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PROCUREMENT SPECIFICATION

Three Mile Island-II Back Up Heated VAC Dryer System (TMI-2 Fuel Vacuum Dryer)

INEEL
Idaho National Engineering & Environmental Laboratory
BECHTEL BWXT IDAHO, LLC

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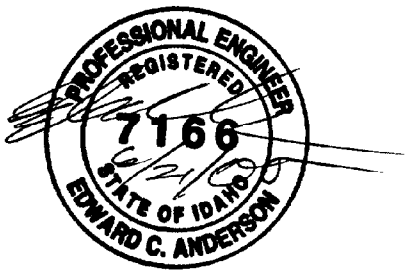
TMI-2 Fuel Vacuum Dryer Specification

The following Procurement Specification was prepared under the responsible charge of the Professional Engineer as indicated by the seal and signature below.



Project Title: **TMI-2 FUEL VACUUM DRYER SPECIFICATION**
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1.0 SCOPE

1.1 Introduction

This document specifies the minimum requirements for the design, fabrication, testing, supply, system checkout, and delivery of a Heated Vacuum Drying System (HVDS). Any proposed substitutions or exceptions to this specification require the contractor's approval. All of the components of the HVDS can be designed and fabricated from standard off-the-shelf type components and hardware.

The HVDS is used to perform heat and vacuum assisted liquid removal and drying of one to four canisters containing irradiated TMI-2 fuel debris. Each canister may initially contain up to 85 gallons of water but will be dewatered by contractor personnel prior to drying, leaving up to 20 gallons of water to be removed from each of the 342 TMI-2 canisters that will be cycled through the HVDS. However, the HVDS shall be capable of removing 85 gallons of water from each of four canisters concurrently (up to four canisters will be loaded into the HVDS vacuum furnace). The furnace is then sealed and the canisters will then be heated in the vacuum furnace while running the vacuum pump continuously until the required level of dryness is obtained. The fluid removed from the canister(s) is water contaminated with borats, clorides, radionuclides and trace amounts of volatiles. The dried fuel debris canisters will eventually be loaded into a larger dry shielded canister (DSC) for transfer and storage.

This HVDS unit is intended to provide back up assemblies and components for the existing HVDS manufactured by Exolon Systems or it may be installed as a complete parallel system. It shall be functionally identical to the previous unit in all respects-including the incorporation of the changes noted in this specification and the referenced sketches and drawings.

1.2 Work Included

The work set forth by this specification shall include the following:

- The incorporation of design changes the original HVDS and fabrication of one HVDS complete and ready for use, which meets the performance requirements of this specification. The HVDS shall consist of three assemblies: **the vacuum furnace assembly** (e.g., vessel, internal spacers, system controller, heating elements, instrumentation, pressure relief, associated hose and fittings); **the condenser assembly** (e.g., isolation valve, refrigeration unit, associated hose and fittings); the **vacuum pump assembly** (e.g., motor, filter and instrument panel and ancillary hoses). Design requirements for the three assemblies are given in Section 5.

- System inspection, operational checkout and acceptance at the subcontractor's shop prior to shipping.

- Documentation including: equipment drawings, as-built shop drawings, data sheets, QA paperwork, PLC (programmable logic controller) and DTAM (operator interface) software and programs in printed and digital format, and operating and maintenance instructions and manuals as specified on Form 414.12A attached.

- Packaging and shipping to the INEEL.

1.3 Related Work by Others

The scope of work does not include the following activities or items, which are provided by others:

- Unloading of the HVDS at the INEEL.

- TMI-2 storage or drying system hardware other than the HVDS described in this specification.

- Installation of the HVDS at the INEEL.

2.0 TECHNICAL TERMINOLOGY

The following definitions and abbreviations shall apply as used with this specification:

2.1 Definitions

Contractor is hereby defined as meaning Bechtel BWXT Idaho, LLC (BBWI).

Subcontractor is hereby defined as meaning the entity awarded the contract for furnishing the equipment specified herein.

Work is hereby defined as meaning collectively all work associated with providing the HVDS equipment to be supplied by the subcontractor under the Contract.

Equipment is hereby defined as meaning collectively and all components, materials, items and parts, or portions thereof to be supplied by the subcontractor under the Contract.

Mixed Waste is waste comprised of hazardous and radioactive material as defined in 40CFR 260.10 and Department of Energy Order 0435.1, respectively.

Commercial Grade Item an item that is:

A. Not subject to design or specification requirements unique to nuclear facilities
B. Used in applications other then nuclear facilities
C. Ordered from manufacture or subcontractor based on specifications published in the manufactures product description (PDD-1; NQA-1-1994, part 1; DOE/RW-0333P)

Hold Point is a point which fabrication cannot proceed without contractor approval.

2.2 Abbreviations

The abbreviations applicable to this specification are as follows:

AISC	American Institute of Steel Construction
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
DSC	Dry Shielded Canister
HVDS	Heated Vacuum Drying System
IEC	International Electrotechnical Commission
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFP(A)	National Fluid Power Association
NFPA	National Fire Protection Association
P&ID	Piping and Instrumentation Diagram
VDS	Vacuum Drying System
VFA	Vacuum Furnace Assembly
TC	Thermocouple

3.0 APPLICABLE CODES, STANDARDS, AND REFERENCES

All services shall be provided and all equipment and materials shall be furnished and tested in accordance with the codes and standards referenced in this section and/or shown on referenced sketch 1-5. The current issue of the following documents (unless otherwise noted) shall form part of the specification.

3.1 National Standards

ANSI AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI Y14.5M Dimensioning and Tollerancing

ASME AMERICAN SOCIETY FOR MECHANICAL ENGINEERS

ASME NQA-1	Quality Assurance Requirements for Nuclear Facility Applications
ASME B1.20.1	Pipe Threads, General
ASME B31.3	Process Piping
ASME Section V	NDE
ASME Section VIII	Division 1 Pressure Vessel Code
ASME Section IX	Welding and Brazing Qualifications

AISC AMERICAN INSTITUTE OF STEEL CONSTRUCTION

Manual of Steel Construction

ASNT AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING

ASNT SNT-TC-1A	Personnel Qualification and Certification in Nondestructive Testing

AWS AMERICAN WELDING SOCIETY

AWS A2.4	Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0	Welding Terms and Definitions
AWS D1.1	Structural Welding Code Steel
AWS QCI	Standard for AWS Certification of Welding Inspectors

NFPA NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 70 NATIONAL FIRE PROTECTION CODE

IEC INTERNATIONAL ELECTROTECHNICAL COMMISSION

NEC NATIONAL ELECTRICAL CODE

DOE-ID Architectural and Engineering Standards

Appendix M	Standard for Piping Materials and Pipe Numbering, Labeling, and Color Coding (For labeling and identification only)

3.2 TMI-2 Canister Heated Vacuum Drying System HVDS Drawing List

Drawing No.	Drawing Type	Date	Revision	EXOLON/SPRINGS FABRICATION DWG NO.	Date	Revision	No of Sheets	Drawing Title
503082			0				1	TAN TMI-2 VACUUM FURNACE LIFT FIXTURE
503106			1				3	TMI-2 VACUUM FURNACE INSTALLATION
503107			0				1	TAN TMI-2 VACUUM FURNACE SPACER RING(TASK DELETED – DWG NOT ISSUED)
503545			4				2	TMI-2 AIR SWEEP PIENUM ASSEMBLY
503674			4				1	TMI-2 HVDS VACUUM FURNACE SUPPORT BRACES
503699			0				1	HVDS P&ID (NOT RELEASED)
507657			1				5	TMI-2 FURNACE LID OPENER ASSEMBLY
507658			2				3	TMI-2 FURNACE LID OPENER ASSEMBLY INSTALLATION
507782			0				1	TMI-2 VACUUM FURNACE HEATER PROTECTOR INSTALLATION
507783			0				1	TMI-2 VACUUM FURNACE HEATER PROTECTOR INSTALLATION ASSEMBLY
509821	ED		0				1	TMI-2 HEATED VACUUM DRYING SYSTEM DEMISTER FILTR FLT3 FILTER END CAPS
509822	ED		0				1	TMI-2 HVDS DEMISTER FILTER INSTALLATION AND SPANNER WRENCH
511458	SP	Not released	0				1	TMI-2 HEATED VACUUM DRYING SYSTEM DPIT1A GAUGE INSTALLTION
509284	ED		0				1	TMI-2 VACUUM FURNACE CAINSTER HOLE COVERS
507771			0				1	TMI-2 HVDS FURNACE LID OPENER SYSTEM BLOCK DIAGRAM
507772			0				2	TMI-2 HVDS FURNACE LID OPENER SYSTEM PANEL ASSEMBLY
507773			0				1	TMI-2 HVDS FURNACE LID OPENER SYSTEM WIRING DIAGRAM

Drawing No.	Drawing Type	Date	Revision	EXOLON/SPRINGS FABRICATION DWG NO.	Date	Revision	No of Sheets	Drawing Title
509455		5/4/99	0				2	TMI-2 HVDS REMOTE AIR SWEEP POWER ENCLOSURE ASSEMBLY AND DETAILS (SK-037)
509456		5/4/99	0				1	TMI-2 HVDS REMOTE AIR SWEEP POWER ENCLOSURE WIRING DIAGRAM (DWS-SK-037)
510299		Not released					1	TMI-2 GAS SAMPLE MONITORING SYSTEM P&ID
509547*		5/26/99	3.0	VDS3CPS1'	1/18/99	2.2	1 of 4	PIPING SCHEMATIC
509548*		5/26/99	3.0	VDS3CPS2'	1/18/99	2.2	2 of 4	PIPING SCHEMATIC
509549*		5/26/99	3.0	VDS3CPS3'	6/8/98	2.1	3 of 4	PIPING SCHEMATIC
509550*		5/26/99	2.0	VDS33CPS4'	1/19/99	1.6	4 of 4	PIPING SCHEMATIC
509551*		5/26/99	2.0	VDS300-VPS'	2/13/98	1.3	1 of 2	VPS OUTLINE VIEWS
509552*		5/26/99	2.0	VDS300-VPS'	1/26/99	1.4	2 of 2	VPS OUTLINE VIEWS
509539*		5/26/99	2.0	VDS300-VPS'	2/13/98	1.3	1 of 5	VPS OUTLINE VIEWS
509540*		5/26/99	2.0	VDS300-VPS'	2/13/98	1.3	2 of 5	VPS OUTLINE VIEWS
509541*		5/26/99	2.0	VDS300-VPS'	2/13/98	1.3	3 of 5	VPS OUT LINE FIEWS
509542*		5/26/99	2.0	VDS300-VPS'	2/13/98	1.3	4 of 5	VPS OUT LINE VIEWS
509543*		5/26/99	1.0	VDS300-VPS'	JULY 98	0.0	5 of 5	VPS OUTLINE VIEWS
5099537*		5/26/99	2.0	VDS-VPS-CP'	2/13/98	1.0	1 of 2	VACUUM PUMP SKID CONTROL PANEL
5099538*		5/26/99	2.0	VDS-VPS-CP'	1/26/99	1.0	2 of 2	VACUUM PUMP SKID CONTROL PANEL
509544*		5/26/99	2.0	VDS-VCS-CP'	1/26/99	1.2	1 OF 3	VACUUM CONDENSER SKID CONTROL PANEL
509545*		5/26/99	2.0	VDS-VCS-CP'	1/26/99	1.2	2 OF 3	VACUUM CONDENSER SKID CONTROL PANEL
509546*		5/26/99	2.0	VDS-VCS-CP'	6/11/98	1.1	3 OF 3	VACUUM CONDENSER SKID CONTROL PANEL
509559*		5/26/99	3.0	VDS300-ES'	1/19/99	2.3	1 OF 8	ELECTRICAL SCHEMATIC
509560*		5/26/99	3.0	VDS300-ES'	6/16/99	2.1	2 OF 8	ELECTRICAL SCHEMATIC
509561*		5/26/99	3.0	VDS300-ES'	1/19/99	2.3	3 OF 8	ELECTRICAL SCHEMATIC
509562*		5/26/99	3.0	VDS300-ES'	1/19/99	2.3	4 OF 8	ELECTRICAL SCHEMATIC
509563*		5/26/99	3.0	VDS300-ES'	1/19/99	2.3	5 OF 8	ELECTRICAL SCHEMATIC
509564*		5/26/99	3.0	VDS300-ES'	1/19/99	2.3	6 OF 8	ELECTRICAL SCHEMATIC
509565*		5/26/99	3.0	VDS300-ES'	1/19/99	2.3	7 OF 8	ELECTRICAL SCHEMATIC
509566*		5/26/99	3	VDS300-ES'	1/19/99	2.3	8 OF 8	ELECTRICAL SCHEMATIC
510044*		3/10/00	2	HEPA17-INEL'	5/26/99	1	1	HEPA EXHAUST FILTER

Drawing No.	Drawing Type	Date	Revision	EXOLON/SPRINGS FABRICATION DWG NO.	Date	Revision	No of Sheets	Drawing Title
				HVF8S'	10/29/97	0	1	HIGH VACUUM INLT FILTER MODEL – FTR2-300
509553*		5/26/99	8	10000051+		7	1 OF 6	STAINLESS VACUUM CHAMBER VESSEL DETAILS
509554*		5/26/99	7	10000051+		6	2 OF 6	STAINLESS VACUUM CHAMBER VESSEL DETAILS
509555*		5/26/99	7	10000051+		6	3 OF 6	STAINLESS VACUUM CHAMBER VESSEL DETAILS
509556*		5/26/99	7	10000051+		6	4 OF 6	STAINLESS VACUUM CHAMBER VESSEL DETAILS
509557*		5/26/99	7	10000051+		6	5 OF 6	STAINLESS VACUUM CHAMBER VESSEL DETAILS
509558*		5/26/99	7	10000051+		6	6 OF 6	STAINLESS VACUUM CHAMBER VESSEL DETAILS
Sketch 1*		4/20/00	0				1 OF 5	Photos of HVDS Mods
Sketch 2*		4/20/00	0				2 OF 5	Photos of HVDS Mods
Sketch 3*		4/20/00	0				3 OF 5	Mechanical Drawings of HVDS Mods
Sketch 4*		4/20/00	0				4 OF 5	Mechanical Drawings of HVDS Mods
Sketch 5*		4/20/00	0				5 OF 5	Mechanical Drawings of HVDS Mods

*** LMITCO Drawing Number**
' EXELON Drawing Number
+ Springs Fabrication Drawing Number

4.0 SUBMITTALS

4.1 Submittals

The subcontractor shall submit all data described in this Specification including that identified on the Vendor Data Requirements Form 414.12A attached. Submittals shall be made at the times, in the copy quantities, and for the purposes shown on Form 414.12A. Each submittal must identify the submittal item number, specific component and the Purchase Order number.

For data submitted "for information only", the contractor reserves the right to require corrections and resubmittals of vendor data submitted by the subcontractor as necessary to achieve compliance with the requirements of this specification.

Approval by the contractor of documents submitted by the subcontractor or their subtier supplier shall not relieve the subcontractor of the responsibility for correctness of the content of the documents. Responsibility for conformance with all provisions of contract requirements, including compliance with applicable regulations, codes or standards shall rest with the subcontractor.

4.1.1 Submittals

The subcontractor shall provide the following documents to the contractor in accordance with the schedules shown on Form 414.12A attached:

- Quality Assurance Program.
- Manufacturing, Inspection and Test Plan, including detailed test procedures (per paragraphs 8.1 of this specification).
- Detailed shop drawings for fabrication of the HVDS. Drawings shall include an electrical schematic and a complete parts list.
- Detailed electrical system control drawings with interconnecting diagrams, block diagrams, single line electrical schematics, cabling, and terminations. The drawings are to identify contacts, overload breakers, and any special electrical features or sensors. Parts lists shall include the individual components used in the system. Labeling and marking shall identify the source and destination connections of individual wires, cables, and controls (see Appendix B, AE Standard for Labeling.)
- Piping and Instrumentation Diagrams (P&ID) identifying lines, instruments, and equipment. All components shall be labeled physically and identically designated on the P&ID (see Appendix B). Existing, valves

and other components are to be numbered identically to the corresponding component as the existing system.

- Assembly drawings in sufficient detail such that normal maintenance and repair activities may be conducted on all subcontractor furnished equipment. Specifically, any through-the-wall connections, heater core connections, etc. shall be detailed.

- Actual Certified Material Test Reports for all materials and weld filler materials used in load bearing, pressure boundary, or containment boundary service. For commercial grade items, a certificate of conformance shall be provided.

- Manufacturer's equipment data sheets for all commercial components including, but not limited to, fittings, valves and tubing.

- Welder and inspection personnel qualification records.

- Complete test, inspection and checkout documentation as specified in Sections 9.3, 9.4 and 9.5. The documentation shall include the test procedures used, the testing/checkout results, and any unsatisfactory conditions encountered along with the resolving/correction documentation.

- One complete set of as-built drawings in electronic form, AutoCAD version 14 or newer.

- Detailed printed and digital copies of the PLC (programmable logic controller) with all rung comments, all internal register addresses and I/O addresses fully identified.

- Detailed printed and digital copies of the DTAM (operator interface) program.

- A complete equipment list for all components of the HVDS and a list of all spare parts showing recommended spare parts. This list shall include name of manufacturer, part number for each part and appropriate technical and QA data. Recommended spare parts shall be supplied with the delivered Vendor Data Schedule.

- Tool control procedures.

- Cleaning procedure-describing methods of cleaning, verification of cleanliness, and maintenance of cleanliness through receipt at the INEEL.

- Packaging and handling plan.

4.1.2 Certificate of Compliance

The subcontractor shall provide a certificate of compliance for the completed HVDS with the following information:

- Identification of the purchased material or equipment by the subcontractor's purchase order number.
- List of specific codes and standards, which the equipment meets.
- Signature by the authorized QA representative responsible for the quality assurance of the purchased equipment.

4.2 Deviations

Consideration of any departures from drawings, specifications, or other contractual requirements shall be requested and recorded on a contractor Interface Document, Form 540.16, and shall be submitted to contractor for approval prior to implementation. The subcontractor shall not proceed with incorporation of changes until contractor approval is received.

4.3 Release To Ship

The subcontractor shall withhold shipment of items covered by this procurement until a Contractor Quality Release Form, 414.20, is received from the cognizant subcontractor Quality Representative. A copy of the Contractor Quality Release completed by the subcontractor shall be submitted to the Purchaser with the shipment. This release is to confirm completion of source inspection/test and does not indicate final acceptance.

5.0 DESIGN

5.1 General

The HVDS design shall be the functionally equivalent to the HVDS supplied to VECTRA for Lockheed Martin Idaho Technologies Co., Contract and incorporate changes noted herein and as depicted on BBWI sketches 1 - 5 and referenced drawings.

5.2 Design Requirements

5.2.1 General System Requirements

The HVDS shall be capable of satisfying the following design and operational requirements:

- The HVDS shall be functionally equivalent to the existing HVDS.
- The shell of the vacuum furnace shall be made of Type 316L stainless steel; any tubing, pipe, fittings and fasteners shall be 300 series stainless steel. Any variation from materials used in the existing HVDS shall be submitted for contractor approval prior to use of materials.
- All interfaces and connections between assemblies and with facility utilities shall be configured and located identical to the existing system.
- The HVDS system shall be capable of fully automated operation (using programmable logic control [PLC] technology) following manual initiation up to and including canister dryness acceptance testing (provision in the design shall be made for periodic manual acceptance testing).
- Provisions shall be made for remote system operation a minimum of 150 feet from the vacuum and condenser skids.
- The system shall have an automatic data-logging system identical to the existing system.
- The design shall provide for 1 to 4 TMI-2 canisters to be dried concurrently and shall be designed and fabricated to prevent insertion of greater than 4 TMI-2 canisters.
- System design shall preclude unfiltered effluent from entering the atmosphere.
- Liquid effluents from the system shall not exceed 100°F and 20 psig.
- The design shall be capable of providing for a minimum mass flow rate of 100-lb water/hour.
- Canister drying temperatures shall be a nominal 900°F and shall not exceed 1000°F.

- The system and its components shall be designed for a minimum of 1200 temperature and pressure cycles based on 120 drying cycles at 100 hours each over a period of two years.

- Special consideration shall be given to preclude the generation of mixed hazardous waste.

- A skid mounted control transformer for 480 VAC 3-phase to 120 VAC single-phase operation shall be provided. The control transformer(s) shall be mounted in the control box and sized by the subcontractor to adequately serve all 120 VAC components in accordance with NEC requirements.

- Motors and motor starters shall be in accordance with NEMA MG-1 or IEC standards and shall have NEMA 4 weatherproof enclosures. All other exposed electrical equipment, which could potentially be a safety hazard, or could be damaged by application of pressurized water, shall be enclosed in NEMA type 4 water-resistant enclosures.

- Each motor starter shall be minimum NEMA size 1.

- The motors and starters shall be rated and configured for 480 volt, 3-phase, 60-hertz operation 100% duty cycle.

5.2.2 System Instrumentation

The following are minimum instrumentation requirements to support the HVDS:

- Means for demonstrating canister dryness shall be such that two unlikely, independent equipment, system, or administrative failures are required to produce a false indication of canister dryness.

- Two pressure gauges (capacitance manometers) shall be mounted on or near the vacuum furnace and interlocked to provide automatic shutdown of the furnace heater when an overpressure condition is sensed. Equivalent equipment and configuration as existing system shall be used.

- Four thermocouples shall be used to monitor the internal temperature of the furnace in the same configuration as existing. Three additional thermocouples shall be installed in furnace locations approximately opposite thermocouples 1, 2, and 3 shown on Drawing SK #4 and shall be labeled with an A suffix. The added thermocouples shall be for temperature indication only and shall be provided with a separate cable/connector assembly used only for the parallel HVDS system configuration. Duel thermocouples shall be installed in each of the seven locations and shall be wired such that the thermocouples may be

changed with out removing the HVDS from its shielding cask. Thermocouples shall be installed with all metallic flex conduit to accommodate thermal expansion.

- Provisions shall be made for selected instrumentation, consistent with the existing HVDS unit; to be remotely located a minimum of 150 feet from the drying skid location.

- One compound pressure gauge and one capacitance manometer shall be mounted on the inlet side of the vacuum pump assembly.

- Furnace temperature control shall be included in the PLC with automatic shutdown capability provided.

- Sensors shall be installed at locations indicated on drawings.

- A thermocouple shall be installed in the inlet stream to the condenser assembly to monitor the flow stream temperature.

5.2.3 Vacuum Furnace Assembly

The following are minimum requirements for the vacuum furnace:

- The shell of the furnace shall be made of Type 316L stainless steel.

