification, actual test report values and chemical/physical properties for all safety significant pressure boundary stress components. See sections 3.1.14 and 10.2.7.3.

10.2.7.3 Chemical and physical analyses for confinement components (see 10.2.7.2) shall be provided by one of the following BNI-evaluated laboratories and submitted for BUYER approval prior to use:

a. Koon-Hall-Adrian Metallurgical
5687-C S.E. International Way
Portland, OR 97222
503-653-2904

b. Stork MMA Testing Laboratories
2 Pheasant Run
Newtown, PA 18940

10.2.7.4 MTRs showing actual test report values shall be submitted for CM components.

10.2.7.5 MTRs with ASME and/or ASTM material numbers and grades shall show actual test report values for the housing, ducts, weld filler metal, and support framing integral to the Thermal Catalytic Oxidizer/Reducer and the Ammonia/Air Dilution assembly.

10.2.7.6 Material Safety Data Sheets (MSDSs).

10.2.8 Data

Data shall include:

10.2.8.1 BUYER's Mechanical Data Sheets, completely filled out by the SELLER, showing all information required to determine that the units are of the design and materials specified herein.

10.2.8.2 All data compiled during FAT testing transmitted in a final report based on BUYER-approved FAT procedure/results/datasheet.

11 References

Design changes incorporated by reference: N/A

ATTACHMENT JQ07

LAW TCO CUSTOMIZED JQ07

Per 24590-WTP-3PS-JQ07-T0001, Rev. 3 Plus SCN's 24590-WTP-3PN-JQ07-00010, 00012, 00013
ENGINEERING SPECIFICATION FOR INSTRUMENTATION FOR PACKAGED SYSTEMS
February 2010

This attachment defines the requirements for instruments, control devices, and control systems associated with the Low Activity Waste Thermal Catalytic Oxidizer/Reducer (LAW TCO). For continuity and maintaining configuration control, the section numbers from the specification noted above have been retained.

1.7 Work by Others

1.7.1 External Connections

All external connections of wiring and piping between the Supplier provided instruments and the BUYER's utilities are excluded unless specified in the RFP or otherwise agreed to by the BUYER and Supplier.

1.7.2 Instrument and Service Air

The BUYER will provide the following air sources for instruments and equipment:

Dry, oil and dust-free instrument air, 90 to 150 psig, with a dew point value of - 40 °F at 100 psig based on ISA 7.0.01. Service air, dew point –32 °F, 90 to 150 psig.

1.7.3 Power Supply

The BUYER will provide normal power and/or Uninterruptible Power Supply (UPS) for the Supplier's instruments unless otherwise specified on the parent specification. Each source will be delivered at 120 VAC, single phase, 60 Hz, grounded system. 480 VAC, 3 phase, 60 Hz power will be provided as required for motors. All other voltages required by the Supplier shall be derived from the BUYER provided 120 VAC or 480 VAC.

2.1 Codes

2.1.1 American Society of Mechanical Engineers (ASME)

ASME B31.3 (1996)	Process Piping
ASME/ANSI PTC 19.3	Performance Test Code for Temperature Measurement

2.2 Industry Standards

2.2.3 Telecommunications Industry Association / Electronic Industries Alliance (TIA/EIA)

TIA/EIA-232-F	Interface Between Data Terminal Equipment and Data Circuit-terminating Equipment Employing Serial Binary Data Interchange

TIA/EIA-485-A	Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

2.2.4 Instrumentation, Systems, and Automation Society (ISA)

50.02, Part 2,3,4,5&6	Fieldbus Standard for Use in Industrial Control Systems Part 2 (1992), 3 (1997), 4 (1997), 5 (1998), 6 (1998)
S75.01	Flow Equations for Sizing Control Valves
S84.01 (1996)	Applications of Safety Instrumented Systems for the Process Industries

2.2.6 International Electrotechnical Commission (IEC)

IEC 60751	Industrial Platinum Resistance Thermometer Sensors
IEC 61508-2/3	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems

2.2.7 National Electrical Manufacturers Association (NEMA)

NEMA ICS 6	Enclosures for Industrial Controls and Systems

2.2.9 WTP Project Specifications

24590-WTP-3PS-JQ00-T0004	Management of Supplier Software

3.3 Design Conditions

3.3.1 Units of Measurement

The following units shall be used for design parameters, calculations, and scales.

Positive gauge pressure	inches H_2O or psig
Vacuum	inches Hg Vac or H_2O Vac
Absolute pressure	inches Hg or psia
Differential pressure	inches H_2O or psi
Temperature	degrees F
Flow: Solids	lb/hr
Flow: Liquids and slurries	gal/min or lb/hr
Flow: Gases or Vapors	std ft^3/min (scfm), std ft^3/hr (scfh) or lb/hr
Flow: Steam or vapors	lb/hr
Level	inches, feet or %
Composition	%, Wt. Fraction or PPM
Density	lb/ft^3
Velocity	feet/second
Viscosity	centipoise (cP)
Current (Electrical)	ampere
Electrical Potential	volt
Resistance	ohm
Conductivity	micro-siemens (μS) per centimeter

3.3.2 Interlock and Alarm Requirements

Packaged systems shall be provided with a Common trouble (if specified) alarm, an Emergency shutdown alarm, and a Safety instrumented system (if specified) alarm to annunciate in the BUYER's control room. In addition, the following control requirements shall also be met:

- Field contacts shall open in the alarm condition
- Field contacts shall open to initiate shutdown
- Instruments and interlock systems shall be designed to be fail safe

3.3.3 Spare Capacity

The Supplier shall provide 25 percent spare intermediate terminal blocks and space for an additional 15 percent increase in terminal blocks.

3.3.4 Instrument Signal/Power Circuit Protection

Instrument circuits shall be protected and housed to meet the electrical area classification in which it is installed. The choices of housing shall satisfy all pertaining codes.

Intrinsically safe instrument systems should not be used, unless there are special site requirements, and then only with the BUYER's approval. Intrinsically safe system requires certification by Underwriters Laboratory (UL) or Factory Mutual (FM) Insurance Company.

Each PLC or controller discrete output signal shall have its own independent fuse. Fuses shall be located in the leg of the wiring scheme that provides power from the source to the field devices.

3.3.6 Local Control Panel Instrumentation Indicators

Local motor controls (i.e. single local/remote switch per equipment control panel, momentary forward/reverse for each motor) shall be provided on control panel for operating equipment in local mode. Local mode will allow control to be taken away from the control system. Operations will be performed from the control panel and will not be subject to ICN interlocks. Independent protection interlocks will remain in force to prevent damage to Supplier's equipment. Indicating lights for local control panels which include indications, status, and alarms from instruments and motor drives shall conform to the following requirements for indicating lights for status, alarms, information, or control:

Color	Meaning
Red	Stopped, Closed, OFF, Alarm
Green	Running, Opened, On
Yellow	Transition, Indeterminate, Force
Cyan (Light Blue)	Manual
Purple	Local Control (HMI Displays)
Clear	Local Control (Local Panels)

NOTE 1: Switches or control effectors shall be turned clockwise or moved upward to increase function or energize a device. For single switch multi-direction control a 3 position switch with center position spring return is recommended (i.e. Forward/Reversing Motors, etc.)

NOTE 2: Applicable standards and guidelines direct consistency of man-machine interface features in order to minimize operator errors. All control panels that are used for normal process operation should feature color-coding and display features that are consistent with the color scheme as defined in section 3.3.6 above. The color scheme applies to vendor packaged control indications as well as any SELLER developed human machine interface screens. However, for control and indication

panels that are intended for maintenance operation only, or that are not used for routine operator control, deviations from the color scheme listed above may be approved at the BUYER's discretion.

3.3.7 Push To Test Alarm Actuator

All alarm indicators (visual) and annunciators (audible), and all lights on Control Panels (ref 3.3.6) shall be activated with an integral momentary contact push to test feature or when a common momentary contact push to test button on the front of the panel is pressed. This function is provided to verify that the alarm and/or indication functions satisfactorily.

3.4 Controls and Instrumentation Requirements

3.4.1 General

It is the intention of this specification that the instrumentation and designated portions of the control system be designed, fabricated, and installed as far as it is practical to the Supplier's design offering. However, the BUYER will select specific manufacturers for purposes of quality and standardization of the instrumentation and control system throughout the WTP facility.

3.4.2 Controls

Control software provided by the Supplier shall be governed by 24590-WTP-3PS-JQ00-T0004.

3.4.2.1 WTP Integrated Control Network (ICN) Architecture

The BUYER has selected the Industrial^{IT} product line supplied by ABB Automation Inc. as the primary control system for the WTP facility. The selected platform is a highly versatile "hybrid" type system which is designed to implement the traditional Distributed Control System (DCS) applications as well as the traditional Programmable Logic controller (PLC) applications. For the purpose of standardization and maintainability, it is a requirement to utilize components from this manufacturer to the extent possible with packaged systems.

Packaged systems shall be integrated into the WTP ICN, the following options are available, listed in order of preference:

3.4.2.1.1 ICN Control Platform

This is the BUYER's preferred implementation method.

When the packaged system implements the ICN control platform it shall utilize the BUYER's selected manufacturer's control system hardware. This includes the processors, input/output modules, power supplies, communications hardware, etc. to be installed in the Supplier's supplied control cabinets. Dependent on the operational requirements of the package this could also include connectivity server equipment and operator interfaces.

The BUYER selected manufacturer's product line is a follows:

Description/Manufacturer	ABB
Controller Platform	AC800M
Input/Output Module Platform	S800
Software Development Environment	Control^{IT} for AC800M/C
Operate Environment	Operate^{IT}

All ABB hardware shall be procured by the BUYER on behalf of the Supplier for applications provided the agreement was made prior to the contract award.

Preliminary design for controls implementation shall be submitted for BUYER approval prior to the detailed design effort.

3.4.2.1.3 Commercial-Off-The-Shelf (COTS) Controls

Procured packaged systems considered as COTS are acceptable for integration into the ICN systems. For this determination, COTS controls are control hardware/software which do not require customization or design engineering for use on WTP. The Supplier shall supply the interface to the ICN using ICN supported communication hardware as follows:

Package Description		Interface	Media
Status Only – No control via ICN	Limited data exchange – Preferred	Profibus DP®	Multimode Fiber Optic
	Limited data exchange – Alternate*	4-20 mA - AI/AO	Hardwired
		24 VDC - DI	
		Dry contact – DO	
	Significant data exchange	OPC over Ethernet	Fiber Optic
Control via ICN	Preferred	Redundant Profibus DP®	Multimode Fiber Optic
	Alternate*	4-20 mA - AI/AO	Hardwired
		24 VDC - DI	
		Dry contact – DO	

* BUYER approval is required for substitution of these or other alternative interfaces. AI- Analog Input, AO- Analog Output, DI- Digital Input, DO- Digital Output.

3.4.2.1.3 Third Party Platform

If utilization of the BUYER's selected controls manufacturer is determined to be unfeasible, a third-party control platform can be utilized with BUYER's concurrence. Unless otherwise stated, application software development will be by the Supplier. The interface of the third party platform to the ICN shall be per table shown in the above paragraph 3.4.2.1.2.

Preliminary design for controls implementation on the third-party platform shall be submitted for BUYER's review prior to the detailed design effort.

3.4.2.2 WTP Integration

3.4.2.2.1 Interface Data Requirements

Where the application software is provided by the Supplier, the Supplier shall provide a complete listing and detailed description of data points available for integration into the WTP ICN for operational, maintenance, and archiving purposes. All required control points required for the appropriate level of ICN control shall be clearly identified. The list shall be submitted to the BUYER for review and mutual concurrence. The final submission listing shall include all applicable interfacing details (entity names, addressing, etc.).

Where the application software is provided by the BUYER, refer to paragraph 3.5 for software design documentation requirements.

3.4.2.2.2 Interface Integration Testing

Supplier shall provide proposed Profibus DP®, Foundation® Fieldbus, protocol converters, and interface devices immediately after the 90% design review. This will facilitate testing at the BUYER's facility in Richland, WA. Previously tested devices by BUYER will not need to be supplied at this time.

3.4.3 Non-Safety Signal Transmission Interface

The BUYER is striving for a consistent implementation of the connection of field instrumentation and equipment to control systems throughout the WTP facility.

Preliminary design for connection of field instrumentation and equipment to control systems shall be submitted for BUYER review prior to the detailed design effort.

Supplier shall organize circuits and circuit terminations in Supplier's interfacing termination enclosures based on signal types or circuit configurations. These signal types will include AI, AO, DI, DO, serial, Profibus DP□, Foundation□ Fieldbus, etc., and should be further grouped by 2- wire, 3- wire, or 4-wire circuit configurations. Based on quantities of these types, cable requirements can be established early. Subsequent to the contract award, C&I will work with the Supplier to "assign" signals to specific circuits and I/O channels as soon as possible.

The Supplier shall apply the following process when determining connection type:

3.4.3.1 Foundation® Fieldbus

Where available, process instrumentation shall be Foundation® Fieldbus compliant. Foundation® Fieldbus interfaces to communicate directly with Fieldbus enabled instruments and equipment. All Foundation® Fieldbus devices supplied shall be registered with the Foundation® Fieldbus, compliant with the current version of the Interoperability Test kit at the date of the purchase order, and supplied with manufacturer developed Device Description files. Only BUYER-approved Interfacing devices shall be used to convert signals from their standard format to the Foundation® Fieldbus protocol. These devices shall be supplied by the Supplier and used only when a native Foundation® Fieldbus device is not available. The same communication, testing, and registration requirements apply to Fieldbus converters as to native Fieldbus devices.

3.4.3.1.1 Foundation® Fieldbus Accessories

All FOUNDATION Fieldbus devices shall be pre-wired with Pepperl + Fuchs (P+F) connector V9-R-M2-S.

3.4.3.1.2 Software Validation and Documentation

The SELLER shall provide Device Description (DD) files with every Purchase Order data sheet release. Device Description (DD) files shall be the manufacturer developed files and submitted in their native electronic form for each firmware version in the order.

The SELLER shall provide a list relating tag numbers to firmware versions and DD files, such as a MS Excel spreadsheet file.

The SELLER shall include manuals that describe how to configure the Foundation® Fieldbus parameters for the device.

If the SELLER changed any BUYER configurable parameters from their default state, these setting shall be documented on a per tag basis.

If the factory calibration settings are available and modifiable by the user, the SELLER shall document the settings and provide the settings along with the calibration certificate for each device.

The BUYER's control system can manage all parameters that are accessible though the Foundation® Fieldbus interface. However, if the BUYER is required to set any additional parameters that are available only though an alternate interface such as FDT/DTM, the SELLER shall provide the necessary hardware (cabling / hand held units) and software, including licenses, to interface with the device.

3.4.3.2 Profibus DP®

Communication interfaces to intelligent mechanical handling and electrical equipment shall be Profibus DP® compliant. Profibus DP® communication link shall be used to interface controllers directly with devices such as "intelligent" motor control centers (MCCs) and variable frequency drives (VFDs). All Profibus DP® devices shall be supplied with .GSD files and documentation describing data interchange. Other interfaces, such as DeviceNet®, AS-Interface®, TIA/EIA-232/485, etc. may be utilized with the appropriate converters with BUYER's approval. Supplier supplied conversion modules will be used where required. When Profibus DP® is the communications link between the BUYER's control system and the Supplier's control cabinets the following shall apply:

3.4.3.3 Communication Network Interface

The BUYER has selected the Industrial^{IT} platform from ABB, Inc. as the primary control system for the WTP facility. A Profibus DP® communication network will be used to communicate to drives and intelligent positioning instruments. The Supplier shall provide the following components for a Fiber Optic cable interface:

3.4.3.3.1 Profibus DP® Communication Interface

The Supplier shall provide a native Profibus DP® slave interface for the control panel or instrument and the associated drivers (GSD files) for communication with the BUYER's control system. The interface should support communication speeds up to 12 Mbit/sec over the Profibus DP® network.

3.4.3.3.2 Fiber Optic Connections

The Supplier shall provide the following component for proper network communication:

a) The supplier shall install a Hirschmann OZD Profi 12M G12 fiber optic converter within the control panel or near the instrument for each communication network.

b) The Supplier shall derive the appropriate power to the fiber optic converter(s) from the control panel power feed. Where the BUYER provided a 120V single phase UPS supply, this supply shall be used to derive the 24VDC supply for the fiber optic converter. Where the only supply available from the BUYER is 480V 3Φ, then the SELLER shall use this to derive the 24VDC supply for the fiber optic converter. A separate power supply shall be provided for each communication network.

c) The Supplier shall follow the general fiber optic requirements described in section 3.4.3.5

3.4.3.3.3 Alternate Communication Interface

If a native Profibus DP® interface is not available, then the Supplier may propose an alternate communication interface or network that is compatible with the BUYER's control system for BUYER consideration and approval. If an alternate communication interface is proposed:

a) The Supplier shall provide all necessary interfaces or converters required to provide the BUYER's control system with the appropriate communications.

b) The Supplier shall provide any required drivers, software, and protocol conversion information to the BUYER for design, development, testing, and maintenance of the supplied networks and interfaces for the period of performance of the contract, including software or firmware upgrades or revisions.

c) As part of the bid submittal package, the Supplier shall provide a description and examples of all required conversions between protocols and/or communication networks including required software applications and hardware components.

3.4.3.4 Classic I/O

If bussed communications are not feasible for connection of field instrumentation and equipment to control systems, standard Input/Output modules shall be used. Circuit design shall account for the WTP preferred I/O module types, as follows:

Analog Inputs – 4-20 mA current
Analog Output – 4-20 mA current
Discrete Input – 24 Volt dc
Discrete Output – 24 Volt dc

I/O modules shall be optically isolated from input and output wires to protect logic circuitry from high voltage transients. All output circuits shall have fused disconnects. The I/O modules shall be of the plug-in type and shall be removable without turning off the power or disturbing field wiring ("hot swappable"). The I/O assemblies shall have indicators that are visible during operation to display the status of the I/O interface and individual I/O channels.

3.4.3.5 Fiber Optic Interface

For equipment packages that include a fiber optic interface the supplier shall provide a fiber optic connection to the control panel or instrument per the following requirements:

a) The Supplier shall use 50/125 glass fiber patch cables to connect between the fiber optic patch plate(s) and the fiber optic converter(s). Any unused fiber optic connections shall be fitted with protective caps to guard against extraneous light and dust.

b) The Supplier shall utilize a Corning MT-RJ patch plate mounted in a protective housing to provide cable management, strain relief, and fiber protection.

c) Fiber optic patch cables shall utilize unpinned MT-RJ connectors on the converter side of the patch plate. BUYER-installed field cables will utilize pinned MT-RJ connectors.

d) For installations that have 24 fibers or less, the Supplier shall install a Corning CCH-CP24-97 patch plate and SPH-01P Single Panel Housing.

e) For installations that have more than 24 fibers, or where multiple fiber optic cables will be terminated on the field-side of the patch plate, the Supplier shall install the appropriate number of Corning WIC-02P or WIC-04P housings with corresponding CCH-CP24-97 patch plates.

f) All fiber optic designs and installations shall follow the manufacturer's guidance including equipment mounting, bending radius, strain relief, fiber termination, fiber and cable protection, and related items. The Supplier's designs shall make provisions for installation of BUYER's field cables that also meet these requirements.

3.4.5 Instrumentation Requirements

Instrument ranges shall be selected such that the normal operating point is between 35 and 75 percent of the range of the instrument. Except where the BUYER has specifically identified manufacturer and model, all the instruments shall be selected by the Supplier in accordance with guidelines provided herein. The instruments described below shall be selected to meet the required safety classification, specified quality, and the design criteria stated herein and in the primary equipment specification. The systems designed and fabricated shall meet the specified reliability and availability for each system or component.

The Supplier may suggest alternative instruments based on their past experience with similar applications subject to the BUYER's review and concurrence.

3.4.5.1 Flow Measurement

Flowmeters shall provide sufficient turn down ratio to accurately cover the required operating ranges of the Supplier's provided system and when installed shall meet the BUYER's required operational accuracy as stated in the package system specification. Isolation and drain valves shall be installed to allow inline flowmeters to be removed and replaced without having to completely drain the pipe.

Flow measurement devices shall be selected that are optimized for the application and environment of the measured fluid. This includes installation constraints, ambient conditions, and process conditions of the measurement device. The following describes the BUYER's requirements for specific type of flow measuring elements and systems.

3.4.5.1.1 Head Type Flowmeter

Head producing flow elements shall be located and installed in straight runs of pipe in accordance with the American Society of Mechanical Engineers (ASME) Standard MFC-10M.

Differential pressure transmitter in conjunction with concentric sharp edged orifice plates shall be considered for flow measurement devices where a turndown of less than 5, a significant permanent head loss, and an accuracy of ±2% of full scale for liquid or gas flow is acceptable. The calculated d/D (Beta ratio) shall be within the limits of 0.2 and 0.7. Two sets of flange taps with one set plugged and seal welded as a spare shall be supplied. The orifice plate shall be of 304L SS minimum and compatible with process fluid and shall comply with ASME MFC-14M-2003 or ASME MFC-3M-1989. Straight piping runs shall be per API Ch 14, Sec 3, Part 2. Honed meter runs shall be used for orifice measurements for line sizes less than 2".

3.4.5.1.4 Coriolis Mass Flow Meter

Coriolis flow meters may be applied to most liquid and some high pressure gas services where accuracy of less than 0.5% of measurement is required. It shall be considered for service applications requiring up to 50 to 1 turndown. The meter shall be sized for the desired accuracy at minimum and normal flow rate without exceeding the permissible pressure drop at the maximum flow rate. The meter shall be also considered for the service where process temperature and density measurement are also required. The meter shall be securely mounted in a vibration-free location in accordance with the manufacturer's recommendations.

3.4.5.1.8 Turbine Meter

Turbine meters shall be considered for clean low viscosity process streams, where there is no plug flow or water hammer; where higher rangeability (> 10 to 1), an accuracy of ±0.5%, and flow totalization is required. API MPMS standard and ISA RP-31.1 should be consulted regarding proper installation and calibration requirement.

3.4.5.1.9 Vortex Flow Meter

Vortex flow meters shall generally not be considered unless suitable alternate means for measuring flow are not practical. Vortex flow meters have a minimum of 10 to 1 rangeability and low head loss. They are generally applicable to liquids of low viscosity (<10 cP) and are often unsuitable for low pressure gas service. Vortex flow meters are vibration sensitive so they should not be located in the vicinity of large rotating machinery or in lines with hydraulic noise. The meters exhibit an unusually large low flow cut-off. The impact of this loss of signal from the meter on safety and process controllability should be evaluated for application.

3.4.5.2 Temperature Measurement

Temperature measurement devices shall be selected that are optimized for the application and environment of the measurement services. This includes installation constraints, ambient conditions, and process conditions of the measurement devices. The following describes the BUYER's requirements for specific types of temperature measuring elements and systems.

3.4.5.2.1 Temperature Elements

All temperature elements, Resistance Temperature Devices (RTDs), shall be installed in thermowells to permit removal without process disturbance except where there is no risk to personnel from the process fluid during removal of the measuring element, i.e. shell skin, motor bearings and motor windings. Where a thermowell is not used, a permanent label shall be affixed to the primary element, indicating that there is no thermowell.

Sheathed RTDs with transmitters shall be used for remote temperature indication.

Motor bearing temperature measurements may use thermocouples provided local transmitters are used.

RTD elements shall be Platinum with a nominal resistance of 100 Ohm at 0 °C (32 °F). The resistance-vs.-temperature characteristic curve shall conform to DIN 43760, IEC 60751 with a temperature coefficient of 0.00385 ohms/ohm/°C. Three wire element design shall be used.

Unless otherwise specified, RTDs shall be sheathed with Magnesium Oxide insulation. The sheath shall be 316SS and ¼" diameter as a minimum. All T/Cs or RTDs shall be duplex design, spring loaded, and supplied with a connection head with internal grounding screw and external ground terminal. All elements shall be connected in the connection head.

Temperature measurements using RTDs shall use remote mounted transmitters with the appropriate input/output voltage isolation and located in the field or panel to connect an isolated signal to the BUYER's or Supplier's control system.

All test thermowells, if provided, shall have a plug or cap permanently attached with a chain or wire and labeled as a test point.

3.4.5.4 Absolute, Gauge, and Differential Pressure Measurement

Pressure instruments shall be ranged for normal operation at 40-60% of scale for pressure gauge and transmitters.

3.4.5.4.1 Pressure and Differential Pressure Transmitters

Pressure and differential pressure transmitters shall have the following performance as a minimum:

Standard accuracy:	±0.15% of calibrated span for ±50°F temperature changes for rangedown of 5:1 or less
Rangedown ratio:	30 to 1 minimum
Overall stability:	±0.125% of upper range limit for ±50°F temperature changes over 5 year period

For draft range differential pressure transmitters the available spans shall be 0.1 to 3.0"WC. The accuracy shall be ±0.10% of span with a stability of ±0.2% of span per year.

Wetted parts shall be a minimum of 316SS for flanges and 316L SS for the process isolating diaphragm. Mounting bolts shall be 316 SS. Pressure transmitters shall normally be gauge pressure type referenced to atmospheric pressure.

On low pressure applications where composition is being controlled using the pressure measurement, absolute pressure type transmitters referenced to a constant true zero pressure shall

be used. Filled fluid shall be compatible with process material, pressure, and temperature. When required by the physical properties of the process fluid, a factory sealed filled system with a diaphragm shall be considered, although these should be avoided at low differential pressures. The capillary should be protected by a 316SS armor. Differential pressure transmitters shall be rated for a minimum 1000 psig static pressure and shall be able to withstand overrange pressure equal to the meter body rating and the pressure conditions or relevant piping specifications.

3.4.5.4.3 Pressure Gauges

All pumps, except sump pumps, shall have a discharge pressure gauge and a suction pressure test connection. Pressure gauges shall be provided downstream of pressure reducing stations and with blind pressure switches.

Pressure indicating scales shall be graduated in direct engineering units for the range specified. Pressure gauges shall be 4 ½" diameter, ½" MNPT bottom connection, plastic case, white laminated phenol dials with black graduations. Process gauges shall be solid front with a blowout back. Movement may be either rotary geared stainless steel or cam and roller type. Accuracy shall be 0.5% of full scale. Bourdon tube, socket, and tip shall be stainless steel or suitable alloy for specific services. Back-of-panel receiver gauges used for testing shall have 2 ½ inch dial.

Pulsation dampeners or snubbers shall be required on all pulsating services such as reciprocating pumps and compressors. Other applications where severe service from pulsating pressure is anticipated, pulsation dampeners may be specified at engineer's discretion. Dampening shall be provided by liquid filled gauge bodies.

Gauge ranges shall be selected such that the operating pressure falls between 40 to 60% of the gauge scale.

3.4.5.5 Control Valves

Valves shall be sized per ISA S75.01. Valves shall be sized to control normal operating design flow at 50% to 70% of its maximum opening. Valves shall be sized to be no more than 90% open at maximum operating flow and no less than 10% open at minimum operating flow. If calculated Cv dictates valve size two line sizes below process line, reduced trim in valve one line size below process line shall be used. The valve shall be selected and sized so that the installed rangeability is at least 20:1.

The potential for cavitation shall be evaluated and the valve size, trim, or type selected to prevent the occurrence of cavitation.

The valve trim shall be selected so that the installed operating characteristics of the control valve shall be nominally linear over the operating flow range. To achieve this, equal percentage trim shall normally be used for control applications except for some applications where linear trim is required. Linear trim shall be used for those applications where the pressure drop across the control valve is more than 50% of the upstream pressure or constant pressure across the control valve. A quick opening valve characteristic shall generally not be used for throttling services. Valve trim materials shall be as follows:

1. For metal to metal seating configuration, 316L SS shall be the normal and minimum acceptable material.
2. Stellite faced seating surfaces or other approved hardened materials shall be provided in difficult services, i.e. cavitation or flashing.
3. Soft seat trim material shall be used when bubble-tight shut off is a requirement or where determined by the process fluid's corrosiveness. Elastomer used for seating material shall be compatible with process fluid and service application.

24590-WTP-3PS-P000-T0001 Piping Material Classes and its Appendix B Piping Material service Class Index shall be followed for the specification of valve body, trim and gasket materials and grades.

All valves shall have bolted gland type stuffing boxes with Teflon packing within the temperature limits of these materials. Graphfoil packing shall be used in the radioactive environment or when process temperature exceeds 450 °F. Bellow seal packing boxes shall be used for toxic or hazardous fluids application to avoid any leakage.

Valves with soft seats shall be used within the limitations of the seating materials for positive bubble tight shut-off. On/off valves shall have integral solenoid pilots and limit switches. Foundation® Fieldbus compliant topworks are preferred by the BUYER for on/off valves. Seat leakage shall be in accordance with ANSI/FCI 70-2 seat leakage definitions and requirements. Fire testing and certification of on/off valves shall be in accordance with provisions of API SPEC 6FA or API STD 607. It should be noted that this testing does not qualify control valves to meet redundancy separation / single failure criteria requirements of Section 4.5-1 of the Safety Requirements Document.

Spring opposed pneumatic diaphragm actuators shall be the normal mechanism for operating throttling valves. Actuator sizing shall permit full valve stroking against the maximum process differential pressure and spring tension with the available instrument air supply pressure and output from positioner. Piston actuators shall be used where stroke length or thrust required exceeds that available from diaphragm actuators, or environmental conditions preclude the use of diaphragm actuators.

Valve positioners shall be furnished for all control valves. Positioners shall have input, output(s), and supply pressure gauges. Any split range requirements shall be achieved by using the control system. The failsafe action of the valves shall be determined by process requirements with regard to safe operation and emergency shutdown requirements and shall be marked on P&IDs. Foundation® Fieldbus positioners shall be supplied for all non-Safety valves and standard positioners shall be supplied for all SAFETY SSC valves. Remote Foundation® Fieldbus positioners shall be supplied where valve environment precludes the use of microprocessor based devices.

All valves shall be designed to meet the maximum noise level as defined in OSHA paragraph 1910.95. Maximum noise level is defined as 85 dBA when measured 3 feet from the valve under normal operating conditions. Noise prediction methods shall be those recommended by the specific valve Supplier.

Limit switches shall be hermetically sealed and suitable for mounting on the valve. Independent switches shall be provided as required for valve open and closed positions.

When control valves are installed in horizontal lines the actuator shall be installed above the line. Sufficient clear space shall be provided above the valve to allow removal of the top works with stem and plug as an assembly. A hand-wheel shall be furnished on each accessible control valve where required for manual control during upset conditions. Modulating control valves shall be provided with isolating block valves, gate or globe type, and vent/drain valve to allow the control valve to be taken out of service and a globe bypass valve for hand control, if required and approved, around the control valve during the time the control valve is out of service. Both isolating block valves and bypass valve shall have flow capacity more than control valve capacity.

3.4.5.6 Solenoid Valves

All solenoid valves shall operate with zero pressure differential and shall close against the maximum design differential pressure. Solenoid valves shall be suitable for the environmental conditions and the electrical area classification specified in the referenced material requisition or

data sheet. Solenoid coils shall be rated for continuous operation and heavy duty type equipped with class H insulation and a minimum of temperature class T3 encapsulated coils. Low wattage type shall be supplied for 24VDC applications and shall not exceed 12 watts. Coil enclosures shall include provisions for terminal connections rather than pigtails and have ¾ inch or ½ inch NPT conduit connections. Vent port is to be fitted with a bug screen.

3.4.5.7 Limit Switches

Limit switches shall be electromechanical type with lever arms, pushbuttons, or cams as actuators that operate momentary contacts.

Switch contacts, if supplied, shall be snap action, hermetically sealed design and suitable for the environmental conditions where they're located. As a minimum, switch contacts shall be of a Single-Pole-Double-Throw (SPDT) design. Contact rating shall be at a minimum 5A @ 120 VAC or 2.5A @ 24 VDC.

Limit switches shall be mounted such that actuation does not cause damage or excessive limit switch movement.

3.4.5.16 Rotating Equipment Monitoring Systems

Detection of imminent machine failure in time to safely shutdown the associated process shall be provided as required by the primary equipment specification. Instrumentation required to protect rotating machinery from damage is addressed herein.

3.4.5.16.1 Machinery Parameters for Monitoring

Machinery requiring high availability should be provided with sensors to continuously monitor:

1. Both radial vibration (X and Y directions) and thrust of shaft
2. Temperature of all journal and thrust bearings
3. Lubrication system operation including oil pressure and temperature
4. Rod drop and impact monitoring for reciprocating compressors.