- The furnace shall be insulated. The insulation and jacket materials composition and thicknesses shall be identical to the original furnace.

- The furnace shall be able to heat 1 to 4 TMI-2 canisters concurrently (each canister envelope shall be a 14" nominal outside diameter and 150" in height). The furnace design and fabrication shall preclude insertion of greater than 4 TMI-2 canisters.

- Furnace shall be capable of supporting (4) 2940-lb TMI-2 fuel canisters.

- The furnace shall fit into a shipping cask with internals removed (51.25" I.D.).

- The furnace, except for piping and electrical conduit, shall be 170" inside height.

- Canisters placed in the furnace shall maintain a 2-1/2" outside to outside minimum spacing in a square lattice. Spacing shall be maintained by spacer disks with a thickness of at least ½" placed within 4" of the top and bottom of the canisters (canisters are 150" in height). All guide plates are to have 1/8"

chamfer on both the top and bottom surfaces of the canister openings. The top guide plates shall be drilled as shown on LMITC drawing 507782 for installation of heater protectors by the contractor.

- Heater protectors shown on LMITC drawing 507783 shall be fabricated and installed as shown on LMITC drawing 507782 by the subcontractor.

- Provisions, as shown on referenced sketch 4, shall be provided for contractor installation of spacer brackets to allow for furnace installation in alternate casks.

- Electric radiant heat shall be provided using durable elements.

- Maximum furnace temperature shall be 1000°F with nominal 900°F drying temperature.

- Furnace design pressure shall be +14.7 psig and 0 psia.

- The furnace shall be equipped with a drain line. The drain valve shall be accessible after the vacuum furnace is installed in a shielded vessel.

- The furnace pressure relief shall have a set pressure of 5 psig and be piped to the vacuum pumps HEPA filter inlet. This valve does not have to be ASME rated and stamped.

- The furnace design and fabrication requirements shall be consistent with the rules for ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. The vessel need not be ASME Code stamped.

- The furnace shall be fully compatible with all existing systems.

5.2.4 Condenser Assembly

The following are the minimum requirements for the condenser assembly:

- During initial system testing, the condenser shall be verified to remove 90% by mass of all water vapor leaving the vacuum furnace before it enters the vacuum pump assembly.

- Condenser operation shall not cause an interruption in the heat and vacuum operations of the HVDS.

- The condenser cooler loop shall be a closed loop system.

- The condenser assembly shall incorporate a form of capacity control such that it shall not cycle more than four starts per hour. The existing system cycles much more frequently, resulting in premature contactor failure. The unit shall be fully compatible with all existing systems.

5.2.5 Vacuum Pump Assembly

The following are minimum requirements for the vacuum pump assembly:

- The pump shall have a minimum rating of 300 cfm.

- The vacuum pump inlet filter shall be sized for the vacuum pump and have a nominal capacity capable of removing at least 98% of all particles 4 micron in size or larger.

- Pump sound level shall be maintained below 85 dBA measured 3 feet from the vacuum pump exhaust gas outlet.

- One ½" helium inlet connection and line shall be provided in the same location as the existing unit.

- Vacuum pump assembly instrumentation shall include one compound gauge, one manometer, and a differential pressure-indicating transmitter, Dwyer series 603A, installed per referenced sketches across FLT4 (Vac-Pump HEPA Filter).

- Design shall maintain oil, if required, and intercooler temperatures within manufacturer's specified limits. An oil-less vacuum pump equivalent to the existing oil type pump, requiring no changes to power, control, or operation is a desired option.

- The vacuum skid shall be capable of drawing the HVDS down to an operating pressure of .1 torr under normal operating conditions.

5.2.6 Hose Assemblies and Fittings

The following are minimum requirements for hose assemblies:

- Fitting design and selection shall consider ease of installation and disassembly.

- All fittings shall provide for leak tight connections.

- The hose assembly connecting the vacuum furnace to the condenser shall have a minimum length of 30 feet.

- The subcontractor shall supply a minimum of 25 feet of 1" drain hose with a male 1" NPT fitting.

- Hoses shall be supported by appropriate strain relief.

- Hoses shall be routed to minimize interference with lid opening apparatus.

5.2.7 Vacuum Pump and Condenser Skid Assemblies

The following are minimum requirements for the vacuum pump and vacuum condenser skid:

- All drying equipment, with the exception of the vacuum furnace, shall be skid mounted in same configuration as original system.
- The vacuum pump and vacuum condenser skids shall be limited to a total footprint of 100 ft^2 combined.

- The vacuum pump and vacuum condenser skid shall be fabricated from carbon steel structural tube, angle, channel, and/or plate and provided with a non-hazardous, pre-approved, durable protective coating.

- The vacuum pump and vacuum condenser skids shall be capable of protecting and supporting all HVDS components other than the vacuum furnace.

- The vacuum pump and vacuum condenser skids shall be designed so that the vacuum pump, filter, and valves are easily accessible and can be lifted using slings or with a fork-lift.

- All moving components such as drive shafts and gears shall be totally enclosed.

6.0 ENVIRONMENTAL AND SERVICE CONDITIONS

6.1 Ambient Conditions

All HVDS components shall be capable of operating continuously under any combination of the following process flow:

Ambient Conditions	Air, steam, and/or helium

Temperature	10°F to 120°F
Humidity	5% to 100%
Pressure	1 atm

6.2 Service Conditions

All HVDS components shall be capable of pumping fluids from the fuel debris canister with the following properties without damage to their operating characteristics:

Temperature	10°F to 1000°F
Humidity	0% to 100%
Pressure	10e-6 torr to 10 psig

The portion of the HVDS used to pressure test and provide a vacuum for the DSC shall be capable of pumping fluids with the following properties without damage to their operating characteristics:

Temperature	10°F to 400°F
Humidity	0% to 100%
Pressure	10e-6 torr to 22 psig

The subcontractor shall ensure that all HVDS internals that come into contact with the pumped fluid shall be fabricated from corrosion resistant materials.

7.0 MATERIALS

All HVDS components shall be constructed of materials which are suitable for the environment and functional requirements specified herein. Fitting, valve, gauge, and pump seal materials shall be Viton or other suitable material. A vacuum rated, low vapor pressure sealant shall be used on all connections in the vacuum line. Skids shall be equipped with swivel lift eyes and sized for 5:1 safety factor. Subcontractor shall submit vendor data verifying swivel lift eye rating per form 414.12A.

8.0 MANUFACTURING/ASSEMBLY

8.1 General

Industry standards referenced in Section 3.1 shall be followed during the fabrication and assembly of the HVDS.

The subcontractor shall prepare, maintain and use an Integrated Manufacturing, Inspection and Test Plan incorporating shop travelers which identifies the

manufacturing, inspection and/or test steps associated with initial material preparation through and including end item delivery. The Integrated Manufacturing, Inspection and Test Plan shall include the schedule for completion of all work with start and finish dates. The plan shall also identify and apply tentative dates to inspection hold points, including hold points specified by the contractor. The Integrated Manufacturing, Inspection and Test Plan shall be submitted to the contractor for inclusion of contractor specified hold points as referenced in Section 9.5.2.

The subcontractor shall maintain a set of redlined as-built configuration drawings, including actual materials used or purchased. The redlined as-built drawings shall be signed by the subcontractor's designated authority as representing the as-built condition and submitted to the contractor. Prior to shipment of the HVDS assembly, the original design drawings shall have the redlined as-built configuration incorporated, be identified as as-built and shall be submitted to the contractor.

8.2 Materials

8.2.1 Base Material

The subcontractor shall furnish the required materials identified in this Specification or shown on the drawings. Materials shall comply with the specified codes and standards in accordance with the Specifications and drawing callouts.

8.2.1.1 Certified Material Test Reports and Certifications

- The subcontractor shall obtain actual Certified Material Test Reports (CMTRs) for the materials designated for use in load bearing, pressure boundary, or containment boundary service. The CMTRs shall certify that the material has been inspected and tested in accordance with the material specification and meets the chemical and physical requirements of the material specification for the specific grade. The heat number shall be recorded on the CMTRs and on the material. CMTRs shall be submitted to the contractor in accordance with the Vendor Data Requirements Form 414.12A. For commercial grade items, a certificate of conformance shall be provided.

8.2.2 Welding Material

Welding filler metals and applicable codes and standards shall be as specified on the drawing and in this Specification.

8.2.2.1 Welding Filler Metal Certified Material Test Reports

All filler material used in fabrication for load bearing, pressure boundary or containment welds shall comply with the applicable requirements of ASME or AWS and shall have actual CMTRs issued by the original manufacturer or independent laboratory performing material testing for each lot/heat number. The heat number shall be recorded on the CMTR. The CMTR shall certify that the material has been tested in accordance with requirements of the material specification and that the results of the chemical analysis meet the requirements of the material specification for the ASME or AWS material classification specified.

The subcontractor shall submit a completed weld map/history in accordance with Vendor Data Requirements Form 414.12A certifying that the weld filler material used is of the same heat number marked on the CMTRs.

8.2.2.2 Welding Material Handling, Storage and Control

Except as otherwise specified, welding filler metals and fluxes shall be stored, handled and controlled in accordance with manufacturer's recommendations and with contractor approved procedures.

After welding filler metals have been removed from their original package, they shall be protected or stored so that their characteristics and welding properties are not affected. All consumable welding material shall be kept free of oil, grease, and foreign matter. Precautions shall be taken to minimize absorption of moisture. Tractability to heat or lot numbers shall be maintained.

Handling, storage, and control procedures for welding filler metals and backing material shall be submitted to the contractor in accordance with the Vendor Data Requirements Form 414.12A.

8.2.3 Gases

Shielding and purge gases shall be in accordance with applicable weld procedure.

8.2.4 Liquid Penetrant

Liquid penetrant materials shall meet the requirements of ASME Section 5, Article 6.

8.2.5 Magnetic Particle

Magnetic particle materials shall meet the requirements of ASME Section 5, Article 7.

8.3 Traceability

8.3.1 Material Marking

The subcontractor shall mark all items designated for use in load bearing structures or for pressure or containment boundaries with a unique identifier which is traceable to the original Certified Material Test Reports (CMTRs) or other certification documents which document that the specified requirements have been met. The identifier may be the heat, lot or other original material identification.

When material is subdivided, cut, or machined, or when the original mark must be removed, the unique identifier shall be permanently marked on the item in such a way as to maintain tractability. Temporary tags marked with the identifier may be used for items, which are too small for marking, until these items are permanently installed into the assembly.

Each end of straight lengths of bare welding metal shall be flagged, laser imprinted or permanently stamped to show the welding filler metal AWS Classification and heat number. Spooled welding filler metal shall be tagged on the end of the spool to show the welding filler metal AWS material classification and heat number.

8.3.2 Material Traceability

Certified Material Test Reports and other material traceability certifications in accordance with Sections 8.2.1.1 and 8.2.2.1, shall be submitted to the contractor per the Vendor Data Requirements Form 414.12A.

8.4 Fabrication

The subcontractor shall perform all operations to fabricate the Vacuum Furnace as called for in this Specification and as shown on the referenced drawings.

8.4.1 Welding Operations

Welding shall be performed by welders or welding operators qualified to ASME Section IX or AWS D1.1 as applicable. The subcontractor shall have on file documentation, affidavits, and records of testing and test results which

qualify the welder or welding operator for certification. These records shall be submitted to the contractor in accordance with the Vendor Data Requirements Form 414.12A.

The subcontractor shall assign each welder or welding operator with an identifying number, letter, or symbol to identify the welds performed by individual welders or welding operators.

All welding operations shall be performed using welding procedures qualified in accordance with Section 8.4.1.2.

8.4.1.1 Weld History

The subcontractor shall develop a weld map and weld history report, including the results of each inspection, examination and test, for each assembly designated as Quality Level 2. The weld history shall also include:

- Date the weld was made
- Fit-up inspection
- Base material heat number
- Welder or welding operator identification
- Weld filler material used with heat number
- Inspection method
- Acceptance criteria
- Weld procedure
- Weld joint number
- Inspector identification

The weld history shall be submitted to the contractor for approval in accordance with the Vendor Data Requirements Form 414.12A.

8.4.1.2 Welding Processes

All welding shall be performed using welding processes in accordance with ASME Section IX for stainless steel and AWS D1.1 for carbon steel. The weld procedure specifications and procedure qualification records shall be kept on record by the subcontractor, including revisions and effective dates of implementation, and shall be submitted to the contractor in accordance with the Vendor Data Requirements Form 414.12A.

8.4.1.3 Preparation of Base Metal

Surfaces within 1 inch of any weld location shall be free of any oil, grease, paint, or other material that would prevent proper welding. Plasma arc or laser beam cutting of material is permitted provided the cut surface is machined or ground a minimum of 1/16 inch to bright metal.

8.4.1.4 Welding Requirements

Welds shall provide a surface that is free from cracks, seams, laps, lamination, and porosity in excess of the acceptance criteria established in accordance with Section 8.4.1.6. Defective welds shall be repaired in accordance with Section 8.4.2. Arc strikes shall be removed by grinding in accordance with Section 8.4.2.4.

8.4.1.5 Temporary Welds

Temporary welds shall be subject to the same welding procedure requirements as the final welds. Temporary welds shall be removed unless otherwise permitted by the contractor. Surfaces at removed temporary welds shall be made flush with the original surface and inspected per Section 8.4.2.1.

8.4.1.6 Examination

All welds shall receive in-process examination and be visual and liquid penetrant or magnetic particle (as applicable) examined in accordance with applicable sections of ASME Section VIII, Division 1 for vessels and AWS D1.1 for static structures. Defective welds shall be repaired in accordance with Section 8.4.2.

8.4.2 Weld Repairs

8.4.2.1 Defect Removal

Defects shall be completely removed to clean, sound metal by grinding or other methods. Excavated areas shall be examined by liquid penetrant or magnetic particle, as applicable, to assure defect removal.

8.4.2.2 Weld Repair Procedures

Repairs of load bearing structures, or pressure or containment boundary welds to correct weld defects shall be made using the same procedures as for the original welds. Two repair attempts will be

allowed on any one weld. Subsequent weld repairs shall be made only after receiving written authorization from the contractor and using weld repair procedures approved by the contractor.

Cutting out and rebeveling, then rewelding is considered to be a weld repair.

8.4.2.3 Weld Repair Examination

Repaired areas shall be examined using the same examination methods and procedures by which the defect was originally detected.

8.4.2.4 Arc Strikes

Blemishes caused by arc strikes shall be ground to a smooth contour but no more than 1/32 inch of the base metal shall be removed. Cracks and Arc strikes extending more that 1/32-inch into the base metal shall be considered as a weld defect and repaired in accordance with Sections 8.4.2.

8.4.2.5 Rewelding

Rewelding shall be performed by welders or welding operators qualified in accordance with Section 8.4.1, using welding procedures qualified in accordance with Section 8.4.1.

The surfaces shall be cleaned before rewelding in accordance with Section 8.4.1.3. Rewelds shall meet all of the requirements for welding in this Specification. Defective rewelds can be grounds for rejection of the entire piece or member.

8.4.2.6 Weld Repair Reports

Weld repair reports shall be submitted to the contractor in accordance with Vendor Data Requirements Form 414.12A. The reports shall include all information required in Section 8.4.1.1 plus the examination procedure, the reason for rejection, the number of repairs performed, and documentation that the weld was repaired and accepted.

8.4.3 Tools and Equipment

Tools and equipment used by the subcontractor and tools and equipment used in the fabrication of stainless steel alloys shall be free from contamination. The tools shall be maintained free of grease, carbon steel particles, or any foreign matter detrimental

to fabrication. Mechanical cleaning tools used for stainless steel shall not cause carbon steel to be embedded into the surface. Grinding wheel material shall be resin bonded. Metal removal tools, wire brushes, and grinding wheels shall not have been previously used on other materials than stainless steels.

The subcontractor shall establish and maintain identification and control procedures for tools and equipment, including wire brushes and grinding wheels used on stainless steel materials. This includes the procedures for isolation, separation, and identification of stainless steel alloy cleaning and grinding tools. These procedures shall be submitted to the contractor in accordance with Vendor Data Requirements Form 414.12A.

The subcontractor shall submit calibration reports that demonstrate traceability to National Institute of Standards and Technology. This requirement shall be applicable to all inspection, test, and measuring equipment used work performed under this procurement.

8.5 Equipment Labeling

All components of the HVDS shall be identified on drawings and other submittals and labeled as shown on LMITCO drawings 5099537, 5099538 and 509944 to 509546, 509552, 509543. (EXOLON drawings VDS-VCS-CP, VDS-VPS-CP, VDS300-VCS, VDS300-VPS). Identification of components shall be identical to corresponding components of the existing HVDS. Markings shall be permanent. Metal tags are the preferred method.

8.6 Cleaning

8.6.1 Cleanliness of Piping, Tubing, Vessel, and Components

Prior to fabrication, all piping or tubing shall be cleaned both internally and externally using ethanol. The piping or tubing shall be maintained visually free of grease, cutting oils, iron oxides and other physical contaminates to NQA-1, Subpart 2.1, Class C cleanliness during fabrication, assembly, and installation.

The vacuum furnace vessel and other system components shall be inspected visually or by wipe test for NQA-1, Subpart 2.1, Class C cleanliness. Dirt, oil residue, metal chips, or other forms of contamination exceeding Class C limits shall be removed by contractor approved cleaning methods. Any entrapped water shall be removed. All items subject to internal or external corrosion, or contamination shall be suitably protected with all openings sealed with plugs, caps or other suitable means to maintain cleanliness.

9.0 QUALITY ASSURANCE

9.1 Program

The subcontractor shall document, implement and maintain a written quality assurance program (QAP) for the work described in this Specification. The QAP shall include controls for identifying suspect/counterfeit materials to assure that substandard, misrepresented, of fraudulent materials are not used for the fabrication and assembly of items under this contract.

The QAP shall be submitted to the contractor for approval in accordance with Vendor Data Requirements Form 414.12A prior to contract award. The QAP requirements shall be imposed on all subtier suppliers commensurate with the procurement activity.

9.2 Acceptance

Final inspection of the HVDS Equipment will be made following successful completion of inspection and system check-outs, and review and approval of all documentation required by this specification.

9.3 Non-Destructive Examination

All piping and structural welds shall receive visual (VT) and liquid penetrant (LP) or magnetic particle (MT), as applicable, examination as described in Section 8.4.1.6.

Nondestructive Examination process controls (materials, personnel, procedures and equipment) shall be in accordance with ASME Section V.

Inspections, examinations, and tests for welds and weldments shall be performed by subcontractor approved, qualified personnel in accordance with Section 9.3.2 using procedures in accordance with Section 8.4.1.6. The Inspection/Examination/Test Reports shall be submitted to the contractor in accordance with Vendor Data Requirements Form 414.12A.

The contractor shall have the right to inspect, examine, and test all welds, and to accept, reject, or demand removal of welds, which are in violation of this Specification or of the applicable welding procedure. The subcontractor shall provide access for this activity.

9.3.1 Nondestructive Examination Procedures

The subcontractor shall establish detailed examination procedures in accordance with ASME Section V and acceptance criteria for each

nondestructive examination required in accordance with Section 8.4.1.6 of this Specification to ensure conformance of the work to the contractual requirements. The detailed examination procedures shall be submitted to the contractor in accordance with Vendor Data Requirements Form 414.12A.

9.3.2 Nondestructive Examination Personnel Qualifications

Nondestructive examination (including visual examination) personnel shall be qualified for the applicable nondestructive testing method in accordance with the requirements of ASNT SNT-TC-1A Levels I, II, or III. Qualification as an AWS certified weld inspector per AWS QC-I is an acceptable alternative for visual examination.

The subcontractor and subtier suppliers shall maintain documentation, affidavits, and records of testing and test results, which qualified the nondestructive examination personnel including records of education, training, and experience, to validate qualification. Records of certification and qualification shall be submitted to the contractor in accordance with Vendor Data Requirements Form 414.12A.

9.4 Testing

9.4.1 Hydrostatic Test

The vacuum furnace vessel shall be hydrostatically tested at 27 psig in accordance with ASME Section VIII, Division 1 and consistent with the existing vacuum furnace. The subcontractor shall submit test procedure and test reports in accordance with Vendor Data Requirements Form 414.12A. When hydrostatic testing stainless steel components, the testing medium shall not contain more then 50 ppm chlorides.

9.4.2 Leak Test

After completion of the vessel and pipe/tubing assembly and prior to installing the heaters, perform the following tests:

- The entire system shall be leak tight to 10-7 atm-cc/sec under a 10-micron vacuum. Any components with indications of leakage shall be repaired or replaced and re-tested.

- Subcontractor shall perform a pressure rise vacuum test at 0.5 Torr or less held constant for one hour. Any components with indications of leakage shall be repaired or replaced and re-tested.

The subcontractor pneumatic test procedures and test reports shall be submitted to the contractor in accordance with Vendor Data Requirements Form 414.12A.

9.4.3 Heater and Thermocouple (TC) Testing

After leak testing and after installation of the Heaters and TC's on the Vacuum Furnace Assembly, the heaters and TC's shall be functionally tested and the test documented.

9.4.4 System Testing

Prior to shipment, the system shall be assembled and functionally tested to demonstrate operation. The subcontractor shall prepare and submit the system test procedure for contractor approval. As a minimum, the test procedure shall include verification of all specification requirements and the performance tests identified in this specification and in the attached (Appendix C) TMI-2 Canister Drying Testing and Monitoring Technical Procedures, TPR-1187 Assembly/Disassembly and Checkout and TPR-1188 Functional Testing. The tests shall be "bucket" tests in lieu of use of TMI-2 Canisters, shall be performed with the vacuum furnace free-standing without a cask, and shall recover the condensate to demonstrate condenser efficiency. The system test shall include a minimum of three operating cycles.

9.5 Inspections and Hold Points

9.5.1 Inspection/Test Data

Results of all actual inspections/tests are to be submitted by the subcontractor to the contractor in suitable form. The inspection/test data required may be dimensional inspection data, functional test data, and/or nondestructive test data. In each case, the data must be able to correlate to the material/items being supplied. The data must include the following information, as applicable:

- Part number
- Drawing number/Specification number
- Serial number
- Lot identification number
- Heat/melt number
- Subcontract/purchase order number
- Each characteristic inspected/tested and the inspection/test sequence
- Each characteristic requirement, including drawing or specification Section reference

- Inspection/test results (attributes or variables data)
- Inspection/test equipment used
- Inspection/test set-up employed
- Inspection/test environment
- Inspector's/tester's/interpreter's name/number
- Supervisor's signature
- Test record for the procedure employed

9.5.2 Hold Points

The contractor reserves the right to establish and witness on the manufacturing, inspection, test plan, and shop travelers hold-points as deemed appropriate. As a minimum, the following activities shall be witnessed by the contractor's representative and serve as hold points:

- Verification of critical dimensions as defined on drawing 509554.
- Hydrostatic and Leak testing
- Heater testing
- System functional test

The contractor's representative shall be notified at least 10 working days in advance of each activity.