Consideration shall also be given to providing seal system leak detection.

The Supplier shall provide and install non-contacting vibration and position sensor probes for machine monitoring of both radial vibration and thrust position of the shaft. The installation of all bearing thermocouple and shaft position monitoring equipment shall be in accordance with API 670. Bearing thermocouples shall be type E calibration.

3.4.5.16.2 Shaft Speed Monitoring and Control

Speed transmitters shall have sensors of non-contact type. Speed control of rotating equipment shall be accomplished by the use of speed transmitters and fast response control loop, Electronic governors are preferred where machine speed regulation is important for process control. Overspeed protection independent of the governor should be provided.

3.4.6 Safety Instrumentation and Controls

3.4.6.1 The following requirements shall apply to only those SS instruments serving an active safety function and are designated as "Z" instruments:

3.4.6.1.1 SELLER must provide components allowing the BUYER to meet the requirements of the Instrument Society of Automation (ISA) ISA-S84.00.01-1996, Section 7.2.1. The methods of meeting this requirement are found in ISA-S84.00.01-2004 Part 1 Clause 11.5 and are described below.

3.4.6.1.2 Components provided shall be in accordance with International Electrotechnical Commission (IEC) 61508-2 and IEC 61508-3 and shall be documented as follows:

- A certificate from a Nationally Recognized Testing Laboratory (NRTL) indicating that the component(s) are SL-2-capable in accordance with IEC 61508-2 and IEC 61508-3.

3.4.6.2 Analog inputs/outputs shall use 4-20 mA signals, and discrete inputs/outputs shall use 24 Volt DC signals.

3.4.6.3 Safety control signals shall be isolated from non-safety control/monitoring signals in accordance with the requirements of IEEE 384. See Attachment 3.

3.4.6.4 "Z" designated instruments shall not include software or firmware. Analog instruments only are to be used for safety functions.

3.5 Control Software

3.5.1 Equipment Embedded Software

Seller configured software shall be prepared, tested, and provided in accordance with 24590-WTP-3PS-JQ00-T0004, *Management of Supplier Software.*

3.5.2 Equipment Embedded Safety Software

3.5.2.1 Safety Software shall only be used if it is not feasible to perform the safety function with non-software (analog) devices. Buyer approval is required prior to implementation of Safety Software in the fulfillment of the referencing Purchase Order.

3.5.2.2 Equipment Embedded Safety software is any software that is used to accomplish a safety function for the equipment. For example, if software is used to ensure that the fans provide the required output, and a safety function of the fans is that they provide the required output, the software controlling the output is safety software.

3.5.2.3 Safety software shall only be implemented via configuration of Non-Modifiable Configurable Firmware (NMCF). NMCF is firmware that is standard to the sub-supplier's product line that is not modified for the WTP project; that is, it is commercially available with the sub-supplier's product. The only configuration specific to the WTP project would be the configuration settings. See also the definitions in Section 1.4 of the primary specification.

3.5.2.4 Safety software shall not be implemented via developed software applications. For example, software associated with Programmable Logic Controllers (PLCs), Programmable Automation Controllers (PACs), or advanced scripting in firmware shall not be implemented.

3.5.2.5 The SELLER shall be responsible for complete development and documentation of all configuration settings for safety software. Configuration settings shall ensure that the associated equipment accomplishes its safety function(s) without allowing the safety function(s) to be defeated.

3.5.2.6 NMCF shall be provided in accordance with the requirements for "COTS Software" and "Firmware" contained in 24590-WTP-3PS-JQ00-T0004.

3.6 Enclosures, Cabinets, Panels, and Racks Requirements

The Supplier shall supply the instrument enclosures, cabinets, panels, and racks necessary to support the instrumentation and control systems required by the primary equipment specification. Instruments that require physical or environmental protection shall be installed in enclosures that

meet the specifications of this section. Instruments that have a construction and NEMA rating that permits unprotected installation in the field shall be either individually field mounted or installed on open instrument racks that meet the requirements of this section. Operator control panels for interfacing to the control systems shall meet the requirements of this section. All enclosures, cabinets, panels, and racks shall be designed and fabricated to be in full compliance with NFPA 70-1999.

3.6.1 Rating and Type

All enclosures shall be designed for front access only unless otherwise specified. All components and equipment in the enclosure shall be accessible and removable from the front. Enclosures shall be either outdoor, indoor, hose down, or corrosive environments per the NEMA 250 and ICS 6 standards based on the environmental specification requirements. In the absence of a specific NEMA requirement in the main mechanical package specification, a NEMA rating of 12 shall be the minimum acceptable requirement for indoor and NEMA 4X for outdoor. In areas where radioactive contamination is likely, only stainless steel enclosures shall be used.

3.6.2 Enclosure Internal Environmental Conditions

The enclosure design shall ensure that no internal equipment or component is subjected to levels of dirt or dust that exceed those specified by the equipment or component manufacturer. The temperature inside of the enclosure shall not exceed the maximum and minimum operating temperatures of any device located within it.

Natural convection and conduction cooling is the preferred method of dissipating heat within the enclosure. If "Hot Spots" such as those generated by power supplies or other electrical equipment are present, or an internal temperature exceeding 100 °F is anticipated, the enclosure shall be fitted with adequately sized ventilation fans where ambient conditions permit.

Where forced-air cooling is necessary and practicable for proper operation of the apparatus housed in the enclosure, the Supplier shall provide special filters, blowers or other suitable filtration or cooling devices that will meet the requirements of NEMA 250 and ICS 6.

Supplier shall provide enclosures with thermostatically controlled space heaters, where required by ambient conditions, to maintain temperature above dew point and above freezing. If equipment is located outdoors, space heaters must be provided, unless otherwise stipulated by the BUYER.

Supplier shall provide all mounting brackets, wire, and equipment needed to attach the heating or cooling devices to the enclosure without degrading the NEMA 250 and ICS 6 enclosure requirements.

3.6.3 Mechanical Requirement

Freestanding enclosures shall be fitted with a base, have rigid bracing, removable lifting eyes and include provisions for securing to floor with anchor bolts or bolted or welded to BUYER's floor embed. Wall mounted enclosures shall be sized by the Supplier and shall include all rigid bracing, door latch, and mounting fixtures needed to mount the enclosure to the wall.

Where lockable enclosure doors are specified on the primary equipment specifications, datasheets, or drawings, the doors shall have a common key lock. BUYER will review and concur with the key arrangement and selection. All packaged systems and equipment controls shall be pre-wired to terminal blocks in permanently mounted enclosure.

The terminal blocks shall be designed for easy interconnection to BUYER's control and communication circuits (see section 3.4.3 design requirements of this specification for signal transmission interface).

Interconnecting wire shall be run in intermediate metallic conduit. Interconnecting Fieldbus communication cables shall be armored type and supported in unistrut channel or on existing structure.

Access to enclosure internal components or equipment shall not require the use of hand tools other than for opening the door. Access to any component within the enclosure for maintenance or replacement shall not be prevented by proximity to other components within the enclosure. Equipment mounted in the rear of the enclosure shall be on a back-panel and positioned to facilitate removal and replacement. Enclosure back-panels shall be fabricated from low-carbon steel and shall be finished with semi-gloss or gloss white paint. Enclosures shall be sized to allow clearance between the enclosed components, cables, print pockets, and components mounted on the door.

Suites of enclosures shall be designed to accommodate shipment for a two bay interface. Where a suite of enclosures is made of discrete cabinet sections that will be separated for shipment and movement on site and then reconnected in the same configuration, provisions shall be made (such as the inclusion of dowel pins) for the alignment to be reproduced on site. If two or more enclosures are connected and share wiring, the side-panels they share shall be removed.

Where enclosures are to be installed by the Supplier, they shall be placed in a position that allows the doors to be opened fully for easy access to wiring and components for maintenance, testing and troubleshooting.

Where enclosed or protected installation is not required, then racks shall be used for mounting instruments to provide ease of maintenance and calibration. The rack frame for mounting non-Safety instruments shall be constructed of stainless steel unistrut channel and stainless steel unistrut systems components and designed to support the weight of installed instruments. The rack frame for mounting SAFETY SSC instruments shall be designed, constructed, and qualified to the requirements stated in the primary equipment specification. Free standing racks shall be fitted with a base, rigid bracing, and lifting eyes. Racks shall also include provisions for securing to walls or floor with anchor bolts or bolted to BUYER's embed. All rack mounted instrumentation shall have NEMA 4X rating or better.

3.6.4 Enclosure Segregation Requirements

This section applies to "Z" components shown on the P&ID.

For some mechanical equipment, a set of enclosures may be required. The enclosures shall be defined in the primary equipment specification. These enclosures shall house the necessary control, instrument, safety, and electrical equipment to facilitate the requirements of the package equipment.

Where small quantities of control equipment are involved, enclosure functions may be combined; however, combining of functions must take into account segregation of power, control, and safety related equipment for commissioning, maintenance, and safety purposes. The enclosures shall be segregated into separate sections for: 1) Safety Instrumented System (SIS) functions, 2) DC Analog, signal conditioning and interface functions, 3) Discrete Inputs and Outputs signals, and 4) DC and AC power.

The SIS enclosure section shall house devices required to interface with BUYER's fault tolerant PLC systems used to execute independent safety system interlocking/tripping for radiological and conventional SIS, emergency stop and asset protection interlocks.

3.6.5 Enclosure Grounding Requirements

The enclosure grounding system shall be installed in conformance to IEEE Guide 1050-1996, section 5.3.1 "Single point grounding system". All instrumentation enclosures shall have an equipment safety ground bus and an isolated signal ground bus, except instrument junction box. Instrument junction box shall only have an equipment safety ground. The grounding bus shall be constructed

with solid copper, and all connections shall be drilled and tapped. The ground bus shall be drilled and tapped for an additional 20 percent spare terminations.

The equipment safety ground bus shall be solidly bolted to the enclosure structure. Where enclosures are to be connected together after final installation, each end of the safety ground bus will include provisions for connection to the adjacent enclosure safety ground bus. A bolted compression type 2/0 terminal lug shall be installed at each end of the bus to facilitate connection of BUYER's 2/0 AWG stranded copper ground cable.

All removable metal components shall be connected to the equipment ground bus. Enclosure and back-panel shall be bonded to the equipment ground. Grounding for electrical devices and instruments, including signal and power supply shall be in accordance with manufacturer's recommendations and applicable NEC requirements. Instrument cable shield and signal common conductors shall be connected to the isolated signal ground bus, unless otherwise required by the manufacturer.

The isolated signal ground bus shall be electrically isolated from the enclosure structure and the safety ground bus. A bolted compression type 2/0 terminal lug shall be installed at each end of the isolated ground bus to facilitate connection either to another isolated signal ground bus in a connected adjacent enclosure or to BUYER's 2/0 AWG stranded copper ground cable.

Instrument cable shields and signal common conductors shall be connected to the isolated signal ground bus. Each signal ground conductor shall be fastened to the isolated signal ground bus. For junction boxes with signal wiring going back to the BUYER's control system, the cable shield shall be terminated on a isolated terminal block and carried back to a ground supplied by the BUYER. Ground conductors connected to the isolated signal ground bus shall have an insulation color code of green with yellow tracer.

3.6.6 Electrical and Wiring Requirements

The Supplier shall mount, connect and wire each instrument or control device such that adjustment, maintenance, removal and replacement may be accomplished in a safe manner without interruption of service to adjacent but unrelated equipment and without placing undue stress on installed wiring or devices. Accommodations for strain relief shall be made when routing wire to hinged enclosure doors and shall be wrapped with spiral wire wrap.

No more than two wires shall be connected to one terminal point and only if the terminal is rated for the two wires. Wire splicing shall not be used unless approved by the BUYER. Bridge or comb jumpers are preferred to wire jumpers on terminal strips. Jumpers shall not be installed on the field side of the terminal strip.

Terminal blocks shall be selected to accommodate the function and electrical requirements associated with each wiring application. They shall incorporate the following features:

Space saving design
Screw clamp wire connection
Single level configuration
Integral test facilities
DIN-rail (35mm) mounted

Isolating type terminal blocks shall be Weidmuller "W" series, Allen Bradley 1492-WKD3TP, Phoenix Contact, or BUYER approved equal. Non-isolating feed-thru terminal blocks shall be Weidmuller "W" series, Allen Bradley 1492-W4, Phoenix Contact, or BUYER approved equal. All terminal blocks shall be identified by a unique terminal block number and approved by the BUYER.

For all enclosures, each incoming power supply shall be provided with circuit protection and shall have a manually actuated electrical power disconnect device mounted on/in the enclosure in an easily

accessible location. The electrical power disconnect device may be a single device or multiple devices for individual circuits.

Each device that uses 120 VAC for power shall have individual connections protected via rail mounted circuit breakers. The circuit breakers used for individual control or power circuit protection within the enclosure shall be thermal magnetic breakers such as Weidmuller CB, Allen Bradley type 1492, Phoenix Contact, or Buyer approved equal. The circuit breakers used for individual control or power circuit protection external to the enclosure shall comply with UL489. They shall be Dual-In-Line, DIN-rail mountable TS35, TS32, or equivalent. Power shall not be "daisy chained" from instrument to instrument; however, the bridge or comb jumpers may be used on the supply side of the circuit breakers. A fuse and circuit breaker directory shall be contained in a holder permanently affixed on the inside of each door or back-panel and protected by a clear window.

All internal enclosure wiring shall be neatly dressed in slotted non-metallic wireways. The wireway shall be securely fastened to the enclosure back-panel by use of Stainless Steel screws. Circuits of different voltages (service level) shall be terminated on physically separate terminal strips and clearly labeled to show the circuit voltage. Terminal blocks shall be segregated according to signal type. In the event SIS system components are included in an enclosure, the wiring shall be clearly identified and segregated from non SIS circuits.

See table 1 for the instrumentation cable schedule:

TABLE 1
Instrumentation Cable Schedule

Cable Code		Cable Desc.	Specific Cable Spec	Comments	Circuit ID	Cable General Spec (superceded by specific cable specification)
Inst. cables-analog circuits	**In SR**	**Analog signals**				
1TSPR#16	X	Single twisted pr, #16AWG, 300V, ITC, PLTC	Single twisted pair with overall foil shield	Individual instrument signals, instrument 24 vdc power	Black, White	Cables UL listed as ITC and PLTC, 300 V insulation, UL1581 listed for 70,000 BTU vertical tray flame test; 100% foil polyester/aluminum individual and overall shields with 22AWG Drain wire. Each circuit shall have a minimum of 6-8 twists/ft.
2TSPR#16	X	Two twisted shielded pr #16AWG, 300V, ITC,PLTC	Individually twisted shielded pairs with overall foil shield		Black, White conductors - individual circuits numbered	
SA-1TSPR#16	X	Single twisted pr, #16AWG, 600V PLTC	Single twisted pair with overall foil shield	SAFETY SSC - Individual instrument signals, instrument 24 vdc power	Black, White W/Blue Jacket	Cables UL listed as PLTC, 600 V insulation, UL1581 listed for 70,000 BTU vertical tray flame test; or IEEE 383 vertical flame test; or UL 1202; 100% foil polyester/aluminum individual and overall shields with 22AWG Drain wire. Each circuit shall have a minimum of 6-8 twists/ft.
SA-2TSPR#16	X	Two twisted shielded pr #16AWG, 600V, PLTC	Individually twisted shielded pairs with overall foil shield	SAFETY SSC- instrument signals, instrument 24 vdc power	Black, White conductors - individual circuits numbered W/Blue Jacket	
Instrument cables-digital circuits		**Discrete I/O**				
use 1TSPR#16 above	X	Single Twisted pr #16AWG, 300V, ITC, PLTC	Single twisted pair with overall foil shield	Individual instrument signals, instrument 24 vdc power		Cables UL listed as ITC and PLTC, 300 V insulation, UL1581 listed for 70,000 BTU vertical tray flame test; 100% foil polyester/aluminum individual and overall shields with 22AWG Drain wire. Each circuit shall have a minimum of 6-8 twists/ft.
2TPR#16	X	Two twisted pr #16AWG, 300V, ITC, PLTC	Individually twisted pairs with overall foil shield	Valve limit switches, process switches	Black, White conductors - individual circuits numbered	

AC power shall be routed through separate wireways or separated with a divider from 24 VDC discrete and analog instrument signals within enclosures. Power and signal cabling shall not be run in parallel, except in separate wireways, and should cross at a 90-degree angle only.

Freestanding enclosures shall be equipped with a guarded tube incandescent light with a switch and an integral 120 VAC receptacle rated for 15A for maintenance convenience. Route wiring within the enclosure for convenience power receptacles, cooling fans (where approved), and space heater (if required) in accordance with standard industrial practice. The Supplier shall derive power for these components from the BUYER provided 480 VAC power supply. If a 480 VAC power supply is not available, the BUYER will provide the 120 VAC supply. Control and instrumentation power sources shall be separate from utility power sources.

All instrument signal cables shall be of the type and specification as listed in Appendix C – Instrumentation Cable Schedule. Power cable, wire size and type shall be in accordance with NFPA 70 - 1999.

All wires and cables external to an enclosure shall be of the instrument tray cable (ITC) type, flame-retardant (passes IEEE 1202 vertical flame test), and have a 90 °C continuous rating in wet or dry locations. All cable insulation and jacket material shall be resistant to heat, moisture, impact, ozone, and meet or exceed the following requirements:

300 V rated for low voltage instrument cables (up to 120 VAC and 125 VDC)
600 V rated for power/motor control cables (up to 480 VAC and 250 VDC)

The wire insulation color for power wiring shall be of the following:

Black	Ungrounded conductors more than 50 VAC
White	Grounded conductors more than 50 VAC
Green	Equipment grounding wire
Green/Yellow tracer	Isolated instrument grounding wire
Light Blue	Ungrounded supply voltage less than 50 V (DC or AC)
Violet	Switched ungrounded voltage less than 50 V (DC or AC)
White/Blue tracer	Grounded or return supply voltage less than 50 V (DC or AC)

3.6.7 Accessibility and Maintenance

The enclosures shall be designed so that tools and test equipment may be used to accomplish all necessary adjustments, maintenance, cleaning, testing, and calibration. If specialized tools are needed for adjustments, maintenance, cleaning, testing, and calibration the Supplier shall provide two sets per order to BUYER upon delivery. Test points and calibration areas shall be accessible, clearly identified, and labeled. Adequate space shall be provided for removal and replacement of individual instruments or components located inside the enclosure. Equipment mounted in the rear of the enclosure shall be positioned to facilitate removal and replacement from the front of the enclosure.

3.6.8 Enclosure Nameplates, Labels, and Wire Markers

Where one end of the wire is provided by the original equipment manufacturer, connected to the component, in a pigtail configuration, and identifiable by other means such as color coding, only the end of the pigtail that is provided un-terminated by the original equipment manufacturer is required to be identified by the mean described in this section.

BUYER will provide the enclosure name, service description as detailed in section 8.1, and wire marker syntax and name/number.

External enclosure nameplate shall be constructed from 2-ply laminated plastic with white surface and black core. Letters shall be engraved through the white surface to the black core. Enclosure nameplate shall be engraved with the equipment tag number and a very brief service description. The nameplate shall be a minimum of 1/8 inch thick with beveled edges. The nameplates shall be attached to the enclosure either with an industrial adhesive appropriate for the tag and enclosure materials or by using stainless steel drive screws without violating the NEMA rating of the enclosure. The minimum character height for enclosure name/number shall be no less than 5/8 inch. The minimum character height for service description shall be no less than 1/4 inch.

Internal enclosure nameplates shall be provided for instruments, instrument accessories, switches, relays, terminal strips, lamps and equipment with a field wiring connection. Nameplates shall be visible from the front of the cabinet with the doors open. The nameplates shall be constructed from 3-ply laminated plastic with white surface and black core. Internal enclosure nameplates shall be attached using epoxy if it is compatible with the mating materials, causes no detrimental effects, and will not cause any structural damage. For a viewing distance of 3 feet, the minimum character height shall be no less than 1/8 inch.

Safety Labels shall not be attached to removable items that could be replaced in a different orientation.

Each wire shall be clearly identified with a wire marker at each end by means of heat shrinkable plastic sleeves or other BUYER approved permanent type wire marker in black text on white background. Open markers or "C" type sleeves that can be applied after a conductor is terminated will not be accepted. Minimum character size for wire marker shall be no less than 3/32 inch. The wire markers shall be attached within a maximum of 2 inches from the termination of the wire. Orientation of the wire marker shall be such that its identification is visible when viewed from the front of the enclosure looking in.

3.6.9 Human Factors

Controls, indicators, and the similar type devices shall be mounted between 36 and 70 inches above the floor.

3.7 Equipment Electrical Requirements

Refer to Attachment EKP0 for any additional electrical requirements.

3.7.2 Discrete Interfaces

The Supplier shall provide isolated, dry contacts where hardwired signals from controls or monitoring equipment on Supplier's packaged equipment is required by the BUYER's control system. The interfaces are distinct from control systems communications interfaces described in paragraph 3.4.

3.7.3 Analog or Continuous Signal Interfaces

The Supplier shall provide current loop isolators where a continuous signal in the Supplier's system is required to be monitored by the BUYER's control system.

3.7.4 Surge Protection

The Supplier shall provide surge protectors for solid-state equipment, if not inherent in the equipment design, to prevent damage from the effect of lightning strikes or other electrical transients.

3.7.5 Arc Suppression

The Supplier shall provide and install a suitable arc suppression device or kickback diode across switched loads unless the switching component includes inherent arc suppression. Kickback diodes shall be supplied and installed on all inductive DC loads.

3.7.6 Emergency Stop and Reset

All machinery Equipment Control Panels shall be provided with an emergency stop (E-stop) independent of software or electronic logic. Where physical injury is credible, E-stops will be provided local to the machine. In addition, where mechanical handling equipment is controlled remotely, E-stops shall be provided at such control points. In order to prevent a subsequent restart, while the dangerous condition exists, the emergency stop circuit shall remain in the shutdown state until the circuitry is reset.

For machinery equipment which has no communication with the BUYER's control system, the E-Stop circuits shall provide a local indication of the status of the E-Stop when activated. Local indication of E-Stop status may be provided by either a local indicating light and/or a physically depressed E-Stop button/switch.

Machinery equipment in communication with the BUYER's control system shall provide status of all E-Stop circuits which shall be individually monitored in the BUYER's control system. This will be achieved by additional contacts on the switch wired directly to the BUYER's control system. Contacts wired from motor control relays will not be accepted.

3.7.7 Conduit and cable

Exposed conduit for process power and instrumentation shall be rigid, galvanized steel (RGS) and supported with corrosive resistant hardware. As a minimum, single pair instrumentation cable shall be 18 AWG, multiple pair instrumentation cable shall be 20 AWG, and control and instrument power circuits (120 VAC/125 VDC) shall be 14 AWG.

3.7.8 Wire and Cable Markers

Where one end of the wire is provided by the original equipment manufacturer, connected to the component, in a pigtail configuration, and identifiable by other means such as color coding, only the end of the pigtail that is provided un-terminated by the original equipment manufacturer is required to be identified by the mean described in this section.

All Supplier provided wiring shall be identified at each end with a numbering system that is cross-referenced on all appropriate drawings. The wire-numbering scheme shall be proposed by the Supplier with BUYER's concurrence. Ferrules or wire markers shall be indelibly and clearly marked in black on white plastic, heat shrinkable sleeves. Open markers or "C" type sleeves that can be applied after a conductor is terminated will not be accepted. Junction box (JB) terminals shall have adequate space between them and the JB internal walls so connected cables and individual wire numbers can be easily read without disturbing the wiring within the JBs.

All cables provided by the Supplier shall be clearly identified with a heat shrink type label.

3.8 Process Connections, Tubing and Instrument Mounting

3.8.1 Instrument Process Connections

The preferred orientation of process connections in horizontal piping is shown in Appendix A. The purpose, for all pipe runs for instrumentation use, is to avoid gas pockets in liquid and vapor sensing lines and to avoid liquid pockets in gas sensing lines. Sensing lines for gas measurements shall slope downward toward the process at least 1/4" per foot. Sensing lines for liquid shall slope downward toward the instrument at least 1/4" per foot. Measurement of pressure or flow in steam lines or condensable vapor lines shall be provided with condensate pots to ensure known liquid fill level in sensing lines.

Piping specifications are generally as required in the process piping section of the primary equipment specification. Pressure measurement connections shall be ¾ inch except where the process piping is ½ inch or less. If the process piping is ½ inch or less, the instrument connection shall be ½ inch.

Instruments mounted in-line or tanks shall be installed per manufacturer's requirements. Welded process connections shall be socket or butt welded per the requirements of the piping specification in the primary equipment specification.

Generally provide connections on piping and vessels for instruments in accordance with the following:

Type of Measurement	Screwed	Socket Welded	Flanged
Analyzer	¾"	-	1 ½"
Flow			
Orifice Tap	½"	¾"	2"
Flow Tube Tap	¾"	¾"	2"
Level			
Differential Type			
Standard	½"	¾"	2"
Flange Mounted	-	-	3"
Ball Floated			
External Cage	1 ½"	1 ½"	1 ½"
Vessel Mounted	-	-	4"
Capacitance	1"	1"	3"
Radar	-	-	6"
Ultrasonic	1"	1"	3"
Purged Tube	½"	½"	6"
Bridle (Standpipe)	3"	3"	3"
Pressure			
Piping	¾"	¾"	-
Vessels	¾"	-	1 ½"
With Seals	-	-	3"
Temperature			
In Piping	1"	1"	1 ½"
In Vessels/Tanks	-	-	1 ½"

3.8.2 Instrument Isolation Valves at the Instrument

To allow isolation of pressure sensing instruments, each pressure-sensing instrument shall have a shutoff valve, or a 2-valve manifold for transmitters, that is close to the instrument and is readily accessible. The Supplier shall, however, provide bleed valves on direct connected pressure gauges and pressure switches. Individual isolation or bleed valves shall be Swagelok instrument ball valve series 40 or BUYER approved equal with either screwed or compression end fittings as appropriate. All remote mounted pressure instruments shall have an integral manifold (block and bleed). All differential pressure instruments shall have integral five valve manifolds. All instrument valve manifolds shall be of 316 SS construction with Viton O-ring seals unless otherwise specified in the primary equipment specification. Other materials shall be required depending on ambient radiation conditions. Supplier shall propose alternate materials for instruments as appropriate for BUYER's review and concurrence.

3.8.3 Thermowells

Thermowells shall be provided for each temperature sensor. Thermowells shall withstand two times the maximum system pressure where installed. Wake frequency calculation shall be performed using ASME PTC 19.3 to ensure that the velocity-induced frequency is not more than 80 percent of the critical frequency during all modes of operation. Maximum stream velocities in temperature

measurement shall be specified in the . Protective tubes in lieu of thermowells are acceptable for HVAC air duct applications.

All thermowells shall have sufficient extension to preclude interference with process pipe or vessel lagging (insulation).

The following are standard thermowell length, insertion (U) length and Lagging (T) length proposed for the project:

A. Threaded Thermowells

Line Size	"U" Length	Stem Length	Remarks
≤ 2"	2 1/2"	4"	Line swage or elbolet installation
3" & 4"	4 1/2"	6"	Elbolet or latrolet installation
4"	2 1/2"	4"	
6 & 8"	4 1/2"	6"	
10 & 12"	7 1/2"	9"	
≥14"	10 1/2"	12"	

Insulation Thickness	"T" Length	Remarks
2" & less	None	
3"	3 1/2"	
4"	4 1/2"	
5"	5 1/2"	
6"	6 1/2"	

B. Flanged Thermowells

Line Size	"U" Length	Stem Length	Insulation Thickness
3"			See note below
4"			See note below
6"		9"	See note below
			See note below
		12"	See note below

Note: Approximately 6" clearance between the top of line and the top of well flange face available for insulation.

Thermowells shall not be installed in the minimum straight run of pipe, upstream or downstream of a flow element.

3.8.4 Sensing Tubing

Sensing lines shall be kept as short as possible and shall have a continuous slope to promote them being kept free of liquid, as appropriate. Slope shall be 1/4 inch per foot minimum. Slope instrument impulse lines toward the process to prevent the accumulation of condensable liquid in gas lines.

Tubing runs shall be properly supported in tube clamps or channel and protected from mechanical loads. Expansion bends shall be provided if necessary to allow for movement of supporting structures or change of length due to temperature caused expansion or contraction. Tubing runs shall not prevent access to equipment or instruments for operation or maintenance. Tubing bends will be provided to allow easy removal of instruments.

Use air or liquid purges, chemical seals, or other suitable means to ensure low maintenance, trouble-free operation for instruments in particulate and/or chemical service. Purges shall be provided such that purge velocity is greater than process velocity. Process leads filled with a special liquid shall not be used.

Tubing runs that can contain high temperature fluids shall be covered with insulation or screens where necessary for personnel protection. Prefabricated heat-tracing bundle is preferred for condensing gasses.

3.8.5 Pneumatic Supply and Signal Lines

Pneumatic piping and tubing shall be grouped and supported in parallel runs. Unless otherwise specified all pneumatic tubing shall be seamless 316 SS as a minimum. To facilitate installation by the BUYER at site, all incoming/outgoing air connections shall terminate at clearly identified bulkhead fittings. Instrument tubing shall be identified at the bulkhead terminal connection with a suitable tag indicating the instrument tag number or an identifier used on Supplier's piping/tubing diagrams.

Where Supplier requires instrument air, BUYER's instrument air supply headers will be connected to Supplier's package at one location. Supplier shall provide filtration and pressure reduction as necessary for air utilization. Where pressure reduction is necessary, Supplier shall provide two pressure regulators and two filters piped in parallel with the necessary valving to allow removal and maintenance of either regulator or either filter without impacting operation of the supplied equipment.

Provide isolation valves and calibration connections on impulse and pneumatic signal lines to permit in-place calibration. When two or more instruments or accessories are connected through fittings to the same bulkhead connection, needle type shutoff valves shall be located at each instrument or accessory.

Where pressure switches are provided as secondary devices for alarm initiation, a plugged tee shall be installed between the isolating valve and the switch to facilitate testing.

3.8.8 Instrument Location and Mounting

Instrument mounting locations shall be selected with consideration of both function operation and accessibility requirements for maintenance. Instrumentation should not be mounted on vibrating equipment or light duty support. Instruments shall not be mounted on handrails or safety railings. Instrument mounting bolting and hardware shall be 316 SS. Mounting brackets and stands for SS instrumentation shall be qualified to the seismic requirements specified by the primary equipment specification.

3.8.8.1 Operability Requirements

The location of pressure sensing instruments shall be selected to minimize the need for purged leads and special seals to achieve satisfactory operation.

3.8.8.2 Accessibility Requirements

Each instrument shall be installed so as to allow adequate safe access for both operation and maintenance.

4 Materials

4.1 General

Selection of material shall be based on fluid properties, environmental conditions, or as specified on the primary equipment specification and/or material requisition, to which this specification is attached.

4.1.1 Instrument Impulse Tubing and Tube Fitting

Instrument impulse lines shall generally be 3/8 inch OD x 0.035 inch wall, seamless, annealed, ASTM A269, Grade TP316 SS with a carbon content of less than 0.03% and an RB80 hardness. Instrument tubing shall be marked in accordance with the ASTM material specification, which shall indicate as a minimum, the type and grade of material.

All compression fittings shall be machined or forged from 316 SS with carbon content less than 0.03% or 316L SS. Other tube fitting materials may be used (with BUYER's approval) as required for the service applications and the environmental conditions. All tube compression fittings shall be of the two ferrule, flareless design, gageable, and maintain a leak tight connection after 20 remakes (minimum) per fitting manufacturer's remake instructions on any recommended tubing. All components of the fitting shall carry the manufacturer's name and trademark. Supplier shall only supply tube fittings from one product line of a single manufacturer. Materials for flareless compression type stainless steel tube fittings shall be ASTM A182 for forgings and ASTM A276 for parts machined from bar stock.

Tubing within radiation areas such as process cells or canyons shall be fusion welded and fabricated from 316L SS. Any tubing fittings within these process cells or canyons shall be butt welded tube fittings fabricated from 316L SS.

Manufacturers of tube and fittings shall also have tubing and fittings available in 316 stainless steel, Alloy 400, Alloy 20, Alloy C-276, Alloy 600, titanium, and carbon steel.

4.1.2 Instrument Manifold Valves

Integral 2-valve manifolds shall be supplied with pressure transmitters. Integral 5-valve manifolds shall be supplied with differential pressure transmitters. The manifolds shall be fabricated of 316 SS. These manifolds shall be manufactured by Anderson Greenwood or BUYER approved equal.

4.1.3 Enclosures, Panels, Cabinets, and Racks

In areas where radioactive contamination is likely, only stainless steel enclosures, panels, and cabinets shall be used.

The Rack structural components and all mounting material shall be constructed entirely with stainless steel. This includes bolts, nuts, washers, screws, retainer springs, and clips.

4.2 Prohibited Materials

Mercury containing instruments or devices such as mercury wetted switch contacts; mercury thermometers or capillary systems using mercury shall not be used.

4.3 Special Requirements

Where a conduit enters a junction box, a bushing shall be provided to protect the wire insulation from damage due to sharp metal edges.

4.4 Painting Requirements

In general, instrument manufacturer's standard painting color and finish shall apply. However, Supplier shall also follow the project Shop applied special protective coating as required by the parent specification.

4.5 Storage of Special Materials

The Supplier shall cover or plug all openings on equipment, tubes, pipes, and instruments prior to shipment and/or for storage.

5 Fabrication

Platforms, ladders, or other means of access shall be provided for instrumentation or components that require maintenance or adjustment which are not accessible from a floor or a major structure.

8 Identification

8.1 Nameplate

Each instrument shall have nameplate information that includes following:

Applicable to ALL Instrumentation

- Manufacturer's Name
- Manufacturer's model and serial number
- BUYER's Purchase Order No.
- BUYER's Item No.
- BUYER's Tag Number

Applicable to PROCESS Instrumentation

- Nominal Pipe size, inches
- Body material
- Size
- Minimum and Maximum flowrate
- Meter Factor
- Pressure and Temperature rating
- Flow direction arrow and/or words IN and OUT on the piping connections

Applicable to ELECTRONIC Components

- Power rating
- Electrical Area Classification
- Approvals and Listings per NEC

Where the combination of manufacturer's standard nameplate and instrument body stampings are unable to accommodate all of the required and applicable information, a separate stainless steel nameplate shall be provided to include the BUYER's tag number, PO number, and all of the applicable missing information. This separate stainless steel nameplate shall have the information impressed, stamped, or etched directly on the stainless steel surface. The nameplate, where physically possible, shall be secured to the body of the instrument by corrosion resistant screws tapped into a low stress area of the assembly, so the structural integrity and functional capability of the assembly are not impaired. If it is not physically possible to secure the nameplate to the body of the instrument, then the nameplate shall be attached using a stainless steel wire.

8.2 Panel Mounted Instrument Nameplate

In addition to the nameplate requirements for instruments, each panel mounted instrument shall be identified by tag number (BUYER provided tag number) engraved as specified in section 3.6.8. Letter shall be a minimum of 1/8 inch in height. Nameplates shall be attached as specified in section 3.6.8.

10 Training

Supplier shall include training courses and durations as required to train BUYER's engineering, maintenance and operation personnel in system overview, system architecture, hardware maintenance, software engineering, software maintenance, operation, troubleshooting, etc. for the supplied instrumentation system in his proposal.

11 Documentation and Submittals

Refer to the RFP or Section 2 and 3 Drawings and Data Requirements of Material Requisition to which this specification is attached and the following for specific requirement of each instrument.

11.1 Instrument Tagging

Instrument tag numbers will be assigned and provided by the BUYER to the Supplier. The Supplier shall incorporate these tag numbers into the design documents and shall comply with instrument identification requirements.

11.2 Drawings and Data

11.2.1 Instrument Data Sheets

Process instrument data sheet forms will be supplied for some equipment by the BUYER and shall be completed by the Supplier for field mounted process instrumentation.

11.2.2 Instrument List

The SELLER shall provide an equipment instrument list, in MS Access format, which lists each instrument and is arranged in numerical order. The fields required are as follows:

- Instrument tag number
- SELLER's referenced tag number if applicable
- Service description
- Instrument type
- Signal type
- P&ID number
- Data sheet number
- Location drawing number
- Instrument installation details
- Manufacturer name
- Model number
- Calibration range of instrument
- Set point
- Wiring diagram number
- Schematic drawing number
- Device address of serial communication link data
- I/O address of serial communication link data
- Shipped loose

In addition, where applicable, a separate list of instruments designated as Safety Significant shall be maintained and provided. See Section 3.1.14 for detailed information.

The list shall include:

The performance specifications for normal operation and under conditions existing during and following accidents.

The load, pressure, voltage, frequency, and other characteristics, as appropriate, for which the performance specified can be ensured.

11.2.3 Panel, Cabinet, Enclosure Outline and Dimensional Drawings

Certified outline and dimensional drawings shall show the size and location of electrical, pneumatic and service connections and information necessary to locate and mount the equipment, if it is to be mounted by the BUYER.

The outline and dimensional drawings shall also include the enclosure weights and approximate location of the enclosure center of gravity with all instruments and components installed. This drawing or a separate drawing shall include dimensional and material information for the enclosure base, including bolt location and size for permanent attachment of the enclosure(s) to the building structure.

Outline and dimensional drawings shall be provided for all instruments shipped loose for BUYER's installation. The drawing shall include the instrument tag number.

11.2.4 Installation Details

Instrument installation details shall be submitted, for the BUYER's review, in accordance with the G321-E form. For instruments the SELLER is installing, these instrument installation details shall be provided prior to proceeding with instrument installations.

11.2.5 Wiring Diagrams

Point to point wiring diagrams provided by the Supplier shall include, but not be limited to the following features:

- Identify all devices with the BUYER's tag numbers, where applicable
- Identify grounding method for incoming cable shields
- Be relative to the equipment or panel terminals
- Show devices and their terminals in relative location
- Include contact developments for control switches, pushbuttons and relays.

11.2.6 Electrical Schematics

Schematics shall be provided for all motor controls. Motor Control Center interfaces with Supplier's provided motors shall be clearly shown with all wiring interfaces shown in schematic form.

11.2.7 Instrument Loop Diagrams

Loop diagrams depicting the wiring between components of electronic analog loops and discrete (on/off) loops shall be provided. These drawings shall contain, as a minimum all the information required by ISA S5.4 Figure 3 with notes and drawing references. The interface between Supplier's and BUYER's equipment, wiring and instruments shall be shown in detail, including terminal and wire identification. Electronic loop diagrams shall show Supplier's grounding and shielding provisions.

In the case of bussed network instruments, network segment drawings shall be provided in lieu of loop diagrams.

11.2.8 Pneumatic Piping or Interconnection Diagram

Diagrams depicting the signal tubing and air source interconnections between pneumatic devices

shall be provided. The interface between Supplier's and BUYER's devices and air source shall be shown in detail.

11.2.9 Control Diagrams

Control diagrams consisting of schematics showing the equipment functional controls shall be provided for BUYER's review. These drawings shall show in detail all the control circuits and the their relationship with other components within the Supplier's package and the interface between BUYER and Supplier provided controls. If BUYER is to implement Supplier's control on a BUYER provided control system, the controls necessary to operate the Supplier's equipment will be based upon these drawings.

11.2.10 Software Documents

Documentation as defined within this specification shall be provided. These will be used for the design development, quality assurance, verification review, approval, and validation testing of all the software supplied by the Supplier and/or its subcontractor. They shall be in accordance with all the requirements depicted in this specification and industrial standards.

11.2.11 Cable Block Diagrams

Cable Block diagrams shall identify the relationship of all cabling with cable numbers that interconnect between panels, junction boxes and components. These diagrams shall identify the size and number of conductors in each cable. Preliminary versions of these diagrams shall be made available for 50% design review. The formal submittal shall be submitted prior to fabrication. Cables that will be provided and installed by BUYER will be identified on the cable block diagram. The Supplier shall identify at the 50% design review the equipment breakdown for shipping that identifies those cables that need disconnecting for shipment. BUYER will provide tag numbers for all junction boxes and panels that BUYER has to terminate to.

11.2.12 Manufacturer's Technical Literature

Supplier shall provide manufacturer's technical literature for all technical components and instrumentation provided within the Supplier's package.

11.3 Procedures

11.3.1 Site Storage and Handling Procedure

Supplier to provide site storage and handling procedures in accordance with the RFP or Section 3 of Material Requisition to which this specification is attached. Procedures shall be issued to BUYER nine-month prior to shipment. One copy of the procedure shall be attached to each shipping container. Supplier is responsible for stipulating any site storage requirements necessary to maintain any implied or stated equipment warranty including shelf life for spare parts. Refer to Engineering Specifications for Packaging, Handling, and Storage Requirements, 24590-WTP-3PS-G000-T0003 for additional requirements.

11.3.2 Functional Test Procedure

Supplier shall submit equipment functional test procedures that will be used to demonstrate to BUYER's satisfaction that the equipment will function in accordance with the specified requirements. Procedures shall be submitted for BUYER's review in accordance with the RFP or Section 3 of Material Requisition to which this specification is attached. Procedures shall be submitted at least one month prior to scheduled performance of the functional demonstration to be witnessed by BUYER's engineer(s). Scope of these tests shall be agreed to between the BUYER and Supplier via review of the proposed test procedure.

The functional test procedure shall include:

- Requirements for maintaining records of functional tests
- Description of method used to track status of testing
- Requirements for inspection prior to testing to determine test readiness
- Procedures for documenting failures and errors encountered
- Procedures for documenting agreed test modifications or procedure corrections deemed necessary to resolve a test finding
- Method of documenting final resolution of test anomalies
- Acceptance criteria

11.3.3 Operating, Startup and Shutdown Procedures

Supplier shall provide procedures in hard copy as well as in electronic describing the method of starting, operating and shutting down the equipment package.

11.4 Calculations

Calculations shall be submitted for BUYER's verification as indicated in the RFP or Section 3 Drawings and Data Requirements, Material Requisition to which this specification is attached. Calculations shall be orderly, complete, and sufficiently clear to permit verification.

The body of the calculation shall include:

- A concise statement of the purpose of the calculation
- Input data, applicable criteria, and stated assumptions
- A list of references used, including drawings, codes, standards, and computer programs, indicate the version or issue date
- A discussion of the rationale used for design assumption basis
- Equations used for all computations
- Numerical calculations, including identification of units used
- A concise statement addressing the calculation results and/or recommendations
- A table of contents for complex calculations.

11.4.1 Electrical Load

Supplier shall submit calculations showing the electrical power consumption, both peak and continuous for each power voltage level required by the Supplier to operate all equipment and instruments provided. The list shall identify 120 VAC UPS loads separately.

11.4.2 Heat Loads

Supplier shall submit a list of all calculated and estimated control panel/cabinet heat loads.

11.4.3 Instrument and Service Air Consumption

Supplier shall submit calculations showing the instrument and service air consumption both peak and continuous. The submittal shall identify instrument and service air consumption separately.

11.4.4 Sizing Calculations

Supplier shall provide, for review and approval, the sizing calculations used to size modulating control valves per ISA S75.01, head producing flow elements, and pressure relieving devices per API RP 520 PT I.

11.5 Manuals

Operation and maintenance (O&M) manuals in both hard copy and electronic form shall be provided for the equipment package. The O&M manual shall include startup, operating and

shutdown procedures as well as periodic and preventative maintenance procedures. The requirements for the package O&M manuals are contained in the Material Requisition.

11.6 Schedules

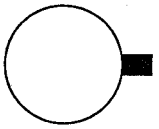
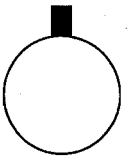
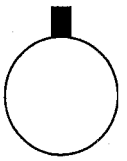
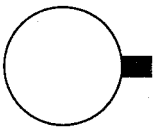
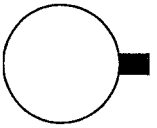
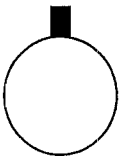
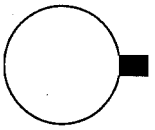
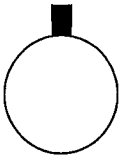
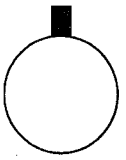
11.6.1 Material Schedule

A schedule of material listing all instruments and devices to be located on or supplied with the equipment package shall be provided. The schedule or bill of material shall contain BUYER's tag numbers where applicable, manufacturer, model number, part number, description, quantity and brief material description.

11.6.2 Spare Parts List

Supplier shall submit a recommended spare parts list covering all items within Supplier's scope. The spare parts recommendation shall be based upon Supplier's experience with component failure, maintenance requirements, environmental conditions, as well as consideration of the total quantities of each device supplied by Supplier. Supplier's recommendation shall include both construction/commissioning and operating spares. Construction/commissioning spare parts are those parts to be held for use during construction, testing, and commissioning. Operating spare parts are those to be held for the first year of operation of the plant.

APPENDIX A-1 Sensing Line Process Connection Orientation

MEASURED VARIABLE	LINE FLUID		
	LIQUID	STEAM VAPOR OR SLURRY	AIR OR GAS
FLOW			
PRESSURE OR DIFFERENTIAL PRESSURE			
ANALYSIS	LIQUID	STEAM, VAPOR, AIR, OR GAS	
			
TEMPERATURE	ALL FLUIDS		
	NOTE: THIS ORIENTATION FOR TEMPERATURE INSTRUMENTS WILL NOT APPLY IF THE PIPE DIAMETER IS SMALL AND REQUIRES A TEE OR ELBOW TO BE USED. 	**INSTRUMENTATION: MEASURED VARIABLE TAPPING POINTS ORIENTATION**	

ATTACHMENT EKP0

LAW TCO CUSTOMIZED EKP0

Per 24590-WTP-3PS-EKP0, Rev. 3 Plus SCN's 24590-WTP-3PN-EKP0-00002, 00004, 00005, 00006
ENGINEERING SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGE SYSTEMS
February 2010

This attachment defines the requirements for electrical equipment, materials and installation associated with the Low Activity Waste Thermal Catalytic Oxidizer/Reducer (LAW TCO), which are provided as manufacturer standard or custom design and pre-assembled units, in accordance with the National Codes and Industry Standards. For continuity, the section numbers from the specification noted above have been retained.

1.7 Work by Others

1.7.3 Power Supply

The BUYER will provide normal power and/or Uninterruptible Power Supply (UPS) for the SELLER's instruments unless otherwise specified on the parent specification. Each source will be delivered at 120 VAC, single phase, 60 Hz, grounded system. 480 VAC, 3 phase, 60 Hz power will be provided as required for motors. All other voltages required by the SELLER shall be derived from the BUYER provided 120 VAC or 480 VAC.

2.0 Criteria for Acceptability of Electrical Equipment

- All electrical equipment for facility and equipment wiring, as defined by the National Electrical Code NFPA 70-1999, shall be Approved. Approval will be in accordance with Article 90-4, "Enforcements", Article 90-7, "Examination of Equipment for Safety," and Article 110-3, "Examination, Identification, Installation, and Use of Equipment."
- Approved means "Acceptable to the Authority Having Jurisdiction" (AHJ), as defined in Article 100 of NFPA 70-1999. Only the WTP Electrical AHJ can provide the approval.
- "Equipment" is defined by the NFPA 70 as, "A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with an electrical installation". As used here, the entire mechanical assembly is not considered an electrical installation, only the electrical and/or electronic components, and the interconnecting wiring.
- Listing and labeling by an OSHA Nationally Recognized Testing Laboratory (NRTL) is the primary means (Method 1 below) of obtaining WTP AHJ approval for electrical equipment, devices and materials.
- All Control Panels shall be UL labeled by a certified UL 508A shop.
- Electrical Equipment that is installed on (standard or custom fabricated) Mechanical Equipment shall comply with the requirements stated above.
- Electrical Equipment, that is part of Mechanical Packaged Equipment, where the entire mechanical skid is field-evaluated and Labeled at the factory by an NRTL is an alternate method of obtaining WTP AHJ approval.

2.1 Method 1 (Primary): Listed, Labeled or Certified (i.e. UL508A)

2.1.1 The WTP AHJ shall approve and accept electrical equipment without additional examination if it is Listed, Labeled, or Certified by a US NRTL, as recognized by OSHA under 29 CFR 1910-Subpart S and is acceptable for the application, environment and other requirements of NEC Article 110. For a listing of and Typical Registered Certification Marks of US NRTL's recognized by OSHA go to http://www.osha.gov/dts/otpca/nrtl/nrtlmrk.html.

2.2 Method 2 (Alternate): Field Evaluation by a NRTL

2.2.1 Electrical equipment that is part of an overall electrical or mechanical assembly having a NRTL safety evaluation or a field evaluation, which states the equipment has been accepted or otherwise deemed safe by the NRTL recognized by OSHA under 29 CFR 1910-Subpart S, using US standards, will be evaluated by the WTP AHJ for acceptability. If found acceptable no further examination of the equipment is required. The SELLER shall submit the NRTL safety/field evaluation report, or evidence of compliant labeling/listing of electrical equipment including UL 508A certification/labeling of control panels for BUYERs Electrical AHJ review and approval prior to having the equipment released for shipment.

2.2.2 The SELLER shall submit all field evaluation reports completed by an OSHA recognized NRTL to the BUYER for review and approval by the AHJ. These field evaluation reports shall show compliance to the applicable USA Electrical Standard(s) recognized by OSHA that are listed on the OSHA website http://www.osha.gov/dts/otpca/nrtl/allstds.html. The NRTL Label will be as shown on the OSHA website with whatever additional markings that are necessary to indicate acceptability for use in the USA http://www.osha.gov/dts/otpca/nrtl/nrtlmrk.html.

2.2.3 The SELLER shall submit a Certificate of Compliance (C of C) document for review and approval by the AHJ that lists the USA Electrical Standard(s) that each electrical material or equipment is evaluated to for it's NRTL Listing. Only those standards that are listed on the OSHA website http://www.osha.gov/dts/otpca/nrtl/allstds.html are acceptable to the AHJ. The certification shall confirm that the NRTL Label for each electrical component will be as shown on the OSHA website including the additional markings required to indicate acceptability for use in the USA http://www.osha.gov/dts/otpca/nrtl/nrtlmrk.html.

2.3 If a SELLER is unable to meet the criteria in Method 1 or Method 2, the SELLER shall request in writing a variance by the WTP Electrical AHJ.

3.0 Applicable Documents

3.1 Codes and Standards

The equipment and installation shall conform to the applicable sections of the following National Codes and Industry Standards:

29 CFR 1910,	Occupational Safety and Health Standards, Electrical Sub part S
NFPA 70-1999	National Electric Code (NEC)
ANSI C80.1	Rigid Steel Conduit – Zinc Coated (GRC)
IEEE 383-1974	Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations *(Only Section 2.5 - Flame Tests, shall be applicable.)*
IEEE 515	Standard for Testing, Design, Installation and Maintenance of Electric Resistance Heat Tracing for Industrial Applications

IEEE 1202	Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies
NEMA ICS-1	Industrial Control and Systems General Requirements
NEMA ICS 6	Enclosures for Industrial Controls and Systems
NEMA RN1	Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metallic Conduit
UL 6	Standard for Safety Electrical Rigid Metal Conduit - Steel
UL 6A	Standard for Safety for Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
UL 13	Standard for Power-Limited Circuit Cables
UL 2250	Standard for Safety Instrumentation Tray Cable
UL 44	Standard for Safety Thermoset Insulated Wires and Cables
UL 360	Standard for Safety Liquid Tight Flexible Steel Conduit
UL 508	Standard for Safety Industrial Control Equipment (17^{th} Edition)
UL 514B	Standard for Safety Conduit, Tubing, and Cable Fittings
UL 1581	Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 1666	Safety Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
NEMA WC 55	Instrumentation Cables and Thermocouple Wire - ICEA S-82-552
NEMA WC 57	Standard for Control Cables - ICEA S-73-532
NEMA WC 70	Non-shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy - ICEA S-95-658
NFPA 262-2002	Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

3.2 WTP Project Specifications

24590-WTP-3PS-JQ00-T0004 Management of Supplier Software

3.3 Nuclear Standards for Equipment Classified as Q

In addition to the above, when required for complying with the nuclear standards for SC and SS equipment or components, the SELLER shall follow the version as called out in this specification.

IEEE 344-1987	Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations, as tailored in Appendix F.
IEEE 383-1974	Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations
IEEE 384-1992	Standard Criteria for Independence of Class 1E Equipment and Circuits, as tailored in Appendix G
IEEE 1023-1988	Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations
ASME NQA-1	Quality Assurance Program Requirements for Nuclear Facilities -2000 (not applicable to this LAW TCO procurement)

3.4 Reference Documents/Drawings

Specification	Title
24590-WTP-3PS-MUMI-T0001 *(As applicable)*	Engineering Specification for Medium Voltage Induction Motors
24590-WTP-3PS-MUMI-T0002	Engineering Specification for Low Voltage Induction Motors
24590-WTP-3PS-EVV1-T0001 *(As applicable)*	Engineering Specification for Low Voltage Adjustable Speed Drives
Addendum JQ07	Engineering Addendum for Instrumentation for Package Systems
24590-WTP-3PS-JQ06-T0005 *(As applicable)*	Engineering Specification for Environmental Qualification of Control and Electrical Systems and Components

4.0 Design Requirements

•4.1 General

4.1.1 BUYER will provide electrical service at the following voltages for SELLER's system, as applicable.

4.1.1.1 Medium voltage:

••13.8 kV, 60 Hz, 3 phase, 3 wire, low resistance grounded neutral, with the ground fault current limited to 2000 amps.

4.1.1.2 Low voltage:

••480 V, 60 Hz, 3 phase, 3 wire, solidly grounded

••208 V / 120 V, 60 Hz, 3 phase, 4 wire, solidly grounded

••120 V AC, 60 Hz, 1 phase UPS

5.0 Construction

•5.1 Motor Starters and Control

Unless otherwise stated in the primary specification, motor starters for 460 V, 3 phase motors ½ Hp and larger will be provided by BUYER and installed remotely from the packaged unit. However, special consideration will be given to packages in which the provision of motor starters by the SELLER may be beneficial. When furnished with the packaged unit, the starters shall have the following configuration. Starter units with electronic overload shall only be used for Non-Safety applications. Electromechanical starters can be furnished for both Non-Safety and Safety applications.

5.1.1 Motor Starters with Electronic Overload

5.1.1.1 Motor starters with electronic overload protection can be supplied for SSCs classified as RRC, or Non-Safety, (i.e. CM quality level). (Note: Siemen # Simocode 3UF50 protection device is used in BUYER's MCCs and is preferred.)

5.1.1.2 Combination starters shall be equipped with a pad-lockable disconnecting means, a magnetic contactor, a dedicated control power transformer (CPT), and a motor overload protection device.

5.1.1.3 Control panels with multiple starters may have a common disconnecting means and CPT.

5.1.1.4 When the motor control is designed for local and remote modes of operation, local controls shall be operable from the starter or control panel door, and remote control signals will be provided through the BUYER's communication network.

5.1.1.5 When furnished, the following local controls shall be available at the starter or control panel door:

1. Start/Stop function (pushbuttons or selector switch)
2. Local/remote selector switch (when local/remote mode is specified)
3. Trip reset
4. Indicating LED for Status (Green - motor stopped, Red - motor running, Amber - motor tripped)

5.1.1.6 When furnished, the electronic overload protection shall include the following features available for remote mode operation through the BUYER's communication network:

1. Start/Stop capability
2. Trip reset
3. Status indication (motor stopped, run and tripped)
4. Current monitoring of all three phases
5. Programmable parameters for the protective functions
6. Diagnostic information
7. Control voltage status
8. Other functions if available in the relay
9. Communication port to interface with the BUYER's Profibus communication network

5.1.2 Motor Starters with Thermal Overload Relay

5.1.2.1 Motor starters with thermal overload relays shall be supplied for SSCs classified as SC or SS, (i.e. QL-1 or QL-2 quality level). SELLER may also provide thermal overload relays for SSCs classified as Non-Safety upon BUYER's approval.

5.1.2.2 Each motor starter unit shall consist of a pad-lockable disconnecting means, a dedicated control power transformer (CPT), and a magnetic contactor with thermal overload relay including, but not limited to the following features:

1. Start/Stop function (pushbuttons)
2. Local/remote selector switch (when local/remote mode is specified)
3. Thermal overload relay (Class 20)
4. Trip Reset
5. Indicating LED for Status (Green - motor stopped, Red - motor running, Amber - motor tripped)
6. Two sets of contacts for the remote position of the selector switch shall be wired to terminal blocks for BUYER's use
7. Spare main contactor auxiliary dry contacts (1 NO, 1 NC minimum) wired to terminal blocks for BUYER's use
8. Auxiliary contact (1 NC) of overload relay shall be wired to terminal blocks for BUYER's use.
9. Terminal blocks with approximately 20% spare terminals.

5.1.3 Space Heater

Where motors are supplied with space heaters, the CPT shall be sized to be the power source, and a dedicated control contact for the heater shall be provided and wired.

5.1.4 Local Disconnects

Where required, local disconnecting means shall be provided in accordance with section 430-102 and 430-113 of NFPA 70-1999.

5.1.5 Emergency Stop and Reset

Control panel for operating machinery shall be provided with an emergency stop (E-stop). Local emergency stop push buttons shall be provided on equipment where physical injury is credible. The emergency stop push button shall be readily identifiable and when depressed, shall remain depressed until it is manually reset. A spare contact shall be available for the BUYER's use. Emergency stop shall be hard-wired to the motor controller.

5.3 Power Protection and Disconnecting Means

5.3.1 Disconnecting means

Enclosures with incoming power supply shall have a manually actuated disconnecting means mounted on or close to the enclosure in an easily accessible location.

5.3.2 Overcurrent Protection

Devices in panels utilizing power shall have suitable overcurrent protection. Power shall not be "daisy chained" from device to device; however, bridge or comb jumpers may be used on the supply side of the circuit breaker or a fuse block.

5.5 Cables and Wiring

5.5.1 The SELLER shall mount, connect and wire each instrument or control device such that adjustment, maintenance, removal and replacement may be accomplished in a safe manner without interruption of service to adjacent but non-associated equipment, and without placing undue stress on installed wiring or devices. Accommodations for strain relief shall be made when routing wire to hinged enclosure doors and shall be wrapped with spiral wire wrap.

5.5.2 Other than the special cables furnished by SELLER, cables shall be in accordance with the following:

a) Low voltage power and control cables shall be stranded copper, 600 V type XHHW-2 or BUYER-approved equivalent.

b) Internal wiring shall be stranded copper, flame-retardant, 600 V, synthetic heat resistant (SIS), or machine tool wire (MTW), or high-flexible thermoset.

c) The minimum size of conductor will be as follows (not including cabling integral to components):

Duty	External Conductor Size (AWG)	Internal Wiring in enclosures Size (AWG)
Power and Lighting (480 V and below only)	12	14
Current Transformer Wiring	10	10
Control Circuits (120 V AC / 125 V DC) and Instrument power circuits	14	16
Instrumentation – Single pair or triad cable	16	18

Instrumentation – Multi-pair or triad cable	18	18
Communication cable (Fieldbus, Profibus)	18-22	18-22

d) Approximately 25% spare conductors shall be included in multi-conductor 300 V analog and low-level signal cables. Spare conductors shall be terminated on the terminal blocks.

5.5.3 Inter-connecting wiring or cabling for packaged units furnished by SELLER, shall be terminated and tested according to this specification.

5.5.3.1 No more than two wires shall be connected to one terminal point if rated for more than one wire. Internal wiring shall be continuous from terminal to terminal without splices (except devices with pig tails). Bridge or comb jumpers are preferred to wire jumpers on terminal strips. Jumpers shall not be installed on field side of the terminal strip.

5.5.3.3 Circuits of different voltages (service level) shall be terminated on physically separate terminal strips and clearly labeled to show the circuit voltage. Terminal blocks shall be segregated according to signal type. In the event safety instrument system components are included in an enclosure, the wiring shall be clearly identified and segregated from non-safety instrument system circuits.

5.5.3.4 AC power shall be routed through separate wireways or separated with a divider from 24 VDC discrete and analog instrument signals within enclosures. Power and signal cabling shall not be run in parallel, except in separate wireways, and should cross at a 90-degree angle only.

5.5.3.5 Wires shall be tagged with the SELLER's cable designation number at both ends with (heat shrinkable or non-shrinkable) plastic sleeve type wire markers.

5.5.4 The SELLER shall furnish terminal boxes or control panels as follows:

5.5.4.1 Instrumentation cables shall be terminated in separate junction boxes from the power and control cables.

5.5.4.2 Where cables supplied and installed by BUYER are run to the package unit, the SELLER shall provide space for installing and terminating the cables.

5.5.4.3 Approximately 25% of spare terminals shall be included in the terminal blocks.

5.5.5. Wiring for electronic, instrument, communication and signal cables shall be segregated from both power and control cables.

5.5.6 Terminal blocks shall be selected to accommodate the function and electrical requirements associated with each wiring application. They shall incorporate the following features:

a) Screw clamp wire connection
b) Single level configuration
c) Integral test points
d) DIN-rail mounted

5.6 Raceway System

5.6.1 Conduit System

5.6.1.1 Wiring shall be installed in metal conduit. Minimum conduit size shall be ¾ inch. ½ inch conduit is allowed when connecting to devices with ½ inch hubs.

5.6.1.2 Liquid-tight flexible metallic conduit shall preferably be used to isolate the transmission of vibration to the conduit system, and for connection to equipment which may be periodically removed.

5.6.1.3 Liquid-tight flexible metallic conduit shall be supported within 12 inches of each box, cabinet, conduit body, or other conduit termination and shall be secured at intervals not to exceed 4½ ft.

5.6.1.5 Conduit connections to junction boxes shall be made using watertight threaded hubs or factory threaded hubs.

5.6.4 Enclosures shall be designed for front access only unless otherwise specified. All components and equipment in enclosure shall be accessible and removable from the front. Enclosures shall be suitably rated for the environment specified.

5.7 Grounding

5.7.1 Non-current carrying metallic parts of electrical equipment shall be bonded together and made electrically continuous. Two grounding pads shall be furnished at diagonally opposite corners at the edge of skids for connection by the BUYER to the area ground grid.

5.7.2 Electrical equipment on the packaged unit shall be bonded to the package unit skid.

9.0 Documentation and Submittals

- **9.1 General**

The SELLER shall furnish the following documents as per form G-321E and G-321V in the subcontract or primary mechanical packaged equipment material requisition or purchase order (all drawings and data shall be in U.S. units):

9.1.1 Functional description of the electrical operation of the package.

9.1.2 Overall Single line diagram showing all electrical equipment.

9.1.3 Overall layout showing location of electrical items.

9.1.4 Interconnection diagram and cable schedule showing details of all internal connections and BUYER external connections. The SELLER's furnished cable schedule shall include service voltage and Class of Circuit per NEC Articles 725, 760 and 800 for each cable.

9.1.5 Individual equipment schematic diagrams, wiring diagrams, general arrangement drawings, foundation details and junction/terminal box details.

9.1.6 Material list with specific model number, manufacturer and catalogue cut sheets shall be submitted as part of the product data.

9.1.7 The SELLER shall include a list of all the electrical loads in the package, their individual consumption (in kW) and voltage level (in volts).

9.1.8 Recommended Spare Parts List

9.1.8.1 SELLER shall provide a list of recommended spare parts as follows:

a) Startup/warranty spare parts – are those parts that may be required at any time during equipment installation, startup, testing and unit operation through the warranty period.

b) Operational spare parts – are those parts that required replacement at regular intervals to maintain continuous operation of the supplied equipment and/or system.

c) Capital spare parts – are major parts or equipment that provide reliable equipment operation throughout the plant life and having a significant lead time for manufacturer and delivery.

9.1.8.2 The spare parts list shall include pricing and delivery information valid for one year after delivery of the equipment.

9.1.9 Test reports as required by the primary specification.

9.1.10 In addition to the above, when required for complying with the nuclear standards for SS equipment or components, the SELLER shall submit the qualification documentation as required by the primary specification, material requisition and purchase order.

ATTACHMENT NN00

LAW TCO CUSTOMIZED NN00

Per 24590-WTP-3PS-NN00-T0001, Rev. 2
ENGINEERING SPECIFICATION FOR THERMAL INSULATION FOR MECHANICAL SYSTEMS
February 2010

This attachment defines the minimum thermal insulation requirements for piping and mechanical equipment associated with the Low Activity Waste Thermal Catalytic Oxidizer/Reducer (LAW TCO) where insulation is specified on drawings, specifications, data sheets, and associated lists. This attachment does not address insulation that is designated as "Safety" or quality level 1 or 2, nor does it cover proprietary tank insulation systems, cryogenic insulation systems, or the insulation of furnaces and buildings. For continuity and maintaining configuration control, the section numbers from the specification noted above have been retained.