10.0 PACKAGING AND SHIPPING

All items shall be inspected for cleanliness to the requirements of section 8.6.

The HVDS assembly shall be packaged to prevent soiling or physical damage during shipping, handling and outdoor storage. Orientation, lifting points, package gross weight and handling and storage precautions shall be clearly marked on the packages. Handling, packaging and shipping procedures and method for off-loading including Professional Engineer (PE) reviewed and approved rigging diagrams, shall be submitted to the contractor in accordance with Vendor Data Requirements Form 414.12A.

10.1 Nameplates

Each major HVDS subcomponent (vacuum furnace, condenser, vacuum pump, motor, circulation pump(s), tanks, etc.) shall have the manufacturer's standard identification tag permanently mounted in a visible location.

APPENDIX A

VENDOR DATA REQUIREMENTS

The Subcontractor shall furnish to the Contractor the specified number of copies of required vendor data for disposition, sufficiently in advance of the date that the material/equipment/service is required to be delivered and/or completed as defined by the Purchase Order. The Vendor Data Requirements Form summarizes the submittal requirements of the Purchase Order and generally specifies the timing for each required submittal. Vendor data for all material and equipment requiring a disposition shall be submitted, reviewed, assigned a disposition code by the Contractor and returned to the Subcontracter. Unless designated as With Shipment, Vendor data shall be submitted under cover of Contractor Form 540.03, Vendor Data Transmittal and Disposition, to:

Bechtel B&W Idaho (BBWI), LLC.
Procurement Document Control
P. O. Box 1625
Idaho Falls, ID 83415-3521

Vendor Data shall be legible, reproducible, and comply with all applicable Purchase Order requirements. Vendor data submittals shall not be utilized to request deviations from, or changes to, the Purchase Order. Vendor data shall be submitted on a stand-alone basis. Reference to, or review of, previous submittals is prohibited. Vendor data shall clearly identify the submittal item and the submittal number to which it applies.

The Subcontractor and all lower-tier suppliers shall perform no work for which the vendor data has not been reviewed and dispositioned by the Contractor in accordance with the Vendor Data Requirements.

Vendor data causing any change to design details, layouts, calculations, analysis, test methods, procedures, or any other Purchase Order requirements shall be identified to the Contractor utilizing Form 540.16, Interface Document.

Vendor Data disposition codes are:

'A' - (APPROVED), Related work may proceed.
'B' - (APPROVED W/COMMENTS), Related work may proceed ONLY after comments have been incorporated or otherwise reconciled.
'C' - (DISAPPROVED), Related work shall NOT proceed. Resubmit.
'D' - (INFORMATION ONLY SUBMITTAL - RECEIPT ACKNOWLEDGED), No further action is required.

Requisition No.: _____

Item Number	Item Description	Clause/Article Reference	Specification Reference	Quantity/Schedule				Contractor Reviews										Contractor Approval Required/Info Only
				BFR	BU	PS	WS	Requestor	Procurement QA	Operations	Engineering	Program QA	Procurement Agent					
	Design Verification																	
	Specification																	
	Design Calculations																	
	Characteristic Calculations																	
	Performance Calculations																	
1	Test Reports		4.1.1, 9.4, 9.5			X		X	X	X	X	X	X					A
	Correction Calculations																	
	Characteristic/Performance Curves - ☐ Actual ☐ Typical																	
	Characteristic Curves																	
	Performance Curves																	
	Test Result Curves																	
	Calibration Curves																	
	Operating Curves																	
	Correction Curves																	
	Design/Qualification Testing																	
2	Catalog Data		4.1.1, 7.0		X			X	X	X	X	X	X					A
3	Engineering Drawings/Reproductions		4.1.1	X				X	X	X	X	X	X					A
4	Schematics		4.1.1	X				X	X	X	X	X	X					A
	Block Diagrams																	
	Piping Plan																	

BFR – Before Fabrication Release BU – Before Use By Subcontracter PS – Prior To Shipment WS – With Shipment A – Approval Required I – Information Only

Requisition No.: _____

Item Number	Item Description	Clause/Article Reference	Specification Reference	Quantity/Schedule				Contractor Reviews										Contractor Approval Required/Info Only
				BFR	BU	PS	WS	Requestor	Procurement QA	Operations	Engineering	Program QA	Procurement Agent					
5	Piping Elevation		4.1.1	X				X	X	X	X	X	X					A
	Foundation Plan																	
6	Elevation Drawing		4.1.1	X				X	X	X	X	X	X					A
7	General Arrangement Drawings		4.1.1	X				X	X	X	X	X	X					A
8	Structural Detail Drawings		4.1.1	X				X	X	X	X	X	X					A
9	Assembly Drawing		4.1.1	X				X	X	X	X	X	X					A
10	Interface Drawing		4.1.1	X				X	X	X	X	X	X					A
11	Flow Diagrams (P. & I.D.)		4.1.1	X				X	X	X	X	X	X					A
	Panel Cutout Drawings																	
12	Original As Built Tracings		4.1.1			X		X	X	X	X	X	X					I
	Weight of Unit																	
	Descriptive Data																	
	Connection Drawing																	
13	Weld Map and History		4.1.1, 8.4.1.1			X		X	X	X	X	X	X					I
14	Manufacturing/Inspection/Test Plan		4.1.1, 8.1,9.5.1	X				X	X	X	X	X	X					A
	Traceability Procedure																	
15	Bill of materials		4.1.1	X				X	X	X	X	X	X					A
16	Cleaning Procedure		4.1.1, 8.6.1		x			X	X	X	X	X	X					A
	Heat Test Procedure																	
	Sensitive leak Test Procedure																	
17	Hydrostatic Test Procedure		4.1.1, 9.4.1		X			X	X	X	X	X	X					A

BFR – Before Fabrication Release BU – Before Use By Subcontracter PS – Prior To Shipment WS – With Shipment A – Approval Required I – Information Only

Requisition No.: _____

Item Number	Item Description	Clause/Article Reference	Specification Reference	Quantity/Schedule				Contractor Reviews										Contractor Approval Required/Info Only
				BFR	BU	PS	WS	Requestor	Procurement QA	Operations	Engineering	Program QA	Procurement Agent					
18	Pneumatic Test Procedure		4.1.1, 9.4.2		X			X	X	X	X	X	X					A
19	Liquid Penetrate Test procedure		4.1.1, 9.3.1		X			X	X			X	X					A
20	Magnetic Particle Test Procedure		4.1.1, 9.3.1		X			X	X			X	X					A
	Radiographic Procedure																	
	Ultrasonic Test Procedure																	
21	Visual Examination Procedure		4.1.1, 9.3.1		X													
22	Weld Procedure/Qualification		4.1.1, 8.4.1.2		X			X	X		X	X	X					A
23	Welder Performance Personnel Certification		4.1.1, 8.4.1		X			X	X			X	X					A
	Hi Pot Dielectric Insulation Test Procedure																	
	Continuity/Resistance Test Procedure																	
	Free Iron Test Procedure																	
24	Calibration Procedure		4.11, 9.4.1		X			X	X		X	X						A
	Inspection/Test Procedure																	
	Weld Joint Test Specimens																	
25	Non Destructive Examination Personnel Certifications		4.1.1, 9.3.2		X			X	X			X	X					A
	Inspector Certifications																	
	Test Certifications																	
	Serialization Procedure																	
	Inspection Test Data																	
	Limited Shelf Life/Operational Life Data																	
26	Recommended Spares		4.1.1			X		X	X	X	X	X	X					I

BFR – Before Fabrication Release BU – Before Use By Subcontracter PS – Prior To Shipment WS – With Shipment A – Approval Required I – Information Only

Requisition No.: _____

Item Number	Item Description	Clause/Article Reference	Specification Reference	Quantity/Schedule				Contractor Reviews										Contractor Approval Required/Info Only
				BFR	BU	PS	WS	Requestor	Procurement QA	Operations	Engineering	Program QA	Procurement Agent					
	Manufacturer's Manuals																	
	Special Tools List																	
	Installation Manual (including drawings)																	
	Maintenance Manual																	
	Operating Manual																	
27	Chemical/Physical Test Reports – xActual ☐ Typical		4.1.1, 8.2.1.1, 8.2.2.1		X			X	X		X	X	X					A
28	Certificate of Conformance		8.2.1.1, 4.1.1		X			X	X		X	X	X					A
29	Special Packaging, Shipping, and Rigging Procedures		4.1.1, 10.0		X			X	X	X	X	X	X					A
30	Certification of Materials to ASME Code		4.1.1, 8.2.4, 8.2.5		X			X	X			X	X					A
	Certificate of Disposal or Destruction																	
	Additional Submittal Requirements																	
31	Detailed PLC Program (printed & digital)		4.1.1			X		X	X	X	X	X	X					A
32	Detailed DTAM (operator interface) Program (printed & digital)		4.1.1			X		X	X	X	X	X	X					A
33	Analysis of water for Cl- used in hydrostatic testing of stainless steel		4.1.1, 9.4.1		X			X	X		X	X						A
34	System Test Procedure		4.1.1,5.2.4,9.4.4		X			X	X	X	X	X	X					A

BFR – Before Fabrication Release BU – Before Use By Subcontracter PS – Prior To Shipment WS – With Shipment A – Approval Required I – Information Only

APPENDIX B

Standard for Piping Materials and Pipe Numbering, Labeling, and Color Coding

STANDARD
for
PIPING MATERIALS
and
PIPE NUMBERING, LABELING AND COLOR CODING

PREFACE

This document consists of a Piping Material for each Line Class. The Piping Material Service Code/Line Class/Color Code/Fluid Category Index lists piping system service codes and identifies the Line Class or Classes that are applicable to each service code. New piping systems at INEEL facilities that require a pipe identification system shall use the Index guidelines unless otherwise directed in specific facility or project design criteria. Facilities with other piping identification systems will provide the Design Organization with a labeling scheme to be used on the design documents.

The Piping Material Standards provide a set of standard piping materials and components based upon criteria which has been established for piping systems at ICPP. The standard materials are recommended for new work at other INEEL facilities and are required for new work at SMC. Each service material designated can be referenced to an applicable code. See Sections 1540 through 1543 for the applicable code.

The piping material standards along with the body of the DOE-ID AE Standards and the applicable code provide a basic guideline to specifying piping materials. These standards do not substitute for education, experience and sound engineering judgement. The material standards are to be considered a starting point and in no way relieve the designer from researching original installation specifications on existing facilities and performing all appropriate piping stress analysis on new designs and specifying piping materials accordingly.

Evaluation of a system may require specification of a more appropriate material than those listed in the material standards. At ICPP and SMC lesser material specifications can only be used upon written approval from appropriate facility representatives. For example, at ICPP or SMC, the Design Engineering Organization may approve alternate piping materials.

For new construction at the FAST facility the various FAST piping specifications shall be used for piping design purposes. See ICPP Design Engineering Organization for more information on FAST specifications.

PIPING MATERIAL
SERVICE CODE / PIPING LINE CLASS / COLOR CODING / FLUID CATEGORY INDEX

SERVICE CODE	SERVICE	LINE CLASS	MATERIAL	COLORS BACKGROUND LETTER	ASME B31 FLUID CATEGORY	NOTES
AA.	Atmospheric Air	AR	Stainless Steel 304L	Blue/White	D	
AC	Acetylene	AR	Stainless Steel 304L	Yellow/Black	Base	
AH	Ammonium Hydroxide	AR	Stainless Steel 304L	Yellow/Black	Base	(1)
AM	Air-Methane	AR	Stainless Steel 304L	Blue/White	D	(d)
AN	Aluminum Nitrate	AR HA	Stainless Steel 304L Hastelloy G-30 [R]	Yellow/Black	Base	(1)
AR	Argon	AR	Stainless Steel 304L	Blue/White	D	
AS	AMSCO	AR NN	Stainless Steel 304L Carbon Steel	Yellow/Black	Base	(D)
AW	Analytical Grade Water	NK	Copper Tubing	Green/White	D	
BA	Breathing Air	AM AR NN	Stainless Steel Tube Stainless Steel 304L Carbon Steel	Blue/White	D	
BB	Boiler Blowdown	NN	Carbon Steel	Yellow/Black	ASME B31.1	
BC	Boiler Chemical	NN	Carbon Steel	Yellow/Black	Base	
BF	Boiler Feedwater	NN	Carbon Steel	Yellow/Black	ASME B31.1	
BR	Chilled Brine Coolant	NN	Carbon Steel	Green/White	D	
BW	Basin Water	AR	Stainless Steel 304L	Yellow/Black	D	(e)
CB	Emergency HF Acid Drain			Yellow/Black	M	
CC	Cask Coolant	AR	Stainless Steel 304L	Green/White	D	(e)
CE	Cation Effluent	NF	Carbon Steel Polypropylene Lined	Green/White	D	
CG	Cell Off Gas	AR	Stainless Steel 304L	Yellow/Black	M	(1)(a)
CL	Chlorine	NF	Carbon Steel Polypropylene Lined	Yellow/Black	M	
CN	Calcium Nitrate (Dry and Solution)	AR	Stainless Steel 304L	Yellow/Black	D	
CO	Chromic Oxide	AR	Stainless Steel 304L	Yellow/Black	BASE	
CO2	Carbon Dioxide	AR NJ	Stainless Steel 304L Galv. Carbon Steel	Blue/White	D	(20) (20)
CP	Cadmium Sulfate	AR CA	Stainless Steel 304L Carpenter 20 Cb3[R]	Yellow/Black	BASE	
CR	Chilled Water Return	AR	Stainless Steel 304L	Green/White	D	

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SERVICE CODE	SERVICE	LINE CLASS	MATERIAL	COLORS BACKGROUND LETTER	ASME B31 FLUID CATEGORY	NOTES
		NK NN	Copper Tubing Carbon Steel			
CS	Chilled Water Supply	AR NK NN	Stainless Steel Copper Tubing Carbon Steel	Green/White	D	
CT	Condensate	AR HG NN NS NC NK	Stainless Steel 304L Hastelloy G-30^{R} Carbon Steel Fiberglass Reinf. Plastic (FRP) Carbon Steel - Weld Fittings Copper Tubing	Yellow/Black	D	(1) (6) (10)
CU	Common Utility	AR	Stainless Steel 304L	Yellow/Black	BASE	
CW	Potable Water (Hot or Cold)	NJ NK NN NR ND NW	Galv. Carbon Steel Copper Tubing Carbon Steel Concrete-Lined Ductile Iron CPVC PVC	Green/White	UPC	(c) (5) (22) (4) (3)
CWR	Cooling Water Return	AR NK NN	Stainless Steel 304L Copper Tubing Carbon Steel	Green/White	D	(F)
CWS	Cooling Water Supply	AR NK NN	Stainless Steel 304L Copper Tubing Carbon Steel	Green/White	D	(F)
DA	Drying Air	NN	Carbon Steel	Blue/White	D	
DC	Decontaminant Solution	AB AR BD HC HG	Nitronic 50^{R} Stainless Steel 304L Stainless Steel 304L 10,000 psi rated Hastelloy C-4^{R} or C-22^{R} Hastelloy G-30^{R}	Yellow/Black	BASE OR M	(15) (f) (g) (1)
DE	Diatomaceous Earth	AR NJ	Stainless Steel 304L Galv. Carbon Steel	Green/White	D	
DG	Dissolver Off-Gas	AA AR	Monel 400^{R} Stainless Steel 304L	Yellow/Black	M	(a) (1)
DL	Diesel oil	NN	Carbon Steel	Yellow/Black	BASE	
DN	Denitrator Product	AC AD	Stainless Steel 347 Stainless Steel Sch 40 and Sch 80 304L	Yellow/Black	M	(b)
DO	Dodecane	AR	Stainless Steel 304L	Yellow/Black	BASE	
DP	DOP Aerosol	AR	Stainless Steel 304L	Yellow/Black	M or D	(h)(a)
DW	Demineralized Water	AR	Stainless Steel 304L	Green/White	D	(1)

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SERVICE CODE	SERVICE	LINE CLASS	MATERIAL	COLORS BACKGROUND LETTER	ASME B31 FLUID CATEGORY	NOTES
EA	Exhaust Air	AR	Stainless Steel 304L	Blue/White	D	(G)(e)
ED	Ethylene Diamine Tetracetic Acid	AR AD	Stainless Steel 304L Stainless Steel Sch 40 and Sch. 80 304L	Yellow/Black	BASE	
FA	Fluidizing Air	AR NN	Stainless Steel 304L Carbon Steel	Blue/White	D	
FB	Fluoboric Acid	CA HC NB	Carpenter 20 Cb-3^{R} Hastelloy C-4^{R} or C-22^{R} Carbon Steel ECTFE-Lined	Yellow/Black	M	
FL	Fuel Oil	AR NN	Stainless Steel 304L Carbon Steel	Yellow/Black	BASE	
FM	Fire Extinguishing Foam	NN	Carbon Steel	Red/White	NFPA	
FP	Filtered Product	AR	Stainless Steel 304L	Yellow/Black	M	(b)
FR	Freon	NM	Copper Tubing (Refrigerant)	Yellow/Black	D	
FW	Fire Water	AR NJ NN NR NA	Stainless Steel 304L Galvanized Carbon Steel Carbon Steel Ductile Iron PVC per AWWA C900	Red/White	NFPA	(21) (14)(21) (5)(14)(21) (14) (19)
GL	Glycol Solution Supply	NN	Carbon Steel	Green/White	D	
GR	Glycol Solution Return	NN	Carbon Steel	Green/White	D	
GS	Gasoline	NJ NN	Galv. Carbon Steel Carbon Steel	Yellow/Black	BASE	
HA	High Pressure Air 100#	AC AM AR NN	Stainless Steel 347 Stainless Steel Tube Stainless Steel 304L Carbon Steel	Blue/White	E	(1)
HB	High Pressure Air 150# (Dry)	AM AR NN	Stainless Steel Tube Stainless Steel 304L Carbon Steel	Blue/White	D	
HE	Helium	AR	Stainless Steel 304L	Blue/White	D	
HF	Hydrofluoric Acid	AA HC NB NF NU	Monel 400^{R} Hastelloy C-4^{R} or C-22^{R} Carbon Steel ECTFE Lined Carbon Steel Polypropylene Lined	Yellow/Black	M	

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SERVICE CODE	SERVICE	LINE CLASS	MATERIAL	COLORS BACKGROUND LETTER	ASME B31 FLUID CATEGORY	NOTES
		NV	Solid PVDF Carbon Steel PVDF Lined			
HG	Halon Gas	AR	Stainless Steel 304L	Red/White	NFPA	
HH	Hydrogen	AR NN	Stainless Steel Carbon Steel	Yellow/Black	BASE	
HI	Instrument Air 100#	AM AR NN	Stainless Steel Tube Stainless Steel 304L Carbon Steel	Blue/White	D	
HS	High Pressure Steam	AM AR NC NN	Stainless Steel Tube Stainless Steel 304L Carbon Steel Weld Fittings Carbon Steel	Yellow/Black	D	(9)(6)(10) (1)
HW	High Level Waste	AR	Stainless Steel 304L	Yellow/Black	M	(a)(1) See ALSO PW
HWR	Hot Water Return	AD AR NN	Stainless Steel Sch. 40 and Sch. 80 304L Stainless Steel 304L Carbon Steel	Green/White	D	
HWS	Hot Water Supply	AD AR NN	Stainless Steel Sch. 40 and Sch. 80 304L Stainless Steel 304L Carbon Steel	Green/White	D	
HX	Hexone	AR NN	Stainless Steel 304L Carbon Steel	Yellow/Black	BASE	(1)
HY	Hydraulic Fluid	AR NN	Stainless Steel 304L Carbon Steel	Green/White	BASE	(1) (11)
JV	Jet Vent	AR NN	Stainless Steel 304L Carbon Steel	Yellow/Black	M	(a) (16
JW	Boric Acid or Borated Water	AR	Stainless Steel 304L	Yellow/Black	D	
KR	Kerosene	AR NN	Stainless Steel 304L Carbon Steel	Yellow/Black	BASE	
LA2	Low Pressure Air 20#	AM AR NN	Stainless Steel Tubing Stainless Steel 304L Carbon Steel	Blue/White	D	
LA5	Low Pressure Air 50#	AM AR NN	Stainless Steel Tubing Stainless Steel 304L Carbon Steel	Blue/White	D	
LH	Air (Humidified)	AM AR	Stainless Steel Tubing Stainless Steel 304L	Blue/White	D	
LI2	Instrument Air 20#	AM AR NN NP	Stainless Steel Tubing Stainless Steel 304L Carbon Steel Copper Tube	Blue/White	D	(8)

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SERVICE CODE	SERVICE	LINE CLASS	MATERIAL	COLORS BACKGROUND LETTER	ASME B31 FLUID CATEGORY	NOTES
		NQ	Aluminum Tube			(8)
LI5	Instrument Air 50#	AM AR NN NP NQ	Stainless Steel Tubing Stainless Steel 304L Carbon Steel Copper Tube Aluminum Tube	Blue/White	D	 (8) (8)
LM	Limestone	NN	Carbon Steel	Green/White	D	
LN	Liquid Nitrogen	AM AR NN	Stainless Steel Tube Stainless Steel 304L Carbon Steel	Yellow/Black	BASE	
LO	Lube Oil	AR NN	Stainless Steel 304L Carbon Steel	Green/White	BASE	
LS	Low Pressure Steam (50# or less)	AM AR NC NN	Stainless Steel Tube Stainless Steel 304L Carbon Steel Weld Fittings Carbon Steel	Yellow/Black	D	(9) (1) (6)(10)
ME	Methane			Yellow/Black	BASE	
MG	Makeup Off-Gas	AB AD AR CA HC NF NV	Nitronic 50[R] Stainless Steel 304L Stainless Steel 304L Carpenter 20 Cb-3[R] Hastelloy C-4[R] or C-22[R] Carbon Steel Polypropylene-Lined Carbon Steel - PVDF Lined	Yellow/Black	D	
MN	Mercuric Nitrate	AR	Stainless Steel 304L	Yellow/Black	BASE	(1)
NA	Nitric Acid	AR	Stainless Steel 304L	Yellow/Black	BASE OR M	(1)(f)
NB	Ammonium Nitrate	AR	Stainless Steel 304L	Yellow/Black	BASE	
NC	Noncondensibles (from Evaporator)	AD NC	Stainless Steel Sch. 40 and Sch. 80 304L Carbon Steel, Weld Fittings	Yellow/Black	D	
NG	Inert Gas	AR AA	Stainless Steel 304L Monel 400[R]	Blue/White	D	(A)
NH	Nitrogen Gas (Humidified)	AM AR NN	Stainless Steel Tube Stainless Steel 304L Carbon Steel	Blue/White	D	
NM	Ammonium Nitrate	AR	Stainless Steel 304L	Yellow/Black	D	(C)
NO	Nitrous Oxide (N_20)	AR	Stainless Steel 304L	Yellow/Black	D	
NPH	Normal Paraffin Hydrocarbon	AR	Stainless Steel 304L	Yellow/Black	BASE	