1.3 Material and Services Required

SELLER shall provide all insulation materials with associated cements, compounds, jacketing, fasteners/securements, personnel protection guards, and other necessary items for complete insulation systems as defined herein, as well as all services necessary for complete installation of insulation on piping and equipment identified on specified drawings, specifications, data sheets, and lists.

1.4 Conflicts

Instructions on specified equipment drawings and piping isometric drawings, including notes, shall supersede any conflicting requirements of this specification. At the time of quotation, the BUYER shall be notified of all conflicts between this specification and any other documents such as the referenced codes and standards, P&ID, or other procurement documents. Discrepancies, errors, or omissions shall be resolved in writing with the BUYER before the work is started.

2.0 Applicable Documents

Work shall be done in accordance with the referenced codes, standards, and documents listed below, which are an integral part of this specification. When specific chapters, sections, parts, or paragraphs are listed following code, industry standard, or reference document, only those chapters, sections, parts, or paragraphs of the document are applicable and shall be applied. If a date or revision is not listed, the latest issue, including addenda, at the time of Request for Quote (RFQ) shall apply. When more than one code, standard, or referenced document covers the same topic, the requirements for all must be met with the most stringent governing.

2.1 American Society for Testing and Materials (ASTM)

A 240 Standard Specification for Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

B 209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

C 167 Standard Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations

C 195 Standard Specification for Mineral Fiber Thermal Insulating Cement

C 302 Standard Test Methods for Density of Preformed Pipe Covering Type Insulation

C 303 Standard Test Method for Density of Preformed Block-Type Thermal Insulation

C 449 Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

C 533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

C 547 Standard Specification for Mineral Fiber Pipe Insulation

C 552 Standard Specification for Cellular Glass Thermal Insulation

C 585 Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing

C 592 Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered)(Industrial Type)

C 610 Standard Specification for Expanded Perlite Block and Pipe Thermal Insulation

C 612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation

C 692 Standard Test Method of Evaluating the Influence of Wicking-Type Thermal Insulations on the Stress Corrosion Cracking Tendency of Austenitic Stainless Steel

C 795 Standard Specification for Wicking-Type Thermal Insulation for Use Over Austenitic Stainless Steel

C 871 Standard Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions

C 1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

D 312 Standard Specification for Asphalt Used in Roofing

2.2 Process Industry Standards

INIH1000 Hot Insulation Installation Details

2.3 Occupational Safety and Health Administration

29 CFR 1910.144 Safety Color Code For Marking Physical Hazards

29 CFR 1910.1200 Hazard Communication

3.0 General Requirements

3.1 Insulation Systems

The following insulation codes are used to identify the functions of thermal insulation on mechanical pipe and equipment:

- Hot services
  - HC: heat conservation
  - PS: process stability
  - PP: personnel protection
  - HF: hot and fire protection
  - PG personnel protection guards
- No insulation
  - NI: no insulation

Insulation for cold services shall be cellular glass. Contraction joints and a vapor barrier covering are not required for cellular glass. Joint sealant shall be used in all insulation joints and to provide vapor stops at insulation terminations.

Insulation for hot services shall be as follows:

- Vertical Equipment
  - Shell mineral fiber semi-rigid board
  - Top head expanded perlite block, or calcium silicate
  - Bottom head mineral fiber blanket
- Horizontal Equipment
  - Shell expanded perlite block, or calcium silicate
  - Heads mineral fiber blanket
- Piping
  - All surfaces expanded perlite block, or calcium silicate

Cellular glass, mineral fiber, or calcium silicate materials may be used for hot services, if approved by the BUYER, but only in the allowable temperature ranges specified in Section 4.2.

The Component Information System (CIS) and associated lists identify the appropriate insulation function code(s) for piping. Piping isometric drawings show the extent of insulation for piping and associated components. Equipment general arrangement drawings and equipment data sheets specify the extent of insulation for equipment. Piping and instrument diagrams (P&IDs) indicate where insulation is required.

If several insulation function codes are applicable, the most stringent requirements shall govern. For example, surfaces above 140°F that can be readily touched by operating or maintenance personnel require personnel protection (code PP). Where other insulation functions may be specified, the most stringent thickness requirement shall apply. In situations where insulation is not practical or appropriate, expanded metal guards (designated as code PG) shall be used for personnel protection rather than insulation.

All thermal insulation shall be protected by aluminum or stainless steel sheet metal jacketing unless specified otherwise. Jacketing shall support the insulation, protect it from damage, and provide weather protection (prevent ingress of water).

3.2 Extent

Removable and reusable insulation should be used in areas requiring periodic access for maintenance.

PP insulation shall be used on surfaces that are accessible to personnel if the maximum temperature exceeds 140°F, with guards (code PG) installed where insulation is not practical or appropriate. Accessible areas include those where personnel perform anticipated operations or maintenance, and include surfaces up to 7 ft above grade, floors, or platforms, and 3 ft horizontally from the periphery of platforms, walkways, or ladders.

Table 3.2 defines the extent of thermal insulation for other function codes.

Table 3.2, Extent of Insulation for Functions Other Than AS and PP

Surfaces to be Insulated	Insulation Function Codes		
	HC	PS	HF, ET, ST, PF
Straight or bent pipe; socketweld, threaded or buttweld pipe fittings, and valves.	YES	YES	YES
Pipe unions	NO[2]	NO[2]	NO[1]
Steam traps, related strainers	NO[2]	NO[2]	NO[1]
Flanged valves (except relief and control valves), flanged orifice sets, piping flanges connected to equipment nozzles	YES[3]	NO[1,3]	YES[3]
Primary piping for instrument connections, sample piping, vent and drain piping.	NO[1]	NO[1]	YES
Expansion or rotation joints, slide valves, etc.	NO[2]	NO[2]	YES[3]
Instruments and associated tube	NO	NO	YES
Relief valves	NO	NO	NO
Control valves, flanged pipe fittings	NO[1,3]	NO[1,3]	YES[3]
Tee and inline strainers	NO[1,3]	NO[1,3]	YES[3]
Heat exchangers, shell side, tube side, excluding body flanges	YES	YES	NA
Heat exchanger body flanges	NO[1,3]	NO[1,3]	NA
Pump casings	NO[1,3]	NO[1,3]	YES[3]
Compressors	[3]	NO[1]	NA
Blowers, fans	[3]	YES[2]	NA

[1] Insulate or guard only where required for personnel protection.
[2] Provide removable metal guards or barriers where required for personnel protection.
[3] Removable and reusable covers should be considered.
[4] Insulation should not be used in inaccessible areas where maintenance is infeasible (e.g., high radiation areas).

Removable, reusable insulation shall be used in areas where insulation may be removed more frequently than once every 20 months (e.g., for flanges or other components requiring periodic maintenance).

3.3 Thickness

Insulation shall be applied in one layer with the thickness per Appendix A unless specified otherwise. Insulation thickness depends on the insulation function (insulation code), normal or maximum operating temperature, and item diameter.

4.0 Materials

4.1 General

4.1.1 The BUYER only shall judge equivalency of materials. The SELLER shall submit complete details with any request for substitution or deviation from this specification.

4.1.2 All insulation and non-metallic accessory materials shall contain no asbestos.

4.1.3 All expanded perlite, calcium silicate, mineral fiber insulation, and mineral fiber cement or other proposed substitution products shall be qualified for use on austenitic stainless steel in accordance with ASTM C 795 by conforming to the pre-production test requirements of ASTM C 692 and the confirming quality control requirements for chemical analysis of ASTM C 871.

4.1.4 Tolerances for sheet metal thickness and wire diameter before working shall be ± 12% of nominal.

4.1.5 Mineral fiber insulation materials shall have less than 30% cumulative shot content as determined by ASTM C 612 Annex A1. Density of mineral fiber products shall be determined by ASTM C 612, C 302, or C 303, as appropriate. "Delivered density" based on 40% shot content calculated per ASTM C 612 shall not be used.

4.1.6 All mastics, cements, caulks, compounds, kraft paper, and other materials used in insulation systems for stainless steel piping and equipment shall be free of leachable lead, bismuth, zinc, mercury, antimony, cadmium, and tin. The inorganic halogen content shall be less than 200 ppm; sulfur content shall not exceed 400 ppm. The low melting elements mentioned above shall be less than 1 percent by weight with mercury less than 50 ppm.

4.2 Insulation

4.2.1 Table 4.2 lists insulation materials and the allowable temperatures and functions for each material.

Table 4.2, Insulation Materials

Material	Description	ASTM Standard	Allowable Process Fluid Temperatures	Allowable Functions
Calcium Silicate	Block and Pipe Covering	C533	320°F to 1130°F	HC, PS, PP, HF
Cellular Glass	Block and Pipe Covering	C552	-355°F to 320°F	All
Mineral Fiber	Preformed Pipe Insulation	C547	230°F to 1130°F [1]	HC, PS, PP (see Note 1)
Mineral Fiber	Blanket	C592	230°F to 1130°F	HC, PS, PP
Mineral Fiber	Semi-Rigid Board	C612	230°F to 1130°F	HC, PS, PP
Expanded Perlite	Block and Pipe Covering	C610	77°F to 1130°F	HC, PS, PP, HF, ET, ST, PF

[1] Although not preferred, mineral fiber insulation material may be used in cold services (codes AS, ET, ST, and PF) at fluid temperatures down to 32°F with BUYER's approval if suitable ASTM C1136 vapor barriers are provided on all insulation surfaces and vapor stops are provided at insulation terminations to prevent water intrusion.

4.2.2 Mineral fiber board, rigid and semi-rigid, used for vertical equipment surfaces shall meet the requirements of ASTM C 612, Class 4 and be suitable for continuous service at system operating temperatures, and shall have a nominal density of 8 lbs/ft^3.

4.2.3 Mineral fiber blanket insulation used for bottom heads of vertical equipment and heads of horizontal equipment shall meet the requirements of ASTM C 592 Class II with the following exceptions:

- Nominal density shall be 8 lbs/ft^3
- One side shall be faced with stainless steel hexagonal mesh

4.2.4 Molded mineral fiber insulation piping ell covers suitable for operating temperatures may be used for all hot applications.

4.2.5 Expanded perlite block and pipe covering used for all piping, horizontal equipment, and vertical equipment top heads shall meet the requirements of ASTM C 610, Type II only, and shall exhibit water repellency up to a service temperature of 410°F.

4.2.6 Cellular glass insulation shall meet the requirements of ASTM C 552. For operating temperatures above 185°F, fabrication of piping insulation and curved radius segments shall be laminated using gypsum cement, not hot asphalt.

4.2.7 Calcium silicate block and pipe insulation shall meet the requirements of ASTM C 533 Type I and shall be marked continuously to designate that no asbestos is present.

4.3 Insulation Form

4.3.1 Shop-fabricated rigid insulation segments used for all elliptical, conical, torispherical, flanged and dished, or hemispherical top heads of vertical equipment shall be fabricated from cellular glass, rigid expanded perlite block, or calcium silicate. Both inside and outside surfaces shall be cut to match the compound curvature of the head. Each of the four sides shall be machined at the necessary bevel angle and radius to match the adjoining courses. Blocks shall be individually numbered and supplied with an assembly map to indicate the relative location of the numbered pieces.

4.3.2 Curved cellular glass sections used for equipment shells and pipe insulation shall be of a density between 7 and 8 lb/ft^3 in accordance with ASTM C 552, "Cellular Glass Block and Pipe Thermal Insulation". Acceptable materials are Pittsburgh-Corning Corporation "Foamglas" or approved equal. Thermal conductivity at 50°F shall be less than 4.6 x 10^{-4} Watts cm/cm^2 °C (0.32 BTU in/hr ft^2 °F). Curved sections for equipment shells and piping insulation shall be manufactured from billets assembled with ASTM D 312 Type III hot asphalt. A factory coating of ASTM D 312 Type II or III hot asphalt shall be applied on the exterior curved surfaces and interior bore. For operating temperatures above 185°F, gypsum cement should be used instead of hot asphalt per section 4.2.6.

4.3.3 Flat stock insulation materials that are grooved to fit cylindrical surfaces for equipment shells and pipe sizes above 12 inches shall be vee-cut so that the cuts close completely along their entire length when the insulation is installed. Materials used for fabrication shall conform to the requirements of this specification. Dimensions of the installed product shall conform to ASTM C 585 for pipe insulation. Backing and adhesives are subject to review and approval by the BUYER.

4.3.4 Loose fill material and cushioning blanket for service temperatures to 680°F shall contain no asbestos, have a density greater than 8 lbs/ft^3, and be glass fiber needled together to form a mat without the use of binders. The following materials are acceptable:

- Alpha Associates "Filomat D"
- Burlington Glass Fabrics "Burlglass 1200"

4.4 Mastics and Cements

4.4.1 Mineral fiber thermal insulating cement shall meet the requirements of ASTM C 195. Insulating and finishing cement shall meet the requirements of ASTM C 449. Reinforcing wire mesh shall be 1 inch hex x 0.023 inch three twist Monel or 18-8 SS wire.

4.4.2 Caulking compound for temperatures up to 365°F sealant shall be silicone rubber, Dow Corning 999 Silicone Rubber, or equal. Compound exposed to temperatures between 365°F and 680°F shall be Childers CP-79 or equal.

4.4.3 Reinforced weatherproofing compound shall be acrylic or vinyl acrylic water base emulsion and reinforced with a Dynel, nylon, or polyester leno weave or knitted fabric with 10 x 10 mesh per inch and a weight of 2 oz/yd^2.

4.4.4 Heat transfer cement shall be appropriate for the tracer temperature and process temperature. The cement shall be compatible with the surface coating system or steel substrate. Preformed flexible heat transfer cement may be used. On carbon steel pipe, steel channel to cover tracer shall be galvanized. For coupling vessel walls with plate heat coils, a non-hardening heat transfer cement shall be used. If required, insulation tape shall be 2 inches wide x 1/8 inch thick plain weave, suitable for operating temperatures to 1000°F.

4.4.5 Joint sealant for cellular glass at all temperatures, and vapor stop sealant for temperatures above 5°F for cellular glass shall be Foster Sealant 95-50. Below 5°F, sealant for vapor stops shall be Foster 90-66. Reinforcement for vapor stops (and weather barrier) shall be synthetic cloth equal to Pittsburgh-Corning PC Fabric 79, or BUYER-approved equal.

4.5 Jacketing

4.5.1 Aluminum jacketing shall be ASTM B 209 Alloy, 1100, 3103, 3105 or 5005 with an H14 temper. Jacketing for piping size 28 inches and below shall be flat, smooth. Jacketing for horizontal equipment shells and piping sizes above 28 inches shall be stucco embossed sheet. Jacketing for vertical equipment shells shall be furnished 1 1/4 inch corrugated. The corrugations shall be 1/4 inch deep. Jacketing for exposed equipment heads shall be gores fabricated from stucco embossed sheet.

Nominal thickness shall be 0.016 inch for piping and 0.024 inch for equipment.

Jacketing shall have a factory applied moisture barrier that is continuously heat-sealed to the aluminum. The moisture barrier shall consist of a 3 mil high density polyethylene, Poly-Surlyn film, or one layer of 40 lb virgin kraft paper laminated with a one mil polyethylene adhesive.

If specified by the BUYER, jacketing shall be supplied with a polyvinylidene fluoride (PVDF) or acrylic exterior coating and the specific color shall be approved by the BUYER. Otherwise all metal jacketing shall be the natural color of the jacketing material.

4.5.2 Stainless jacketing shall be ASTM A 240 Type 304 flat, smooth sheet 0.016 inch thick furnished in the annealed or soft condition with a regular 2B mill finish and have a factory applied moisture barrier as specified for aluminum jacketing.

4.5.3 Die formed two-piece aluminum ell covers shall be used for NPS 12 and smaller pipe sizes. Die formed four piece aluminum ell covers or molded fiberglass covers shall be used for sizes above NPS 14. Aluminum covers shall be deep drawn from 0.024 inch thick aluminum alloy 1100-0. Fiberglass covers shall be 0.040 inch thick flame retardant polyester.

Aluminum covers shall have a factory applied moisture barrier coating such as PVDF or Poly-Surlyn on the inner surface. The external surface of aluminum covers shall be coated or not coated to match the adjacent pipe jacket. Vapor barriers used with fiberglass insulation or other mineral fiber insulation for cold services shall comply with ASTM C1136.

4.5.4 If available, stainless steel die formed covers with a factory applied moisture barrier shall be furnished for ells and tees. Gored segments or stove-pipe construction of 304 stainless steel may be substituted.

4.5.5 Gored segmented aluminum or stainless steel covers shall be used over welded tees. The metal thickness and coating shall be the same as adjacent pipe jacketing. The seams shall shed water and keep the insulation dry. Flanged tees shall be insulated with flexible removable covers and shall not have metal covers.

4.6 PP Guards (Code PG)

4.6.1 Personnel protection guards shall be fabricated from perforated or expanded metal. For hot stainless steel pipe or equipment to be protected, the expanded metal guard shall be Type 304 stainless steel. For carbon steel surfaces, galvanized steel shall be used. Support may be provided by structural steel anchored at the equipment foundation or by clips banded to the piping or equipment. Support clips shall be designed to locate the expanded metal a minimum of 3 inches from the hot surface, and shall be the same or compatible material as the pipe or equipment.

4.6.2 Guards on flanged connections and equipment shall be designed for convenient removal for maintenance access. Individual section shall not weigh more than 40 lbs.

4.6.3 Typical design sketches for metal shields shall be submitted by the SELLER and shall be approved by the BUYER prior to fabrication or installation.

4.7 Insulation and Jacketing Securement

4.7.1 Tie wire, lacing wire, and lacing hair pins shall be 16 gauge Type 304 soft annealed SS wire.

4.7.2 Tape for fastening cellular glass pipe insulation shall be 3/4 inch wide fiberglass reinforced filament tape. The tape shall not be applied to stainless steel unless it conforms to the halogen content requirements of Section 4.1.6.

4.7.3 Bands shall be 0.020 inch thick by 0.50 inch or 0.75 inch wide as required by Sections 4.0, 5.0, and 6.0 and conform to ASTM A 240 Type 302 or 304 stainless steel. Seals shall be heavy-duty wing type or crimp (closed) type fabricated from 0.032 inch thick ASTM A 240 Type 302 or 304 stainless steel. Crimp (closed) type seals are required with spring tensioned banding.

4.7.4 Springs for securement of jacketing on piping and rigid insulation on equipment shall be Type 302 stainless steel limited expansion type. Springs for securement of jacketing on vessels and tanks with diameters exceeding 10 feet shall be compression type.

4.7.5 Sheet metal screws shall be #8 x 1/2 inch 18-8 SS self-tapping screws with elastomeric gaskets.

4.7.6 Stainless Steel "S", "J", or "U" Clips for supporting metal jacket courses or banding shall be 0.020 inch thick by 0.75 inch wide ASTM A 240 Type 302 or 304 stainless steel.

5.0 General Installation Requirements

5.1 Safety

5.1.1 All surface preparation, materials, and work shall comply with all applicable environmental and safety provisions, laws, regulations, ordinances, etc., of the city, county, state, province, or nation pertaining to the work being performed and the materials being used. Work being performed in the United States shall also be in strict accordance with federal (OSHA Standard 29 CFR 1910.144), state, and local safety and environmental requirements.

5.1.2 SELLER shall comply fully with OSHA Hazard Communication Standard 29 CFR 1910.1200 or the applicable country code. Material Safety Data Sheets (MSDS) shall be provided by the materials supplier and available at the place of application for review.

5.1.3 The volatile organic compound (VOC) content of all materials shall meet federal, state, and local or other regulatory requirements.

5.2 Weather Protection

All insulation and necessary materials shall be protected from moisture during storage and installation. Temporary polyethylene sheeting shall protect insulation in wet weather conditions until the final application of the permanent jacketing. Wet insulation is unacceptable and must be replaced with dry materials. Expanded perlite and cellular glass that has been exposed to the rain or other moisture shall be dried to the BUYER's satisfaction. Mineral fiber and calcium silicate that becomes wet shall be removed from the site and not used.

5.3 Conditions of Surfaces to be Insulated

5.3.1 All surfaces to be insulated shall be clean and dry.

5.3.2 Because corrosion is more aggressive to insulated surfaces than uninsulated surfaces operating in the temperature ranges just above ambient, all carbon steel normally operating at temperatures up to 300°F will be coated with epoxy.

5.3.3 No insulation shall be installed until completion of any stress relieving, chemical cleaning, coating application, pressure testing, tracer installation, and release of the surfaces in writing by the BUYER's site representative.

5.4 Insulation Fit-Up

5.4.1 All voids and cracks (larger than 3/32 inch) in hot insulation shall be pointed and filled with the insulating cement. Thickness of cement on irregular surfaces shall equal the thickness of the adjacent preformed insulation. Cracks larger than 5/16 inch shall be corrected by re-fitting the insulation unless filling is accepted by the BUYER.

For anti-sweat insulation, all joints shall be fitted up to be 1/16 inch or less or the insulation removed and remachined. All joints shall be completely filled with joint sealant from interior to exterior surface.

5.4.2 For rigid insulation materials, a 1 inch gap adjacent to support rings, tie bars, or piping ells shall be provided as an expansion joint. The joint shall be filled with loose fill material. Piping ells insulated with preformed mineral fiber do not require expansion joints.

5.4.3 Flanged fittings, flanged valves, flanged pumps, flanged blinds and single flange pairs on piping and equipment including manways and nozzles, if insulated, shall be insulated last, after the completion of all testing, and insulation of adjacent pipe or equipment surfaces.

5.5 Multi-Layer Insulation

Where possible, insulation shall be applied in a single layer as indicated in the insulation thickness tables of Appendix A. When multi-layer construction is used, joints of the top two layers shall be offset at least 1.5 inches from each other using staggered layer techniques to ensure all joints in each layer are offset.

5.6 Jacketing and Compound

5.6.1 Unless specified otherwise, aluminum jacketing shall be used for all insulation except for function HF, which shall have stainless steel jacketing.

5.6.2 Reinforced mastic weather coating compound may be used on surfaces of complex shapes that cannot be fitted with aluminum and do not require fire resistance as for function HF. It shall be used only on calcium silicate and perlite insulation. The emulsion-type weather coating shall not be applied when atmospheric precipitation or condensation may wet the finished surface within 24 hours after application.

The mastic weather coating shall be applied as follows for most applications:

- Apply a layer of finishing cement over the insulation to provide a smooth, even surface
- Apply mastic to 1/8 inch wet thickness
- While still wet, wrap with reinforcing fabric. Lap joints 2 inches
- Apply finish coat of mastic to completely cover fabric. The total dry film thickness shall be a minimum of 1/8 inch

5.6.3 Jacketing shall prevent entry of liquid water into the insulation under all normal weather conditions and wash down operations. The design of the jacketing shall be such that joints shed water and do not depend on organic caulks to prevent the ingress of water. All penetrations through the metal jacketing shall be flashed to lap the penetration and jacketing a minimum of 3 inches, banded, and sealed with caulk.

5.7 Fireproofing Insulation

For fireproofing insulation, function HF, the metal jacket on piping and equipment shall be stainless steel rather than aluminum or mastic coating. Insulation for function HF shall be cellular glass or calcium silicate. HF insulation thickness shall be as specified on applicable drawings, data sheets, and/or other specifications, but shall be 2.5 inches minimum thickness. For both piping and cylindrical equipment, the insulation as well as the jacketing shall be circumferentially banded with 1/2-inch stainless steel bands on 6 inch centers.

5.8 Installation Details

Typical insulation details are provided in Process Industry Practices INIH1000 and INIC1000. The SELLER may submit alternate sketches for BUYER approval.

5.9 Piping Versus Equipment Installation Methods

Heat exchanger and cylindrical equipment shells less than 24 inches in diameter shall be insulated in the same manner as piping. Piping larger than 48 inches shall be insulated by the methods specified for equipment. Heads on equipment less than 24 inches diameter shall be insulated with a flat disk of block butted against extended cylindrical shell insulation.

6.0 Specific Installation Requirements for Piping

6.1 Insulation Placement

6.1.1 On traced lines, the preformed pipe covering shall be of a larger insulation size or used in combination with straight block insulation as required to enclose the trace line without grooving the insulation.

6.1.2 Circumferential joints of pipe insulation sections shall be offset or staggered between top and bottom sections by a section half length. Longitudinal joints shall be nearly horizontal, and in multi-layer construction, shall not coincide with the longitudinal joints of previous (or subsequent) layers. The offset distance between staggered joints shall be at least 1.5 inches. Hinged vee-grooved pipe covering is permitted on hot piping insulation sizes larger than 12 inches. If hinged vee-grooved insulation sections are used, the hinge shall be located on top to shed any encroaching water. Only the second and third layers may be combined into a composite block for application as a unit.

6.1.3 Where insulation terminates on pipe runs, insulation will be stopped short a minimum 1.25 times the bolt length from the face of the flange or sufficient distance to remove flange bolts without disturbing the insulation and jacketing.

6.1.4 Hot welded and screwed fittings and valves 3 inches and smaller can be insulated with wire mesh reinforced combination insulating and finishing cement applied in 0.5 inch layers to achieve the thickness of the adjacent pipe insulation.

6.2 Insulation Support

6.2.1 Insulation and jacketing on vertical piping shall be supported on an approved bolt-on support ring supplied and installed by the SELLER. Carbon steel rings shall be installed on carbon steel pipe and stainless steel rings shall be installed on chrome steel (Cr-Mo), austenitic stainless steel, Inconel, and Hastelloy piping.

6.2.2 Ring supports shall be installed at the bottom of the pipe run and above interruptions in the pipe run such as at flanges and valves; however, maximum spacing shall be 13 feet. Support rings are not required for vertical rises less than 6 feet when measured from the bottom of a pipe run or from a support at an interruption.

6.2.3 Rings shall be sized to support all layers of insulation but smaller than the insulation diameter. A 0.5 inch gap shall be maintained between the insulation jacketing and the outside edge of the support ring.

6.3 Hot Insulation Expansion Joints

6.3.1 Periodically, circumferential joints shall be filled with loose glass fill or mineral fiber blanket to make an expansion joint in the rigid insulation covering. The fill shall be compressed 50% during installation to yield a joint 1 inch wide. The joint shall be filled completely to the full layer thickness of the insulation.

6.3.2 The expansion joints shall be spaced equally between pipe supports or pipe anchors but shall not exceed the distance between expansion joints listed in Table 6.3.

Table 6.3, Expansion Joint Spacing

OPERATING TEMPERATURE	MAXIMUM DISTANCE
Below 320°F	33 feet
320°F to 500°F	26 feet
Above 500°F	16 feet

6.4 Insulation Securement

6.4.1 Each individual pipe insulation section shall have a minimum of two securements.

6.4.2 Cellular glass shall be secured with adhesive tape on 9 inch centers before jacketing is banded in place.

6.4.3 Each layer of expanded perlite and calcium silicate insulation shall be secured to pipe using tie wire, 0.5 inch wide stainless steel bands, or adhesive tape on 9 inch or 12 inch spacing according to Table 6.4.

Table 6.4, Securement Spacing

PIPE SIZE (inches)	NUMBER OF LAYERS	OUTER LAYER SECUREMENT / SPACING (inches)	INNER LAYER SECUREMENT / SPACING (inches)
Below 12	1, 2 or 3	Wire/9	Wire/12
12 to 28	1	Wire/9	N.A.
12 to 28	2 or 3	Bands/12	Wire/9
Above 28	1	Bands/9	N.A.
Above 28	2 or 3	Wire/9	Wire/9

6.5 Jacketing Securement

6.5.1 On horizontal pipe insulation, metal jacketing shall overlap 3 inches both longitudinally and circumferentially. Seams shall be arranged to shed water, i.e., the upper shall overlap the lower sheet. Longitudinal seams shall be located at the 3:00 or 9:00 position on the pipe circumference. Securement of the metal jacket shall be by 0.5-inch wide bands placed on the circumferential overlaps and on 12-inch centers.

6.5.2 On vertical pipe insulation, metal jacketing shall overlap 2 inches for circumferential seams and 3 inches for longitudinal seams. Jacketing shall be supported from insulation support rings or from jacketing below using 3 or more stainless steel "S" clips. Circumferential joints shall be lapped to shed water. The longitudinal seam shall be located on the leeward side from the prevailing storm wind direction if possible. In any case, the joints shall be located so they are easily accessible for caulking. Securement of the metal jacket shall be by 0.5 inch bands placed on the circumferential overlaps and by screws on 3 inch centers along the longitudinal over-laps. Screws shall be placed in the longitudinal over-laps so that circumferential joints are free to accommodate expansion and contraction movements. Longitudinal seams of vertical pipe jacketing shall be caulked.

6.5.3 Expansion springs shall be fitted to bands that secure jacketing over multi-layer insulation on piping larger than 28 inches. Bands shall not be located adjacent to jacketing laps. Springs shall be extended 1.3 times their original length when tensioned.

6.5.4 Die formed covers shall have their heel and throat fastened with screws on 4-inch maximum centers. The cover sections shall overlap themselves and the pipe jacketing at least 2 inches. Bands 0.5-inch wide shall secure each end of the cover to the pipe jacketing.

6.6 Caulking

A heavy fillet of heat resistant caulk shall be applied around flashing at all protrusions through the jacketing. Protrusions must rely on flashing to keep water out. Other jacket-to-jacket seams not waterproof by virtue of their design shall be caulked with silicone rubber sealant.

7.0 Specific Installation Requirements for Vessels and Heat Exchangers

7.1 Insulation Placement

7.1.1 Unless otherwise approved by the BUYER, expanded perlite or calcium silicate rigid block insulation shall be used as the single layer on all shells of horizontal equipment. Semi-rigid mineral fiber board shall be used as the single layer on vertical equipment shells.

7.1.2 Joints shall not align between the top two layers of multi-layer insulation but shall be offset at least 1.5 inches.

7.1.3 Heads on equipment 24 inches diameter and less shall be insulated with a flat disk of block butted against extended cylindrical shell insulation.

7.1.4 Top heads and heads not protected by a skirt on vertical equipment larger than 24 inches diameter shall be insulated with shop fabricated rigid insulation segments. Machine cut rigid block for heads shall be installed in the locations indicated by the manufacturer's map.

7.1.5 Heads protected by a skirt and heads on horizontal equipment larger than 24 inches shall be insulated with mineral fiber blanket applied over steel surfaces operating below 680°F. For horizontal equipment shells, rigid blocks shall be installed with the long axis of the insulation block parallel to the equipment axis. The first course of block applied around the equipment shell circumference shall be applied with every other block cut to a half length so that circumferential joints are broken or staggered between adjacent blocks of the first and subsequent courses.

7.1.6 Cut and bevel blocks as necessary to obtain joints no wider than 7/32 inch at the outside surface of the insulation. Rigid block lengths shall be at least 18 inches. Acceptable maximum rigid block widths are as follows in Table 7.1.

Table 7.1, Rigid Block Widths

EQUIPMENT SIZE	MAXIMUM BLOCK WIDTH
Up to 39 inch diameter	3 inch vee-cut block or pipe covering
39 to 79 inch diameter	4 inch vee-cut block
79 to 118 inch diameter	6 inch vee-cut block
Above 118 inch diameter	9 inch vee-cut block

7.1.7 For Vertical Equipment shells, semi-rigid board shall be installed in vee-grooved sections for diameters less than 13 feet. For shell diameters larger than 13 feet, flat board is acceptable.

7.2 Insulation Securement

7.2.1 Adhesives shall not be used to hold insulation on equipment.

7.2.2 Cellular glass, if used, shall be secured with 0.75 inch wide fiberglass tape on 9 inch centers before jacketing is banded in place.

7.2.3 Each layer of rigid insulation shall be secured to equipment shells using 0.5 inch wide stainless steel bands. Where required, insulation shall be coped to accommodate expansion springs below the profile of the insulation. Expansion springs and securement shall be according to the Table 7.2.

Table 7.2, Expansion Springs and Securements

EQUIPMENT DIAMETER	NUMBER OF INSULATION LAYERS	OUTER LAYER SECUREMENT	INNER LAYERS SECUREMENT	EXPANSION SPRINGS PER BAND
39 to 118 inches	1, 2 or 3	Bands	Bands	None
Above 118 inches	1	Bands	N.A.	1
Above 118 inches	2 or 3	Bands	Bands	2, 180° Apart

7.2.4 Each layer of mineral fiber semi-rigid board insulation shall be secured with bands 0.75 inch wide. Expansion springs are not required.