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SERVICE CODE	SERVICE	LINE CLASS	MATERIAL	COLORS BACKGROUND LETTER	ASME B31 FLUID CATEGORY	NOTES
NR	Nitrogen Gas (Dry)	AM AR NN	Stainless Steel Tube Stainless Steel 304L Carbon Steel	Blue/White	D	(1)
NW	Nuclear Poisoned Water	AR	Stainless Steel 304L	Yellow/Black	D	
ON	Oxygen	AR	Stainless Steel 304L	Yellow/Black	D	
OW	Organic Waste	AD	Stainless Steel 304L	Yellow/Black	M	(a)
PA	Process Ash	AR NU NV	Stainless Steel 304L Solid PVDF Carbon Steel, PVDF Lined	Yellow/Black	M	(a)
PB	Process Bed Material	AR NU NV	Stainless Steel 304L Solid PVDF Carbon Steel PVDF Lined	Yellow/Black	M	(a)
PC	Process Solution Complexed w/HF Exposure	AB AR HC	Nitronic 50^{R} Stainless Steel 304L Hastelloy C-4^{R} or C-22^{R}	Yellow/Black	M	(a)
PE	Process Equipment Waste	AR HC	Stainless Steel 304L Hastelloy C-4^{R} or C-22^{R}	Yellow/Black	M	(1)(a)(i)
PEF	Process Equipment Waste w/HF Exposure	AR HC	Stainless Steel 304L Hastelloy C-4^{R} or C-22^{R}	Yellow/Black	M	(a)(i)(H)
PF	Process - Fluoride			Yellow/Black	M	(a)
PL	Process Waste Low Level w/HF Exposure	AR HC HG NL	Stainless Steel 304L Hastelloy C-4^{R} or C-22^{R} Hastelloy G-30^{R} Polypropylene	Yellow/Black	M	(1)(a)
POG	Process Off-Gas			Yellow/Black	M	(a) (l)
PP	Propane	NN	Carbon Steel	Yellow/Black	BASE	
PR	Process Heating/ Cooling	AR	Stainless Steel 304L	Green/White	D	
PS	Process Solution (Uncomplexed)	AA AB AR HC NU NV	Monel 400^{R} Nitronic 50^{R} Stainless Steel 304L Hastelloy C-4^{R} or C-22^{R} Solid PVDF Carbon Steel PVDF Lined	Yellow/Black	M	(a) (1)
PSF	Process Waste to Calcination Process			Yellow/Black	M	(a)
PSG	Process System Off-			Yellow/Black	M	(E)(a)

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SERVICE CODE	SERVICE	LINE CLASS	MATERIAL	COLORS BACKGROUND LETTER	ASME B31 FLUID CATEGORY	NOTES
	Gas					
PSL	Process Liquid Sample	AD AR HC HG	Stainless Steel Sch. 40 and Sch. 80 304L Stainless Steel 304L Hastelloy C-4^{R} or C-22^{R} Hastelloy G-30^{R}	Yellow/Black	M	(a)
PSS	Process Scrub Solution	AR	Stainless Steel 304L	Yellow/Black	M	(a)
PU	Purge	AR	Stainless Steel 304L	Blue/White	D	
PW	Process Waste High Level	AB AR	Nitronic 50^{R} Stainless Steel 304L	Yellow/Black	M	(a)
PWL	Process Waste Low Level	AR	Stainless Steel 304L	Yellow/Black	M	(a)
RC	Recycle Water (Process)	AR	Stainless Steel 304L	Yellow/Black	M	(a)
RD	Refrigerant Hot Gas	AR NN	Stainless Steel 304L Carbon Steel	Yellow/Black	D	
RE	Analytical Reagent Chemical	AR	Stainless Steel 304L	Yellow/Black	M	
RG	Rare Gas	AR	Stainless Steel 304L	Yellow/Black	BASE OR M	(a)(e)
RL	Refrigerant Liquid	AR NM NN	Stainless Steel 304L Copper Tube (Refrigerant) Carbon Steel	Yellow/Black	D	
RS	Refrigerant Suction	AR NM NN	Stainless Steel 304L Copper Tube (Refrigerant) Carbon Steel	Yellow/Black	D	
RW	Raw Water	AR NN NR	Stainless Steel 304L Carbon Steel Ductile Iron	Green/White	D	(14) (5)(14) (14)
SA	Sulfuric Acid	CA NF	Carpenter 20 Cb3^{R} Carbon Steel Polypropylene Lined	Yellow/Black	BASE	
SC	Sodium Carbonate	AR	Stainless Steel 304L	Green/White	D	
SFA	Sulfamic Acid	AD AR	Stainless Steel Sch. 40 and Sch. 80 304L Stainless Steel 304L	Yellow/Black	BASE	
SG	Sampler Off-Gas	AR HC HG	Stainless Steel 304L Hastelloy C-4^{R} or C-22^{R} Hastelloy G-30^{R}	Yellow/Black	M	(1)(a)
SGC	CAM Vacuum System	AM	Stainless Steel Tube	Yellow/Black	D	

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SERVICE CODE	SERVICE	LINE CLASS	MATERIAL	COLORS BACKGROUND LETTER	ASME B31 FLUID CATEGORY	NOTES
		AR	Stainless Steel 304L			
SH	Sodium Hydroxide	AR NN	Stainless Steel 304L Carbon Steel	Yellow/Black	BASE	
SP	Span Gas (for Calibration)	AR	Stainless Steel 304L	Yellow/Black	See notes	(j)
SS	Sample Station Utilities	AM AR	Stainless Steel Tube Stainless Steel 304L	Yellow/Black	BASE	
ST	Starting Air	NN	Carbon Steel	Blue/White	D	
SV	Sanitary Vent	NJ NO NT NY	Galv. Steel PVC - DWV Cast Iron ABS	Blue/White	UPC	(7)(c) (11)(12)(13) (11)(12)(13)
SW	Service Waste	AM NF NH NN NS	Stainless Steel Tube Carbon Steel Polypropylene Lined Polyethylene Carbon Steel FRP	Green/White	D	(e)
TA	Transport Air	AB AR	Nitronic 50^{R} Stainless Steel 304L	Blue/White	D	(18)(e) (17)
TP	Tributyl Phosphate	AR	Stainless Steel 304L	Yellow/Black	BASE	
TR	Tartaric Acid	NJ	Galv. Carbon Steel	Green/White	D	
TW	Treated Water	AM NJ NN	Stainless Steel Tube Galv. Carbon Steel Carbon Steel	Green/White	D	(1)
UV	Utility Vent	AR NN	Stainless Steel 304L Carbon Steel	Blue/White	D	(e)
VA	Vacuum Air	AR NN	Stainless Steel 304L Carbon Steel	Blue/White	D	(G)
VG	Vessel Off Gas	AC AR HC HG NB	Stainless Steel 347 Stainless Steel 304L Hastelloy C-4^{R} or C-22^{R} Hastelloy G-30^{R} Carbon Steel ECTFE-Lined	Yellow/Black	M	(a)(i)
WQ	Sanitary Waste	NE NH NO NT NY NI	Vitrified Clay Polyethylene PVC-DWV Cast Iron ABS Concrete	Yellow/Black	UPC	(c)
WR	Cooling Water Return			Green/White	D	(B)(F)
WS	Wash Solution	AR NU NV	Stainless Steel 304L Solid PVDF Carbon Steel PVDF	Green/White	D	(F)

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SERVICE CODE	SERVICE	LINE CLASS	MATERIAL	COLORS BACKGROUND LETTER	ASME B31 FLUID CATEGORY	NOTES
			Lined			
XW	Chemical Waste	AR ND NF NS	Stainless Steel CPVC Carbon Steel Polypropylene Lined FRP	Yellow/Black	M	(1)(i)

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GENERAL NOTES:

(I) In cases of cross connects, such as utility lines to process lines, where the less severe service piping can be contaminated by backfilling from the more severe service, the line class shall follow that of the more severe service back to and including the first normally closed valve on the less severe service line.

(II) Where a line class has not been specified for a specific service code, contact the Facility Design Engineering Organization for recommendations.

(III) For higher pressures the designer has the option of using heavier schedule pipe.

(IV) For corrosion allowance information on piping contact ICPP Materials Development and Technology Group.

(V) This is not a closed listing. New codes will be devised and this Appendix will be updated when needed.

SERVICE CODE/COLOR CODE NOTES:

(A) This service code shall not be used in the future. Use AR for Argon or NR for Nitrogen.

(B) This service code has been replaced by CWR.

(C) NB shall be the preferred service code for ammonium nitrate in the future.

(D) AS is the accepted service code for AMSCO. AS was also used as a code for ash in Rover, however, this code shall not be used in the future for ash.

(E) POG shall be the preferred service code for process off-gas in the future.

(F) Color code dependent on chemical additives - contact Industrial Safety for guidance.

(G) Color code dependent on contamination levels - contact Health Physics for guidance.

(H) PE was used at FDP for Process Equipment Waste w/ HF Exposure in the original installation, however, to be consistent with the rest of the plant where PE refers to Process Equipment Waste (without HF exposure) all future PEW lines w/ HF exposure shall be coded PEF.

LINE CLASS NOTES:

(1) Original Plant - Type 347, Since 1956 - Type 304L

(2) AR shall be used on all new installation in NWCF instead of existing NWCF spec. classes AD and AF, however, the designer is cautioned to research the original NWCF spec. and upgrade the requirements of line class AR if required for the particular service. See also the preface to this appendix and notes under line class AR for direction to the designer for upgrading for the intended service.

(3) Cold water outside buildings only.

(4) Hot (180°F max.) and cold water inside and outside buildings.

(5) For underground utility piping it is suggested that C.S. pipe and welded fittings be used to ensure electrical continuity. Buried pipe to be coated and protected per Cathodic Protection Section of this Standard. All buried utility lines under concrete slabs shall be all welded construction.

(6) All underground steam and condensate piping shall be C.S. with welded fittings. Buried pipe to be protected per Cathodic Protection Section of this Standard.

(7) Galvanized steel pipe shall not be used for sanitary vents underground and shall be kept at least 6" above the ground.

(8) Where tubing and fittings are used in applications having direct or indirect communication with either radioactive or corrosive chemical, they shall be fabricated of austenitic stainless steel as a minimum or a suitable corrosion resistant material.

(9) Steam tracing only.

(10) Carbon steel pipelines that carry steam or condensate and are buried or located in inaccessible areas shall be of Schedule 80 wall thickness and heavy wall fittings shall be used.

(11) 4" pipe size and less.

(12) Limited to structures where combustible construction is allowed.

(13) Not for use under buildings.

(14) For buried fire water lines and buried raw water lines supplying fire water mains, mechanical joints shall be used except under concrete slabs. Raw water lines which supply fire water mains shall be designed using the same design criteria as for fire water lines. See individual line class specification sheets for more detail. Note that mechanical joints must be bonded to pipe for electrical continuity per this standard.

(15) For FPR high pressure decon jumpers only.

(16) Some portions of the jet vent header systems have used carbon steel piping in the past. All future installations on jet vent header systems shall use only austenitic stainless steel piping.

(17) In-cell solids-free.

(18) Containing solids.

(19) For use in underground pressurized fire water lines only.

(20) NJ and AR line classes shall be used in general, however, the designer shall modify these line classes for this service code per the requirements of Kidde-Fenwal CO2 Fire Protection System Manual "Standard Specification for Pipe and Fittings Conveying High Pressure Carbon Dioxide". For line class NJ use the specification for "Steel Pipe and Fittings". For line class AR use the equivalent pipe and fitting pressure ratings as found in the specification for "Steel Pipe and Fittings".

(21) For use in aboveground pressurized fire water lines only.

(22) For all new and replacement metallic piping use Class NJ or NK. Class NN shall not be used for any future work.

FLUID CATEGORIZATION NOTES:

(a) Dependent on location. In limited access areas such as process cells this service can be considered base category and takes precedence over notes (b), (e), (f) and (h).

(b) Although this service does not fit the definition of category M in ASME B31.3 it shall be considered category M for ICPP application due to the fissionable material hazard.

(c) UPC is the Uniform Plumbing Code.

(d) Equal to or less than 10% methane for RAL x-ray spectrometer.

(e) GENERAL CATEGORIZATION NOTE: Services with a normal radiological contamination level above 3.6×10^{-6} μc/ml solution shall be considered category M.

(f) Hot nitric acid (above 100EF) shall be considered category M.

(g) May contain a variety of fluids. When the service contains hot nitric acid see note (f).

(h) Category M on contaminated side of valve. DOP aerosol supply on uncontaminated side of valve is category D.

(i) Some services may have very low contamination and/or chemical concentration levels and could therefore be considered a lower category than indicated. Contact design engineering organization for these cases.

(j) Dependent on particular service being sampled. See fluid category for service being sampled.

(k) GENERAL CATEGORIZATION NOTE: Services in this listing which are within the confines of power/steam generating facilities shall be ASME B31.1.

(m) Service code POG can be considered category D fluid service if threshold contamination limit described in note (e) above is not exceeded.

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The following is a list of the line classes used in the index. For a complete description of the piping specifications, see individual piping material specification sheets.

Line Class Code	Material
AA	Monel 400[R]
AB	Nitronic 50[R] (11)
AC	347 SST
AD	304L SST Piping Sch 40 and Sch 80 (1)
AE	Inactive (3)
AF	Inactive (2)
AJ	Inactive (4)
AM	304 SST Tubing
AR	304L SST Pipe Sch 40
BD	304L SST Pipe - 10,000 PSI Rated (8)
CA	Carpenter 20 Cb-3 SST[R] (11)
HC	Hastelloy C-4[R] or C-22[R] (10) (11)
HG	Hastelloy G-30[R] (10) (11)
NA	PVC per AWWA C900
NB	Carbon Steel ECTFE-Lined (Halar[R])
NC	Carbon Steel w/SW or BW Fittings
ND	CPVC (6)
NE	Vitrified Clay (7) (11)
NF	Carbon Steel Polypropylene - Lined
NG	Inactive (5)
NH	Polyethylene (11)
NI	Concrete (11)
NJ	Galvanized Carbon Steel
NK	Copper Tubing - Type L or K
NL	Polypropylene (11)
NM	Copper Tubing (Refrigerant Service)
NN	Carbon Steel w/SCRD, SW, BW or Flanged Fittings
NO	PVC-DWV (11)
NP	Copper Tubing - Type K
NQ	Aluminum Tubing
NR	Ductile Iron, Concrete - Lined (11)
NS	Fiberglass Reinforced Plastic (FRP) (11)
NT	Cast Iron (11)
NU	Solid PVDF (Kynar[R]) (11)
NV	Carbon Steel, PVDF - Lined (Kynar[R])
NW	PVC
NX	Transite (Prohibited in all new installations) (11)
NY	ABS Plastic Drain, Waste, and Vent (11)
NZ	Inactive (9)

NOTES:

1. AD was also a line class used on original construction at NWCF. It included both Sch 40 and Sch 80 304L SST pipe. See NWCF Spec. SP-453504-50-3 for reference. It was incorporated

into line classes AD and AR. In general where Sch 80 pipe was used in a line class use line class AD. Use line class AR for Sch 40. At FPR class AD is used for in-cell piping and class AR for out-of-cell piping. Class AD provides for Sch 80 pipe in the 1/2" to 2" pipe sizes to attain corrosion allowances for the 40 year design life of the facility.

2. AF was a line class used on original construction at NWCF. It included both Sch 40 and Sch 80 304L SST pipe. See NWCF Spec. SP-453504-50-3 for reference. It was incorporated into line classes AD and AR. In general where Sch 80 pipe is used in a line use line class AD. Use line class AR for Sch 40.

3. AE was a line class used on original construction at NWCF. It included Sch 10, 40 and Sch 80 304L SST pipe for oxygen service. See NWCF Spec. SP-453504-50-3 for reference. It was incorporated into line classes AD and AR.

4. AJ was an Inconel^{R} line class. Inconel pipe is no longer used at ICPP.

5. NG was an aluminum line class. Aluminum pipe is no longer used at ICPP.

6. Line class ND, CPVC, shall be used for hot water services in systems where line class NW, PVC, is used for potable water.

7. NE is the designated line class for vitrified clay. NE was used at NWCF for cast iron, however, NT is the designated line class for cast iron. All future work at NWCF shall use NT for cast iron.

8. BD is a line class used at FPR only for jumpers at the cell wall for high pressure decon. This line class is not anticipated to be used elsewhere in the future. No piping specification is provided here as this line class is inactive for future work. See FPR Spec. Package CP-5B Div. 15 Subdivision 15.18 for more details.

9. NZ was a line class designation for concrete pipe. NI is the preferred line class designation for concrete pipe.

10. HG has been used as a line class designation for Hastelloy C-4^{R} / C-22^{R} in CPP-601 E-Cell and at FDP. All new installations shall use HC line class designation for Hastelloy C-4^{R}/C-22^{R}.

11. These materials as well as Nitronic 60^{R} used for bolting materials are not listed in ASME/ANSI B 31.3 for the service intended, however, they are approved for service based on prior experience and additional testing per paragraph 304.7.2. In addition, some of these may be Water Supply and Sewage piping and are listed in the Uniform Plumbing Code.

PIPING MATERIAL
SERVICE CODE / PIPING LINE CLASS / COLOR CODING / FLUID CATEGORY INDEX

The following are trademarks used throughout the material specification sheets:

Blue Brute - J.M. Manufacturing Co., Inc.
Carpenter 20 Cb3 - Carpenter Technology Corp.
DOW Plastic - Lined Valves, Fittings and Pipe - DOW Chemical Company
Driscopipe - Philips Driscopipe, Inc.
Fluoroflex-K - Resistoflex Corp.
Grafoil - Union Carbide
Gylon - Garlock, Inc.
Halar - Allied Chemical Co., Inc.
Hastelloy C-4 - Haynes International, Inc.
Hastelloy C-22 - Haynes International, Inc.
Hastelloy G-30 - Haynes International, Inc.
Hypalon - E.I. DuPont De Nemours and Co.
Inconel - Huntington Alloys Inc.
Kynar - Pennwalt Corp.
Monel 400 - Huntington Alloys, Inc.
Nitronic 50 - Armco, Inc.
Nitronic 60 - Armco, Inc.
Nupro - Crawford Fitting Company
R-Con Pipe Connector - R-Con International, Inc.
Superproline - Asahi/America Inc.
Swagelok - Crawford Fitting Company
Tefzel - E.I. DuPont De Nemours and Co.
Triple-Lok - Parker-Hannifin Corp.
Viton - E.I. DuPont De Nemours and Co.
Whitey - Crawford Fitting Company

PIPING MATERIAL STANDARDS

Monel 400R, 150 psi Service Rating, Line Class AA

Design Notes

1. All external components for valves shall be 304, 316, or approved equal Stainless Steel.

2. Where corrosion or erosion will be excessive or higher pressures or other pipe stresses are encountered, the designer has the option of selecting heavier walled pipe and higher rated valves and fittings.

3. When using spiral wound gaskets, see Rules for Bolted Flange Connections, ASME Section VIII Div.1 Appendix 2 or ASME Section VIII Div.2 Appendix 3 and ASME Section III Div. 1, Subsection ND, Section ND-3658 (for equivalent pressure approach) to ensure that the gaskets are applicable for the particular service intended. In cases where spiral wound gaskets are incompatible with the above requirements contact ICPP Design Engineering Organization for further guidance.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	2" & Smaller	Seamless Monel 400R, Sch 80S, Annealed.	ASTM B165 UNS NO4400
	2-1/2" - 8"	Seamless or welded Monel 400 R, Sch 40S, Annealed.	ASTM B165 UNS NO4400
Fittings	2" & Smaller	Seamless Monel 400 R, Sch 80S Butt-Weld Ends, Annealed.	ASTM B366 WPNCS UNS NO4400 Dimensions per ANSI B16.9
	2-1/2" - 8"	Seamless Monel 400 R, Sch 40S Butt-Weld Ends, Annealed.	ASTM B3166 WPNCS UNS NO4400 Dimensions per ANSI B16.9
Branches		Use full or reducing tees or saddles.	
Bolting		Use 304 SST bolts ASTM A193 Gr B8 and galling resistant Nitronic 60R nuts ASTM A194 Gr 8S (UNS S21800).	ASTM A193 Gr. B8 ASTM A194 Gr. 8S UNS S21800
Flanges	2" & Smaller	150# ANSI B16.5, R.F., Weld Neck, Sch 80S, Monel 400R, ASTM B127 UNS NO4400, Finished per ASTM A182.	ASTM B127 UNS NO4400 Dimensions per ANSI B16.5 Finish per ASTM A182
	2-1/2" - 8"	150# ANSI B16.5, R.F., Weld Neck, Sch 40S, Monel 400R, ASTM B127 UNS NO4400, Finished per ASTM A182.	ASTM B127 UNS NO4400 Dimensions per ANSI B16.5 Finish per ASTM A182
Gaskets	All Sizes	Spiral Wound Metallic Type, Monel 400R Spiral Windings, Monel 400R Centering Guide.	API 601 Note 3
	All Sizes	Select for service	

PIPING MATERIAL STANDARDS

Stainless Steel Nitronic 50^{R}, 150 psi Service Rating, Line Class AB

Design Notes

1. All external components for valves shall be 304, 316, or approved equal Stainless Steel.

2. Where corrosion or erosion will be excessive or higher pressures or other pipe stresses are encountered, the designer has the option of selecting heavier walled pipe and higher rated valves and fittings.

3. When using spiral wound gaskets, see Rules for Bolted Flange Connections, ASME Section VIII Div.1 Appendix 2 or ASME Section VIII Div. 2 Appendix 3 and ASME Section III Div.1, Subsection ND, Section ND-3658 (for equivalent pressure approach) to ensure that the gaskets are applicable for the particular service intended. In cases where spiral wound gaskets are incompatible with the above requirements contact ICPP Design Engineering Organization for further guidance.

4. Full port valves are preferred in fouling service.

5. Nitronic 50^{R} preferred, 316L only when Nitronic 50^{R} not available.

6. Alternate disc materials which are suitable for the intended service may be substituted to minimize galling between the seat and disc with prior approval of ICPP Design Engineering Organization.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	2" & Smaller	Seamless Nitronic 50^{R} Stainless Steel, Sch. 80, Beveled Ends	ASTM-A312 Grade TP XM-19
	2-1/2" and Larger	Seamless or welded Nitronic 50^{R} Stainless Steel, Sch. 40.	Same as above
	5" & Larger	Nitronic 50^{R} Stainless Steel, Sch 40, Centrifugally Cast	ASTM-A-351 Grade CG6MMN
Fittings		Seamless Wrought Stainless Steel, Butt Welding Ends. Note: 90E and 45E Ells to be used only where space prohibits the use of bends. Wall thickness shall match pipe.	ASTM A403 Class WP-S Grade XM-19 ANSI B16.9
Gate Valves	2" and Smaller	150# Class BW or SW Ends, OS&Y, Bolted Bonnet, Integral Seat, Body, Bonnet and Disc Nitronic 50^{R}, Casting ASTM A351, Grade CG6MMN or 316 SST, Casting ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316L. Select packing and gaskets for service.	ASTM A351 Grade CG6MMN (5) ASTM A351 Grade CF8M ASTM A182 Grade F316 ANSI B16.34 Notes 1 and 6
	1/2" and Larger	150# Class, 1/2" and RF, OS&Y, Bolted Bonnet, Integral Seat, Body Bonnet, and Disc Nitronic 50^{R}, Casting ASTM A351, Grade CG6MMN or 316 SST, Casting ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316. Select packing and gaskets for service.	ASTM A351 Grade CG6MMN (5) ASTM A351 Grade CF8M ASTM A182 Grade F316 ANSI B16.34 Notes 1 & 6
Globe Valves	1/2" to 2"	150# Class, BW Ends, RF, OS&Y, Bolted Bonnet, Integral Seat Body, Bonnet, and Disc Nitronic 50^{R}, Casting ASTM A351, Grade CG6MMN or 316L Stainless Steel, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L. Select packing and gaskets for service.	ASTM A351, Grade CG6MMN (5) ASTM A351 Grade CF3M ASTM A182 Grade F316L ANSI B16.34 Notes 1 & 6

PIPING MATERIAL STANDARDS

Stainless Steel Nitronic 50^{R}, 150 psi Service Rating, Line Class AB

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
	1/2" and Larger	150# Class, RF OS&Y, Bolted Bonnet, Integral Seat Body, Bonnet, and Disc Nitronic 50^{R}, Casting ASTM A351, Grade CG6MMN or 316 SST Castings ASTM A351 Grade CF8M Forgings ASTM A182, Grade F316. Select packing and gaskets for service.	ASTM A35.1, Grade CG6MMN (5) ASTM A351 Grade CF8M ASTM A182 Grade F316 ANSI B16.34 Notes 1 & 6
	1/2" and Larger	150# Class, BW ends, SST Bellows-Seal Type, OS&Y, Bolted Bonnet, Integral Seat, Body, Bonnet and Disc Nitronic 50^{R}, Casting ASTM A351, Grade CG6MMN or 316L Stainless Steel. Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, 3" Long Minimum Pipe Stub Each End.	ASTM A351 Grade CG6MMN (5) ASTM A351 Grade CF3M ASTM A182 Grade F316L ANSI B16.34 Notes 1 & 6
Check Valves	1/2" - 2"	160# Class, BW Ends, Swing Type, Bolted Bonnet, Integral Seat, Body Bonnet and Disc Nitronic 50^{R}, Casting ASTM A351, Grade CF3M. Forgings ASTM A182, Grade F316L.	ASTM A351 Grade CG6MMN (5) ASTM A351 Grade CF3M ASTM A182 Grade F316L ANSI B16.34 Notes 1 & 6
	1/2" and Larger	150# Class, RF, Swing Type, Bolted Bonnet, Integral Seat, Body, Bonnet and Disc Nitronic 50^{R}, Casting ASTM A351, Grade CG6MMN or 316 SST, Castings ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316.	ASTM A351 Grade CG6MMN (5) ASTM A351 Grade CF3M ASTM A182 Grade F316L ANSI B16.34 Notes 1 & 6
Ball Valves	1/2" - 2"	150# Class, BW Ends, 3-Piece, Solid Body or Split-Body, Top Entry, Body Nitronic 50^{R}, Casting ASTM A351, Grade CG6MMN or 316L Stainless Steel, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, Nitronic 50^{R}, or 316 SST Ball and Stem. Seats to be determined for particular service	ASTM A351 Grade CG6MMN (5) ASTM A351 Grade CF3M ASTM A182 Grade F316L See Notes 1 & 4 ANSI B16.34
	1/2" and Larger	150# Class, RF, Body, Ball and Stem Nitronic 50^{R}, Casting ASTM A351, Grade CG6MMN or 316 SST, Castings ASTM A351, Grade CF8M Forgings ASTM A182 Grade F316. Seats to be determined for particular service.	ASTM A351 Grade ASTM A351 Grade CF8M ASTM A182 Grade F316 See notes 1 & 4 ANSI B16.34
Butter-fly Values	2" and Larger	150# Class, RF or Wafer Type, Body and Disc Nitronic 50^{R} Casting ASTM A351, Grade CG6MMN or 316 SST, Castings Grade CF8M, Forgings ASTM A182, Grade F316, 17-4 PH Stem, Lever-Lock Handle, Seal Rings to be determined for Particular service.	ASTM A351 Grade CG6MMN (5) ASTM A351 Grade CF8M ASTM A182 Grade F316 ANSI B16.34 Note 1
Plug Values	1/2" - 2"	150# Class, BW Ends, Body, Cover, and Plug Nitronic 50^{R}, Casting ASTM A351, Grade CG6MMN or 316 SST, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, Sleeve Material to be determined for particular service.	ASTM A351 Grade CG6MMN (5) ASTM A351 Grade CF3M ASTM A182 Grade F316L ANSI B16.34 Note 1
	1/2" and Larger	150# Class, RF, Body, Cover and Plug Nitronic 50^{R}, Castings ASTM A351, Grade CG6MMN or 316 SST, Castings ASTM A351, Grade CF8M, Forgings, ASTM A182, Grade F316, Sleeve Material to be determined for particular service.	ASTM A351, Grade CG6MMN (5) ASTM A351 Grade CF8M, ASTM A182 Grade F316 ANSI B16.34 Note 1
Flanges	All Sizes	150# ANSI B16.5, RF, Weld-neck, Nitronic 50^{R} Stainless Steel	ASTM A351 Grade CG6MMN ASTM A182 Grade FXM-19 ANSI B16.5 Note 3
Orifice Flanges		300# ANSI B16.5, Raised Face Weld-Neck Type, Nitronic	ASTM A351 Grade CG6MMN

PIPING MATERIAL STANDARDS

Stainless Steel Nitronic 50^{R}, 150 psi Service Rating, Line Class AB

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
		50^{R} Stainless Steel with 1/2" Socket Weld Taps, Schedule 40S Bore.	ASTM A182 Grade FXM-19 ANSI B16.36
	All Sizes	Spiral Wound Metallic Type, 304L SST Spiral Windings, 304 SST Centering Guide.	API-601 Note 3
Gaskets	All Sizes	Select for service	ANSI B16.21
Bolting		Use 304 SST Bolts, ASTM A193 Gr B8 and Galling Resistant Nitronic 60^{R} Nuts, ASTM A194 Gr 8S (UNS S21800).	ASTM A193 Gr B8 ASTM A194 Gr 8S UNS S21800
Line Reduction		Eccentric reducers shall be used where entrapment of contaminated substances can occur	
Branches	Run Size	Branch Size — Use	
	2" and smaller	Full size or reducing — Tee	
	Larger than 2"	2" and smaller — Saddle Larger than 2" — Stub-in (a)	
		9a) When reinforcement is required, use tees or socket weld or butt-weld saddles in lieu of stub-in.	ANSI B.31.3 Fig. 327.4.6D

PIPING MATERIAL STANDARDS

347 Stainless Steel, 300 psi Service Rating, Line Class AC

Design Notes

1. This specification shall be used in lieu of AD and AR for high temperature service. Temperature limit 1000°F.

2. All external components for valves shall be 304, 316, or approved equal SST.

3. Where corrosion will be excessive or higher pressures or other pipe stresses are encountered, the designer has the option of selecting heavier walled pipe and higher rated valves and fittings.

4. When using spiral wound gaskets, see Rules for Bolted Flange Connections, ASME Section VIII Div.1 Appendix 2 or ASME Section VIII Div. 2 Appendix 3 and ASME Section III Div.1, Subsection ND, Section ND-3658 (for equivalent pressure approach) to ensure that the gaskets are applicable for the particular service intended. In cases where spiral wound gaskets are incompatible with the above requirements contact ICPP Design Engineering Organization for further guidance.

5. Full port valves are preferred in fouling services.

6. Alternate disc materials which are suitable for the intended service may be substituted to minimize galling between the seat and disc with prior approval of ICPP Design Engineering Organization.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	2" and Smaller	Seamless Stainless Steel, ASTM A312, Grade TP347 Schedule 80S, Beveled Ends.	ASTM A312 Grade TP347
	2-1/2" and Larger	Seamless Stainless Steel, ASTM A312, Grade TP347, Schedule 40S, Beveled Ends.	ASTM A312 Grade TP347
Fittings	2" and smaller	Seamless Wrought Stainless Steel, BW Ends, ASTM A403, Class WP-S Grade 347, Schedule 80S, Beveled Ends or Forged Stainless Steel, SW Ends, 6000#, ASTM A182 Grade F 347.	ASTM A403 Class WP-S Grade 347 ASTM A182 Grade F 347 Dimensions Per ANSI B16.9 or B16.11
	2-1/2" and Larger	Seamless Wrought Stainless Steel, BWE, ASTM A403 Class WP-S Grade 347, Schedule 40S Beveled Ends.	ASTM A403 Class WP-S Grade 347 Dimensions per ANSI B16.9
Gate Valves	2" and Smaller	300# class BW or SW Ends, OS&Y, Bolted Bonnet, Integral Seat, Body, Bonnet and Disc 347 SST, Casting ASTM A351, Grade CF8C, Forgings ASTM A182, Grade F347, Packing Grafoil[R], Bonnet Gasket Grafoil[R].	ASTM A351 Grade CF8C ASTM A182 Grade F347 ANSI B16.34 Note 2 & 6
	2-1/2" and Larger	300# Class, Same as above except BW Ends.	Same as above
	1/2" and Larger	300# Class, RF, OS&Y, Bolted Bonnet, Integral Seat, Body, Bonnet and Disc 347 SST, Casting ASTM A351, Grade CF8C, Forgings ASTM A182, Grade F347 Packing Grafoil[R], Bonnet Gasket Grafoil[R].	ASTM A351 Grade CF8C ASTM A182 Grade F347 ANSI B16.34 Note 2 & 6
Globe Valves	2" and Smaller	300# Class, BW or SW Ends, OS&Y, Bolted Bonnet, Body, Bonnet and Disc 347 Stainless Steel, Integral Seat, Castings ASTM A351, Grade CF8C, Forgings ASTM A182, Grade F347, Grafoil[R] Packing, Bonnet Gasket Grafoil[R].	ASTM A351 Grade CF8C ASTM A182 Grade F347 ANSI B16.34 Note 2 & 6
	2-1/2" and Larger	Same as above except for BWE.	Same as above

PIPING MATERIAL STANDARDS

347 Stainless Steel, 300 psi Service Rating, Line Class AC

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
	1/2" and Larger	300# Class, RF, OS&Y, Bolted Bonnet, Body, Bonnet and Disc 347 SST, Integral Seat, Castings ASTM A351, Grade CF8C, Forgings ASTM A182, Grade F347, Grafoil[R] Packing, Bonnet Gasket Grafoil[R].	ASTM A351 Grade CF8C ASTM A182 Grade F347 ANSI B16.34 Note 2 & 6
	1/2" and Larger Bellows-Seal	300# Class, BW Ends, SST Bellows Seal Type, OS&Y, Bolted Bonnet, Integral Seat, Body and Bonnet 347 Stainless Steel, Castings ASTM A351, Grade CF8C, Forgings ASTM A182, Grade F347, Disc 316 Stainless Steel, Packing Grafoil[R], Bonnet Gasket Grafoil[R], 3" Long Minimum Pipe Stub each end.	ASTM A351 Grade CF8C ASTM A182 Grade F347 ANSI B16.34 Note 2 & 6
Check Valves	1/2" - 2"	300# Class, BW or SW Ends, Swing Type, Bolted Bonnet, Body, Bonnet and Disc 347 Stainless Steel, Integral Seat, Castings ASTM A351, Grade CF8C, Forgings ASTM A182, Grade F347, Bonnet Gasket Grafoil[R].	ASTM A351 Grade CF8C ASTM A182 Grade F347 ANSI B16.34 Note 2 & 6
	2" and Larger	Same as above except for BWE.	Same as above
	1/2" and Larger	300# Class, RF, Swing Type, Bolted Bonnet, Body, Bonnet and Disc 347 SST, Integral Seat, Castings ASTM A351, Grade CF8C, Forgings ASTM A182 Grade F347, Bonnet Gasket Grafoil[R].	ASTM A351 Grade CF8C ASTM A182 Grade F347 ANSI B16.34 Note 2 & 6
Ball Valves	1/2" - 2"	300# Class, BW or SW Ends, 3 Piece, Split-Body or Top Entry, Body, Ball and Stem 347 Stainless Steel Castings ASTM A351, Grade CF8C, Forgings ASTM A182, Grade F347, Seal and Gasket Grafoil[R], seats to be determined for particular service.	ASTM A351 Grade CF8C ASTM A182 Grade F347 See Note 5 ANSI B16.34
	2" and Larger	Same as above except BWE.	Same as above
	1/2" and Larger	300# Class, RF, Body, Ball and Stem 347 SST, Castings ASTM A351, Grade CF8C, Forgings ASTM A182 Grade F347, Seal and Gasket Grafoil[R], Seats to be determined for particular service.	ASTM A351 Grade CF8C ASTM A182 Grade F347 See Note 5 ANSI B16.34
Plug Valves	1/2" - 2"	300# Class, BW or SW Ends, Body, Cover, and Plug 347 SST, Castings ASTM A351, Grade F8C, Forgings ASTM A182, Grade F347, Sleeve material to be determined for particular service.	ASTM A351 Grade CF8C ASTM A182 Grade F347 ANSI B16.34
	2" and Larger	Same as above except BWE.	Same as above
	1/2" and Larger	300# Class, RF, Body, Cover and Plug 347 SST, Castings ASTM A351, Grade CF8C, Forgings ASTM A182, Grade F347, Sleeve material to be determined for particular service.	ASTM A351 Grade CF8C ASTM A182 Grade F347 ANSI B16.34
Flanges	All Sizes	300# ANSI B16.5, RF, Slip-on, Weld-neck, or Lap Joint and Stub-end, Forged 347 SST.	ASTM A182 Grade F347 ANSI B16.5
Orifice Flanges	All Sizes	300# ANSI B16.5, Raised Face Weld-neck Type, Forged 347 Stainless Steel with 1/2" Socket Weld Taps, Schedule 40S Bore.	ASTM A182 Grade F347 Dimensions Per ANSI B16.36

PIPING MATERIAL STANDARDS

347 Stainless Steel, 300 psi Service Rating, Line Class AC

TYPE	PIPE SIZE	MATERIAL DESCRIPTION		CODE
Gaskets	All Sizes	Spiral Wound Metallic Type, 304L SST Spiral Windings with Grafoil[R] Filler, 304 SST Centering Guide.		API-601 Note 4
	All Sizes	Grafoil[R]		ANSI B16.21
Bolting		Use 304 SST Bolts ASTM A193 Gr B8 and Galling Resistant Nitronic 60[R] Nuts ASTM A194 Gr 8S (UNS S21800).		ASTM A193 Gr B8 ASTM A194 Gr 8S UNS S21800
Line Reduction		Eccentric Reducers shall be used where entrapment of contaminated substances can occur.		
Branches	Run Size	Branch Size	Use	ANSI B.31.3 Fig. 3327.4.6D
	2" and smaller	Full size or reducing	Tee	
		Full Size	Tee	
	Larger than 2"	2" and smaller	Saddle	
		Larger than 2"	Stub-in (a)	
		(a) When reinforcement is required, use tees or socket weld or butt-weld saddles in lieu of stub-in.		

PIPING MATERIAL STANDARDS

Stainless Steel - 304L, 150 - 300 psi Service Rating, Line Class AD

Design Notes

1. This specification shall be used instead of Line Class AR when increased corrosion allowance is required.

2. This line class shall be used in lieu of all or portions of the following line classes. See the Piping Material Specification Index and the specific project specification for more details.

   o NWCF Spec. SP-453504-50-3 line classes AD, AE and AF.

3. For oxygen service all valves shall be prepared, packaged and tagged "For Oxygen Service".

4. For oxygen service all piping shall be carefully cleaned to be completely free of oil, grease, dirt, or other readily oxidizable foreign material.

5. NPT Fittings shall be used in cell only for instruments and equipment (such as pressure gages, pumps, etc) where welded ends are not available. Out-of-Cell NPT fittings may be used when upstream of the cell wall block valve with prior written approval of ICPP Design Engineering Organization.

6. Three hole flanges, fabricated in accordance with Dwg. 1550-CPP-666-P-600, shall be used where remote removal of equipment or components is required.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	2" & Smaller	Seamless 304L SST, Sch 80S, Beveled Ends.	ASTM A312 Grade TP304L
	3" and Larger	304L SST, Sch 40S, Beveled Ends.	ASTM A814 Grade TP304L
Fittings	2" & Smaller	Seamless Wrought SST, Sch 80S, BW Ends, ASTM A403 Class WP-S Grade 304L or Forged SST, 6000#, SW Ends, ASTM A182.	ASTM A403 Class WP-S Grade 304L Grade F 304L ASTM A182 Grade F 304L Dimensions per ANSI B16.9 or B16.11
	1-1/2" and Larger	Seamless Wrought SST, Sch 40S BW Ends.	ASTM A403 Class WP-S Grade 304L Dimensions per ANSI B16.9
		For remainder of specification see Line Class AR Spec. All butt-weld valves shall match the bore of pipe and fittings.	

PIPING MATERIAL STANDARDS

Stainless Steel Tubing, 150 - 300 psi Service Rating, Line Class AM

Design Notes

1. This specification can be used on original plant process installations where tubing was used (where organics in cells prevent welding of piping components). Note restrictions on use of tubing in 1543 2.3 of this AE Standard.

2. Where corrosion will be excessive or higher pressures or other stresses are encountered, the designer has the option of selecting thicker walled (.065" wall) tubing.

3. Only 304 SST or 316 SST seats will be acceptable for in-cell valves or on steam valves. No TFE in cell.

4. Swagelok^{R} compression fittings are required without or equal substitution for make-up of all tubing except where components must be compatible with existing flare fittings (Parker Triple-Lok^{R}). Parker Triple-Lok^{R} flare fittings may be used in this case only. The intent is to eliminate all flare fittings where possible. See also1543 2.3.

5. Use tube to pipe weld connectors for fit-up.

6. Alternate disc materials which are suitable for the intended service may be substituted to minimize galling between the seat and disc with prior approval of ICPP Design Engineering Organization.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Tube	1/8" - 1"	Stainless Steel MIL-T-8504 Composition 304 or ASTM A269 TP 304, .035" Wall, Seamless.	ASTM A269 TP304 or MIL-T-8504 Comp. 304
Fittings	1/8" - 1"	Stainless Steel, ASTM A276 TP316, Swagelok^{R} Compression Fittings.	ASTM A276 TP 316
	1/8" and Larger	Parker Triple Lock^{R} flare Fittings	See Note 4
Globe Valves	1/8" - 1" Bellows-Seal	150# - 300# Class, Bellows Sealed BW, 316L Stainless Steel Body, 316 Stainless Steel Disc, Integral Seat, Grafoil^{R} Gasket and Packing.	ASTM A351 Grade CF3M ASTM A182 Grade F316L Notes 5 & 6
	1/8" - 1"	150# - 300# Class, SW, OS&Y, BB, 316L Stainless Steel Body and Integral Seat, 316 SST Disc, Grafoil^{R} Gasket and Packing.	Same as above
	3/4" Bellows Seal	Nupro^{R} 12U Series, Pipe Butt Weld Ends, 316L SST Body, 316 SST Stem Insert. For use as cell wall valve.	
Needle	Valves	Stainless Steel Type 316 forged Body, 3000 PSI Rating, Swagelok^{R} X Swagelok^{R} Ends, Whitey^{R}. For out-of-cell use only.	
Check Valves	1/2" - 1"	150# - 300# Class, Butt Weld and Socket Weld Ends, Swing Type, Bolted Cover, 316L Stainless Steel Body, Integral Seats, 316 Stainless Steel Disc.	ASTM A351 Grade CF3M ASTM A182 Grade F316L Notes 5 & 6
	1/8" - 1"	3000#, Swagelok^{R} X Swagelok^{R} Ends, Spring Return, 316 SST. For Out-of-Cell Use Only.	
Tubing Bends		Bends shall be minimum 5 times nominal tube diameter.	

PIPING MATERIAL STANDARDS

Stainless Steel - 304L, 150 psi Service Rating, Line Class AR

Design Notes

1. This specification at the 150# service rating will form the bulk of all process and in-cell utility piping at ICPP.

2. Where corrosion will be excessive or higher pressure or other pipe stresses are encountered, the designer has the option of selecting heavier walled pipe and higher rated valves & fittings. See also line class AD for heavier walled pipe.

3. All external components for valves shall be 304, 316, or approved equal stainless steel.

4. Do not use plug, diaphragm, or butterfly valves for steam service.

5. This line class shall be used in lieu of all or portions of the following line classes. See the Piping Material Specification Line Class List and the specific project specifications for more details.

   o NWCF Spec. SP-453504-50-3 line classes AD, AE, and AF.

6. Full port ball valves are preferred in fouling services.

7. When using spiral wound gaskets, see Rules for Bolted Flange Connections, ASME Section VIII Div. 1 Appendix 2 or ASME Section VIII Div. 2 Appendix 3 and ASME Section III Div.1, Subsection ND, Section ND-3658 (for equivalent pressure approach) to ensure that the gaskets are applicable for the particular service intended. In cases where spiral wound gaskets are incompatible with the above requirements contact ICPP Design Engineering Organization for further guidance.