7.2.5 Secure shell insulation by banding each layer on 12 inch maximum centers. For longer block or board lengths, 18 inch maximum centers may be used, but secure every block or board with a minimum of two bands.

7.2.6 Extend head bands radially from a central floating ring, and space them to provide at least one band per block at extreme circumference of the head. Bands shall be applied and sealed under tension by machine.

7.2.7 Where projections prevent a continuous band, secure the band at the projection by a bridle ring. Tie wire may be used to hold the blocks where projections prevent the use of continuous bands, e.g., between platform or ladder support brackets.

7.2.8 Insulating cement shall be used to fill up any voids or cracks flush with the block surface. See Section 4.4.

7.2.9 Expansion joints are required on horizontal vessels operating above 320°F or having a tangent length greater than 20 feet. An expansion joint shall be provided for each 10 feet of length and be equally spaced along the length. Fill expansion joints with loose mineral fiber or glass fiber.

7.2.10 Removable blanket insulation, where designated for manways, heads, and flanges shall be installed after all permanent insulation work is completed.

7.3 Jacketing Securement

7.3.1 Corrugated covering on vertical equipment shall be installed with corrugations running vertically with a minimum of 2.5 corrugations overlap. The edge of the sheet shall terminate in a valley. Circumferential overlap shall be 4 inches.

7.3.2 For stucco embossed jacketing on horizontal equipment, longitudinal and circumferential joints shall be lapped 3 inches and arranged to shed water.

7.3.3 Each section of metal jacketing shall be supported from the next lower section with "S" clips. The bottom section of covering shall be supported by "J" clips attached to the insulation support.

7.3.4 The covering shall be banded with 3/4 inch wide bands over circumferential laps with intermediate bands on 12 inch maximum centers. For resistance to high winds, band spacing shall be 9 inches with 2 bands located on circumferential overlaps.

7.3.5 Bands over rigid insulation and jacketing without corrugations shall have expansion devices as specified for the outer layer of insulation in Table 7.2.

7.3.6 Bands without springs shall be tensioned sufficiently to remove all slack.

7.3.7 Bands shall be supported by a minimum of two "S", "U", or "J" clips with a maximum spacing of 6 feet between supports. Springs, if present, shall be located away from jacketing laps.

7.3.8 On vertical vessels, metal screws shall be installed on 6 inch maximum centers in longitudinal seams. For resistance to high winds, screws shall be installed on 4 inch maximum centers.

7.3.9 Head gore segments shall be fastened to each other with screws on 6 inch centers and bands placed over each gore. For resistance to high winds, screws shall be installed on 4 inch maximum centers.

7.3.10 Flashing and a heavy fillet of silicone caulk shall be used to seal around all projections through the jacketing and all longitudinal seams. Jacketing shall be cut to fit tightly around all penetrations while allowing adequate room for expansion and contraction over the operating temperature range. All penetrations must be designed and flashed so that water will not enter.

10.0 Documentation and Submittals

10.1 SELLER shall submit detailed installation procedures complete with detailed sketches showing methods of applying insulation, particularly for valves, flanges, fittings, expansion joints, and metal jacketing.

10.2 All materials used must be completely described as to manufacturer and type. The SELLER shall furnish a certificate from the manufacturer confirming compliance with all requirements of Sections 2.0 and 3.0.

10.3 SELLER's procedures must describe how materials will be stored, handled, mixed, and used in accordance with the manufacturer's printed instructions.

10.4 SELLER shall maintain a copy of his procedures properly revised and used by site supervision to control the execution of the work. The procedures and revisions thereof must be submitted for the BUYER's review and authorization to proceed prior to use.

11.0 Inspection

The BUYER reserves the right to inspect the insulation prior to and after jacketing installation. The SELLER shall replace or correct any materials or installations that do not meet the requirements of this specification and reference drawings.

Appendix A
Insulation Thickness Tables

Table A-1

Insulation Thickness for Heat Conservation (HC), Process Stability (PS), Electric Traced (ET), and Steam Traced (ST) Function Codes

Pipe Size (inches)	Normal Operating Temperature of Process Fluid (°F)						
	≤ 140	140-230[1]	231-320	321-410	411-500	501-590	591-680
	Insulation Thickness (inches) [1]						
0.5	1.0	1.0	1.0	1.5	1.5	2.0	2.5
0.75	1.0	1.5	2.0	2.5	2.5	3.0	3.0
1	1.0	1.5	2.0	2.5	2.5	3.0	3.0
1.25	1.0	2.0	2.0	2.5	3.0	3.0	3.0
1.5	1.0	2.0	2.0	2.5	3.0	3.0	3.0
2	1.5	2.0	2.5	2.5	3.0	3.0	4.0
3	1.5	2.5	2.5	3.0	3.0	4.0	4.0
4	1.5	2.5	3.0	3.0	3.0	4.0	4.0
6	1.5	2.5	3.0	4.0	4.0	4.0	4.0
8	1.5	2.5	3.0	4.0	4.0	4.0	4.0
10	1.5	2.5	3.0	4.0	4.0	4.0	4.0
12	1.5	2.5	4.0	4.0	4.0	4.0	4.0
14	2.0	3.0	4.0	4.0	4.0	4.0	4.0
16	2.0	3.0	4.0	4.0	4.0	4.0	4.0
18	2.0	3.0	4.0	4.0	4.0	4.0	4.0
20	2.0	3.0	4.0	4.0	4.0	4.0	4.0
24	2.0	3.0	4.0	4.0	4.0	4.0	6.0
30	1.5	3.0	4.0	4.0	4.0	4.0	6.0
36	1.5	3.0	4.0	4.0	4.0	6.0	6.0
48	1.5	3.0	4.0	4.0	4.0	6.0	6.0
Flat	2.0	4.0	4.0	4.0	6.0	6.0	6.0

[1] HC insulation is not required for normal process fluid temperatures below 70°F (for outdoor or unheated locations) and 100°F (for indoor, heated locations).

Table A-2

Insulation Thickness for Personnel Protection (PP) Function Code

Pipe Size (inches)	Maximum Operating Temperature of Process Fluid (°F)					
	140-230[1]	231-320	321-410	411-500	501-590	591-680
	Insulation Thickness (inches) [1]					
0.5	0.5	0.5	0.5	1.0	1.0	1.5
0.75	1.0	1.0	1.0	1.5	1.5	2.0
1	1.0	1.0	1.0	1.5	1.5	2.0
1.25	1.0	1.0	1.0	1.5	2.0	2.0
1.5	1.0	1.0	1.0	1.5	2.0	2.0
2	1.0	1.0	1.0	1.5	2.0	2.5
3	1.0	1.0	1.5	2.0	2.0	2.5
4	1.0	1.5	1.5	2.0	2.5	3.0
6	1.0	1.5	1.5	2.0	3.0	3.5
8	1.5	1.5	2.0	2.5	3.0	3.5
10	1.5	1.5	2.0	2.5	3.5	4.0
12	1.5	1.5	2.0	2.5	3.5	4.5
14	1.5	1.5	2.0	3.0	3.5	4.5
16	1.5	1.5	2.5	3.0	4.0	5.0
18	1.5	1.5	2.5	3.0	4.0	5.0
20	1.5	1.5	2.5	3.5	4.0	5.0
24	1.5	2.0	2.5	3.5	4.0	5.0
30	1.5	2.0	2.5	3.5	4.5	5.5
36	1.5	2.0	3.0	3.5	4.5	6.0
48	1.5	2.0	3.0	4.0	5.0	6.0
Flat	1.5	2.5	3.5	4.5	6.0	7.5

[1] Insulation thickness is based on maintaining 140°F jacket temperature; for process fluid temperatures below 140°F, insulation is not required for personnel protection (PP).

ATTACHMENT PS02

LAW TCO CUSTOMIZED PS02

Per 24590-WTP-3PS-PS02-T0001, Rev. 10
ENGINEERING SPECIFICATION FOR SHOP FABRICATION OF PIPING
February 2010

This attachment defines the requirements and the work necessary for fabrication of piping subassemblies (pipe spools) in accordance with the requirements of ASME B31.3, Process Piping, other codes and standards, and documents as referenced in this specification. This specification applies to all quality levels as specified by the purchase order. For continuity and maintaining configuration control, the section numbers from the specification noted above have been retained.

1.2 Work Included

1.2.1.14 Perform Positive Material Identification (PMI) on completed fabrication in accordance with specification 24590-WTP-3PS-G000-T0002, *Engineering Specification for Positive Material Identification (PMI) for Shop Fabrication.*

1.4 Codes and Standards

1.4.1 ASME B321.3-1996; *Process Piping,* is the piping code for the WTP Project.

For Q applications, the editions of reference codes, standards and specifications shown in Appendix E of ASME B31.3-1996 listed below, and those listed in 24590-WTP-3PS-PB01-T0001, *Engineering Specification for Technical Supply Conditions for Pipe, Fittings, and Flanges,* are acceptable for use. If the Supplier wants to use a later edition or addenda of a reference code, standard, or specification then the Supplier shall submit an SDDR.

When using ASTM material specifications for commercial material (CM) items, any version more recent than the ASTM version listed in Appendix E of ASME B31.3 1996 is acceptable. An SDDR is not required for these commercial material (CM) item ASTM material specification edition changes.

ASME materials identified in ASME Boiler & Pressure Vessel Code, Section II Material Specifications as being identical to the ASME B31.3, Appendix E listed ASTM Material Specifications, for the year, alloy, type and / or grade, (if applicable), are acceptable for use.

See Specification 24590-WTP-3PS-PB01-T0001, Section 2.1 for ASTM Material Specifications table for acceptable years.

1.4.1.1 The American Society of Mechanical Engineers (ASME)

ASME B16.11-1991; *Forged Fittings, Socket-Welding and Threaded*

ASME B16.25-1986; *Buttwelding Ends*

ASME B16.28-1986; *Wrought Steel Buttwelding Short Radius Elbows and Returns*

ASME B16.36-1988; *Orifice Flanges*

ASME B16.47-1990; *Large Diameter Steel Flanges NPS 26 through NPS 60*

ASME B16.5-1988; *Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inches*

ASME B16.9-1986; *Factory-Made Wrought Buttwelding Fittings*

ASME B36.10M-1985; *Welded and Seamless Wrought Steel Pipe*

ASME B36.19M-1985; *Stainless Steel Pipe*

1.4.1.2 ASME Boiler and Pressure Vessel Code (B & PV)

ASME B & PV Code Section V- latest edition, *Nondestructive Examination*

ASME B & PV Code Section VIII, Division 1, latest edition, *Rules for Construction of Pressure Vessels*

ASME B & PV Code Section IX- latest edition, *Welding and Brazing Qualifications*

1.4.1.3 American Society for Testing and Materials (ASTM) Material Specifications

For ASTM material designations, refer to 24590-WTP-3PS-PB01-T0001, *Engineering Specification for Technical Supply Conditions for Pipe, Fittings, and Flanges*

1.4.1.4 Pipe Fabrication Institute (PFI) Standards

ES-7 - 1962 (R1984), *Minimum Length and Spacing for Welded Nozzles*

1.4.1.5 Manufacturers Standardization Society

MSS SP-25-1978 (R1988), *Standard Marking System for Valves, Fittings, Flanges, and Unions*

MSS SP-83-1987, *Class 3000 Steel Pipe Unions Socket Welding and Threaded*

MSS SP-95-1986 (R1991), *Swaged Nipples and Bull Plugs*

MSS SP-97-1987, *Integrally Reinforced Forged Branch Outlet Fittings*

1.4.2 Other Standards

The following standards are not reference standards of ASME B31.3, 1996, but are acceptable for use to facilitate ASME B31.3 piping fabrication, or are used for pipe fabrication that is not within the scope of ASME B31.3.

1.4.2.1 Pipe Fabrication Institute (PFI) Standards

ES - 3, Fabricating Tolerance

ES - 5, Cleaning of Fabricated Piping

ES - 16, (Deleted)

ES - 24, Pipe Bending Methods, Tolerances, Process, and Material Requirements

ES - 31, Standard for Protection of Ends of Fabricated Piping Assemblies

1.4.2.2 International Association of Plumbing & Mechanical Officials

Uniform Plumbing Code (UPC), 1997 Edition

1.4.3 In case of a conflict between the requirements of the referenced codes, standards, specifications, regulations, and procedures, the Supplier shall submit a recommended resolution to the BUYER via a Supplier Deviation Disposition Request (SDDR) for review and permission to proceed prior to implementation.

1.5 Reference Documents and Drawings

The entire list of documents below may or may not apply in all cases. Refer to the purchase order for a listing of those documents that are applicable.

1.5.1 24590-WTP-3PS-PB01-T0001, *Engineering Specification for Technical Supply Conditions for Pipe, Fittings, and Flanges*

1.5.3 24590-WTP-3PS-NWP0-T0001, *Engineering Specification for General Welding and NDE Requirements for Supplier Fabricated Piping*

1.5.9 24590-WTP-3PS-G000-T0002, *Engineering Specification for Positive Material Identification (PMI) for Shop Fabrication*

1.7 Cleaning and Coating

See Attachment AFPS for additional clarification.

1.7.1 Cleaning

1.7.1.1 Perform cleaning after fabrication has been completed. Cleaned piping shall be free of loose rust or mill scale, blisters, grease, sand, oil, dirt, and other foreign materials.

1.7.1.2 Fabricated spools shall be cleaned in accordance with the standard cleaning method described in PFI-ES-5.

1.7.1.3 Clean austenitic stainless steel, nickel alloy, and titanium piping in a protected area that is free from airborne chloride contamination. Prevent contamination from non-stainless steel, non-nickel alloy or non-titanium particles such as machine chips, grinding dust, weld spatter, and other debris during fabrication by shielding or other suitable means.

1.7.1.4 Only austenitic stainless steel brushes not previously used on other material may be used on austenitic stainless steel piping.

Stainless steel wire brushes that have not been used on other materials shall be used to clean nickel alloy or titanium.

1.7.1.5 Where solvent is required to remove grease or oil from austenitic stainless steel piping, acetone, or alcohol (ethyl, methyl, or isopropyl) shall be used. Alternatively, a detergent flush may be used in lieu of solvent cleaning with prior permission to proceed from BUYER.

- Cleaning solvents used for cleaning titanium materials are methyl alcohol, acetone, or other chlorine-free solvents.
- Titanium weld preparation includes removing any oil, grease, dirt, or grinding dust from surfaces to be joined. Steam cleaning or an alkali dip in a dilute solution of sodium hydroxide can remove most of these contaminants. To remove the last remaining organic compounds just before welding, use a lint-free glove and methyl alcohol, acetone, or other chlorine-free solvent.

1.7.1.6 Final cleaning materials in contact with austenitic stainless steel shall contain less than 200 ppm chlorides. If detergent cleaning is used, rinse austenitic stainless steel with potable water having no more than 100 ppm chloride content. After rinsing, the piping shall be drained out completely such that no standing pockets/puddles of water remain that may later concentrate by evaporation. Removal of excess rinse water may be augmented by swabbing, use of a "squeegee," or air blowing.

1.7.1.7 After cleaning, blow dry the interior surfaces of all piping with clean, filtered, oil-free air.

1.7.3 External Surface Coating

1.7.3.1 Apply external surface coating in accordance with Attachment AFPS, Appendix D, Number 8.20, System Code D.

1.7.3.4 Do not paint the gasket seating surface of flange faces. The gasket seating surface of flange faces shall be cleaned and coated with a one of the following rust preventives:

1.7.3.4.1 Grease (manufacturer's standard)

1.7.3.4.2 Lectra Shield and SP-400, CRC Industries

1.7.3.4.3 Mobilarma 247, Mobil

1.7.3.4.4 Any preservative listed in Attachment AFPS

1.8 Packaging, Storage, Handling, and Protection

Packaging, handling, and storage of pipe spools are as list below. These requirements are based on the applicable requirements listed in Specification 24590-WTP-3PS-G000-T0003.

1.8.1 Sealing Openings

1.8.1.1 Comply with the minimum end protection requirements criteria outlined in PFI-ES-31 to protect all openings and/or as required in the purchase order. The BUYER must provide review and give permission to proceed prior to use of each specific type of desiccant material. Fabrications must be clearly marked indicating desiccant inside.

1.8.1.2 Cover all pipe openings with metal, polyethylene, or nonmetallic end caps, flange protectors, or plugs. Polyethylene or nonmetallic end caps and plugs shall be friction fit, (e.g., Niagara series) or secured by other means. At a minimum, one of the caps or plugs on each spool shall be provided with a 1/8-inch max diameter vent hole to preclude the buildup of internal pressure. Avoid placing the cap or plug with the vent hole on a spool that is oriented in an upward, vertical position. Tape shall not be used to secure end caps or plugs. Clamps used for securing end caps, on stainless steel or alloy spools, shall be made of stainless material.

1.8.2 Marking

1.8.2.3 Any marking material and packing tape used on stainless steel or alloy material is required to be made from low chloride (less than 200 ppm) and low sulfur (less than 400 ppm) type material. The Supplier shall provide a chemical analysis report of the marker/tape for each lot or typical representative sample. The chemical analysis report shall be submitted for BUYER's review and permission to proceed. A copy of the report is not required with each shipment of pipe spools.

2.1.2 Material Traceability

2.1.2.1 Material traceability (such as identification of the item to applicable material specification, heat, batch, lot, part, or serial number or specified inspection, test, or other records) also includes transferring material identification mark(s) prior to subdividing material for all piping material. Traceability is being able to trace the piping material to the applicable MTR. All piping material, regardless of quality level, requires traceability.

2.1.5 Positive Material Identification (PMI)

To ensure material is correctly supplied as specified, the Supplier shall perform Positive Material Identification (PMI) tests in accordance with Specification 24590-WTP-3PS-G000-T0002. The Supplier shall submit their PMI test procedure for BUYER's review and permission to proceed. Note that PMI is not applicable for carbon steel materials and titanium materials. PMI is not to be performed on BUYER furnished valves unless otherwise stated in the purchase order.

2.1.6 Material Commitment

The Supplier shall submit to the BUYER a complete itemized listing of all materials purchased or reserved from the Supplier's inventory for each project. The Supplier shall also provide, upon request, the current status of pre-bought or BUYER-furnished material.

2.1.7 Material Substitutions

All materials shall be in accordance with the BUYER-furnished drawings, the purchase order, and specifications, unless written permission to proceed is granted by the BUYER via the SDDR in accordance with the purchase order requirement.

2.1.8 Material Identification and Marking

2.1.8.1 All materials shall be marked with the information and using marking materials required by the specific ASTM or ASME material specification.

2.1.8.2 Labeling with a marking pen on stainless steel and nickel based alloy material shall be done by any permanent method that will neither result in harmful contamination or sharp discontinuities, nor infringe upon the minimum wall thickness. All marking materials other than material manufacturer's marks shall be of the low chloride (less than 200 ppm) and low sulfur (less than 400 ppm) type. It is acceptable to use a rounded, low stress, vibro-etch tool for this marking.

2.1.8.3 Weld identification symbols must be recorded on detailed spool sheets and extended spool sheets (as applicable) with a cross-reference to any NDE report numbers.

2.1.8.4 Any piece of material not readily identifiable during fabrication shall be rejected, including other components welded thereto.

2.1.8.5 All valves installed by the Supplier shall be tagged after being welded into the pipe spool (this tag is in addition to the tag being furnished with the valve). Each tag shall be stamped (not etched) with the individual "unique" valve identification number specified on the face of the isometric drawing (example, CHW-V-04558). Tags shall be 1/2 in. by 2 in. (min.) rectangle or 1 in. diameter (min.) stainless steel material and securely attached to the valve with 1/32 in. diameter (min.) braided stainless steel wire. Characters shall be 3/16 in. (min.) height.

2.1.9 Damaged Materials

2.1.9.4 The Supplier shall not make any base metal material repairs using welding.

3 Execution

3.1 Fabrication

3.1.2 Weld Joint Preparation

3.1.2.2 Do not use backing rings.

3.1.7 Flanges

Furnish flanges for flanged connections in accordance with the piping material classes and as shown on design drawings.

3.1.7.1 All slip-on flanges shall be double welded in accordance with paragraph 328.5.2 of ASME B31.3 unless directed otherwise by design document(s).

3.1.10 Valves

3.1.10.1 Install all valves in accordance with the manufacturer's recommended instructions and design drawings. BUYER shall furnish valve manufacturer's installation/disassembly instructions for Supplier's use and reference. The Supplier shall notify the BUYER if they have not been sent the applicable valve manufacturer's installation/disassembly instructions.

3.1.10.2 In addition to manufacturer's instructions, the following apply for valve installation:

3.1.10.2.1 Valve stems shall be positioned in accordance with the isometric and is normally not be inclined below the horizontal. Also, flow arrows, when present on the valve, must align with the flow arrow shown on the isometric.

3.1.10.2.2 Before conducting any welding on diaphragm valves or other soft-seated valves, the bonnet assembly and diaphragm, and any other heat-sensitive components shall be disassembled and valve body cooled, if required by vendor instructions. Particularly for stainless steel valves, care shall be exercised to ensure that contact with cooling medium (e.g., water-soaked wick) is not harmful. Water used for cooling of stainless steel valves shall have a maximum chloride content of 200 ppm.

3.1.10.2.3 To prevent damage or distortion to valve seat and disc, follow the vendor's instructions with respect to position of the valve stem and the disc during installation and welding.

3.1.10.2.4 If disassembly beyond the vendor's standard installation instruction is required, valves and actuators shall be disassembled and reassembled only after documented concurrence has been obtained from the BUYER that doing so will not compromise the warranty and performance of the valve.

3.1.10.2.5 Manual valves shall be disassembled and reassembled, if required, in accordance with the manufacturer's disassembly and reassembly procedures.

3.1.10.2.6 Valves shall be handled and supported with care to preclude damage to handwheels and appurtenances. Lifting lugs shall be used whenever they are provided on a valve. In no case shall a valve be picked up by the valve actuator.

3.1.11 Rework of Fabricated Spools

3.1.11.1 Reworked spools being shipped to the jobsite shall be provided with a Certificate of Conformance (C of C) stating the spools identified are the same spool number(s) originally delivered and received. The C of C shall state that the re-worked spools are in strict accordance and fully comply with the purchase order and all procedures and specifications. The C of C shall also state the re-work performed on each spool.

If additional materials are added, or if additional documentation is provided (NDE reports, MTRs, etc.) a complete documentation package for that spool shall be furnished.

3.2 Inspection and Testing

3.2.1 General

3.2.1.1 The Supplier is responsible for nondestructive examination and testing of piping furnished under this specification.

3.2.1.2 All examination, inspection, and testing shall be in accordance with this specification and other governing codes and standards, as applicable. This includes nondestructive examination of the piping spools in accordance with the requirements for Normal Fluid Service piping in ASME B31.3-96.

3.2.1.3 BUYER's representative shall be provided free access to the Supplier's and Supplier's subcontractor's or Supplier's facilities, to witness, inspect, and report progress of work.

3.2.1.4 Note: No sub-supplier shall perform NDE work without prior submittal of the sub-supplier's NDE procedure and BUYER's review and permission to proceed.

3.2.2 Examination of Fabrication Welds

3.2.2.1 Examine all completed pressure boundary welds in accordance with the ASME B31.3-96 and/or standard, including the requirements listed below, as applicable. Weld repair shall be examined according to the requirements used for the original weld.

3.2.2.2 Perform and evaluate examinations in accordance with procedures and acceptance standards prepared in accordance with the ASME B31.3-96 and/or standard, and the *ASME Boiler & Pressure Vessel Code*, Section V.

Summary Table of Non-Destructive Examinations (NDE) of Pipe & Tubing Shop Welds

Table 2 Piping Weld Examination Requirements

See sections 3.2.2.2 for applicable shop weld NDE, inspection, and acceptance criteria requirements.

Type of Weld	Piping Outside Black Cells and Hard-To-Reach areas
All Girth and Miter Welds	100% VT 5% RT or 5% UT
All Pipe and Integral Attachment Fillet Shop Welds - including thermowell socket welds, integral support welds, non pressure & non load bearing piping attachment welds	100% VT
All integrally reinforced forged branch fittings welded to main piping run.	100% VT

Legend: VT = Visual Examination per ASME B31.3 para 344.2
RT = Radiographic Examination per ASME B31.3 para 344.5
UT = Ultrasonic Examination per ASME B31.3 para 344.6
PT = Liquid Penetrant Examination per ASME B31.3 para 344.4
MT = Magnetic Particle Examination per ASME B31.3 para 344.3

ATTACHMENT AFPS

LAW TCO CUSTOMIZED AFPS

Per 24590-WTP-3PS-AFPS-T0001, Rev. 4

ENGINEERING SPECIFICATION FOR SHOP APPLIED SPECIAL PROTECTIVE COATINGS FOR STEEL ITEMS AND EQUIPMENT

February 2010

Only the sections and appendices contained in this Attachment AFPS apply to the LAW Thermal Catalytic Oxidizer/Reducer (TCO). For continuity and maintaining configuration control, the section numbers from the AFPS specification noted above have been retained. Additional clarifications have been added to Sections 1.1 and 6.4.1, identified by an asterisk.

1 Scope

1.1 This specification defines the minimum requirements for Special Protective Coating (SPC) materials/coating systems, surface preparation, application, and inspection of protective coatings to be shop applied. Items and surfaces to be coated shall be coated in accordance with Appendix D of this specification. Unless indicated otherwise in the base technical specification/material requisition or purchase order, all coats will be shop applied. Finish color shall be *ANSI 70 Gray unless indicated otherwise in Section 2.0 of the Material Requisition (MR).

1.2 All Special Protective Coatings (SPC's) are designated as Commercial Grade (CM) and non-safety.

2 General

2.1 Responsibility

2.1.1 The SELLER shall supply all personnel, coating materials and all necessary surface preparation, application, inspection and other equipment as required.

2.1.2 The SELLER shall unload, inspect, and store all inbound steel items and equipment scheduled for coating when manufactured by others. Items found to be damaged or otherwise unsuitable for coating shall be identified and segregated for evaluation by the SELLER.

2.1.3 The SELLER shall store all coating materials, perform surface preparation, coating application and inspection in accordance with this specification and Buyer reviewed procedures. The coating systems and associated coating materials used shall be in accordance with Appendix D Coating Schedule or the Material Requisition (MR) when coatings are specifically identified.

2.1.4 The SELLER shall perform all inspections and tests contained in this specification as necessary prior to verification by the BUYER.

2.1.5 The SELLER shall provide application and inspection documentation for all coating Work in accordance with this specification.

2.1.6 The SELLER shall provide environmental control equipment as necessary for coating application and curing.

2.1.7 The SELLER shall provide erection marking. Marks for color-coding of bulk materials and erection marking shall be fully compatible with the coating system specified.

2.1.8 The SELLER shall touch-up and repair defective or damaged coating in accordance with procedures submitted and reviewed by the BUYER.

2.1.9 The SELLER shall protect all coated surfaces prior to shipment and provide suitable coverings, padding and strapping to protect coated items during shipment.

2.1.10 The SELLER shall only use inspection equipment that is currently (in date) calibrated.

2.2 Surfaces Not To Be Coated

2.2.1 Hold back coating from weld areas-

2.2.1.2 Three (3) to Four (4) inches for **shop** welds when using epoxy or other types of organic coatings

2.2.1.4 Note - The above coating hold back dimensions are only for items previously coated prior to welding. These coating hold back dimensions do not apply to shop welds that will be coated after welding is completed. This Section of the shop coating spec does not have anything to do with coating cold back requirements associated with visual inspection of welds during hydro testing. Coating hold back requirements associated with weld inspection must come from the prevailing code.

2.2.1.6 The coating hold back shall be sufficient to expose the entire shop weld for visual inspection on items fabricated prior to coating.

2.2.2 Name and instruction plates, etc.

2.2.3 Rubber or similar nonmetallic parts.

2.2.4 Machined surfaces.

2.2.5 Non-Ferrous metals unless otherwise specified.

2.2.6 Stainless Steel surfaces, unless specifically required by the BUYER (areas where stainless steel is welded to carbon steel the coating overlap onto the stainless steel shall be approximately 1" or as otherwise specified.)

2.3 Definitions

2.3.1 Batch- A quantity of coating made in one production run. A unique batch number is assigned for each production run of the coating material, curing agent, zinc powders, fillers and thinner.

2.3.3 Dry Film Thickness (DFT)- The thickness of an applied coating, once dry or cured. Usually expressed in mils (each mil is 1/1000 of an inch).

2.3.4 Fish Eyes (cratering)- Formation of holes or visible depression in the coating film. Usually from a contaminated particle on the surface prior to applying the coating.

2.3.5 Holiday- A Pinhole, skip, discontinuity, or void in the applied coating film.

2.3.7 Mfg. Std. Coating- A manufacturers standard coatings system applied to off the shelf items or standard line items of routine manufacture that are not specifically manufactured for the WTP project.

2.3.8 NIST- National Institute of Standards and Technology.

2.3.10 Pinholes- Minute holes visible in the applied coating without magnification that appears to penetrate one or more layers of the coating film.

2.3.11 Profile- The surface roughness resulting from surface preparation by abrasive blasting or other authorized methods. (Refer to Section -7.3.6).

2.3.13 Sag- The running of freshly applied coating on a vertical surface due to being applied too thick. (Same definition for runs and drips)

2.3.16 Training and Certification- Training shall include an understanding of the specification, work procedures and manufacturers published instructions. Certification shall include a documented performance test demonstrating quality work verifiable by the BUYER. (Refer to Sections 4.8, 5.1.7, 7.1.2, and 8.1.1.1)

2.4 Safety

2.4.2 The SELLER shall comply fully with OSHA Hazard Communication Standard 29CFR 1910. Material Safety Data Sheets (MSDS) for all materials, including thinners and cleaning solvents, shall be obtained from the materials manufacturer and upon request made available, at the place and time of Work, for review.

2.4.3 The Volatile Organic Compound (VOC) content of all materials shall comply with Federal, State and Local or other Regulatory requirements.

3 Applicable Documents

3.1 Codes and Standards

The latest applicable edition of the following codes, standards, specifications or WTP procedures form a part of this specification.

3.1.1 American Society for Testing and Materials (ASTM)

ASTM E337- R96; 02	Test for Relative Humidity by Wet-and-Dry Bulb Psychrometer
ASTM D3276- 00; 05	Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D4285- 99	Test Method for Indicating Oil or Water in Compressed Air
ASTM D4417- 99; 03	Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4537- 96; 04; 04a	Standard Guide for Establishing Procedures to Qualify and Certify Inspection Personnel for Coating Work Inspectors in Nuclear Facilities.
ASTM D4940- 98; 03	Test for Conductimetric Analysis of Water Soluble Ionic Contaminants of Blasting Abrasives
ASTM D5064-01	Standard Practice for Conducting a Patch Test to Assess Coating Compatibility

3.1.2 The Society for Protective Coatings (SSPC)

SSPC-AB1 6/1/97;7/1/07	Mineral Slag Abrasive
SSPC-PA2 5/1/04	Measurement of Dry Paint Thickness with Magnetic Gages
SSPC-SP1 11/1/82;11/1/04	Solvent Cleaning
SSPC-SP10 11/1/04	Near White Metal Blast Cleaning
SSPC-SP11 11/1/87; 11/1/04	Power Tool Cleaning to Bare Metal
SSPC-VIS 1 6/1/02; 11/1/04	Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

3.1.3 Occupational Safety and Health Administration (OSHA)

OSHA 29 CFR 1910	Occupational Safety and Health Standards

4 Submittals

4.1 SELLER shall prepare detailed written procedures for material receiving, marking, storage, handling, surface preparation, environmental control, application, curing, inspection, testing, touch-up/repair, application personnel qualification, inspector qualification, (G321- E , category 28.0) and proposed documentation forms as described within this specification. The final procedure and documentation forms shall be submitted and

reviewed with BUYER's permission to proceed prior to the start of coating Work. (G321-E category 15.0). Submittal requirements for manufacturers standard coating are found in Section 6.0.

4.2 The SELLER shall submit all procedures and verification documents in accordance with the purchase order (e.g., Appendix J, Form G-321-E. & V, Exhibit "D" located in the purchase order.).