8. FPR Line Class AF (304L SST Pipe Sch 10) shall be considered Line Class AR for future installations. Line Class AS in FPR shall be considered Line Class AR for future installations but shall be upgraded to: (Accountability sample bias control governs this wall thickness).

   1/2" Pipe Sch 160
   3/4" Pipe Sch 80

9. Material of construction for cell wall block valve bodies on utility lines not contacting process solutions going into cells can be 316 SST or 304 SST instead of 316L SST. (ASTM A351 Grade CF8M or Grade CF8 ASTM A182 Grade F 316 or Grade F 304)

10. Note that in some portions of the original plant process installations, tubing was used. Organics in these in-cell areas may prevent welding on piping components. See line class AM for these cases.

11. For oxygen service all valves shall be prepared, packaged, and tagged "For Oxygen Service."

12. For oxygen service all piping shall be carefully cleaned to be completely free of oil, grease, dirt, or other readily oxidizable foreign material.

13. When ball valves are to be used for cryogenic services use only valves designed specifically for cryogenic service.

14. Examples: R-Con^{R} International R-Con^{R} connector, Swing-bolt type.

15. Fittings and equipment in this line class for firewater lines or raw water lines supplying fire water mains shall be specified per NFPA-13 and Factory Mutual Data Sheet 2-8N for above ground piping and NFPA 24 and Factory Mutual Data Sheet 3-10 for underground piping in lieu of the fittings and equipment specified herein.

PIPING MATERIAL STANDARDS

Stainless Steel - 304L, 150 psi Service Rating, Line Class AR

16. NPT fittings shall be used in-cell only for instruments and equipment (such as pressure gages, pumps, valve actuators etc.) where weld ends are not normally available. Out-of-Cell NPT fittings may be used when upstream of the cell-wall block valve with prior written approval of ICPP Design Engineering Organization.

17. Where required diaphragm valves shall be oriented to allow for free draining.

18. Three hole flanges, fabricated in accordance with Dwg. 1550-CPP-666-P-600, shall be used where remote removal of equipment or components is required.

19. Alternate disc materials which are suitable for the intended service may be substituted to minimize galling between the seat and disc with prior approval of ICPP Design Engineering Organization.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1/4"-2-1/2"	Seamless Stainless Steel, ASTM A312 Grade TP304L, Sch. 40S, Beveled Ends for BW, Plain Ends for SW, or Screwed.	ASTM A312 TP304L
	3" - 12"	Stainless Steel, ASTM A814 Grade TP304L, Sch. 40, Beveled Ends for BW, Plain Ends for SW or Screwed.	ASTM A814 TP304L
Fittings	2" and Smaller	Seamless Wrought SST, BW Ends, Sch 40S, ASTM A403 Class WP-S Grade 304L or Forged SST, SW Ends, 3000#, ASTM A182 Grade F304L	ASTM A403 Class WP-S Grade 304L ASTM A182 Grade F 304L Dimensions per ANSI B16.9 or B16.11
	2-1/2" and Larger	Seamless Wrought SST, BWE, Sch 40S.	ASTM A403 Class WP-S Grade 304L Dimensions per ANSI B16.9
Gate Valves	2" and Smaller	150# Class, BW or SW Ends, OS&Y, Bolted Bonnet, Integral Seat, Body and Bonnet 316L SST, Casting ASTM A351, Grade CF3M Forgings ASTM A182, Grade F316L Packing Grafoil^{R}, Bonnet Gasket Grafoil^{R} Disc 316 SST.	ASTM A351 Grade CF3M ASTM A182 Grade F316L ANSI B16.34 See Notes 3, 9, & 19
	2-1/2" and Larger	150# Class, Same as above except BW Ends.	Same as above
	1/2 and Larger	150# Class, RF, OS&Y, Bolted Bonnet, Integral Seat, Body and Bonnet 316 SST Casting ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, Packing Grafoil^{R} Bonnet Gasket Grafoil^{R}, Disc 316 SST.	ASTM A351 Grade CF8M ASTM A182 Grade F316 See Notes 3, 7, 9, & 19 ANSI B16.34
Globe Valves	2" and Smaller	150# Class, BW or SW Ends, OS&Y, Bolted Bonnet, Body and Bonnet 316L Stainless Steel, Integral Seat, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, 316 SST Disc, Grafoil^{R} Packing, Bonnet Gasket Grafoil^{R}.	ASTM A351 Grade CF3M ASTM A182 Grade F316L See Notes 3, 9, & 19 ANSI B16.34
	2-1/2" and Larger	Same as above except for BWE	Same as above
	1/2" and Larger	150# Class, RF, OS&Y, Bolted Bonnet, Body and Bonnet 316 SST, Integral Seat, Castings ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, 316 SST Disc, Grafoil^{R} Packing, Bonnet Gasket Grafoil^{R}.	ASTM A351 Grade CF8M ASTM A182 Grade F316 See Notes 3, 7, 9, & 19 ANSI B16.34

PIPING MATERIAL STANDARDS

Stainless Steel - 304L, 150 psi Service Rating, Line Class AR

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
	1/2" and Larger Bellows Seal	150# Class, BW Ends, SST Bellows Seal Type, OS&Y Bolted Bonnet, Integral Seat, Body and Bonnet 316L Stainless Steel, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, Disc 316 Stainless Steel, Grafoil[R] Packing, Bonnet Gasket Grafoil[R] 3" Long Minimum Pipe Stub Each End.	ASTM A351 Grade CF3M ASTM A182 Grade F316L See Notes 3, 9, & 19 ANSI B16.34
Check Valves	1/2" - 2"	150# Class, BW or SW Ends, Swing Type, Bolted Bonnet, Body and Bonnet 316L Stainless Steel, Integral Seat, Castings ASTM A351, Grade CF3M, Forgings ASTM A182 Grade F316L, Bonnet Gasket Grafoil[R]. Disc 316 Stainless Steel.	ASTM A351 Grade CF3M ASTM A182 Grade F316L See Notes 3, 9, & 19 ANSI B16.34
	2" and Larger	Same as above except for BWE.	Same as above
	1/2" and Larger	150# Class, RF, Swing Type, Bolted Bonnet, Body and Bonnet 316 SST, Integral Seat, castings ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, Bonnet Gasket Grafoil[R], Disc 316 SST.	ASTM A351 Grade CF8M ASTM A182 Grade F316 Dimensions per ANSI B16.34 See Notes 3, 7, 9, & 19
Ball Valves	1/2" - 2"	150# Class, BW or SW Ends, 3 Piece, Split Body or Top Entry, Body 316L Stainless Steel, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, 316 SST Ball and stem, Seal and Gasket Grafoil[R], Seats to be determined for particular service.	ASTM A351 Grade CF3M ASTM A182 Grade F316L See Notes 3, 6, 13, & 9 ANSI B16.34
	2" and Larger	Same as above except BWE.	Same as above
	1/2" and Larger	150# Class, RF, Body, Ball and Stem 316 SST, Castings ASTM A351, Grade CF8M, Forgings ASTM A182 Grade F316, Seal and Gasket Grafoil, Seats to be determined for particular service.	ASTM A351 Grade CF8M ASTM A182 Grade F316 See Notes 3, 6, 13, & 9 ANSI B16.34
Butterfly Valves	2" and larger	150# Class, RF, or Wafer Type Body and Disc 316 SST, Castings ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, 17-4 PH Stem, Lever-Lock Handle, Seal Rings to be determined for particular service.	ASTM A351 Grade CF8M ASTM A182 Grade F316 ANSI B16.34 See Notes 3, 4, 7, & 9
Plug Valves	1/2" - 2"	150# Class, BW or SW Ends, Body, Cover, and Plug 316L SST, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, Sleeve Material to be determined for particular service.	ASTM A351 Grade CF3M ASTM A182 Grade F316L See Notes 3, 4, & 9 ANSI B16.34
	2" and Larger	Same as above except BWE.	Same as above
	1/2" and Larger	150# Class, RF, Body, Cover, and Plug 316 SST, Castings ASTM A351, Grade CF8M, Forgings, ASTM A182, Grade F316, Sleeve Material to be determined for particular service.	ASTM A351 Grade CF8M ASTM A182 Grade F316 ANSI B16.34 See Notes 3, 4, 7, & 9
Diaphragm	1/2" - 2"	150# Class, BW or SW Ends, Body and Cover 316L SST, Castings ASTM A351, Grade CF3M, Forgings ASTM A182, Grade F316L, Diaphragm Material and packing to be determined for particular service.	ASTM A351 Grade CF3M ASTM A182 Grade F316L ANSI B16.34 See Notes 3, 4, 9, & 17

PIPING MATERIAL STANDARDS

Stainless Steel - 304L, 150 psi Service Rating, Line Class AR

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
	2" and Larger	Same as above except BWE.	Same as above
	1/2" and Larger	150# Class, RF, Body and Cover 316 SST, Castings ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, Diaphragm and Packing Material to be determined for particular service.	ASTM A351 Grade CF8M ASTM A182 Grade F316 ANSI B16.34 See Notes 3, 4, 7, & 17
Remote Connectors	All Sizes	150# Class, Remotely Operated R-Con^{R} Type Connector, 304L or 316L Stainless Steel Butt Weld Hubs, 316 Stainless Steel Seal Rings and Clamps, Nitronic 60^{R} Screw, Schedule 40S Bore.	Note 14
Flanges	All Sizes	150# ANSI B16.5, RF, Slip-On, Weld Neck, or Lap Joint and Stub-End Forged 304L SST.	ASTM A182 Grade F304L Note 7 & 18 ANSI B16.5
Orifice Flanges	All Sizes	300# ANSI B16.5, Raised Face Weld-Neck, Type, Forged Stainless Steel with 1/2" Socket Weld Taps, Schedule 40S Bore.	ASTM A182 Grade F304L ANSI B16.36
	All Sizes	Spiral Wound Metallic Type, 304L SST Spiral Windings with Grafoil^{R} Filler, 304 SST Centering Guide.	ASTM A182 Grade F304L API-601 Note 7
Gaskets	All Sizes	Grafoil^{R}	ANSI B16.21
Bolting		Use 304 SST Bolts ASTM A193 Gr B8 and Galling Resistant Nitronic 60^{R} Nuts ASTM A194 Gr 8S (UNS S21800).	ASTM A193 Gr B8 ASTM A194 GR 8S UNS S21800
Line Reduction		Eccentric Reducers Shall be used where entrapment of contaminated substances can occur	
	Run Size	Branch Size — Use	
Branches	Run Size 2" and smaller Full size Larger than 2"	Full size or reducing — Tee Full size — Tee 2" and smaller — Saddle Larger than 2" — Stub-in (a)	ANSI B.31.3 Fig. 327.4.6D
		(a) When reinforcement is required use tees or socket-weld or butt-weld saddles in lieu of stub-in.	

PIPING MATERIAL STANDARDS

Carpenter 20 Cb3^{R} Stainless Steel, 150 psi Service Rating, Line Class CA

Design Notes

1. Examples: R-Con^{R} Connector, R-Con^{R} International, Swing-bolt Type.

2. Plug valves shall not be used in steam service.

3. Three hole flanges, fabricated in accordance with Dwg. 1550-CPP-666-P-600 shall be used where remote removal of equipment or components is required.

4. All external components for valves shall be 304, 316, or approved equal SST.

5. When using spiral wound gaskets, See Rules for Bolted Flange Connections, ASME Section VIII Div. 1 Appendix 2 or ASME Section VIII Div. 2 Appendix 3 and ASME Section III Div.1, Subsection ND Section ND-3658 (for equivalent pressure approach) to ensure that the gaskets are applicable for the particular service intended. In cases where spiral wound gaskets are incompatible with the above requirements contact ICPP Design Engineering Organization for further guidance.

6. Pipe stub wall thickness shall be the same as connecting pipe.

7. Alternate disc materials which are suitable for the intended service may be substituted to minimize galling between the seat and disc with prior approval of the ICPP Design Engineering Organization.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1/4" - 3/4"	Carpenter 20 Cb-3^{R}, Seamless SCH 80S UNS NO8020	ASTM 729
	1" and Larger	Carpenter 20 Cb-3^{R}, Seamless SCH 40S.	ASTM 729 UNS NO8020
Fittings	1/4" - 3/4"	Carpenter 20 Cb-3^{R}, BW, SCH 80S	ASTM B366 Grade WP20CB
	1" and Larger	Carpenter 20 Cb-3^{R}, BW, SCH 40S.	Same as above
Gate Valves	All Sizes	150# Class, BW, OS&Y, BB, Carpenter 20 Cb-3^{R} Body, Bonnet and Disc, Integral Seat Grafoil^{R} Packing and Gasket.	ASTM B462 UNS NO8020 ASTM A351 Grade CN7M ANSI B16.34 See Notes 4, 6, & 7
	1/2" and Larger	150# Class, RF, OS&Y, BB, Carp. 20 Cb-3^{R} Body, Bonnet and Disc, Integral Seat, Grafoil^{R} Packing and Gasket.	See Notes 4, 5, & 7
Globe Valves	All Sizes	150#, Class, BW, OS&Y, BB Carp. 20 Cb-3^{R} Body, Bonnet and Disc, Integral Seat, Grafoil^{R} Packing and Gasket.	Same as above ANSI B16.34 See Notes 4, 6, & 7
	1/2" and Larger Bellows-Seal	150# Class, BW, Bellows Sealed OS&Y, BB, Carp. 20 Cb-3^{R} Body, Bonnet and Disc, Integral Seat, and Bellows, Grafoil^{R} Gasket. Shall be provided with factory welded 3 inch long Carpenter 20 Cb-3^{R} pipe stub on each end.	Same as above
	1/2" and Larger	150# Class, RF, OS&Y, BB, Carp. 20 Cb-3^{R} Body, Bonnet and Disc, and Integral Seat, Grafoil^{R} Gasket.	Same as above ANSI B16.34 See Notes 4, 5, & 7
Check Valves	All Sizes	150# Class, BW, Swing Type, Carp. 20 Cb-3^{R} Body, Bonnet and Disc, Integral Seat, Grafoil^{R} Gasket.	Same as above ANSI B16.34 See Notes 4, 6, & 7

PIPING MATERIAL STANDARDS

Carpenter 20 Cb3^{R} Stainless Steel, 150 psi Service Rating, Line Class CA

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
	1/2" and Larger	150# Class, RF, Wafer Check, Carp. 20 Cb-3^{R} Body, Trim and Plates, Metal to Metal Seal, S/S Spring.	ANSI 16.34 See Notes 4 & 5
Ball Valves	All Sizes	150# Class, BW, Carpenter 20 Cb-3^{R} Body, Ball and Stem, Lever Operated. Seats and Body Seals to be determined for particular service.	Same as above ANSI B16.34 See Notes 4 & 6
	1/2" and Larger	150# Class, RF, Carp. 20 Cb-3^{R} Body, Ball and Stem, Lever Operated. Seats and Seals to be Determined for particular service.	ASTM B462 UNS NO8020 Grade CN7M UNS NO802 ANSI B16.34 See Notes 4 & 5
Butterfly Valves	All Sizes	150# Class, Single Flanged Lug Type, Carp. 20 Cb-3^{R} Body and Disc, 17-4 pH Stem, Grafoil^{R} Seal Rings, Grafoil^{R} Packing.	Same as above ANSI B16.34 See Notes 4 & 5
Plug Valves	All Sizes	150# Class, BW, Carp. 20 Cb-3^{R} Body, Cover, and Plug, Wrench Operated, 4" and Larger Gear Operated. Sleeve and Diaphragm Material to be determined for particular service.	Same as above ANSI B16.34 See Notes 2, 4, & 6
	1/2" and Larger	150# Class, RF, Carp. 20 Cb-3^{R} Body, Cover, and Plug, 4" and Larger Gear Operated. Sleeve and Diaphragm Material to be determined for particular service.	Same as above ANSI B16.34 See Notes 2, 4, & 5
Diaphragm Valves	All Sizes	150# Class, BW, Carp. 20 Cb-3^{R} Body, Bonnet, and Stem, Weir Type, Diaphragm Material to be determined for particular service.	ANSI B16.34 See Notes 4 & 6
	1/2" and Larger	150# Class, RF, Carp. 20 Cb-3^{R} Body, Bonnet and Stem, Weir Type, Diaphragm Material to be determined for particular service.	ANSI B16.34 See Notes 4 & 5
Remote Connectors		150# Class, Remotely Operated R-Con^{R} Type Connector, Carpenter Cb-3^{R} Butt Weld Hubs and Seal Rings, 316 Stainless Steel Clamps, Nitronic 60^{R} Screw.	See Note 1
Flanges		150# ANSI B16.5, Carp. 20 Cb-3^{R}, RF, Weld neck or Lap Joint and Stub End.	ASTM B462 UNS NO8020 ANSI B16.5 See Note 3
Orifice Flanges		300# ANSI Raised Face Weld-neck Type, Forged, Carpenter 20 Cb-3^{R}, ASTM B462 with 1/2" SCRD Taps.	ASTM B462 UNS NO8020 ANSI B16.36
Gaskets		Grafoil^{R} Flange Gaskets, Flat Ring, 1/16" Thick.	ANSI B16.21
	All Sizes	Spiral Wound Metallic Type, Carpenter 20 Cb-3^{R} Spiral Windings with Grafoil^{R} Filler, 304 SST Centering Guide.	ASTM B366 Grade WP 20CB API-601 Note 5
Bolting		Use 304 SST Bolts ASTM A193 Gr B8 and Galling Resistant Nitronic 60^{R} Nuts ASTM A194 Gr 8S (UNS S21800).	ASTM A193 Gr B8 ASTM A194 Gr 8S UNS S21800
Branches	All Sizes	Use full or reducing tees.	
Line Reductions		Use reducers. Eccentric reducers shall be used where entrapment of contaminated substances can occur.	

PIPING MATERIAL STANDARDS

Hastelloy C-4^{R} or C-22^{R}, 150 psi Service Rating, Line Class HC

Design Notes

1. These pipe wall thicknesses are suggested only. The designer shall choose specific pipe wall thicknesses for the particular corrosion service and pressure rating and other piping stresses.

2. Due to lack of availability of C-4 and increased corrosion resistance, Hastelloy C-22^{R} shall replace C-4 where applicable.

   Hastelloy C-4^{R} (UNS NO6455)
   Hastelloy C-22^{R} (UNS NO6022)

3. Examples: R-Con International R-Con^{R} Connector, swing-bolt type.

4. NDE requirements on all line class HC systems shall be 100% radiography on all butt weld joints and 100% LP examination on all socket weld joints.

5. All external components for valves shall be 304, 316 or approved equal stainless steel.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1/8" - 3/4"	Hastelloy C-4^{R} or C-22^{R} Solution Annealed Beveled Ends SCH 160 Seamless.	ASTM B622 UNS NO6455 UNS NO6022
	1" - 2"	Hastelloy C-4^{R} or C-22^{R} Solution Annealed Beveled Ends SCH 80 Seamless.	ASTM B622 UNS NO6455 UNS NO6022
	2-1/2" and Larger	Hastelloy C-4^{R} or C-22^{R} Solution Annealed Beveled Ends SCH 40 Seamless.	ASTM B622 UNS NO6455 UNS NO6022
Orifice Flanges		300# ANSI B16.5, RF, Hastelloy C-4^{R} or C-22^{R} Weld Neck Type to Match Pipe Schedule with Socket Weld Taps. Dimensions per ANSI B16.5.	ASTM B574 UNS NO6455 UNS NO6022 ASTM B575 UNS N06455 UNS N06022 ANSI B16.36
Gaskets		Grafoil^{R} Flange Gasket, Flat Ring 1/16"	ANSI B16.21
Bolting		Use 304 SST Bolts ASTM A193 Gr B8 and Galling Resistant Nitronic 60^{R} Nuts ASTM A194 Gr 8S (UNS S21800).	ASTM A193 Gr B8 ASTM A194 GR 8S UNS S21800
Branches		Use full or reducing tees or saddles.	
Fittings	1/8" - 3/4"	Seamless Hastelloy C-4^{R} or C-22^{R} solution Annealed Butt Welded Ends, Sch 160.	ASTM B366 WPHC4S UNS NO6455 WPHC22S UNS NO6022 Dimensions per ANSI B16.9
	1" - 2"	Seamless Hastelloy C-4^{R} or C-22^{R} Solution Annealed Butt Welded Ends, Sch 80.	Same as above
	2-1/2" and Larger	Seamless Hastelloy C-4^{R} or C-22^{R} Solution Annealed Butt Weld Ends, Sch 40.	Same as above
Gate Valves	1/2" and Larger	150# Class, BW to Match Schedule of Pipe, OS&Y, BB, Hastelloy C-4^{R} or C-22^{R} Body, Bonnet and Disc, Integral Seat, Grafoil^{R} Packing and Gasket.	Same as above ANSI B16.34 Note 5
	Same as above	150# Class, RF, OS&Y BB, Hastelloy C-4^{R} or C-22^{R} Body, Bonnet and Disc, Integral Seat, Grafoil^{R} Packing and Gasket.	Same as above ANSI B16.34 Note 5

PIPING MATERIAL STANDARDS

Hastelloy C-4^{R} or C-22^{R}, 150 psi Service Rating, Line Class HC

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Globe Valves	1/2" and Larger	150# Class, BW to match Schedule of Pipe, OS&Y, BB, Bellows Seal, Hastelloy C-4^{R} or C-22^{R} Body, Bonnet, Disc and Bellows, Grafoil^{R} Gasket, Integral Seat.	Same as above ANSI B16.34 Note 5
	Same as above □	150# Class, BW to Match Schedule of OS&Y, BB, Hastelloy C-4^{R} or C-22^{R} Body, Bonnet and Disc, Integral Seat, Grafoil^{R} Packing and Gasket.	Same as above ANSI B16.34 Note 5
	Same as above □	150# Class, RF, OS&Y, BB, Hastelloy C-4^{R} or C-22^{R} Body, Bonnet and Disc, Integral Seat, Grafoil^{R} Packing and Gasket.	Same as above ANSI B16.34 Note 5
Check Valves	1/2" and Larger	150# Class, BB, BW to match Schedule of Pipe, Hastelloy C-4^{R} or C-22^{R} Body, Bonnet and Disc, Grafoil^{R} Gasket.	Same as above ANSI B16.34 Note 5
	Same as above □	150# Class, RF, BB, Hastelloy C-4^{R} or C-22^{R} Body, Bonnet and Disc, Grafoil^{R} Gasket.	Same as above ANSI B16.34 Note 5
Ball Valves	1/2" and Larger	150# Class, BW to match Schedule of Pipe, Hastelloy C-4^{R} or C-22^{R} Body, Ball and Stem, Lever Operated, Seats and Seals to be determined for particular service.	ASTM B366 WPHC4S UNS NO6455 ASTM B366 WPHC22S UNS NO6022 ANSI B16.34 Note 5
	1/2" and Larger	150# Class, RF, Hastelloy C-4^{R} or C-22^{R}, Body, Stem and Ball Lever Operated, Seats and Seals to be determined for particular service.	Same as above □
Remote Connections		150#, Remotely operated R-Con^{R} Type Connector, Hastelloy C-4^{R} or C-22^{R} Butt Weld Hubs and Seal Rings, 316 or 304 Stainless Steel Clamps, Nitronic 60^{R} Screw.	ASTM B574 UNS NO6455 UNS NO6022 Note 3
Flanges		150# ANSI B16.5, Hastelloy C-4^{R} or C-22^{R} Stub End for Use w/Slip-on Flanges to make a Lap Joint or Van Stone Flanged Connection to Vessels, Valves, Pumps, or other Flanged Equipment.	ASTM B575 UNS NO6455 UNS NO6022 ASTM B574 UNS NO6455 UNS NO6022 Dimensions per ANSI B16.5
		150# ANSI B16.5, Hastelloy C-4^{R} or C-22^{R} RF, Weld Neck to match Pipe Schedule.	ASTM B575 UNS NO6455 UNS NO6022 ASTM B574 UNS NO6455 UNS NO6022 Dimensions per ANSI B16.5

PIPING MATERIAL STANDARDS

Hastelloy G-30^{R}, 150 psi Service Rating, Line Class HG

Design Notes

1. These pipe wall thicknesses are suggested only. The designer shall choose specific pipe wall thicknesses for the particular corrosion service, piping stresses, and pressure rating.