4.4 The SELLER shall identify the specific products by manufacturer and catalog number and shall submit the coating manufacturer's latest published product data sheet, application instructions and Material Safety Data Sheets (MSDS). Conflicts, if any, between the SELLER's normal procedures, the coating manufacturer's recommendations, and this specification shall be brought to the attention of the BUYER for resolution and written permission to proceed. (G321-E category 11.0)

4.5 The SELLER shall submit original or copies of original Coating Manufacturer's Product Identity Certification Records for each and every batch of coating material used on the WTP project (Appendix F). (Refer to G321V category 13.0)

4.6 The SELLER shall submit a daily inspection record as part of the Work procedures that includes all the elements provided in Appendix G as a minimum. An entry for Wet Bulb is not required when the accepted device used to measure humidity and dew point does not require a wet bulb. (Refer to Section 8.1.9 and 10.2) (G321V category 15.0)

4.8 The SELLER shall provide a personnel training and certification plan for applicators and inspectors. (Refer to Section 2.3.16, 5.1.7, 7.1.2 and 8.1.1.1.).

5 Quality Plan

5.1 General

5.1.1 The SELLER shall control the quality of items and services to meet the requirements of this specification, applicable codes and standards, associated procurement documents, referenced herein. The SELLER shall prepare and maintain documentation to provide evidence of compliance with reviewed procedures and this specification. A copy of the coating inspection documentation shall be included in the shipping documentation.

5.1.2 The SELLER, including any lower-tier organizations engaged by him, shall be subject to surveillance inspection by the BUYER representative until completion or termination of the procurement. This surveillance inspection does not relieve the SELLER from the responsibility for conformance to the requirements of procurement documents, this specification and authorized procedures.

5.1.4 The BUYER representative shall be provided with a work activity schedule and shall be notified of all required inspection points prior to the scheduled date for coating activities (Refer to MR Section 5.0).

5.1.5 If the SELLER's proposed Work plan or procedures differ from the requirements of this specification, the SELLER shall specifically identify and explain all differences in writing and submit them to the BUYER for review and verification prior to the start of Work (e.g., Supplier Deviation Disposition Request-SDDR).

5.1.6 All pre-established witness and hold points shall be witnessed by the BUYER unless a written waiver has been issued.

5.1.7 The SELLER's coating inspectors shall have previous experience in coating inspection and shall receive documented training in the specific project coating requirements, ASTM standards and other relevant standards including the reviewed work procedures. All coating inspectors working on steel items or equipment shall be trained and qualified meeting the requirements of Section 8.1.1.1.

6 Materials

6.1 Coating Materials

6.1.2 Coating materials including the primer, intermediate and finish coat on a given item, shall all be from the same manufacturer. One exception to this rule is when upgrading a Manufacturer's Standard (Mfg. Std.) coating using a compatible epoxy tie-coat and suitable topcoat coating system (refer to Section 6.2).

6.1.3 Appendix D Coating Schedule and Appendix C Tables contain the specified Special Protective Coatings for the WTP project. Appendix C contains the generic coating systems and approved coating materials.

6.1.4 Repair materials shall be the same as those originally used. Repair materials shall be in pre-measured units, and only complete kits shall be mixed. Splitting or breaking down pre-measured units of multi-component coating materials may be considered if the SELLER prepares a procedure that requires accurate measurement of all materials and Seller's QC inspector monitoring/verification of each and every mix. This procedure must be submitted to the BUYER for review and permission to proceed.

6.2 Manufacturer's Standard Coating

6.2.1 Components and equipment which are normally mass-produced, inventoried, and supplied from stock generally have been coated with the Manufacturer's Standard Coating (Mfg. Std.) system. Included are small valves, pumps and rotating equipment, filters and electrical equipment such as switchgear, control panels, instrumentation, motors, transformers and electrical enclosures. Items and equipment which are specifically fabricated for the WTP project shall be coated per this specification unless the item is shown to be too delicate to properly coat per Appendix D or the specific requirements contained in the MR.

6.2.1.1 The SELLER may submit an alternate coating to the specified or Mfg. Std. System, by identifying the coating materials, surface preparation, application and inspection on Appendix H including the coating material's latest published technical data sheet and MSDS, to the BUYER for review and permission to proceed.

6.2.1.2 All Mfg. Std. coatings must be identified on an Appendix H and submitted to the BUYER along with technical data sheets and MSDS'. A small, easily replaceable item where coating touch-up is not practical (e.g., very small, too delicate, low cost and easily replaceable) and can only be purchased with the manufacturer's standard coating, an Appendix H Manufacturer's Standard Coating Data Sheet is not required.

6.3 Machined-Surfaces Coating

6.3.1 Machined surfaces not specified to be coated with a specific coating system shall be protected with a solvent cutback asphalt temporary preservative (Daubert Chemical Tectyl 891, EF Houghton Chemical Rust Veto 342 or authorized equivalent). Temporary preservative applied to carbon steel that is overlapped onto stainless steel must meet the same chemical requirements as listed in Section 6.4. All equivalents must be identified on an Appendix H form and submitted along with the manufacturer's latest published data sheet and MSDS for review and permission to proceed by the BUYER.

6.4 Coating Over Stainless Steel

6.4.1 All coating materials, thinners, solvents and cleaning materials used on SS shall be shown to comply with the following requirements:

Leachable halogen content shall not exceed 200 ppm

The total sulfur content shall not exceed 400 ppm

The total of low melting point metals such as lead, zinc, copper, tin, antimony and mercury shall not exceed one (1) percent. Of this, mercury should not exceed 50 ppm. These low melting metals shall not be intentionally added during the manufacture of the coating.

* (ADDED for LAW TCO MR): Sherwin Williams Macropoxy 646 and Carboline Carboguard 890 have been tested and meet the requirements above. Only these materials are approved for direct contact with stainless steel.

6.5 Batch Information

6.5.1 Each container of coating material used by the SELLER shall be marked with the following:

- The manufacturer's name
- The product designation
- Batch or lot number
- Location and date of manufacture
- The shelf life expiration date

6.6 Abrasives

6.6.1 Abrasives for blast cleaning shall be clean, free of oil or contaminants, and dry. The particle size shall be capable of producing the specified surface profile. Mineral and slag abrasives shall meet the requirements of SSPC AB-1. The first batch/lot of bulk, non-packaged, abrasives shall be tested for water-soluble contaminants and the conductivity shall not exceed 500 micro siemens/cm when tested in accordance with ASTM D4940. As an alternate, a chloride ion test kit, such as the Chlor*Test "A" manufactures by Chlor Rid International Inc, or BUYER accepted equal may be used. The maximum allowable chloride level is 200ppm.

6.6.2 When using reclaimed steel grit/shot abrasive, the particle size shall be capable of producing the specified angular surface profile (minimum 50% steel grit in original mix and all adds shall be 100% steel grit). Reclaimed abrasives already in use and the first batch/lot of new abrasive shall be tested for water-soluble contaminants and conductivity. Conductivity shall not exceed 500 micro siemens/cm when tested in accordance with ASTM D 4940. As an alternate, a chloride ion test kit, such as the Chlor*Test "A" manufactures by Chlor Rid International Inc, or BUYER accepted equal may be used. The maximum allowable chloride level is 200ppm.

7 Application

7.1 General

7.1.1 It shall be the SELLER's responsibility to stop the surface preparation and coating at any time when conditions exist that might adversely affect the quality. The BUYER representative may reject any prepared or coated surfaces not in compliance with this specification.

7.1.2 All painters (e.g., surface preparation personnel and paint/coating material application personnel), shall be individually qualified and certified in accordance with the SELLER's written description that includes classroom training and capability demonstration using the WTP project specification, and the SELLER's procedures as reviewed by the BUYER.

7.1.3 Care shall be taken to avoid blasting or grinding away critical markings, which identify welders, joint numbers, or other markings, which identify the item. Where such data appears in the area to be coated, it shall be protected. SELLER's are responsible for assuring their sub-suppliers are instructed concerning these requirements.

7.2 Pre-Surface Preparation

7.2.1 Prior to mechanical cleaning, the surfaces to be coated shall be cleaned in accordance with SSPC SP1 to remove oil, grease, dirt, and other foreign matter that can interfere with the proper bonding of the coating. Any remaining sharp edges, weld spatter, or burrs found after the start of coating Work shall be completely removed by grinding or other means. Pneumatic tools shall not be used unless they are fitted with effective oil and water traps on the exhaust air. If the steel items or equipment was shipped or stored

so that the surface could have been contaminated with soluble salts (e.g., above deck ship transport, truck transport on dirt roads close to ocean, storage), the area shall be pressure water washed (2,000-5000psi) with demineralized water to remove as much soluble salt contamination as possible prior to abrasive blasting.

7.3 Surface Preparation

7.3.1 Prior to the start of Work, the SELLER shall examine all surfaces to be coated to determine their acceptability for the specified coating application. If the surfaces are found to be unacceptable, the SELLER shall return the surface to an acceptable condition. Coating work shall not commence until corrective action has been taken. Commencement of coating work prior to the taking of correctable action shall preclude any subsequent claim by the SELLER. The BUYER may require corrective action at the SELLER's expense.

7.3.2 Prior to blast cleaning items to be coated, they shall be visibly dry with the surface temperature of at least 5°F above the dew point. When using automatic blasting equipment that recycles steel abrasive, the steel need only be visibly dry.

7.3.3 All surfaces to be coated shall be pre-cleaned per SSPC SP 1 where oil, grease, and other contaminants are present.

7.3.4 Abrasives shall meet the requirements of Section 6.6.

7.3.5 Surfaces to be coated shall be blast cleaned in accordance with the surface preparation requirements specified in Appendix D (e.g., SSPC SP10). Where abrasive blasting will damage the items or is impractical, SSPC-SP11 Power Tool Cleaning to bare Metal may be substituted only in limited areas and only with BUYER's permission to proceed (e.g. SDDR).

7.3.6 Abrasive blasting carbon steel shall result in an angular surface profile 1.5 to 3.0 mils deep as measured using a profile comparator or Testex Press-O-Film replication tape, in accordance with ASTM D4417 method A or C.

7.3.6.1 Methods established for measuring surface profile produced by abrasive blast cleaning are not valid or conclusive on surfaces that are excessively rough prior to blast cleaning (e.g. rough mill finishes, heavy rusting or pitting [SSPC-VIS 1 Condition D or rougher], cast surfaces, weld beads or physically damaged surfaces). Therefore, to accurately determine the surface profile produced by blast cleaning, profile measurements shall be taken in areas exhibiting the least surface roughness. For example, SSPC-VIS 1 pre-blast Conditions A, B or C typically result in a blasted surface that is acceptable for surface profile measurement.

7.3.6.2 If excessive surface roughness covers the entire item, then a smooth, clean ASTM A36 steel plate (e.g., SSPC-VIS 1 Condition A, B or C), approximately 6" square and at least 1/4" thick, shall be blasted using the identical abrasive, pressure, nozzle, blasting equipment and method used on the actual item. The surface profile measured on the smooth plate is regarded as an accurate measurement of the profile produced by that blasting method, and shall be recorded as the surface profile for the actual item. A new plate shall be blasted and measured at a frequency accepted in the SELLER'S procedures (refer to Section 8.1.9).

7.3.7 Recycled abrasive blasting using a steel grit/shot mix is acceptable. The maximum amount of shot in the original mix shall be 50%. All additions of abrasive shall be steel grit. The stabilized working mix shall be maintained by frequent small additions of new grit abrasive commensurate with consumption. Infrequent large additions of grit shall be avoided. Steel grit or shot is not acceptable for use on stainless steel surfaces.

7.3.7.1 The working abrasive mix shall be maintained clean of contaminants by continuous effective operations of cleaning machine scalping and air wash separators. Reclaimed grit used for abrasive cleaning shall be tested for the presence of oil/grease by immersing a sample in clean tap water and checking for oil flotation. Tests shall be made at the start of blasting and at a minimum of every

four (4) hours thereafter. If oil is evident, the contaminated abrasive shall be cleaned or replaced. All surfaces blasted since the last successful test shall be completely cleaned of contamination then re-blasted using clean abrasive.

7.3.8 Blast cleaning shall not be performed in the immediate area where coating or curing of coated surfaces is in progress. All surfaces and equipment, which are not to be coated, shall be suitably protected from blast cleaning.

7.3.9 Burrs, slivers, scabs, lamination, and weld spatter which become visible after blasting shall be removed. The tools and manner employed to remove weld defects and sharp edges shall not burnish or destroy the profile. If the profile or roughness is reduced, it shall be re-blasted to produce the profile and roughness as required. The exhaust of pneumatic grinders shall not impinge on the cleaned surface. If the surface becomes contaminated, it shall be cleaned of contamination and re- blasted. Carbon steel tools or implements specifically employed for coating surface preparation shall not be used on stainless steel surfaces.

7.3.10 If visible rust occurs or if the cleaned surface becomes wet or otherwise contaminated, these surfaces shall be re-cleaned to the degree specified. Cleaned surfaces remaining uncoated overnight shall be visually reinspected 100% for required cleanliness prior to coating or shall be re-cleaned to the specified cleanliness prior to applying the coating.

7.3.11 After surface preparation is complete and before coating, pressurized air or a vacuum shall be used to remove all dust and abrasive residue. The air shall be clean and dry as verified in accordance with Section 8.1.6 so as not to contaminate the prepared surface.

7.3.12 Machined surfaces shall be wiped with clean solvent before the application of coating and shall be protected from damage due to blasting and coating operations.

7.3.13 Machined portions of pipe flanges and other machined mating faces which will not be exposed after final fit-up shall be masked or covered and protected from surface preparation and coating activities. The remaining part of the flange face and exposed surfaces shall then be blasted and coated (bolt holes need only to be sufficiently coated for visible coverage. No dry film thickness required.).

7.3.14 Equipment shall have all openings plugged, masked, and/or blinded sufficiently to protect internals before abrasive blasting. After the coating operation is complete all internals shall be blown clean and/or vacuumed to remove any dust or abrasive blast media that may have entered the coated equipment.

7.3.15 The abrasive mixture and the compressed air shall be clean, dry and oil free. Moisture traps, in addition to oil and water extractors mounted on the compressor, shall be used in compressed air lines to remove oil and moisture from air close to the point of use. (Refer to Section 7.3.7.1 and 8.1.6)

7.3.16 All valves, valve actuators and motors that will be shop coated shall be blasted and coated prior to assembly. Areas of assembled items that are not coated prior to assembly and subject to damage during blasting must be carefully protected from abrasive damage or abrasive contamination.

7.4 Coating Application

7.4.1 The coating shall be applied in accordance with reviewed procedures (refer to Section 4.1). The coating manufacturer's recommendations for the application temperature and the curing temperature and times (between coats and after last coat) of the specified material shall become a part of this specification. Application and curing temperatures above or below the limits allowed by this specification (Refer to Section 7.4.4) shall be submitted to the BUYER for review (e.g., SDDR).

7.4.2 Coatings shall be applied using properly sized and type of equipment for the size & complexity of the item being coated. The equipment shall be clean with all components in good working order.

7.4.3 Surfaces that will become inaccessible shall be coated before assembly, tagging, fitting, or welding. Inaccessible surfaces includes lap joint flanges, nozzle necks, lap joint stub ends, lap rings, bolt holes, flanges for exchangers and vessels, and welded joints that become inaccessible after assembly.

7.4.4 Coatings shall be applied only when the surface to be coated is clean and dry. The substrate temperature shall be a minimum of 5°F above the dew point during coating application and until the applied coating is no longer moisture sensitive per the coating manufacturer's published data or written recommendations. The substrate and air temperature during coating application and curing shall be a minimum of 50°F (Inorganic zinc primers 40°F) and a maximum of 110°F. The relative humidity during coating application shall not exceed 85 percent. Measure humidity in accordance with ASTM E 337 (Sections 1.0-19.0) or using an alternate method reviewed and accepted by the BUYER. Deviations from the above listed minimum and maximum substrate/air temperature and humidity limits may be allowed when in accordance with the coating manufacturer's published or written recommendations and are accepted by the BUYER. The one firm limit is that the minimum substrate or air temperature shall not be less than 35 °F regardless of the coating manufacturer's published or written recommendations.

7.4.5 The SELLER shall record all batch numbers for each coating component used along with other information necessary for the BUYER to relate the batch to the item for which it was applied. (Refer to Appendix G)

7.4.6 All coatings shall be thoroughly mixed until they are smooth and free from lumps, then strained through a screen of at least 30 mesh. Zinc filled coatings shall be continuously agitated from the time initially mixed and while being applied. Other coating materials shall be mixed in accordance with the coating manufacturer's published recommendations. All multi-component coating materials shall be in pre-measured units. Splitting or breaking down pre-measured units is not permitted. See Section 6.1.4 for requirements for mixing repair materials.

7.4.7 Alternating coats shall have a visible color difference to insure full coverage over previous coats. Touch-up of individual small spots < 6 sq. in, do not require a visible color difference when individually marked for repair and the mark remains in place until the repair is accepted.

7.4.8 Dry film thickness of each coating shall be in accordance with Appendix C/Table 1 Acceptable Coating Materials or as specified in the MR. (Refer to Section 8.3.2 & 8.3.3).

7.4.9 Relative to the ambient and surface temperatures the minimum and maximum drying times between coats shall be in strict accordance with the coating manufacturer's latest published technical data sheets.

7.4.10 Runs, sags, voids, drips, overspray, loss of adhesion, bubbling, peeling, or inadequate cure are not permitted. Where possible, defects shall be corrected as detected during application of the coating.

7.4.11 Spray equipment, brushes and rollers shall be cleaned using only manufacturer recommended solvents/cleaners.

7.5 Remedial Work

7.5.1 The completed coating on each item shall have the correct dry film thickness and shall be free of damage and visible defects.

7.5.2 Repair of Dry Film Thickness (DFT) deficiencies

7.5.2.1 Defects such as runs, sags, overspray and embedded particles shall be corrected by sanding to remove the defect. When the defects are in the finish coat, all areas sanded must be overcoated with the finish coat. If the DFT of primer or intermediate coat is reduced to less than the specified minimum, the area shall be abraded with 80 grit sand paper or flapper wheel and an additional layer of coating shall be applied until sufficient thickness is achieved. If noticed during application, the sags or runs may be brushed out.

7.5.3 Repair of Damage

7.5.3.1 All damaged and loosely adhering coating shall be removed and the surface thoroughly cleaned using 80 grit sanding disc, 80-grit flapper wheel or 3M Clean-N-Strip. Edges of the breaks shall be

feathered and the resulting surfaces shall be roughened. The designated number of prime and finish coats shall be applied.

7.5.4 Loss of adhesion, delamination blisters, bubbling and fish eyes in the applied coating require the coating to be removed and reapplied in accordance with this specification.

8 Inspection

8.1 General

8.1.1 The SELLER shall have the full responsibility for the coating application quality in accordance with this specification and shall be responsible for stopping Work activities when conditions develop that could adversely affect the quality of the completed work. All Work is subject to the BUYER's inspection surveillance.

8.1.1.1 All coating Work inspection personnel shall be trained, qualified and certified in accordance with the SELLER's reviewed procedures. The inspectors shall meet or exceed the minimum capability requirements for a Level I coatings inspector as described in ASTM D4537 Section 6.2. The SELLER's inspector training, qualification and certification procedures and plan shall include classroom training on the WTP project specification, and the SELLER's reviewed procedures using the guidelines provided in ASTM D5498. The SELLER's inspector must demonstrate his/her capability of using the inspection equipment and performing all the required inspections. Additional coating work inspection guidance is found in ASTM D3276 and ASTM D6237 which may also be used in developing procedures for training and certifying coating work inspectors.

8.1.2 The BUYER representative shall be the final authority on the specification compliance for surface preparation and material application. Any coating, which in the BUYER representative's judgment, has not been applied in conformance with this specification, shall be rejected.

8.1.3 The BUYER representative shall have access to each part of the process and shall have the right and opportunity to witness any of the Quality Control Tests.

8.1.4 The SELLER shall furnish the necessary testing and inspection instruments, properly calibrated and maintained. If equipment is suspected of being out of calibration, it shall be re-calibrated and certificates made available for verification to the BUYER. Such equipment shall be available for use by the BUYER in conducting surveillance of the work. Calibration of testing and Inspection instruments shall be traceable to NIST or Buyer authorized alternative standards.

8.1.5 The SELLER shall halt the coating Work and make corrections to the procedures, as necessary to correct repetitive faults found in the Work.

8.1.6 Prior to using compressed air, the quality of the air downstream of the separator shall be tested in accordance with the requirements of ASTM D4285 by blowing the air onto a clean white blotter or cloth for two (2) minutes at a distance of no more than (12) inches to check for any contamination, oil, or moisture. "This test shall be performed at the start of work and every 4 hours thereafter". The test shall also be made after any interruption of the air compressor operation or as required by the BUYER. The air shall be used only if the test indicates no visible contamination, oil, or moisture. If contaminants are evident, the equipment deficiencies shall be corrected and the air stream shall be re-tested. Moisture separators shall be bled continuously. All lines shall be tested individually prior to use. Surfaces determined to have been blown down or blasted with contaminated air shall be cleaned of all contamination then re-blasted with clean air and abrasive. Coatings determined to have been applied using contaminated air shall be removed and reapplied using clean air.

8.1.7 Inspection points shall be established as follows:

- Prior to the start of Work.
- Immediately following the surface preparation

- Immediately prior to the coating application
- Following the application of each coat
- Following the curing of the coating
- Final inspection and sign-off, in accordance with the project requirements

8.1.8 Any defects disclosed by inspection shall be re-inspected after correction.

8.1.9 The SELLER shall keep the records indicated below, and submit these records to the BUYER (refer to Section 4.6 and Appendix G). The following lists the frequencies:

Coating/Inspection Step		Required Frequency
1.	Pre-Surface Prep Surface Preparation Profile	100% visual on Pre- Surface 100% on Surface Prep/Cleanliness Profile first item of each type per shift and every 20 items thereafter or other frequency as BUYER accepted in SELLER's procedures.
2.	Environmental/Air Quality	At the start of each work and every 4 hours thereafter or more often during changing conditions.
3.	Recirculated Abrasive	At the start of work and every 4 hours thereafter
4.	Thickness Per SSPC PA2	On large items five (5) spot reading per 100 sq.ft. On items < 100 sq.ft. four (4) spot readings On items less than 4" (valves, fittings, components, etc) two (2) spot readings, For repair spots < 6 sq. inches and > 1 sq. inch. Two (2) spot readings For repair spots < 1 sq. inch one (1) spot reading For small chips/nicks/scratches and pinhole size repair spots need only a visual. For complex surfaces such as structural steel (steel beams) the frequency of dry film thickness readings shall be in accordance with SSPC-PA2 Appendix 3 section A3.4.1 excluding any readings on the flange toes. In accordance with figure A.3 "The Surface of a Steel Beam" the following locations are acceptable for the test readings- 1, 3, 4, 5, 7, 9, 10 and 11; and the following locations are excluded from test readings- 2, 6, 8, 12. For beams less than 20'-0" two (2) sets of 8 spot readings shall be taken. For beams 20'-0" thru 60'-0" three (3) sets of 8 spot readings shall be taken.
5.	Visual on Applied Coating.	100% of all items

8.2 Surface Preparation Inspection

8.2.1 Verify environmental conditions and compressed air quality (refer to Section 7.3.2, 8.1.6).

8.2.2 Verify recirculated grit is grease and oil free (refer to Section 7.3.7).

8.2.3 Verify surface cleanliness and profile (refer to Sections 7.3.5, 7.3.6 and 8.1.9).

8.2.4 Grease free chalk shall be used to mark local areas, which do not meet the specified requirements (e.g., soapstone and crayons are not acceptable).

8.3 Coating Application

8.3.1 Environmental conditions and compressed air quality shall be verified per Sections 7.3.2, 7.4.4, 8.1.6 and 8.1.9.

8.3.2 Dry coating thickness (DFT) shall be measured with a magnetic film thickness gage such as an Elektro-Physik "Mikrotest" or Positector 2000, Positector 6000 or BUYER authorized equal in accordance with SSPC PA2. The number and location of dry film thickness readings shall be in accordance with section 8.1.9.4.

8.3.2.1 The gage shall have an appropriate range that is suitable to measure the thickness expected and record calibration accuracy in accordance with SSPC PA 2 at the start of work, against certified coating thickness calibration standards for non-magnetic coating of steel, traceable to NIST or BUYER authorized alternative standards. The calibration standards shall be in date, and 1.5 mil to 20.0 mil range, unless otherwise specified.

8.3.3 Any surface with a measured thickness outside of the limits described in Section 7.4.8 shall be rejected. These areas shall be reworked or re-cleaned and re-coated at the SELLER's expense. The average of the required number of readings shall be within the specified dry film thickness range. Any of the required spot readings may be as low as 80% of the minimum specified or 120% of the maximum specified as long as the average of all the readings is within the specified range. An individual spot reading that conforms to this criteria conforms to the specified dry film thickness.

9 Storage, Handling and Shipping

9.1 Coating Materials

9.1.1 Coating materials shall not be stored in direct sunlight or exposed to inclement weather (e.g. rain, snow, sleet, freezing rain, dew point condensation, see also Section 9.1.5). Materials shall remain under cover until ready to use.

9.1.3 Coating material shall be delivered in manufacturer's original unopened containers. Each container shall be clearly identified with the manufacturer's name, product designation, batch number, date of manufacture and shelf life expiration date.

9.1.4 The maximum shelf life allowed for coating materials used on the WTP project is 24 months from the date of their manufacture. Coating materials that are older than 24 months or that exceed the manufacturer's published shelf life, if less than 24months, shall not be used and shall be placed on HOLD and segregated from other coating materials. A one-time shelf life extension of no less than three (3) months and no more than six (6) months, may be issued by the coating manufacturer. The shelf life extension shall be based on laboratory testing of retain samples taken at the time of manufacture or by testing a sample provided from the actual coating material in question. Where testing verifies an outdated coating material still complies with its original design criteria, it is acceptable for shelf life extension. Expiration date stickers, provided by the coating manufacturer, shall be affixed to each container prior to release from HOLD. The stickers

shall include the product number, batch/lot number, the new expiration date and suitably marked to indicate that they came from the coating manufacturer. A new Appendix F shall be provided by the coating manufacturer that includes the test results and specifically indicates it was provided to document shelf life extension including new expiration date. Coating materials that have not been stored or handled in accordance with Sections 9.1.5, 9.1.6, 9.1.7 and 9.1.8, may not have their shelf life extended.

9.1.5 Coating material shall be protected from moisture, direct sunlight and temperatures below 40°F or above 100°F unless otherwise allowed by the coating manufacturer's latest published instructions and verified by the BUYER.

9.1.6 Coating material containers where the airtight seal has been broken or any of the contents are lost, shall not be used and shall be clearly marked and segregated from useable coating material.

9.1.7 Coating material containers shall not be opened except for immediate use.

9.1.8 Unused material shall be returned to storage as soon as possible at the end of each Workday. Materials left out for more than eight (8) hours in an uncontrolled storage area (areas without environmental controls that are exposed to ambient weather) shall not be used and shall be clearly marked and segregated from useable coating material.

9.1.9 All required coating material certifications (Appendix F forms) for each batch of material delivered to the SELLER shall be available at the time of material receipt. Materials delivered to the shop without the required documentation shall not be used and the SELLER shall tag and place discrepant materials into a hold area clearly separated from acceptable material. Once required documentation is received or otherwise corrected and found to be acceptable, the discrepant material may then be taken off hold status and used.

9.2 Steel Items and Equipment

9.2.1 The SELLER shall be solely responsible for the condition of the steel items and equipment from the time they are received until they have been delivered to the BUYER.

9.2.2 All booms, hooks, clamps, forks, supports, and skids used in handling or storing coated items shall be designed and maintained in such a manner as to prevent any damage to the items or to the coating and shall be reviewed by the BUYER's representative. Chains and wire rope in direct contact with the coated items are not acceptable. Fabric lifting and tie down straps shall be used.

9.2.3 The SELLER shall inspect all items upon receipt for shipping and handling damage. Any visible damage observed at this point shall be noted on the receipt inspection report.

9.2.4 All coated steel items and equipment shall be stored on padded supports as necessary to preclude damage to the coating. The supports shall be properly spaced and leveled.

9.2.5 The BUYER's representative will have authority to stop any storage or handling activity, if there is a possibility of damage to the coating.

9.2.6 All steel items and equipment damaged by the SELLER shall be repaired in accordance with the specification at the SELLER's expense. Only repair procedures reviewed by the BUYER shall be used.

10 Documentation

10.1 The SELLER shall provide a record of all materials used (related to individual batch number- refer to Appendix F).

10.2 The SELLER shall provide a record of all required daily inspections (Example- Appendix G) that includes pre-surface preparation, compressed air cleanliness, environmental conditions, surface preparation and roughness, location of field repairs coated, application, visual inspection, dry film thickness, holiday testing

and all touch-up/repair. This record shall include the coating and thinner materials used and the ID of the items coated to provide traceability.

10.3 All quality documentation shall be available for review by the BUYER representative within 24 hours from the time it is generated.

10.4 SELLER documentation forms or the way that the actual Work will be documented shall be provided by the SELLER as part of the procedures submittal for review by the BUYER.

10.5 Documentation shall be submitted in accordance with the requirements listed in Section 3 of the Material Requisition (MR).

APPENDIX C
Coating Materials/Coating Systems

TABLE 1 - PREQUALIFIED COATING PRODUCTS

Coating Number	Generic Products	Dry Film Thickness (mils)	Ameron	Carboline	Devoe	Dudick	Inter-national	Sherwin Williams
P02	Organic Zinc Epoxy Primer	3.0-5.0	Amercoat 68HS	Carbozinc 859	313	None	Interzinc 52	Zinc Clad IV
P04	High Build Epoxy	4.0-6.0	Amercoat 385	Carboguard 890	224HS	Protecto-Coat 330 or 300	Intergard 475HS	Macropoxy 646

NOTES to Table 1, Appendix C:

1) All versions of the above coating materials shall comply the WTP project VOC requirements of 3.8 lbs./gal and shall also comply with more restrictive local VOC requirements where the work is being performed. In the event the listed coating materials or acceptable versions of the listed coating materials do not meet the local VOC requirements an alternate VOC compliant material may be submitted for review.

TABLE 2 – COATING SYSTEM CODES

SYSTEM CODE	D
COAT 1	P02
COAT 2	P04
COAT 3	P04
COAT 4	

NOTES to Table 2, Appendix C:

1) The surface preparation for all coating systems shall be SSPC SP10 Near White Blast with a surface profile of 1.5 to 3.0 mils unless otherwise noted in this specification or the material requisition.

Appendix D
Coating Schedule

No.	Item – Component	System Code	Surface Prep. SSPC		1st Coat	DFT in mils	2nd Coat	DFT in mils	3rd Coat	DFT in mils	Color
			Initial	Repair							
7.0	**Skid Mounted Equipment**										
7.10	Skid Mounted Equipment-interior	All items on the skid shall be individually coated.									
8.0	**Miscellaneous Steel Items and Equipment**										
8.20	Miscellaneous Mechanical Equipment-Interior	D	SP10	SP11	P02	3.0-5.0	P04	4.0-6.0	P04	4.0-6.0	ANSI 70 GRAY

NOTES TO APPENDIX D

5. Flange surface (except gasket surfaces) & boltholes shall be cleaned and coated the same as the adjacent component.
8. Individual components of skid-mounted units shall be coated as noted for each individual item listed in Appendix D.
9. Complete details of the Manufacturer's Standard coating system shall be submitted for review. Refer to Section 6.2.
18. To minimize the potential of cracking or chipping where bolts are torqued onto precoated surfaces and within the bolted connection itself, a three coat coating system may be reduced to the prime coat and one finish coat directly under the bolt head, washer and nut up to 1/2" beyond.

Appendix F

Coating Manufacturer's Product Identity Certification Record

Project Name: _____ Coating Manufacturer: _____

Project Number: _____ Purchase Order Number: _____

Project Location: _____ Contract Number: _____

Coating Applicator: _____ Generic Coating Type: _____

Product Name: _____ Product Number: _____

(For multi-component products, provide data for all components on one or more Appendix F forms).
(Provide the standard range and actual batch values for each test)

TEST RESULTS		**Component A Batch No.**		**Component B Batch No.**	
Test	**Test Method Used**	**Standard Range**	**Batch Actual**	**Standard Range**	**Batch Actual**
Weight per Gallon					
Viscosity					
Flash Point (Typical)					
% Solids by Volume (Typical)					
Cure to recoat time @ 50F, 70F, & 90F (typical)					
Batch Size					
Date of Mfg.					
Shelf Life					
Expiration Date					

COMMENTS:

I hereby certify that the coating materials described above were manufactured with the same formulation, raw materials, production methods, and quality control standards as the coating materials originally tested and/or accepted for use at the River Protection Project-Waste Treatment Plant (WTP) Project site, located in the 200 East Area of the Hanford Site in Washington State in accordance with the requirements of WTP specification 24590-WTP-3PS-AFPS-T0001, 24590-WTP-3PS-AFPS-T0003,24590-WTP-3PS-AFPS-T0004, 24590-WTP-3PS-AFPS-T0006 and 24590-WTP-3PS-PX04-T0004.