2. Note that original installation on LET&D project used Hastelloy G-30^{R} welded seam pipe 1/2" thru 2-1/2" per ASTM B619 class II with 20% minimum cold reduction and eddy-current testing and 3" thru 8" pipe per ASTM B619 Class I with eddy-current testing. Seamless pipe per ASTM B622 is now available up to 4".

3. Eddy-current testing or 100% weld x-ray required.

4. Liquid penetrant test on root and final pass of welds is required. 100% x-ray test on final weld is required.

5. Note that original installation on LET&D project allowed either WPHG30S fittings made from ASTM B622 seamless pipe or WPHG30WX fittings made from ASTM B619 Class I welded seam pipe for 3" to 8" pipe. For future installations all fittings 1/4" to 4" shall be WPHG30S made from ASTM B622 seamless pipe.

6. Flange surfaces shall be finished to 125 microinches AARH for seating to spiral wound gaskets.

7. This gasket for use at LET&D where concentrated nitric acid is encountered and radiation levels are negligible. For radiation service consult ICPP Design Engineering Organization for a more suitable material. When using spiral wound gaskets, see Rules for Bolted Flange Connections, ASME Section VIII Div. 1 Appendix 2 or ASME Section VIII Div 2 Appendix 3 and ASME Section III Div.1, Subsection ND, Section ND-3658 (for equivalent pressure approach) to ensure that the gaskets are applicable for the particular service intended. In cases where spiral wound gaskets are incompatible with the above requirements contact ICPP Design Engineering Organization for further guidance.

8. All external components for valves shall be 304, 316, or approved equal stainless steel.

9. Note that 316L SST and Carpenter 20 Cb-3^{R} ball valves were installed where the corrosion service allowed it as original equipment at LET&D due to lack of availability of Hastelloy G-30^{R} valves. For all future work Hastelloy G-30^{R} is required unless it can be demonstrated that the above materials are adequate for the particular corrosion service. Prior written approval is required from ICPP Design Engineering Organization.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1/4"	Hastelloy G-30^{R}, ASTM B622 UNS NO6030, Seamless, Sch. 80S, Heat Treated and Descaled.	ASTM B622 UNS NO6030
	1/2" - 4"	Hastelloy G-30^{R}, ASTM B622 UNS NO6030 Seamless, Sch. 40S, Heat Treated and Descaled.	ASTM B622 UNS NO6030
	5" - 8"	Hastelloy G-30^{R}, ASTM B619 UNS NO6030 Class I, Welded Seam, Sch. 40S, Heat Treated and Descaled.	ASTM B619 UNS NO6030 See Note 3
	10" - 14"	Hastelloy G-30^{R}, UNS NO6030, Welded Seam from ASTM B582 material using Hastelloy G-30^{R} Weld Filler Material Sch. 10S, Heated Treated and Descaled. Outside diameter (O.D.) shall be within the Requirements of ASTM A530 Table I "Permissible Variations of Outside Diameters" of the O.D.'s Specified in ANSI B36.19.	ASTM B582 UNS NO6030 See Note 4 ASTM A530 ASTM B36.19
Fittings	1/4"	Hastelloy G-30^{R}, UNS NO6030, ASTM B366, Class WPHG30S from ASTM B622 Seamless Pipe, Sch. 80S, Butt Weld Ends.	ASTM B366 Class WPHG30S UNS NO6030 ASTM B622 Dimensions per ANSI B16.9

PIPING MATERIAL STANDARDS

Hastelloy G-30^{R}, 150 psi Service Rating, Line Class HG

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
	1/2" - 4"	Hastelloy G-30^{R}, UNS NO6030, ASTM B366 Class WPHG30S from ASTM B622 Seamless Pipe, Sch. 40S Butt Weld Ends.	Same as above
	5" - 8"	Hastelloy G-30^{R}, UNS NO6030, ASTM B366 Class, WPHG30WX from ASTM B619 Class I Welded Seam Pipe, Sch. 40S, Butt Weld Ends.	ASTM B366 Class WPHG30WX UNS NO6030 ASTM B619 Dimensions per ANSI B16.9
	10" - 14"	Hastelloy G-30^{R}, UNS NO6030, ASTM B366 Class WPHG30WX from ASTM B582 Material, Sch 10S, Butt Weld Ends.	ASTM B366 Class WPHG30WX UNS NO6030 ASTM B582 Dimensions per ANSI B16.9
	All Sizes	Spiral Wound Metallic Type, Hastelloy G-30^{R} Spiral Windings with TFE Filler, 304 SST Centering Guide.	API-601 ASTM B582 UNS NO6030 See Note 7
Gaskets	All Sizes	Grafoil^{R}	ANSI B16.21
Bolting		Use 304 SST Bolts ASTM A193 GR B8 and Galling Resistant Nitronic 60^{R} Nuts ASTM A194 GR 8S (UNS S21800).	ASTM A193 GR B8 ASTM A194 GR 8S UNS S21800
Gate Valves	All Sizes	150# Class R.F. Bonneted Knife Gate Bi-Direction, Close Bonnet and Body Fabricated (not cast) Carpenter 20Cb-3^{R}, Internal Gate Wiper Between Body and Bonnet and Multiple Rows of Stem Packing. Viton^{R} Steel Belted Radial Seats.	ASTM B462 UNS-08020 ASTM B463 UNS-08020 ASTM B472 UNS-08020 ANSI B16.34 See Notes 6 & 8
Globe Valves	All Sizes	150# Class, Body, Bonnet and Disc Fabricated (not case) Carpenter 20 Cb-3^{R}, Flanged or B.W., Seats and Seals Shall be determined for the service intended.	ASTM B462 UNS-08020 ASTM B463 UNS-08020 ASTM B472 UNS-08020 See Notes 6 & 8
Ball Valves			ASTM B581 UNS-NO6030 ASTM B462 or 472 ANSI B16.34 Notes 8 & 9

PIPING MATERIAL STANDARDS

PVC Pressure Pipe, Line NA Class 200

Design Notes

1. To be used for underground pressurized fire water lines only.

2. Installation shall be per manufacturer's instructions.

3. PVC pipe shall be bedded all around with 4" to 6" of sand.

4. This line class shall not be used in contact with or within 10' of 300 series stainless steel line classes to avoid chloride contamination.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	4" - 12"	Polyvinyl Chloride (PVC) Pressure Pipe, Class 200, Bell and Spigot Ends. As manufactured by J-M Manufacturing Co. Inc. Blue Brute^{R} or equal.	AWWA C900 UL Listed and Factory Mutual approved for fire protection service.
Fittings	4" - 12"	Ductile Iron per Line Class NR.	

PIPING MATERIAL STANDARDS

Carbon Steel - ECTFE Lined (Harlar^{R}), 150 psi Service Rating, Line Class NB

Design Notes

1. Manufacturer's suggested bolt torque shall be used in assembling flange joints.

2. No gaskets are normally required between flanges with molded raised faces. Before disconnecting flanges scribe match marks in flange sides to ensure exact line-up when reconnected.

3. Threaded flanges are to be used only on field fit spool pieces to make final connections to flanged pipe.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1" - 10"	Carbon Steel Sch. 40 with ECTFE lining, 150# ANSI B16.5 wrought steel Van Stone (lap joint) flanged ends with molded raised face.	ASTM A587 ASTM A234 ANSI B16.5
Fittings	1" - 10"	Wrought steel Van Stone (lap joint) flanged fittings, 150# ANSI B16.5 lined with ECTFE, molded raised face.	ASTM A234 ANSI B16.5
Flanges Blind Flanges & Reducing Flanges	1" - 10"	Forged Carbon Steel Van Stone (lap joint) and Threaded Flanges with ECTFE Lining, 150# ANSI B16.5, Molded Raised Face.	ASTM A105 or A181 ANSI B16.5 See Note 3
Plug Valves	All Sizes	150# Class Molded Raised Face Flanged Cast Steel with ECTFE Lining, PFA Coated Plug (or other coating suitable for service intended).	ASTM A216 Grade WCB ANSI B16.34
3-Way Plug Valves	All Sizes	150# Class Molded Raised Face Flanged, Cast Steel or Ductile Iron with ECTFE Lining, PTFE Coated Plug (or other coating suitable for intended service).	ASTM A395 or A216 Grade WCB
Bolting		Hexhead Machine Bolt with Hex Nut, Chrome-moly Steel.	ASTM A193 Grade B7 ASTM A194 Grade 2H
Branches		Use Full or Reducing ECTFE Lined Flanged Fittings.	

PIPING MATERIAL STANDARDS

Carbon Steel-Weld Fittings, 150 psi Service Rating, Line Class NC

Design Notes

1. Line Class NC at FPR included only socket-weld fittings. This line class shall be used for future work.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	All Sizes	Seamless Carbon Steel, Sch. 40, Plain Ends.	ASTM A106 Grade B
Fittings	2" & Smaller	3000# Carbon Steel, Forged, Socket-Weld or Butt Weld Ends.	ASTM A105
	2-1/2" and Larger	Seamless Wrought Carbon Steel, Butt Weld Ends.	ASTM A234 Grade WPB
Gate Valves	All Sizes	800# Class, Forged Steel, SW or BW, OS&Y, BB, Grafoil[R] Packing & Gaskets, Trim for Steam Service.	ASTM A105 ANSI B16.34
	Same as above	150# Class, Cast Steel, BW, OS&Y, BB, Standard Trim, Grafoil[R] Packing and Gaskets.	ASTM A216 ANSI B16.34
	3" & Larger	150# Class, Cast Steel, Flanged OS&Y, BB, STD Trim, Grafoil[R] Packing and Gaskets.	Same as above
Globe Valves	All Sizes	800# Class, Forged Steel, SW or BW, OS&Y, BB, Renewable Disc & Seat, Grafoil[R] Packing and Gasket, Trim for Steam Service.	ASTM A105 ANSI B16.34
	Same as above	150# Class, Cast Steel, BW, OS&Y, BB, Standard Trim, Grafoil[R] Packing and Gaskets.	ASTM A216 ANSI B16.34
	3" & Larger	150# Class, Cast Steel, Flanged, OS&Y, BB, Standard Trim, Grafoil[R] Packing and Gaskets.	Same as above
Check Valves	All Sizes	800# Class, SW or BW, Piston or Lift Type, Forged Steel, Trim, for Steam Service Grafoil[R].	ASTM A105 ANSI B16.34
	Same as above	150# Class, Cast Steel, BW, BB, Standard Trim, Swing Type, Grafoil[R] Gaskets.	ASTM A216 ANSI B16.34
	3" & Larger	150# Class, Flanged, Cast Steel, Swing Type, Bolted Cap, Swing Type, Grafoil[R] Gasket.	Same as above
Flanges	All Sizes	150# ANSI B16.5, RF, Forged CS Weld Neck, All Sizes Slip-on or SW.	ASTM A181 ASTM A105 ANSI B16.5
Orifice Flanges	2" - 8"	Forged Carbon Steel, 300# Raised Face, Bored to match pipe.	ASTM A105 ANSI B16.36
Gaskets	1/2" - 24"	Grafoil[R] Gaskets, 1/16" Thick.	ANSI B16.21
		Note: Use 300# Ring Type with Orifice Flanges.	
Bolting		Chrome-moly, Stud Bolt Threaded Full Length Two Semi-Finished Heavy Hex Nuts Each.	ASTM A193 Grade B7 ASTM A194 Grade 2H

	Run Size	Branch Size	Use	
Branch Connection	2" & Smaller	Full Size or Reducing Full	Tee Tee	

PIPING MATERIAL STANDARDS

Carbon Steel-Weld Fittings, 150 psi Service Rating, Line Class NC

TYPE	PIPE SIZE	MATERIAL DESCRIPTION		CODE
s	Larger than 2"	2" and Smaller	Saddle	
		Larger than 2"	Stub-in	

PIPING MATERIAL STANDARDS

Chlorinated Polyvinyl Chloride (CPVC) CPVC (Temperature Limit 180EF)
Line Class ND

Design Notes

1. When assembling nonmetallic flanges, flat washers shall be used under all bolt heads & nuts.

2. When plastic pipe is used for potable water in buildings, CPVC shall be used on all hot and cold potable water piping.

3. Bronze or iron body valves may be used at designers options.

4. Use CPVC primer and cement for solvent welding of SW fittings.

5. See manufacturers recommendations for cleaning and joining CPVC pipe and fittings.

6. This line class shall not be used in contact with or within 10' of 300 series austenitic stainless steel line classes to avoid chloride contamination.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1/2" - 6"	Hi Temperature CPVC, Plain Ends for SW (Preferred) or SCRD. Schedule 80.	ASTM F441
Fittings	1/2" - 3"	CPVC Fittings, SW (Preferred) or SCRD, Schedule 80.	ASTM F437 or ASTM F439
	1" - 6"	CPVC Fittings, 150# ANSI B16.5 Flanged, Schedule 80 SW (Preferred) or SCRD.	Same as above ANSI B16.5
Ball Valves	1/2" - 4"	CPVC, SCRD, SW or Flanged. True Union Type.	See Note 3
Flanges	1/2" - 6"	CPVC, SW (Preferred) or SCRD 150# ANSI B16.5.	ASTM F437 or ASTM F439 See Note 1 ANSI B16.5
Gaskets		TFE, Full Face - Non Radiation Use Only	
Bolting		Carbon Steel Bolts & Nuts	See Note 1 ASTM A307 Grade B

PIPING MATERIAL STANDARDS

Vitrified Clay, Extra Strength Uniform Building Code, Line Class NE

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	2" - 4"	Vitrified Clay Pipe, Extra Strength	ASTM C700
Fittings	2" - 4"	Vitrified Clay, Extra Strength Molded Rubber Compression Joints	ASTM C700 ASTM C425

PIPING MATERIAL STANDARDS

Carbon Steel - Polypropylene Lined (PPL), 150 psi Service Rating, Line Class NF

Design Notes

1. All spool assemblies involving lined piping shall be fabricated from PPL lined carbon steel pipe w/150# ductile iron flanges and flanged ductile iron, or cast steel PPL lined fittings.

2. Straight sections of pipe available in standard spool lengths of 10 feet and 20 feet.

3. Manufacturer's suggested bolt torque shall be used in assembling flange joints.

4. No gaskets required between flanges with molded raised faces.

5. The following pressure limitations shall be followed for diaphragm valves at 100°F.

Size	Max. Pressure	Size	Max. Pressure
1/2"-1"	200 psig	3"-4"	150 psig
1-1/2"-2"	175 psig	6" only	125 psig

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1" - 6"	Carbon Steel, Standard Weight, lined with Polypropylene, 150# ANSI B16.5 Screwed Ductile Iron Flange Ends.	ASTM A53 Grade B ASTM A395 ANSI B16.5
Fittings	1" - 6"	Ductile Iron Flanged Fittings, 150# ANSI B16.5 Lined with Polypropylene, Molded Raised Face.	ASTM A395 ANSI B16.5
Check Valves		150# Class, RF, Cast Steel, Polypropylene Lined.	ASTM A216 Grade WCB Dimensions per ANSI B16.34
Plug Valves	1" - 4"	150# Class, RF, Cast Steel, Polypropylene Lined Furnished with Wrench.	ASTM A 216 Grade WCB Dimensions per ANSI B16.34
	6" only	Same as above except furnished with enclosed worm gear operator.	
Diaphragm Valves	1/2" - 6"	150# Class, RF, Polypropylene Lined Cast Carbon Steel, Hand Wheel Operated.1/2" - 6"	ASTM A216 Grade WCB Dimensions per ANSI B16.34
Flanges (Loose)	1" - 6"	150# ANSI B16.5, Ductile Iron, Screwed, Chamfered Acceptable: DOW #520^{R} or equal. To be used with Polypropylene Lining.	ASTM A395 ANSI B16.5
	1" - 6"	150# ANSI B16.5, Ductile Iron Blind Flanges, (use with Polypropylene Full Face Blind Spacer) Acceptable: DOW #522^{R} or equal.	ASTM A395 ANSI B16.5
Orifice Flanges (Loose)		300# ANSI B16.5, Ductile Iron, Screwed, Chamfered with 1/2" SCRD Taps. To be used with Polypropylene Lining.	ASTM A395 ANSI B16.36
Spacers		Use Standard Full-Face or Reducing Full Face PPL Spacer when mating PPL lined piping items with all other types of flanged piping.	
Bolting		Hex Head Machine Bolt with Hex Nut.	ASTM A307 Grade B
Branches	1" - 6"	Use Full or Reducing PPL Lined Flanged Fittings.	

PIPING MATERIAL STANDARDS

Polyethylene (Very High Molecular Weight High Density Polyethylene)
Line Class NH

Design Notes

1. VHMWHD Polyethylene used for service waste shall be used only in out-of-cell areas and only where compatible with the service waste material.

2. See ASME B31.3 Chapter VII "Nonmetallic Piping and Piping Lined with Non-metals" and ICPP Materials Development Organization for further direction on specifying material for the intended application and obtain prior written approval of ICPP Design Engineering Organization.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	3/4" - 14"	VHMWHD Polyethylene as manufactured by Phillips Driscopipe No. 8600^{R} or equal. Pressure Rating 110 psi. 160 psi or as required.	None
Fittings	All Sizes	VHMWHD Polyethylene as manufactured by Phillips Driscopipe No. 8600^{R} or equal. Pressure Rating to match pipe system rating. Ends suitable for butt-fusion.	None
Special Fittings		Molded Stub Ends of VHMWHD Polyethylene as manufactured by Phillips - Driscopipe No. 8600^{R} or equal shall be used in conjunction with Slip-on Flanges for interface between VHMWHDPE Pipe and Metallic Pipe. Pressure Rating to match pipe system rating.	None
Flanges		Slip-On (Flat Metal Plate) 304 SST 150 psi Driscopipe^{R} or equal.	ANSI B16.21
Gaskets		Gylon^{R}, Ring Type, 1/16" Thick 150 psi	ANSI B16.21
Bolts		Use 304 SST Bolts ASTM A193 Gr B8 and Galling Resistant Nitronic 60^{R} Nuts ASTM A194 Gr 8S (UNS S21800)	ASTM A193 Gr B8 ASTM A194 Gr 8S UNS S21800

PIPING MATERIAL STANDARDS

Concrete, Line Class NI

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	4" & Larger	Concrete Sewer, Storm Drain, and Culvert Pipe	ASTM C14
Joints	4" & Larger	Joints for ASTM C443 Sewer, Storm drain and culvert pipe shall be rubber gasketed belled ends.	ASTM C443

PIPING MATERIAL STANDARDS

Galvanized Carbon Steel, 125 - 150 psi Service Rating, Line Class NJ

Design Notes

1. Fittings and equipment in this line class for firewater lines or raw water lines supplying fire water mains shall be specified per NFPA-13 and Factory Mutual Data Sheet 2-8N for above ground piping and NFPA 24 and Factory Mutual Data Sheet 3-10 for underground piping in lieu of the fittings and equipment specified herein.

2. For ASME B31.3 Base Category fluids see ASME B31.3 Table 314.2.1 for minimum pipe schedule requirements instead of those listed below. Match fitting class to pipe rating.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1/2" - 4"	Carbon Steel, Galvanized, Sch 40, Threaded and Coupled Ends.	ASTM A53
Fittings	All sizes	150# Class, Galvanized Malleable Iron Screwed.	ASTM A197
Gate Valves	All Sizes	125# Class Bronze, SCRD, Double Wedge, Rising Stem.	ASTM B62
	Same as above □	125# Class, Iron Body, Flat-Faced Flanged, Double Wedge, Non-Rising Stem, Bronze Trim.	ASTM A126 Class B
Globe Valves	All Sizes	125# Class, Bronze, SCRD, Rising Stem, Bronze Disc and Seats, GrafoiL^{R} Packing and Gasket.	ASTM B62
	Same as above □	150# Class, Bronze, SCRD, Rising Stem, Renewable Composition Disc, Bronze Seat, Grafoil^{R} Packing and Gasket.	ASTM B62
	Same as above □	125# Class, Iron Body, Flat-Faced Flanged, OS&Y Bolted Bonnet, Rising Stem, Solid Bronze Disc, Trim and Seats.	ASTM A126 Class B
	Same as above □	125# Class, Iron Body, Raised Face Flanged, OS&Y Bolted Bonnet, Rising Stem, Composition Disc & Seats.	ASTM B62
Check Valves	All Sizes	125# Class, OS&Y, Bronze, Screwed, Full Way Bronze Discs and Seats.	ASTM B62
	Same as above □	150# Class, Bronze, Screwed, Renewable Composition Disc, Seats.	ASTM B62
	All Sizes	125# Class, Iron Body, Bronze Mtd., Flanged, Horizontal Swing.	ASTM B62
Service Stops	Same as above □	125# ANSI, Bronze, SCRD, Square or Flat Head.	ASTM B62
		125# ANSI, Iron Body, SCRD, Square Head.	ASTM A126 Class B
Ball Valves	1/4" - 2"	300# Class WOG, SCRD, Bronze Body TFE Seats and Seals, Lever Operated.	ASTM B62
	3" - 4"	150# Class, Raised-Face Flange, Ductile Iron Body, TFE Seat, Top Entry, Lever Operated.	ASTM A395
Plug Valves	1/2" - 2"	200# Class, SCRD, Cast Iron Body and Plug, TFE Sleeve and Diaphragm, Lever operated.	ASTM A126 Class B

PIPING MATERIAL STANDARDS

Galvanized Carbon Steel, 125 - 150 psi Service Rating, Line Class NJ

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Flanges	2" - 4"	Galvanized Malleable Iron 150# FF, Screwed Flange.	ASTM A105
Orifice Flanges	All Sizes	Forged Carbon Steel, 300# RF, Weld Neck Type, with 1/2" SCRD Tops, with bore to match Pipe.	ASTM A105
Gaskets	1/4" - 6"	Grafoil^{R} flange gasket, flat ring, 1/16" Thick.	ANSI B16.21
Bolting		Hex head machine bolt with hex nut.	ASTM A307 Grade B
Branches	1/4" - 2"	For full size or reducing branch, use full or reducing tee.	
	3" - 6"	For full size branch, use full size tee.	