Signed: _____ Date: _____

Title: _____ Company: _____

Appendix G
Surface Preparation and Coating Inspection Form

Page __ of ___

REPORT NO:_____ DATE: _____
PROJECT:_____ DAY: M T W T F S S
SUBCONTRACTOR/SELLER:_____ SHIFT: _____
EQUIPMENT/AREA:_____ INSPECTOR: _____
SUBSTRATE: STEEL/CONCRETE/OTHER- _____ COATING SPEC NO/REV:_____
ENVIRONMENTAL CONDITIONS:

WORK ACTIVITY						
TIME						
DRY BULB TEMP. °F						
WET BULB TEMP. °F						
RH %						
DEW POINT °F						
SURFACE TEMP. °F						
BLOTTER TEST						

PRE-SURFACE PREPARATION:
SP-1:_____ MASKING/PROTECTION:_____ SURFACE DEFECTS:_____

SURFACE PREPARATION:
METHOD:_____ ABRASIVE TYPE/SIZE/STORAGE:_____
CLEANLINESS SPEC:_____ ACTUAL:_____PROFILE SPEC:_____ ACTUAL:_____
EQUIPMENT:_____

COATING MATERIALS & MIXING:
PRODUCT(S)_____
BATCH NO(S)/QUANTITIES/EXPIRATION DATE:_____/_____/_____
THINNERS/THINNING RATIO:_____/_____/_____
STORAGE:_____ MIXING: _____ INDUCTION TIME:_____
MATERIAL TEMPERATURE:_____ POT LIFE EXPIRATION TIME:_____
COATING/LINING APPLICATION START TIME:_____ FINISH TIME:_____
COAT: PRIMER/PRIMER T.U./SECOND/SECOND T.U./THIRD/THIRD T.U./OTHER
METHOD:_____ WFT:_____ RECOAT TIME/TEMP:_____ CURE TIME/TEMP:_____
EQUIPMENT:_____

APPLIED COATING:
VISUAL INSPECTION (FILM IMPERFECTIONS):_____
DRY FILM THICKNESS: SPEC:_____ ACTUAL:_____ METHOD:_____
HOLIDAY TEST:_____ METHOD:_____ OTHER TESTING:_____ METHOD:_____
TOUCH-UP AND REPAIR:_____ FINAL CURE:_____

COMMENTS: (*Use reverse side or attach extra pages*)

_____/_____
INSPECTOR'S SIGNATURE/DATE

Appendix H
Manufacturer's Standard Coating Data Sheet

The SELLER proposes the following Manufacturer's Standard (Mfg. Std.) or alternate coating system that is suitable for the exposure conditions of steel items and equipment in radiation and non-radiation areas.

1. **^Equipment Description:** _____
   - A. Tag Number _____
   - B. Part(s) i.e. skirt, shell, channels, lugs, etc.* _____
   - C. Design/Operating Temperatures, designate °F or °C..... _____ °F °C
   - D. Does Equipment Receive Steam out (Yes/No), Temperature _____ °F °C
   - E. Insulated/Uninsulated _____
   - F. Fireproofing (Yes/No) _____
   - ^G. Carbon Steel (CS), Stainless Steel (SS), other (List) _____
2. **^Seller:** _____
3. **^Surface Preparation:** SSPC No./Profile _____ / _____
4. **Coating System Designation:** (Code)

	First Coat	Second Coat	Third Coat
^A. Type of Coating.....			
^B. Coating Mfg./No.**			
^C. Dry Film Thickness (Min/Max in mils)/(µm) ...			
D. Wet/Film Thickness (Min/Max in mils)/(µm)			
E. Curing Method.....			
^F. Color			
G. Dry to Recoat			
H. Pot Life			
L. Thinner / %			

5. **Total DFT of System:** (Mils/µm)(Min/Max)..... _____ / Min. _____ / Max.
6. **Material Storage:** Temperature Requirements (Min/Max) _____ / _____
7. **Shelf Life:** _____ Months
8. **Application Environmental Limits:**
   - A. Temperature Ambient and Surface (Min/Max)..... _____ / _____ _____ / _____
   - B. Humidity (Min/Max)..... _____ / _____
   - C. Surface Temp ≥5°F above Dew Point temp. (Yes/No) ..... _____
9. **Protection of surfaces that will be inaccessible after equipment installation (such as underside of base plates, interior of fans, vessels or equipment housings)** _____
10. **Rust Preventative for machined faces:** (**Mfg./No.) _____
11. **Quantity of touch-up coating supplied:** *None*
12. **Additional information:** (attach extra page as necessary) _____

* Use additional copies of this form for each part described in 1 above that requires a different coating system. A completed copy of this data sheet shall be submitted to CONTRACTOR/BUYER with the initial vendor data submittal.

** Include manufacturer's technical data sheets and MSDS for each proposed coating & preservative.

^ Mandatory data entry. Other entries should be completed where information is available from sub vendor or from coating material technical data sheets.

ATTACHMENT EEQ

LAW TCO CUSTOMIZED EEQ GUIDANCE

Environmental Equipment Qualification Requirements for SS-Chemical Toxicity Equipment in the LAW Facility

Environmental Equipment Qualification Requirements for SS-Chemical Toxicity Equipment

1. The equipment shall be designed under applicable codes and standards to withstand the effects of its environmental and process conditions and perform its safety function under the applicable Design Basis Event (DBE) conditions.
2. The Seller shall establish and document the ability of the supplied safety equipment to perform its safety function under the most severe environmental and process conditions to which it is subject during its installed life.

   The evaluation necessary for this purpose may be based on testing, analyses or operating experience. The necessary data shall have been obtained under quality assurance requirements imposed elsewhere in the procurement documents.

   The environmental service conditions considered shall be those contained in the Equipment Qualification Datasheets (EQD) applicable to the supplied equipment and are provided as part of the procurement documents. The process conditions considered shall be those stated in the equipment datasheets or elsewhere in the procurement documents.

   Testing performed to establish adequate performance under Design Basis Event (DBE) conditions, including Seismic testing, need not be performed on an aged test specimen.
3. The Seller shall consider the aging effects of the environmental and process conditions.

   The Seller shall consider the effects of temperature (thermal aging), radiation and wear as aging mechanisms. For radiation exposure evaluations, a total radiation dose of less than 1.0E03 Rad is not a significant radiation aging mechanism for electronic components. A total dose of less than 1.0E04 Rad is not a significant radiation aging mechanisms for organic compounds.

   The results of the aging evaluation shall be documented as recommended maintenance, replacement and/or surveillance actions which are required in response to the aging effects.

   The desired qualified life for the supplied equipment for the WTP is 40 years. However, if agreed to by the BUYER, the equipment/component qualified life may be less than 40 years.
4. Components not involved in the equipment's safety function(s) may be excluded from the SELLER's qualification process if it can be shown, through a documented means such as analysis that assumed failures, including spurious operation, have no adverse effect on the stated safety function(s) or by way of interfaces, on the safety function(s) of other equipment.

5. The results of the qualification evaluations required above shall be specific to the equipment items supplied to WTP. Any modifications made to the equipment after the evaluations are complete shall also be evaluated in accordance with the above requirement and the results shall be similarly documented.. Modifications to the equipment include changes in its design, materials, manufacturing process, clearances, lubricant, or mounting conditions.
6. Documentation of Qualification
    a. The Seller shall provide a signed Certificate of Conformance to the specified performance requirements. The certificate shall be in the form shown in Attachment 11 of the primary specification 24590-LAW-3PS-MBTV-T0001, Rev 1, *Engineering Specification for LAW Thermal Catalytic Oxidizer/Reducer.*
    b. Passive Equipment
        i. The Seller shall provide a documented evaluation confirming that the applicable bounding normal, abnormal, accident and post accident environmental and process conditions will not degrade non-metallic component/subcomponent performance in such a manner as to prevent the equipment from performing its required passive safety function(s).
    c. Active Equipment (including all electrical, instrumentation and controls equipment)
        i. The Seller shall provide an analysis and material evaluation of passive function(s), if any, as required for passive equipment (above) with additional documentation of testing, analysis, operating experience, or any combination of the three demonstrating that the equipment assembly is qualified to perform its intended active safety function(s).
    d. The Seller shall either: a) document recommended replacement (whole equipment or parts) or maintenance actions which are required in response to the aging effects and include a specific statement that the recommended replacement (whole equipment or parts) or maintenance actions are based on the aging considerations, or b) provide a statement that no maintenance / components replacements are required due to aging considerations if the equipment is not susceptible to aging,
    e. All qualification documentation shall be submitted to WTP under document category 35 of BNI Form G-321-E.

34.0 ANSI K61.1, American National Standard Safety Requirements for the Storage and Handling of Anhydrous Ammonia

Revision: 1999
Sponsoring Organization: Compressed Gas Association, Inc.

WTP Specific Tailoring

The following tailoring of ANSI K61.1 is required for use by the WTP project as an implementing standard for the safety related systems design.

Page 9; Section 5.1 Equipment and systems

Revise Section 5.1 as follows:

Not Applicable

Justification: Section allows the continued use or reinstallation of containers and systems designed and installed under earlier versions of codes and ANSI standards. WTP does not plan on using previously installed or design equipment. Therefore, Section 5.1 of this standard will not be implemented for this project.

Page 19; Section 6.3 Pressure relief devices

Revise Section 6.3.2 as follows:

Not Applicable

Justification: Section specifies relief valve design for underground containers. WTP does not plan to install underground containers. Therefore, Section 6.3.2 of this standard will not be implemented for this project.

Revise Section 6.3.3 as follows:

Not Applicable

Justification: Section specifies manhole design for relief for underground containers. WTP does not plan to install underground containers. Therefore, Section 6.3.3 of this standard will not be implemented for this project.

Page 19; Section 6.4 Installation of storage containers

Revise Section 6.4.4 as follows:

Not Applicable

Justification: Section specifies design requirements for the installation of underground containers. WTP does not plan to install underground containers. Therefore, Section 6.4.4 of this standard will not be implemented for this project.

Revise Section 6.4.5 as follows:

Not Applicable

Justification: Section specifies design requirements for the installation of underground containers. WTP does not plan to install underground containers. Therefore, Section 6.4.5 of this standard will not be implemented for this project.

Revise Section 6.4.7 as follows:

Not Applicable

Justification: Section specifies design requirements for the installation of underground storage systems. WTP does not plan to install underground storage system. Therefore, Section 6.4.7 of this standard will not be implemented for this project.

Revise Section 6.4.8 as follows:

Not Applicable

Justification: Section specifies design requirements for the installation of underground tanks. WTP does not plan to install underground tanks. Therefore, Section 6.4.8 of this standard will not be implemented for this project.

Page 20; Section 6.5 Reinstallation of containers

Revise Section 6.5 as follows:

Not Applicable

Justification: Section specifies requirements for reinstallation of containers. WTP does not plan to use previously used containers. Therefore, Section 6.5 of this standard will not be implemented for this project.

Pages 21-26; Section 7 Refrigerated storage

Revise Section 7 as follows:

Not Applicable

Justification: This section establishes design requirements for system using tanks for the storage of anhydrous ammonia under refrigerated conditions. WTP does not plan on a system using tanks for the storage of anhydrous ammonia under refrigerated conditions. Therefore, Section 7 of this standard will not be implemented for this project.

Pages 26-28; Section 8 Systems mounted on railcar structures (tank cars), other than DOT class 106A, for transportation of ammonia

Revise Section 8 as follows:

Not Applicable

Justification: This section establishes design requirements for tank cars for the rail transportation of ammonia. WTP does not plan to receive anhydrous ammonia by rail car. Therefore, Section 8 of this standard will not be implemented for this project.

Pages 31-32; Section 10 Systems using DOT portable tanks and cylinders

Revise Section 10 as follows:

Not Applicable

Justification: This section establishes requirements for cylinders (less than 1000 pounds), DOT portable tanks and DOT containers. WTP does not plan to receive anhydrous ammonia by container or cylinder. Therefore, Section 10 of this standard will not be implemented for this project.

Pages 32-34; Section 11 Systems mounted on farm wagons (implements of husbandry) for the transportation of ammonia

Revise Section 11 as follows:

Not Applicable

Justification: This section establishes requirements for equipment mounted on farm wagons for the transportation of ammonia. WTP does not plan to use farm wagons for the transportation of ammonia. Therefore, Section 11 of this standard will not be implemented for this project.

Pages 34-35; Section 12 Systems mounted on farm wagons (implements of husbandry) for the application of ammonia

Revise Section 12 as follows:

Not Applicable

Justification: This section establishes requirements for equipment mounted on farm wagons for the application of ammonia. WTP does not plan to use farm wagons for the application of ammonia. Therefore, Section 12 of this standard will not be implemented for this project.

Pages 35-37; Section 13 References

The references listed shall be constrained to the approved versions listed in the SRD or approved changes and equivalencies.

The following references shall be excluded:

ANSI/ASHRAE 15, American National Standard Safety Code for Mechanical Refrigeration

ANSI/IIAR 2, American National Standard for Equipment, Design and Installation of Ammonia Mechanical Refrigeration Systems

ANSI/ASME B31.5, American National Standard for Refrigeration Piping

ANSI/SAE J1513f, Refrigeration Tube Fittings

API Standard 620, Design and Construction of Large Welded Low-Pressure Storage Tanks

Justification: The above references are for the design of refrigerated storage systems. WTP does not plan to use a refrigerated anhydrous ammonia storage system. Therefore, these references will not be implemented for this project.

The following references shall be excluded:

40 CFR Part 280, Technical standards and corrective action requirements for owners and operators of underground storage tanks (UST)

Justification: The above reference is for underground storage tanks. WTP does not plan to use underground storage tanks for anhydrous ammonia. Therefore, these references will not be implemented for this project.

The following references shall be excluded:

CGA G-7, Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers

ANSI/CGA V-1, American National Standard Compressed Gas Association Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections

Justification: The above references are for the use of cylinders and small (less than 1 ton) containers. WTP does not plan to use cylinders or small containers for anhydrous ammonia storage. Therefore, these references will not be implemented for this project.

The following references shall be excluded:

ANSI/ASAE S276, Slow Moving Vehicle Identification Emblem
ANSI/ASAE S338.2, Safety Chain for Towed Equipment

Justification: The above references are for the use of ammonia systems mounted on farm equipment. WTP does not plan to use farm equipment for anhydrous ammonia storage. Therefore, these references will not be implemented for this project.

ATTACHMENT 2

26.0 ASME B31.3-1996, Process Piping

Revision: 1996
Sponsoring Organization: ASME

WTP Specific Tailoring

The following tailoring of ASME B31.3, *Process Piping*, is required for use by the WTP contractor as an Implementing Standard for: (1) the fabrication and installation of those portions of the C5V ductwork that are being embedded in concrete, (2) the use of ASME B16.9 welding tees in accordance with ASME B31.3-2002, (3) use of vacuum box leak testing, (4) the ASME B31.3-1998, paragraph 345.2.3(c), allowance for not leak testing closure welds outside of a closed cell (black cell) and/or hard-to-reach area, (5) the test pressure that is used for piping systems subjected and designed to HPAV events, and (6) design for HPAV Detonation/Deflagration loads and associated thermal gradients.

- The tailored sections of ASME B31.3 applicable to embedded ductwork will only be utilized to the extent that it will cover the fabrication, installation, and inspection (and associated testing) of Category D fluid service piping being used as C5 ductwork. Air testing requirements for this ductwork will be compliant with ASME AG-1. Below is a description of those portions of ASME B31.3 that apply to fabrication, installation, and inspection of Category D fluid service piping and the sections of the SRD that they will apply to.
- The tailored sections of ASME B31.3 applicable to welding tees will only be used for ASME B16.9 welding tees. As long as the stress intensification factors from ASME B31.3-2002 are used in the stress analysis for the welding tees, welding tees fabricated to either the 1996 or the 2002 edition of ASME B31.3 can be used. Below is a description of those portions of ASME B31.3, Appendix D, Table D300, that apply to welding tees and the section of the SRD to which they will apply.
- The tailored paragraphs of ASME B31.3 applicable to vacuum box leak testing, in lieu of hydrostatic or pneumatic leak testing, will only be used to leak test full penetration circumferential piping field butt welds inside a closed cell (black cell) and/or hard-to-reach area as defined in Appendix M, out to the first isolation component outside the closed cell (black cell) and/or hard-to-reach area. Further, if the 100 % volumetric inspection using ultrasonic examination per ASME B31.3 paragraph 344.6, is conducted for welds to be vacuum box tested, then the ultrasonic examination shall be conducted using a method that creates and maintains a reproducible computerized image(s) of the entire weld in the axial and radial direction.
- The tailored paragraphs of ASME B31.3 adopting the provisions of ASME B31.3 (c) - 1998 Addendum paragraph 345.2.3(c) are applicable to all ASME B31.3 piping in all facilities except for closure welds in closed cells (black cell) and/or hard-to-reach areas.

Piping providing a confinement function in accordance with SRD 4.4-3 will comply with the following sections of ASME B31.3-1996, *Process Piping*. These sections of ASME B31.3 are applicable for embedded ductwork.

Chapter 3, Materials

ATTACHMENT 2

Chapter 5, Fabrication

Table 341.3.2, Visual acceptance criteria for Category D fluid service piping

Justification: Due to wall thickness requirements of duct embedded in concrete, piping materials are required. ASME B31.3 will apply to materials, fabrication, and inspection standards as appropriate. Testing requirements for nuclear air treatment systems will be consistent with ASME AG-1.

Piping providing a confinement function in accordance with SRD 5.1-2 will comply with the following sections of ASME B31.3-1996, *Process Piping*. These sections of ASME B31.3 are applicable for embedded ductwork.

Chapter 3, Materials

Chapter 5, Fabrication

Table 341.3.2, Visual acceptance criteria for Category D fluid service piping

Justification: Due to wall thickness requirements of duct embedded in concrete, piping materials are required. ASME B31.3 will apply to materials, fabrication, and inspection standards as appropriate. Testing requirements for nuclear air treatment systems will be consistent with ASME AG-1.

Piping providing a confinement function in accordance with SRD 4.2-2 will comply with ASME B31.3-1996, *Process Piping*, with the following modification:

In Table D300, the description of welding tee per ASME B16.9 shall be revised so it is consistent with that shown in Table D300 of ASME B31.3-2002:

Description	Flexibility Factor k	Stress Intensification Factor [Notes (2), (3)] Out-of-Plane, i_o	In-Plane i_i	Flexibility Characteristic, h	Sketch
Welded tee per ASME B16.9 [Notes (2), (4), (6), (11), (13)]	1	$\frac{0.9}{h^{2/3}}$	$3/4\ i_o + 1/4$	$3.1\frac{\overline{T}}{r_2}$	Same as ASME B31.3-1996

This means that for welding tees per ASME B16.9, note 11 in Table D300 is also changed to:

(11) If $r_x \geq 1/8 D_b$ and $T_c \geq 1.5\overline{T}$, a flexibility characteristic of $4.4\,\overline{T}/r_2$ may be used.

ATTACHMENT 2

Justification: The use of a lower flexibility characteristic for welding tees per ASME B.16.9 in accordance with ASME B31.3-2002 will increase both the out-of-plane and in-plane stress intensification factors. The increased stress intensification factors will reduce the allowable out-of-plane and in-plane moments that can be applied to the welding tee and keep the calculated stress below the stresses allowable by ASME B31.3-1996.

Safety piping within the scope of SRD 4.2-2 shall comply with ASME B31.3-1996, Chapter V, Paragraph 345, using the following approach for vacuum box leak testing. Vacuum box leak testing, in lieu of hydrostatic or pneumatic leak testing, may be used to leak test full penetration circumferential piping, field butt welds inside a closed cell (black cell) and/or hard-to-reach area as defined in Appendix M, out to the first isolation component outside the closed cell (black cell) and/or hard-to-reach area, only under the following conditions:

Vacuum Box Leak Test Method - The vacuum box leak test shall be in accordance with a Bubble Test - Vacuum Box Technique method specified in ASME BPV Code, Section V, Article 10, Appendix II, subject to the requirements listed below:

(a) Sensitivity of the test shall be demonstrated to be not less than 1E-3 atm-ml/sec at 15 psig.

(b) The test pressure shall be a partial vacuum of at least 7 psi below atmosphere, applied to the outside of the weld.

(c) The required partial vacuum shall be maintained for at least 20 sec examination time.

In addition, the following limitations and restrictions shall apply to the application of vacuum box leak testing in lieu of a hydrostatic or a pneumatic leak test:

- Vacuum box leak testing will only be used to leak test circumferential piping field welds inside a closed cell (black cell) and/or hard-to-reach area (as defined in SRD Appendix M). This includes any welds in extensions of piping systems contained or originating in accessible areas between the closed cell (black cell) and/or hard-to-reach area boundary and the first isolation valve or device beyond the closed cell (black cell) and/or hard-to-reach area boundary;
- It shall only be used for piping field welds where required to avoid damage to components, ensure the safety to construction workers, perform leak tests of field welds where physical limitations prevent hydrostatic or pneumatic leak testing as prescribed in ASME B31.3-1996 paragraph 345.4 and paragraph 345.5 respectively;
- Pipe welds that are to be vacuum box leak tested will be assessed for suitability. The number of welds to be vacuum box leak tested shall be limited to a maximum of three welds between termination points (two termination or closure welds and one intermediate weld) on a given pipe system except where physical limitations prevent examination by hydrostatic or pneumatic leak testing. DOE will be informed of such exceptions, and may at its discretion and within 48 hours of being informed, respond to BNI on the suitability of the use of vacuum box leak testing for such instances. Termination points may be tanks, vessels, valves, etc. (Specifically excluded from the definition of termination points are junctions where the piping changes design class). This could be either the last two closure welds in a closed cell (black cell) and/or hard-to-reach area or the last

ATTACHMENT 2

closure weld in the closed cell (black cell) and/or hard-to-reach area and the last closure weld outside the closed cell (black cell) and/or hard-to-reach area. In addition, vacuum box leak testing would be permitted for the connection welds between construction modules if this is limited to one module-to-module weld per piping run within the cells. This is in addition to termination welds on the piping run. A module is defined as a pre-leak-tested subassembly containing multiple pipe spools;

- Vacuum box leak testing shall be limited to full penetration girth butt welds, on straight pipe or between straight pipe and pipe components of the same nominal pipe size and same wall thickness on both sides of the weld at the weld location. The following configurations are candidates for vacuum box testing:

  (a) Straight pipe to straight pipe connection butt welds

  (b) Straight pipe to 90° elbow connection butt welds

  (c) Straight pipe to 45° elbow connection butt welds

  (d) Straight pipe to concentric reducer connection butt welds

  (e) Straight pipe to eccentric reducer connection butt welds

  (f) Straight pipe to butt welding tee connection butt welds

  (g) Straight pipe to butt welding reduced outlet tee connection butt welds

  (h) Straight pipe to valve nozzle connection butt welds

  (i) Straight pipe to tank or vessel nozzle connection welds

  (j) Straight pipe to safe-end of a weldolet connection butt welds - full penetration butt welded connection only

  (k) Straight pipe to pipe cap connection butt welds

  Prior to the application of vacuum box testing using any of the candidate configurations on piping butt welds at the WTP, the Contractor must successfully demonstrate to the DOE, for the candidate configuration, that (1) all portions of the weld to be inspected are visible and can be inspected in accordance with the ASME Boiler and Pressure and Vessel Code, Section V, Article 10, Appendix II - 1995; (2) the vacuum box can adequately maintain a partial vacuum of 7 psid; and (3) vacuum box leak testing can be accomplished in the time limits and other requirements established by this procedure. The DOE shall be advised at least 7 days in advance of any demonstration to qualify a new weld configuration so that they can witness the demonstration. The Contractor shall document any demonstration relied upon to justify the use of vacuum box leak testing on a new configuration. Further, vacuum box leak testing shall be conducted with a vacuum box that completely encapsulates the weld, at the test location;

- All welds shall be 100 % volumetrically inspected in accordance with ASME B31.3-1996, paragraphs 344.5 or 344.6. If the 100 % volumetric inspection is conducted using ultrasonic examination per ASME B31.3-1996 paragraph 344.6, then the ultrasonic examination shall be conducted using a method that creates and maintains a reproducible computerized image(s) of the entire weld in the axial and radial direction;

- It shall be limited to welds made using the Orbital welding machines. The only exception is that vacuum leak box testing may be used on manual welds if the 100 % volumetric inspection was conducted by radiography per ASME B31.3-1996 paragraph 344.5;

ATTACHMENT 2

- The piping systems and or components on both sides of the weld to be vacuum box leak tested shall have been subjected to a hydrostatic leak test in accordance with ASME B31.3-1996 paragraph 345.4, a pneumatic test in accordance with ASME B31.3-1996 paragraph 345.5, a combination pneumatic-hydrostatic leak test in accordance with ASME B31.3-1996 paragraph 345.6, or in the case of components, leak tested in accordance with the Code or Standard applicable to the design of the component;
- At a minimum, a flexibility analysis in accordance with ASME B31.3-1996 paragraphs 319.4.2 (a) and (b) shall be required on any piping systems that contain welds that are to be vacuum leak box tested. In addition, a comprehensive flexibility analysis in accordance with ASME B31.3-1996 paragraphs 319.4.2 (c) and (d) shall be performed on any piping systems that contain welds that are to be vacuum box leak tested when the piping systems have a design temperature greater than or equal to 150 °F;
- For manual welds, the requirements of ASME B31.3-1996 paragraph 344.7.1 (a) through (g) shall be invoked on any weld to be vacuum box leak tested with the exception that the requirement of subparagraph 344.7.1 (e) "... aided by liquid penetrant or magnetic particle examination when specified in the engineering design" shall not be required. For welds made using Orbital welding machines, the requirements of ASME B31.3-1996 paragraph 344.7.1 (a), (b), (c), (d), and (g) shall be invoked. The requirements of 344.7.1 (e) and (f) shall not be required. The implementation of these requirements shall be documented in the weld inspection report;
- Pipe welds and the associated line numbers that are to be vacuum leak box tested shall be identified in advance of the testing. This identification shall be documented in the controlled document Weld List, which must include this information prior to the initiation of any vacuum box leak testing associated with those welds and line numbers. It is understood that the controlled document Weld List may need to be revised and updated periodically through the construction phase of the WTP Project; and
- The following special requirements shall be placed on the training programs used to certify the technicians that will be conducting the vacuum box leak tests:
  1. The BNI Construction Manager shall pre-approve the technician qualifying examination(s) for vacuum box leak testing;
  2. The BNI Construction Manager shall pre-approve the qualifications of each Level III technician preparing or giving the examinations for vacuum box leak testing;
  3. DOE ORP at their discretion shall reserve the right to observe any and/or all practical leak test examinations and review of the results of any and/or all written vacuum box leak test examinations;
  4. The minimum topical content of each Level II examination shall be specified by BNI, and approved by DOE;
  5. The 80 % correct criteria for passing the examination shall apply to each part of the three part examinations that are to be given;
  6. BNI shall provide reasonable assurance that they will take adequate measures to assure the integrity of written examination is maintained; and
  7. There shall be several versions of each examination in use to assure Level II knowledge and ability concerning vacuum box leak testing is confirmed.

ATTACHMENT 2

Justification: The requirement for the vacuum box leak test sensitivity is consistent with the ASME B31.3 requirement for a sensitive leak test as given in ASME B31.3-1996 paragraph 345.8 and for at least 7 psi vacuum and an examination time of at least 20 seconds. The limitations in using vacuum box leak testing better define when this method can be used. DOE ORP may further change the definition and application of these special vacuum box leak testing criteria based on the Contractor's experience with their use, or the Contractor's request for a change.

Piping system closure welds outside of a closed cell (black cell) and/or hard-to-reach area as defined in SRD Appendix M, shall comply with the requirements of ASME B31.3-1998, subparagraph 345.2.3(c). When ASME B31.3-1998, subparagraph 345.2.3(c) is invoked the following restrictions shall apply:

- It shall not be invoked on any closure welds on piping systems in a closed cell (black cell) and/or hard-to-reach area as defined in SRD Appendix M. This includes any welds in extensions of piping systems contained or originating in a closed cell (black cell) and/or hard-to-reach area, between the closed cell (black cell) and/or hard-to-reach area boundary and the first isolation valve, or device beyond the closed cell (black cell) and/or hard-to-reach area boundary;
- It shall only be invoked on full penetration butt welds in straight pipe, full penetration butt welds at the safe-end of an equipment nozzle, or full penetration butt welds at the safe-end of branch connections. [The safe-end is defined as the piping to equipment nozzle connecting weld or the branch connection to branch piping connecting welds.];
- The requirements of ASME B31.3(c) - 1998, subparagraph 345.2.3 (c) shall be met;
- The piping systems and or components on both sides of the closure weld shall have been subjected to a hydrostatic leak test in accordance with ASME B31.3-1996 paragraph 345.4, a pneumatic leak test in accordance with ASME B31.3-1996 paragraph 345.5, a combination pneumatic-hydrostatic leak test in accordance with ASME B31.3-1996 paragraph 345.6, or in the case of components leak tested in accordance with the Code or Standard applicable to the design of the component;
- For manual welds, the requirements of ASME B31.3-1996 paragraph 344.7.1 (a) through (g) shall be invoked with the exception that the requirement of subparagraph 344.7.1 (e) "...aided by liquid penetrant or magnetic particle examination when specified in the engineering design" shall not be required. For welds made using the Orbital welding machines, the requirements of ASME B31.3 -1996 paragraph 344.7.1 (a), (b), (c), (d), and (g) shall be invoked. The implementation of these requirements shall be documented in the weld inspection report;
- Piping welds and the associated line numbers for which the closure weld classification is invoked shall be documented in a controlled document Weld List;
- Piping components may include mechanical elements other than piping; and
- In addition, BNI shall incorporate these requirements into the appropriate specification. DOE-ORP may further change the definition and application on the use of closure welds based on the Contractor's experience with their use or the Contractor's request for a change.

Justification: This change does not change the safety function of any pressure boundary components. The requirement to leak test pressure boundary field welds is primarily to ensure the reliability of the welds in addition to the reliability provided by the other required examinations. The exception allowed

ATTACHMENT 2

by ASME B31.3-1998, paragraph 345.2.3 that the final weld connecting piping systems or components which have been successfully tested in accordance with paragraph 345 need not be leak tested provided the weld is examined in-process in accordance with paragraph 344.7 (a), (b), (c), (d), and (g) and passes with 100 % radiographic examination in accordance with paragraph 344.5 or 100 % ultrasonic examination in accordance with paragraph 344.6 provides adequate assurance that the weld is reliable and leak tight. The change continues to provide adequate safety since it requires that all piping closure welds that are not leak tested are in-process examined and 100 % volumetrically examined which exceeds the requirements of ASME B31.3-1996 for closure welds that are leak tested. The inability to hydrostatically or pneumatically leak test these closure welds does not affect the soundness of the welds.

Design for Hydrogen Detonation/Deflagration Loads and Thermal Gradients

This section provides design criteria to determine the acceptable responses of piping systems and components to occasional loads that may result from HPAV events. Piping routes that fail to meet these criteria require preventive controls. The development of such criteria is permitted by B31.3 and is, therefore, not a deviation from it.

A best-estimate design tool may be used to determine the number of cycles for defined classes of HPAV events that differ in applicable structural design considerations for their accommodation subject to the following constraints to ensure consistency with safety analysis expectations:

1. The route specific factors that affect the potential for significant quantities of combustible gases to accumulate must be considered, including the maximum expected waste characteristics (i.e., combustible gas generation rate, temperature, viscosity), the proposed configuration of the route, and the related human and equipment failure rates.
2. An ignition probability of one is to be assumed at each maximum bubble size unless a technical basis for a lower probability is submitted to DOE-ORP and receives their concurrence.
3. The design tool shall not be used to exclude limiting events such as PRC-DDT that can occur for credible gas configuration conditions.
4. A defined class of events may be designated as structurally insignificant provided the included events are shown not to affect compliance with these Appendix C, B31.3 tailoring provisions.
5. Documentation of the model must be provided including the process for its application, the defined event classes, the parameters chosen, and the results.

For HPAV events, analysis will use 100/sec strain-rate dependent stress-strain curves for austenitic stainless steels (SS 304, 304L, 316 and 316L), which are used in the construction of WTP piping systems. Strain rate dependent properties will be developed based on a literature survey of academic, National Laboratory and industry information, covering the range of experimental test data to which the material in question will be subjected in service. Specifically, the experimental data requirements shall provide:

(a) A lower-bound estimate for strength over the strain rate and temperature regime of interest,

(b) Variation of yield strength with strain-rate and temperature,

(c) Variation of the rate of strain-hardening with strain-rate,

(d) Determination of a loading path-dependence to both the quasi-static (QS) and rate-dependent yield behavior,

ATTACHMENT 2

(e) A loading path-dependence to both the quasi-static (QS) and rate-dependent strain-hardening behavior, and

(f) Development of an equation (or mathematical model) that describes the strength properties over the regime of interest.

(g) Scaled to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 2, static, room temperature true stress-true strain curve.

Events Affecting Piping Located in Black Cells or Designated as Hard-To-Reach

Deflagrations events must meet the criteria of ASME B31.3-1996, *Process Piping*, and B31.3 Code Case 178, with appropriate consideration of deflagration pressure, sustained loads, and thermal gradients.

In evaluating Code Pressure Boundary for detonation events (including deflagration to detonation [DDT] transitions and reflected DDTs [PRC-DDT]), the straight pipe equivalent through-wall average strain will be limited to 0.2 % plastic strain using the 100/sec strain-rate dependent stress-strain curves, finite element time-history analysis, and end-of-life wall thickness.

For bends fabricated from straight pipe, the equivalent through-wall average strain will be limited to 0.2 % plastic strain using the 100/sec strain-rate dependent stress-strain curves, finite element time-history analysis, and end-of-life wall thickness.

Fittings (tees, elbows, reducers) manufactured in accordance with B31.3 Paragraph 303 and the standards listed in B31.3 Table 326.1 are considered to be as strong as the matching pipe, due to the burst test requirements of the standards. BNI will verify that burst test methods (in lieu of calculation methods) have been used to validate representative fitting designs.

Fatigue damage from high frequency oscillations, bar waves, thermal gradients, pressure changes, and traveling detonation waves must be evaluated.

B31.3 302.3.5 limits the sum of longitudinal stresses due to pressure, weight, and other sustained loads to S_h, the basic Code allowable at maximum temperature. Combining only longitudinal stresses, as is done in B31.3 paragraph 302.3.6, does not consider the possible combination of hoop and longitudinal (axial) effects. For highly dynamic pressures during a traveling wave detonation event, the axial and hoop effects due to pressure are not necessarily both tensile, so a departure from the normal B31.3 methods (sum of longitudinal stresses) must be made to allow for the possible combination of hoop and axial effects. Therefore, for traveling wave detonation events, the combination of hoop and axial effects must be considered without exceeding the 100/sec strain-rate dependent yield; the dynamic interaction ratio added to the dead weight interaction ratio shall not exceed 1. Since DDT and PRC-DDT events are point events, the requirement to combine hoop and axial effects does not apply.

Events Affecting Piping Not Located in Black Cells or Designated as Hard-To-Reach

Except as noted below, all HPAV requirements in the BC/HTR apply. The criteria below are limited to affected piping systems and components located in the HLW Process Cells, or in the Pretreatment facility Hot Cell and C3 area bulges that serve as extensions of the Hot Cell.

For HPAV events that are anticipated to result in a PRC-DDT, detonation, or DDT, the maximum pressure that produces a straight pipe (or 3D bend, whichever is limiting) equivalent through-wall average strain of 0.2 % plastic strain, as determined above for the BC/HTR, will be permitted to be 1.5 times higher. This results in a plastic through-wall average strain estimated to be less than 2.5 %.

ATTACHMENT 2

Other Components

Stresses in the nozzle/vessel intersection or in the dipped line due to the traveling detonation wave loading will be combined with stresses due to normal loads (PJM operation, if applicable, thermal expansion, internal pressure, weight) and the primary results limited to 1.2 times the normal condition allowable stress for that type of stress, as permitted by the ASME Boiler and Pressure Vessel Code, Sections VIII-1 and VIII-2, for occasional loads.

Stresses in pipe supports inside BC/HTR areas under combined weight, thermal expansion, and detonation loading will be limited to B31.3 allowable stress (if a catalog support) or the AISC allowable stress (if a structural shape), for occasional loads.

Stresses in pipe supports outside BC/HTR areas under combined weight, thermal expansion, and detonation loading will be limited to 1.6 times the B31.3 or AISC normal condition allowable stress. The basis for the 1.6 is AISC N690, Table Q1.5.7.1 for extreme and higher loading.

In-line instrumentation, such as pressure transducers, will be shown to be acceptable up to DDT loading by limiting the maximum pressure to the maximum rated pressure of the instrumentation pressure boundary. Since these items are replaceable, i.e., there are none in Black Cells, their possible failure to function after a PRC-DDT is acceptable.

Components such as jumper connectors, valves, jet pump pairs, etc., whose function cannot be demonstrated by analysis alone may be qualified by a combination of analysis and test as follows:

1. Analyses per the criteria above as applicable for the component boundary.
2. Demonstrate other significant design aspects such as leak tightness of jumper connectors or valve operability, closure function and stem leakage by performing a bounding impulsive load test. Provide test acceptance criteria similar to those that would be used for the same functions in a seismic test.

Justification: ASME B31.3 does not address detonation pressure loading, but does permit the designer to perform detailed analysis for unusual situations, as indicated in Paragraphs 300(c)(3) and 304.7.2. The purpose of the criteria described above is to implement that provision.

Exception to B31.3 Paragraph 302.2.4

Piping subjected to HPAV events, as defined in Appendix A, Section 5.4, and designed to withstand those events without controls will be leak tested at a pressure equal to the system design pressure (from the Mechanical line list) multiplied by the applicable factors in Section 345 of ASME B31.3-1996, *Process Piping*. The HPAV pressure will be permitted to exceed the test pressure, which is an exception to Paragraph 302.2.4.

Justification: ASME B31.3 does not address highly impulsive pressure loading, and does permit the designer to perform detailed analysis for unusual situations, as indicated in Paragraph 304.7.2 for Unlisted Components. The design rules developed in Report 24590-WTP-RPT-ENG-07-011, Revision 2, ensure that the piping system will maintain pressure boundary under all conditions.

River Protection Project – Waste Treatment Plant
Safety Requirements Document Volume II
24590-WTP-SRD-ESH-01-001-02, Rev 5e

Appendix C: Implementing Standards

19.0 IEEE-384, IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits

Revision: 1992
Sponsoring Organization: The Institute of Electrical and Electronics Engineers, Inc.

RPP-WTP Specific Tailoring

The following tailoring of IEEE-384 is required for use by the RPP-WTP project as an implementing standard for SC or SS electrical equipment and circuit design.

All Sections Clarification of Nuclear Power Generating Station Terminology

The term "Standby Generator" in the Standard is synonymous with "Emergency Generator" in the RPP-WTP.

Justification: As determined by the ISM review process, the Standby Generators on the RPP-WTP are not classified as SC while the Emergency Generators are classified as SC.

Section 2.0, Purpose

Replace with the following:

This standard establishes the criteria for implementation of the independence requirements of IEEE 603-1998 (as tailored in C.33) and IEEE 308-1991 (as tailored in C.18).

Justification: This section was revised to clarify that SRD implementing standards IEEE 603-1998 and IEEE 308-1991 are tailored in Appendix C.

Section 3.0, References

The following reference standards, do not apply for the RPP-WTP.

- [1] ANSI/ANS-58.2-1988, Design Basis for Protection of Light Water Nuclear Power Plants Against the Effects of Postulated Pipe Rupture.

Justification: This document is applicable to the high pressure steam lines found in nuclear power generating stations and doesn't apply for the RPP-WTP.

- [4] ANSI/NFPA 803-1988, Fire Protection for Light Water Nuclear Power Plants.

Justification: This document specifically addresses nuclear power generating stations. Per Section 4.5 of volume II of the SRD, the RPP-WTP will use NFPA 801-2003 as an implementing standard for fire protection.

- [11] IEEE Std 494-1974 (Reaff 1990), IEEE Standard Method for Identification of Documents Related to Class 1E Equipment and Systems for Nuclear Power Generating Stations.

Justification: This standard has been withdrawn by the IEEE standards committee and no replacement standard has been recommended. This standard is not called out as an implementing standard in the SRD. Procedures for identification of documents related to SC or SS equipment will be developed internally for the RPP-WTP project.

Replace the 1991 version of IEEE 603 with the following version.

IEEE Std 603-1998, *IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.*

Justification: SRD Safety Criterion 4.4-4 lists the 1998 version of IEEE 603 as an implementing standard for SC electrical power systems. The 1998 revision of IEEE 603 shall be used in place of the 1991 revision called out as a reference in the body of IEEE 384-1992 for SC electrical power systems only.

The following reference Standards shall be included:

- [16] DOE/RL-96-0006, Revision 1, *Top-level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors.*

Justification: Called out as a regulatory basis in the SRD.

- [17] ANSI/ISA-S84.01-1996, *Application of Safety Instrumented Systems for the Process Industries.*

Justification: Replaces IEEE-603 for Control and Instrumentation Systems at the WTP, per 24590-WTP-ABCN-ESH-01-027.

- [18] NFPA 801-2003, *Standard for Fire Protection for Facilities Handling Radioactive Materials.*

Justification: Called out as an implementing standard under safety criteria 4.5-1 through 4.5-4.

Section 4.0, Definitions

- The definition of **design basis events** shall be replaced with the following:

"Postulated events providing bounding conditions for establishing the performance requirements of structures, systems, and components that are necessary to: 1) ensure the integrity of the safety boundaries protecting the worker; 2) place and maintain the facility in a safe state indefinitely; or 3) prevent or mitigate the event consequences so that the radiological exposures to the general public or the workers would not exceed appropriate limits. The Design-Basis Events also establish the performance requirements of the structures, systems and components whose failure under Design-Basis Event conditions could adversely affect any of the above functions."

Justification: This definition is from DOE/RL-96-0006.

ATTACHMENT 3

Section 5.3, Equipment and Circuits Requiring Independence

Replace with the following sentence:

Equipment and circuits requiring independence shall be determined during the ISM review cycle and shall be identified on documents and drawings in a distinctive manner.

Justification: The reference to IEEE-494 is not applicable since this standard has been withdrawn by the IEEE standards committee and no replacement standard has been recommended. This standard is not called out as an implementing standard in the SRD. The ISM process will provide reliability requirements for each control strategy. These reliability requirements determine when control strategies require independence, redundancy, and seismic qualifications.

Section 6.1.3.2, Area Boundaries

Replace the reference to NFPA 803-1988[4] with NFPA 801-2003 [18].

Justification: Standard NFPA 803-1998 is not applicable for the RPP-WTP. Per Section 4.5 of the SRD, NFPA 801-2003 shall be used for the RPP-WTP.

Section 6.5, Containment Electrical Penetrations

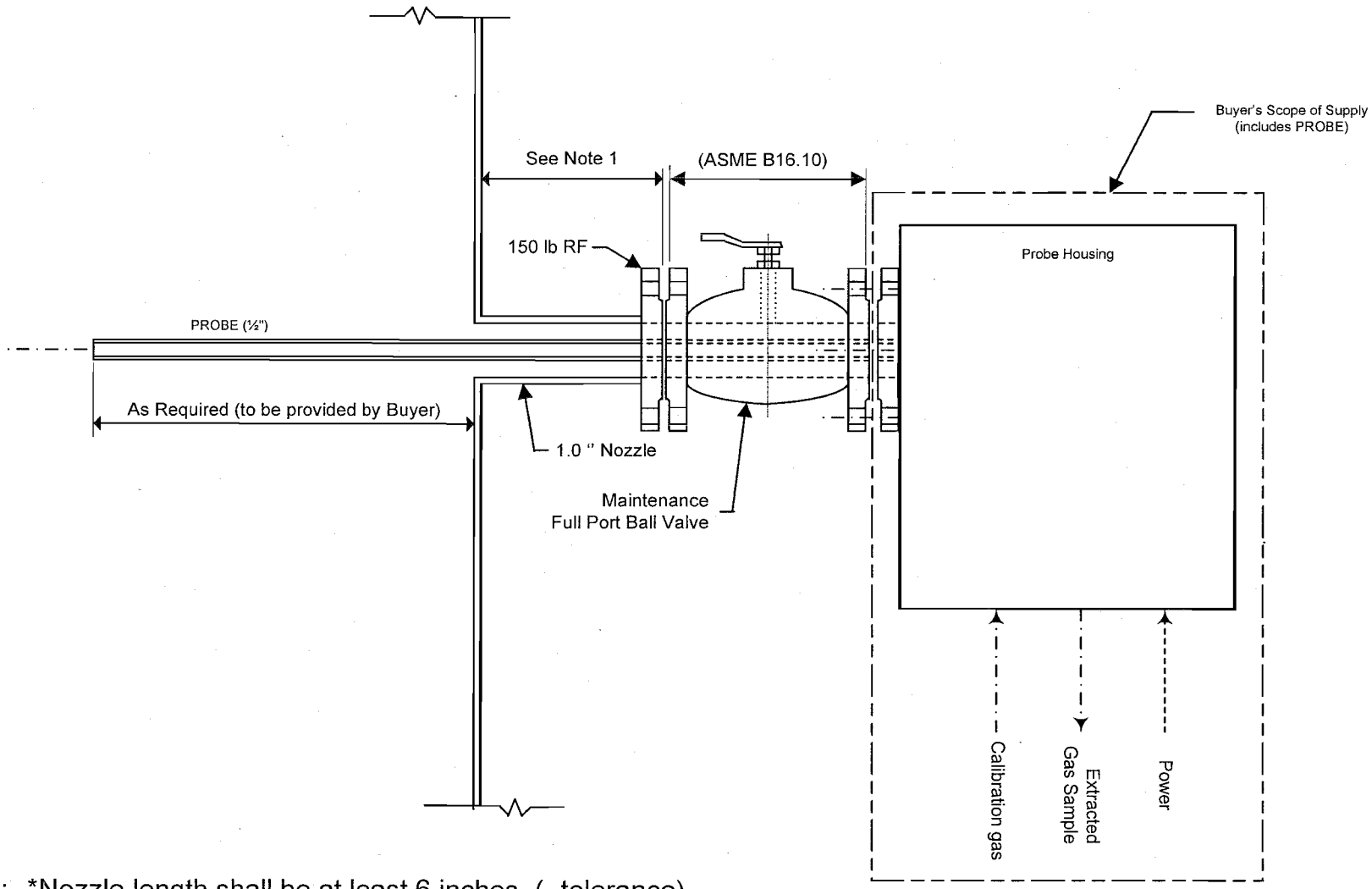
Not applicable for the RPP-WTP.

Justification: Containment electrical penetration assemblies are unique to the containment structure of Nuclear Power Generating Stations and have no equivalent in the RPP-WTP project.

ATTACHMENT 4

LAW SKID INTERFACE CONNECTIONS

SERVICE	NOZZLE	SIZE	INTERFACE
LVP-SKID-00002			
PROCESS GAS IN	N01	18"	FLG WN, A182-F316/316L, CL150, RF
PROCESS GAS OUT	N02	18"	FLG WN, A182-F316/316L, CL150, RF
AMMONIA/AIR IN	N03	8"	FLG WN, A182-F316/316L, CL150, RF
LVP-SKID-00003			
AMMONIA/AIR OUT	N04	8"	FLG WN, A182-F316/316L, CL150, RF
AMMONIA GAS IN	N05	2"	FLG SW, A350LF2, CL300, XS, RF
C3 DUCT AIR IN	N01	8"	FLG WN, A182-F316/316L, CL150, SCH 10, RF
C3 DUCT AIR IN	N02	8"	FLG WN, A182-F316/316L, CL150, SCH 10, RF



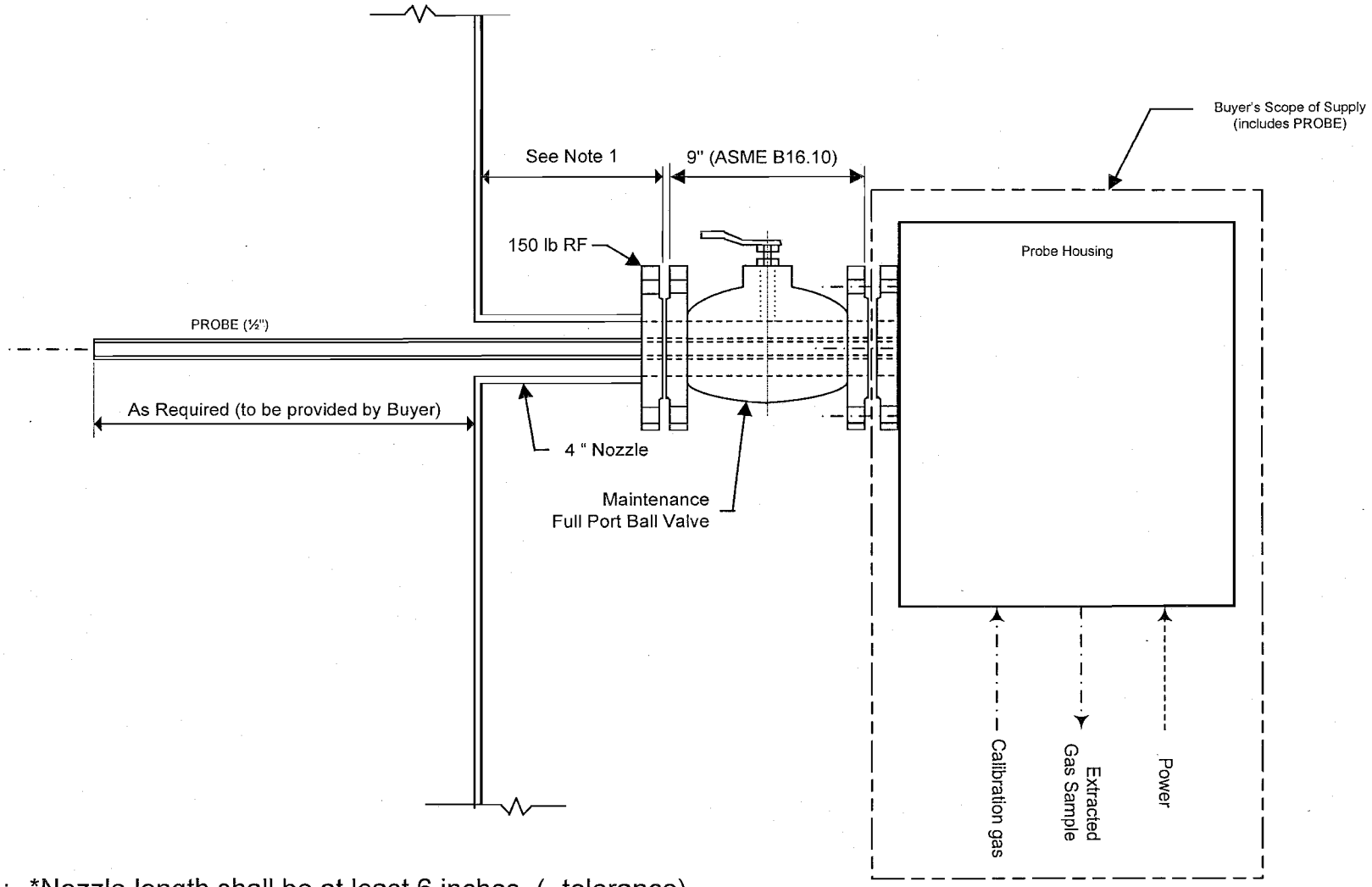
Note 1: *Nozzle length shall be at least 6 inches (- tolerance).
*There shall be at least 3 inches (- tolerance) of clearance, for tightening bolts, between the surface of the insulation jacketing and the underside of the flange.

Scale: None

Connection for Non-Routine Sample Extraction

Secondary Offgas Flange Connection for Gas Monitor Probe with Ball Valve for Maintenance

Gas Extraction Connection



Note 1: *Nozzle length shall be at least 6 inches (- tolerance).
*There shall be at least 3 inches (- tolerance) of clearance, for tightening bolts, between the surface of the insulation jacketing and the underside of the flange.

Scale: None

Connection for Sample Extraction-Permanent Typical

Secondary Offgas Flange Connection for Gas Monitor Probe with Ball Valve for Maintenance

Gas Extraction Connection

Attachment 7

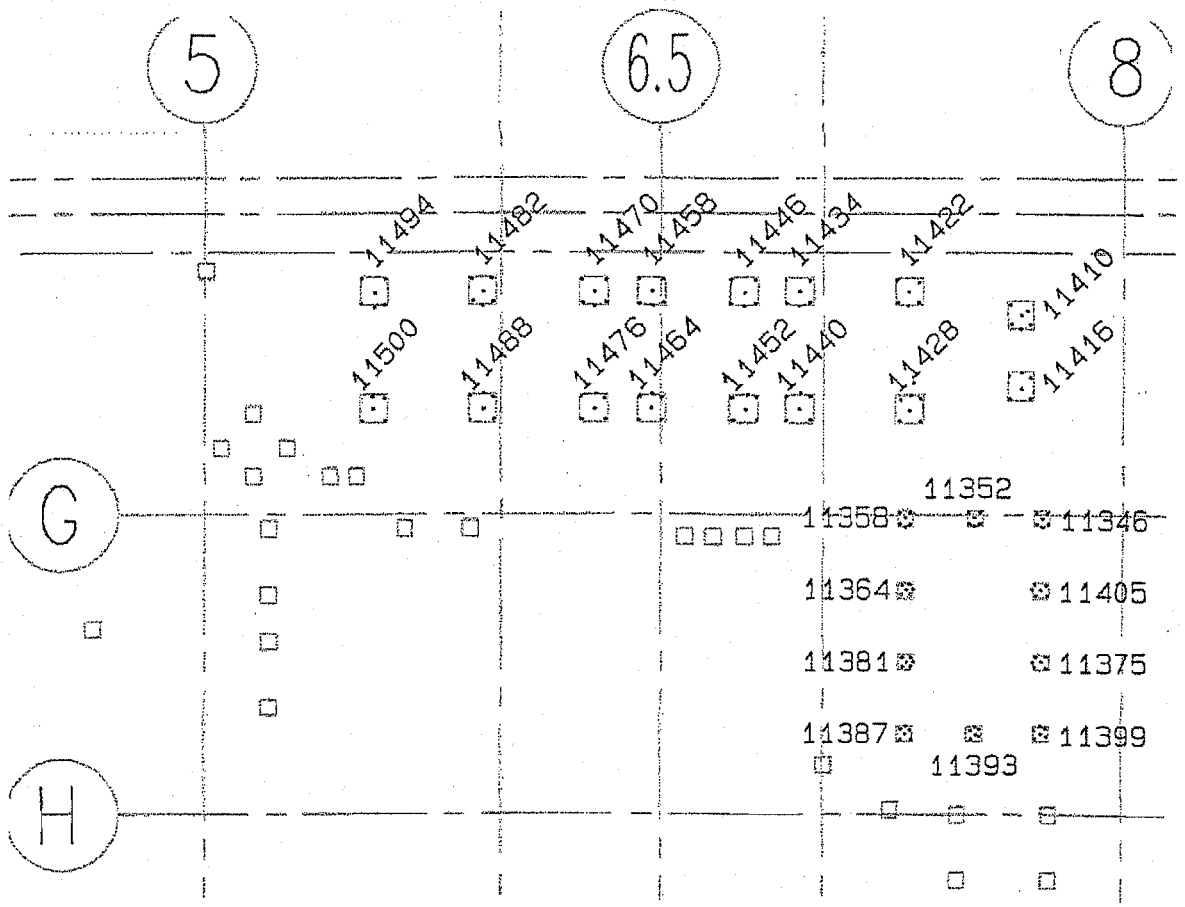
Certificate of Analysis for BASF Catalysts, LLC (VOCat 300S)

The Buyer will provide Certificate of Analysis (COA) for VOCat 300S when this information becomes available. Seller's use of the COA is described in Section 10.2.5.3.

Attachment 8

LAW TCO & Ammonia/Air Dilution Skid Embed As-Built Elevations

[Reference Drawing 24590-LAW-DB-S13T-00135]



Embed #	Elevation	Embed #	Elevation
11346	47.984	11434	47.978
11352	47.986	11440	47.993
11358	47.998	11446	47.976
11364	47.994	11452	47.992
11375	47.991	11458	47.969
11381	47.993	11464	47.967
11387	47.995	11470	47.964
11393	47.978	11476	47.972
11399	47.986	11482	47.969
11410	47.963	11488	47.976
11416	47.973	11494	47.976
11422	47.963	11500	47.967
11428	47.973		

9.0 AISC M016, Manual of Steel Construction, Allowable Stress Design (ASD)

Revision: 9th Edition
Sponsoring Organization: American Institute of Steel Construction

WTP Specific Tailoring

The following tailoring of M016 is required for use by the WTP contractor as an implementing standard for design of structural steel for Seismic Category III and IV SSCs.

No specific section

The design of structural steel utilizes the requirements of the *Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design, June 1, 1989 with Commentary* as found in Part 5 of the AISC M016, *Manual of Steel Construction.* The current reference for this specification is:

AISC S335-89, ***Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design June 1, 1989 with Commentary.***

Justification: At the time the AISC M016 Manual was first published, AISC had not assigned a publication number for the specification in Part 5. Beginning in March 2002, AISC implemented a new publication numbering system. Under this system, every AISC standard and publication was assigned a reference number. The *Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design, June 1, 1989* found in Part 5 of M016 can now be referenced as AISC S335-89.

No specific section

Load combinations for design of structural steel members utilize those identified in UBC 97, Section 1612.3.

Justification: These load combinations represent the commercial requirements for allowable stress design of structural steel. Use of these load combinations will ensure compliance with the commercial design in accordance with the UBC.

No specific section

Seismic detailing requirements shall be in accordance with UBC 97, Chapter 22, Division V, Section 2214, for moderate seismic risk structures.

Justification: The requirements contained in this section contain accepted industry practice for design of important commercial steel structures. Use of this section will ensure compliance with the commercial design in accordance with the UBC.

ATTACHMENT 10

River Protection Project – Waste Treatment Plant
Safety Requirements Document Volume II
24590-WTP-SRD-ESH-01-001-02, Rev 5e

Appendix C: Implementing Standards

22.0 IEEE-344, IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations

Revision: 1987(R1993)
Sponsoring Organization: The Institute of Electrical and Electronics Engineers, Inc.

RPP-WTP Specific Tailoring

The following tailoring of IEEE-344 is required for use by the RPP-WTP project as an implementing standard for SC/SS Seismic Class I electrical and instrument system design.

Pages 1-43, All Sections Clarification of Nuclear Power Generating Station Terminology

The term "Class 1E" in the Standard applies to "SC-I" in the RPP-WTP.

Justification: The Scope, Section 1.0, of IEEE-344 applies to equipment that needs to function during and after an SSE for a Nuclear Power Generating Station. For RPP-WTP the equipment that needs to function during and after a design basis earthquake is SC/SS equipment which must be qualified to SC-1.

Page 1, Section 1.2 References

Delete reference [5] CFR (Code of Federal Regulations), Title 10: Energy, Part 100, Reactor Site Criteria, published by office of the Federal Register, 1992.

Justification: Reference [5] contains radiation dose criteria and seismic criteria for Nuclear Power Generating Stations and is not applicable to the RPP-WTP project. The applicable criteria for RPP-WTP is found in 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document (SRD) Volume II, Safety Criteria 2.0-1 for radiological dose and 2.0-2 for chemical hazards. The applicable seismic criteria is contained in 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document (SRD) Volume II, in Section 4.1 General Design, Safety Criterion 4.1-3. This Safety Criterion defines Seismic Category (SC) I, II and III and provides seismic loads and source documents.

Delete reference [3] ANSI/IEEE Std 382-1985, *IEEE Standard for Qualification of Actuators for Power Operated Valve Assemblies with Safety-Related Functions for Nuclear Power Plants.*

Justification: This standard will be replaced with IEEE Std 382-1996. The IEEE Std 382-1996 includes a Required Input Motion (RIM) curve.

Pages 1-2, Section 2 Definitions

Delete the definitions for **Operating basis earthquake (OBE)** and **safe shutdown earthquake (SSE).**

Add a definition for **design basis earthquake** as: Earthquakes for RPP-WTP and the applicability to systems, structures and components (SSCs) is contained in 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document (SRD) Volume II, in Section 4.1 General Design, Safety Criterion 4.1-3. This Safety Criterion defines Seismic Classes (SC) I, II and III and provide seismic loads and source documents.

ATTACHMENT 10

River Protection Project – Waste Treatment Plant
Safety Requirements Document Volume II
24590-WTP-SRD-ESH-01-001-02, Rev 5e

Appendix C: Implementing Standards

Justification: The definition of OBE and SSE are applicable to Nuclear Power Generating Stations and the new definitions is applicable to the RPP-WTP project as defined in the SRD. This is consistent with the tailoring of AISC N690 as documented in ABCN-013.

Pages 1-43, All Sections Clarification of OBE and SSE

The term SSE in the standard is treated as a design basis earthquake. The requirement to apply and document the loads of a number of OBEs before an SSE is deleted from the standard.

Justification: The earthquake applicable to RPP-WTP is the design basis earthquake. The requirement to subject equipment to several OBEs prior to an SSE is not included in the requirements of the SRD for the RPP-WTP project. This is consistent with the tailoring of AISC N690 as documented in ABCN-013.

Page 13, Section 7.1.3.2, Repairs

In the fifth line delete the words, ", such as LOCA,".

Justification: LOCA is a term specific to Nuclear Power Generating Stations and not to the RPP-WTP project.

Page 15, Section 7.1.5, Vibrational Aging

In the last paragraph change the first sentence to read, "The purpose of the vibrational aging is to show that the lower levels of normal and transient vibration associated with plant operation will not adversely affect an equipment's performance of its safety function nor cause any condition to exist that, if undetected, would cause failure of such performance during a subsequent design basis earthquake.

Justification: This sentence within the standard included additional vibration aging of an OBE, but used the terms "lower intensity earthquake" rather than OBE. The rewording is needed to clarify the meaning of the sentence. The requirement to subject equipment to several OBEs prior to an SSE is not included in the requirements of the SRD for the RPP-WTP project. The earthquake applicable to RPP-WTP is the design basis earthquake. This is consistent with the tailoring of AISC N690 as documented in ABCN-013.

Page 16, Section 7.1.6.1, Hydrodynamic Loads

Delete the words, "and the loss-of-coolant accident (LOCA)

Justification: LOCA is a term specific to Nuclear Power Generating Stations and not to the RPP-WTP project.

ATTACHMENT 11

SAMPLE Certificate of Conformance

I (Signer's Name) , (Signer's Title) of (SELLER), being duly authorized by (SELLER) to make this certification, do hereby certify that:

1) The (Equipment descriptive name - Example: Pressure Transmitter), Model No.(s) (or Equivalent Identification), supplied to the WTP Project for application as Nuclear Safety item(s) under (MR /P.O. No., or equivalent Buyer's purchase document no.) is (are) environmentally and seismically qualified in accordance with the requirements in the standards, specifications, data sheets and technical notes in said purchase documents and will meet the acceptance criteria stated for its safety function.

2) The said environmental and seismic qualification are based on the tests, analyses and results documented in: (List of documents establishing Environmental and Seismic Qualification to WTP requirements)

3) The particular items (Equipment descriptive name(s), Model (Model designation(s) and List of serial numbers or other identification of the particular items supplied for Nuclear Safety application to the WTP project) supplied for Nuclear Safety application at the WTP Project are identical to, or have been shown to be sufficiently similar to, the test sample(s) subjected to qualification testing/analyses documented in the qualification documents listed above, such that the data and results in the said documents are specifically applicable to the particular items supplied to the WTP project. (If necessary) Sufficient similarity between the test sample(s) and the safety related items supplied to WTP is documented in (Document title).

4) All modifications to the test sample and manufacturing methods which were necessary to establish qualification have been effected in the particular items supplied to the WTP Project.

5) All maintenance, surveillance requirements necessary to maintain the qualified status of the equipment in the installed configuration and service conditions at the WTP Project are stated in (Document Title).

6) All replacements of parts necessary to maintain the qualified status of the equipment in the installed configuration and service conditions at the WTP Project are stated in (Document Title).

Seller (Company name) _____

Signature of Authorized Representative _____

_____
Date Signed

Name of Authorized Representative _____

Title of Authorized Representative _____