PIPING MATERIAL STANDARDS

Copper Water Tubing Type L or K, Line Class NK

Design Notes

1. Note restrictions on use of tubing in Section 5.6.2 of this A-E Standard.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Tubing	1/4" - 2"	Seamless Copper Water Tubing, Hard Drawn or Soft Drawn, Type L or K Straight Length or Coil.	ASTM B88
Fittings	1/4" - 2"	Wrought Copper or Bronze Solder - Type Pressure Fittings.	ANSI B16.22
Soldering Material		Silver Brazing Wire.	
Gate Valves	1/4" - 2"	125# Class, Bronze, Double Wedge Rising Stem Screwed-In Bonnet, Solder Joint Tubing End or SCRD.	ASTM B62
Globe Valves	1/4" - 2"	150# Class, Bronze, Renewable Composition Disc, Rising Stem, Union Bonnet, Solder Joint Tubing End or SCRD.	ASTM B62
Check Valves	1/4" - 2"	125# Class, Bronze, Screwed-In Cap, Bronze Disc, Solder Joint Tubing End or SCRD.	ASTM B62

PIPING MATERIAL STANDARDS

Polypropylene, Line Class NL

Design Notes

1. Polypropylene piping systems shall be fabricated in strict accordance with the manufacturer's recommendations.

2. Installation practices, including flange bolt torque, support spacing, and expansion considerations shall be in compliance with the manufacturer's recommendations.

3. Joints in underground and trench piping shall be made by fusion. Break-out joints in above ground piping shall be made w/flanges.

4. Installed piping shall be pressure tested before putting it into service in accordance with the manufacturer's recommendations.

5. TFE not suitable for radiation area use. In radiation areas ring material shall be selected for particular radiation fields and chemical compatibility.

6. When assembling nonmetallic flanges, flat washers shall be used under all bolt heads and nuts.

7. Original installation in FDP was ASTM 2146 (replaced by D4101) Type 1-29209 with thickness and tolerance per ASTM D-1785. However, these are not specific PP pipe standards. See ASME B31.3 Chapter VII "Nonmetallic Piping and Piping Lined with Nonmetals" and ICPP Materials Development Organization for further application and obtain prior written approval of ICPP Design Engineering Organization.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1/2" - 6"	Polypropylene pipe, Schedule 80	Note 7
Fittings	All Sizes	Polypropylene Fittings, Socket Ends, Schedule 80	Note 7
Ball Valves	1/2" - 6"	Ball Valves, 150 psi, CWP, True Union, Polypropylene Body with TFE Seats, and TEE O-Ring Seal, Socket Ends with Socket Diameter compatible with Schedule 80 Polypropylene Pipe for Fusion Joining. Handle Operated.	See Note 5
Flanges		Polypropylene Flanges, Socket Ends, 150# FF ANSI B16.5.	ASTM D2146 Type 1-29209 ANSI B16.5 See Note 6
Gaskets		Hypalon^{R} Gaskets for Polypropylene Flanges, Viton^{R} Gaskets in Radiation Area, 150# FF ANSI B16.5 Drilling Full Face w/Bolt Holes, 1/8" Thick.	ANSI B16.5
Bolts		Hex Head machine Bolts w/Hex Head Nuts.	ASTM A307 Grade B See Note 6

PIPING MATERIAL STANDARDS

Copper Tubing (Refrigeration), Line Class NM

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Tube	2/8" - 6-1/8" O. D.	Seamless Refrigeration Tubing Hard Drawn, Straight Length.	ASTM B280 UNS #Cl2200
Fittings	3/8" - 6-1/8" O. D	Wrought Copper Solder - Type Pressure Fittings.	ANSI B16.22
Soldering Material		Silver Brazing Wire.	
Gate Valves		125# Class, Bronze, Double Wedge, Rising Stem, Screwed Bonnet, Solder Joint Tubing End or SCRD.	ASTM B62
Globe Valves		150# Class, Bronze, Renewable Composition Disc, Rising Stem, Union Bonnet, Solder Joint Tubing End or SCRD.	ASTM B62
Check Valves		125# Class, Bronze, Screwed-In Cap, Bronze Disc, Solder Joint Tubing End or SCRD.	ASTM B62

PIPING MATERIAL STANDARDS

Carbon Steel, 150 psi Service Rating, Line Class NN

Design Notes

1. On all buried lines except firewater lines or raw water lines supplying fire mains, consideration should be given to welding all joints. See body of this standard for further direction.

2. Fittings and equipment in this line class for firewater lines or raw water lines supplying firewater mains shall be specified per NFPA-13 and Factory Mutual Data Sheet 2-8N for above ground piping and NFPA 24 and Factory Mutual Data Sheet 3-10 for underground piping in lieu of the fittings and equipment specified herein.

3. For high temperature service (250°).

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	2" and Smaller	Seamless Black Carbon Steel, SCH 40	ASTM A106 (3) Grade B
	All Sizes	Carbon Steel Schedule 40	ASTM A53
Fittings	2" & Smaller	150# Class, Malleable Iron, SCRD or 3000# Class, Forged Carbon Steel, SW or SCRD.	ASTM A197 or ASTM A105 See Note 3
	All Sizes	Seamless Wrought Carbon Steel BWE, Sch 40.	ASTM A234 Grade WPB
Gate Valves	2" & Smaller	800# Class, Forged Steel, SW or BW, OS&Y, BB, Trim for Steam Service, Grafoil[R] Packing and Gaskets.	ASTM A105 Note 3
	Larger than 2"	150# Class, Cast Steel, Flanged, OS&Y, BB, STD Trim, Grafoil[R] Packing and Gaskets.	ASTM A216 Class B
	All Sizes	150# Class, Bronze, Cast Iron or Malleable Iron, SCRD, OS&Y, BB Standard Trim, Grafoil[R] Packing and Gaskets.	ASTM A126 Class B ASTM B61 ASTM B62
	Same as above	150# Class, Cast Steel, BW, OS&Y, BB Standard Trim, Grafoil[R] Packing and Gaskets.	ASTM A216
Globe Valves	2" & Smaller	800# Class, Forged Steel, SW or BW, OS&Y, BB, Trim for Steam Service, Renewable Disc & Seat Grafoil[R] Packing and Seat.	ASTM A105 Note 3
	All Sizes	150# Class, Bronze, Cast Iron or Malleable Iron, SCRD, OS&Y, BB, Standard Trim, Grafoil[R] Packing and Gaskets.	ASTM A126 Class B ASTM B61 ASTM B62
	Same as above	150# Class, Cast Steel, BW, OS&Y, BB, Standard Trim, Grafoil[R] Packing and Gaskets.	ASTM A216
	Larger than 2"	150# Class, Cast Steel, Flanged, OS&Y, BB, Standard Trim, Grafoil[R] Packing and Gaskets.	ASTM A216
Check Valves	2" & Smaller	800# Class, SW or BW, Piston or Lift Type Forged Steel, Trim for Steam Service, Grafoil[R] Gasket.	ASTM A105 Note 3
	3" & Larger	150# Class, Flanged, Cast Steel, Swing Type, Bolted Cap, Swing Type, Grafoil[R] Gasket.	ASTM A216
	All Sizes	150# Class, Bronze, Cast Iron or Malleable Iron SCRD, BB, Standard Trim, Grafoil[R] Packing and Gaskets.	ASTM A126 Class B ASTM B61 ASTM B62

PIPING MATERIAL STANDARDS

Carbon Steel, 150 psi Service Rating, Line Class NN

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
	Same as above	150# Class, Cast Steel, BW, BB, Standard Trim, Grafoil^{R} Packing and Gaskets.	ASTM A216
Ball Valves	2" & Smaller	300# Class, Cast Steel Body, SCRD, or SW 316 SST Ball & Stem, CS Packing Retainer and Gland, TFE Ball Seat, Grafoil^{R} Seal Ring & Stem Packing.	ASTM A216
Butterfly Valves		150# Class, FF or Wafer-Type, Cast Iron, SST Shaft, Disc and Seat to be determined for particular service.	ASTM A126
Plug Valves	2" & Smaller	150# Class, Malleable Iron, Screwed, TFE Sleeve and Diaphragm.	ASTM A197
	3" & Larger	150# Class, Cast Steel, Flanged, TFE Sleeve and Diaphragm, Austenitic Stainless Steel Plug.	ASTM A216
	All Sizes	150# Class, Cast Steel, BW, TFE Sleeve and Diaphragm, Austenitic SST Plug.	ASTM A216
Diaphragm Valves	1/2" - 2"	125# Class, WOG, Screwed Ends, Cast Iron, Ethylene Propylene Diaphragm, Weir Type, Handwheel Operated Indicating Stem.	ASTM A126
	3" - 6"	125# Class, FF Flanged Ends, Cast Iron, Ethylene Propylene Diaphragm, Weir Type, Handwheel Operated Indicating Stem.	ASTM A126
Flanges	2" & Smaller	150# ANSI B16.5, RF, Forged CS Weld Neck, Slip-on, Threaded or SW.	ASTM A105 ASTM A181 ANSI B16.5
	3" & Larger	150# ANSI B16.5, RF, Forged CS Weld Neck, Threaded or Slip-on.	ASTM A105 ASTM A181 ANSI B16.5
Orifice Flanges	2" - 8"	Forged Carbon Steel, 300# Raised Face, bored to match pipe.	ASTM A105 ANSI B16.36
Gaskets	1/2" - 24"	150#, Grafoil^{R} Gaskets, 1/16" Thick	ANSI B16.21
		Note: Use 300# Configuration with Orifice Flanges.	
Bolting		Chrome-moly, Stud bolt Threaded Full Length, Two Semi-Finished Heavy Hex Nuts Each	ASTM A193 Grade B7 ASTM A194 Grade 2H

PIPING MATERIAL STANDARDS

Polyvinyl Chloride - Drain, Waste and Vent (PVC-DWV) Uniform Plumbing Code
PVC-DWV, Line Class NO

Design Notes

1. Although referenced in the UPC, some of the fittings shown in ASTM D3311 are not acceptable under the UPC. See UPC for more details.

2. Use PVC cement for solvent welding of SW fittings. (ASTM D2564)

3. Use UPC for connections or transitions to bell and spigot pipe fittings.

4. See the UPC for installation standards for PVC-DWV.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	2" - 4"	PVC-DWV, (SCH 40), Plain Ends for SW (Preferred) or SCRD.	ASTM D2665
Fittings	2" - 4"	PVC-DWV SW (Preferred or SCRD.	ASTM D2665 ASTM D3311 See Note 1 See Note 3

PIPING MATERIAL STANDARDS

Copper Tubing, Line Class NP

Design Notes

1. Note restrictions an use of tubing in Section 5.6.2 of the A-E Standard.

2. Where higher pressures are encountered, the designer has the option of selecting thicker-walled tubing.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Tube	1/8" - 1"	Copper, .035" Wall, Hard-drawn or soft-drawn Type K, Straight Length or Coil.	ASTM B88
Fittings	1/8" - 1"	Brass, Swagelok^{R} Compression Type fittings	
Valves		Brass, Whitey^{R} or Nupro^{R} with Swagelok^{R} Compression Type Fittings, TFE Seats and Seals.	

PIPING MATERIAL STANDARDS

Aluminum Tubing, Line Class NO

Design Notes

1. Note restrictions an use of tubing in Section 5.6.2 of the A-E Standard.

2. Where higher pressures are encountered, the designer has the option of selecting thicker-walled tubing.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Tube		Aluminum, Seamless, 0.035" Wall, Alloy 6061-T6.	Fed. WW-T-700/6 or ASTM B210
Fittings	1/8" - 1"	Aluminum, Swagelok^{R} Compression Type Fittings.	
Valves		Aluminum, Whitey^{R} or Nupro^{R} with Swagelok^{R} Compression Type Fittings, TFE Seats and Seals.	

PIPING MATERIAL STANDARDS

Ductile Iron Water Pipe, Line Class NR

Design Notes

1. Fittings and equipment in this line class for firewater lines or raw water lines supplying fire water mains shall be specified per NFPA-13 and Factory Mutual Data Sheet 2-8N for above ground piping and NFPA 24 and Factory Mutual Data Sheet 3-10 for underground piping in lieu of the fittings and equipment specified herein.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe		Ductile Iron with Rubber Gasketed Mechanical Push-On Seal Joints. Pipe shall be lined with cement-mortar and coated on the outside with coal tar (minimum 45 mils) or polyethylene (minimum thickness of 20 mils).	AWWA C151 AWWA C111 AWWA C104
Fittings		Ductile Iron, 150#, Joints to Match Pipe.	AWWA C110 AWWA C111
Hydrant Tee		Mechanical Joint with Rotating Gland, Run Size equal to Water Main Size, Branch Size 6" Nominal.	
Connecting Pieces		Hydrant Connecting Pieces, Mechanical Joint.	
Restrained Mechanical Joints		Ductile Iron Retainer Gland w/Square Head Set Screws.	UL Listed and Approved by Factory Mutual Engineering Division
Gate Valves		150# Class, Iron Body, OS&Y, Bolted Bonnet Bronze Mounted, Double Disc, Non-Rising Stem, Parallel Seat, Hub End, Flanged End, Mechanical Joint, or Mechanical and Flanged Joint as required.	ASTM A126 Class B
Check Valves		150# Class, Iron Body, Flanged Ends, Swing Type Bronze Faced Disc, Bolted Flanged Cap.	ASTM A126 Class B
Branches		Use Full or Reducing Tee, Cast Iron, Cement Lined, ends to match piping system.	

PIPING MATERIAL STANDARDS

Fiberglass Reinforced Plastic (FRP), Line Class NS

Design Notes

1. FRP type formulation and standard shall be determined for the particular service and associated corrosion and radiation requirements. Thermoplastic lined FRP shall be considered where corrosion is severe. See ASME B31.3 Chapter VII "Nonmetallic Piping and Piping Lined with Nonmetals" and ICPP Materials Development Organization for further direction on specifying material for the intended application and obtain prior written approval of ICPP Design Engineering Organization.

2. Valves for corrosion services shall be specified of materials suitable to withstand the particular corrosion service. 316 SST valves listed are for general use only.

3. TFE not for use in radiation areas.

4. When assembling nonmetallic flanges, flat washers shall be used under all bolt heads and nuts.

TYPE / PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	150# Rated Fiberglass Reinforced Plastic.	Note 1
Fittings	Bell & Spigot or Flanged, Compatible w/Manufacturer's System. Adapt to other systems w/Grooved, Threaded, or Flange Adapters.	
Gate Valves	150# Class, RF, OS&Y, Double Wedge, BB, 316 SST Body & Trim, Grafoil^{R} Packing and Gaskets.	ASTM A351 Grade CF8M ASTM A182 Grade F316
Globe Valves	150# Class, RF, OS&Y, BB, 316 SST Body and Trim, Grafoil^{R} Packing and Gasket	ASTM A351 Grade CF8M ASTM A182 Grade F316
Check Valves	150# Class, RF, Wafer Check 316 SST Body, Plates and Trim, Metal to Metal Seat, Inconel^{R} Spring.	ASTM A351 Grade CF8M ASTM A182 Grade F316
Ball Valves	150# Class, RF, 316 SST Body, Ball & Stem, TFE Seats & Body Seals, SST External Parts, Lever Operated.	See Note 3 ASTM A351 Grade CF8M ASTM A182 Grade F316
Butterfly Valves	150# Class, Single Flange, Lug Type 316 SST Body & Disc, 17-4 pH Stem, Tefzel^{R} Seal Ring, EPR Back-up Ring, Lever Lock Handle.	See Note 3 ASTM A351 Grade CF8M ASTM A182 Grade F316
Plug Valves	150# Class, RF, 316 SST Body, Cover and Plug, UHMW Polyethylene Sleeve and Diaphragm, Wrench Operated.	See Note 3 ASTM A351 Grade CF8M ASTM A182 Grade F316
Diaphragm Valves	150# Class, RF, 316 SST Body, Bonnet and Stem, Viton^{R} Rubber Diaphragm, Weir Type, Handwheel Operated.	See Note 3 ASTM A351 Grade CF8M ASTM A182 Grade F316
Flanges	150# ANSI B16.5, FRP Flanges, when mating to raised face flanges or lug valves, use spacers to prevent damage to fiberglass flanges.	See Note 4 ANSI B16.5
Gaskets	Full Face, 1/8" Thick 60 Durometer. Torque as recommended by manufacturer of flange.	
Bolting	Stud Bolts 18-8 SST ASTM A193, Grade B8, Class 2 with Hex Nuts ASTM A194, Grade 8M	ASTM A193 Grade B8 Class 2 ASTM A194 Grade 8M See Note 4
Line Reduction	Use Concentric Flanged or Bell & Spigot Reducers.	
Branches	Full Size - Use Tee Reducing - Use Saddle	

PIPING MATERIAL STANDARDS

Fiberglass Reinforced Plastic (FRP), Line Class NS

Design Notes

1. On the original NWCF specification SP-453504-50-3 cast iron was designated as class NE. All future installations throughout ICPP will be designated as class NT.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	4" - 12"	Cast Iron Soil Type, Bell and Spigot, Extra Heavy, Five or Ten Foot Lengths. (Nominal Sizes 4, 6, 8, 10 and 12.)	ASTM A74
Fittings	4" - 12"	Cast Iron Soil Type, Bell and Spigot, Extra Heavy.	ASTM A74
Clean Outs		Cast Iron Soil Type, with Cored Square Head Brass Plug, Bell and Spigot Ends, Extra Heavy.	ASTM A74
Joints		Bell and spigot joints shall be caulked with oakum and lead.	
Transitions to Existing VC		Cast iron soil pipe, spigot ends can be joined to the hubs of the same size vitrified clay.	

PIPING MATERIAL STANDARDS

Solid PVDF (Kynar)[R], Line Class NU

Design Notes

1. PVDF piping system shall be fabricated in strict accordance with the manufacturers recommendations and approved ICPP PVDF fusion-weld procedures.

2. Installation practices including flange bolt torque, support spacing and pipe expansion considerations shall be in compliance with the manufacturers recommendations.

3. Installed piping shall be hydrostatically tested before putting it into service in accordance with the manufacturers recommendations.

4. When assembling nonmetallic flanges, flat washers shall be used under all bolt heads and nuts.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1/2" - 2"	PVDF Pipe for Socket-Welding as manufactured by Resistoflex (Fluoroflex-K)[R] or equal. Sch 80.	
	1/2" - 3"	PVDF Pipe for Butt-Welding as manufactured by ASAHI/America (Superproline)[R], 230 psi Pressure Rating for Water at 73.4°F.	
	4" - 8"	PVDF Pipe for Butt-Welding as manufactured by ASAHI/America (Superproline)[R], 160 psi Pressure Rating for Water at 73.4°F.	
Fittings	1/2" - 2"	PVDF Fittings for Socket-Welding as manufactured by Resistoflex[R] or equal. Sch 80.	
	1/2" - 3"	PVDF Fittings for Butt-Welding as manufactured by ASAHI/America (Superproline)[R], 230 psi Pressure Rating for Water at 73.4°F.	
	4" - 8"	PVDF Fittings for Butt-Welding as manufactured by ASAHI/America (Superproline)[R], 160 psi Pressure Rating for Water at 73.4°F.	
Flanges	1/2" - 2"	PVDF Flanges, Socket-Weld, 150# FF ANSI B16.5 Dimensions as manufactured by Resistoflex[R] with SST Back-up Washers.	ANSI B16.5
	1/2" - 3"	PVDF Stub End Butt-Weld with SST Back-up Ring as manufactured by ASAHI/America (Superproline)[R], 230 psi Pressure Rating for Water at 73.4°F with SST Back-up Washers.	
	4" - 8"	PVDF Stub-End Butt-Weld with SST Back-up Ring as manufactured by ASAHI/America (Superproline)[R], 160 psi Pressure Rating for Water at 73.4°F with SST Back-up Washers.	
Gaskets		Viton A[R] Gaskets for 150# PVDF Flange, 1/8" Thick, 60 Durometer.	
		TFE Envelope Gasket for 150# PVDF Flange.	
Bolts		Use 304 SST Bolts ASTM A193 Gr B8 and Galling Resistant Nitronic 60[R] Nuts ASTM A194 Gr 8S (UNS S21800).	See Note 4 ASTM A193 Gr B8 ASTM A194 Gr 8S UNS S21800

PIPING MATERIAL STANDARDS

Solid PVDF (Kynar)^{R}, Line Class NU

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Gate Valves	1-1/2" - 8"	Solid PVDF, 150# Class FF Flanged, Non-Rising Stem, Seal material to be specified for particular corrosion and radiation service.	
Check Valves	3/4" - 8"	Solid PVDF, 150# Class FF Flanged, Horizontal Swing, Seat and Seal Material to be specified for particular corrosion and radiation service.	
Ball Valves	1/2" - 6"	Solid PVDF, 150# Class FF Flanged, True-Union Type, Seat and Seal Material to be specified for particular corrosion and radiation service.	
	1/2" - 2"	Solid PVDF, 150# Socket-Weld, True-Union, Seat and Seal Material to be specified for particular service.	

PIPING MATERIAL STANDARDS

Carbon Steel - PVDF (Kynar)[R] Lined, 150 psi Service Rating, Line Class NV

Design Notes

1. Manufacturer's suggested bolt torque shall be used in assembling flange joints.

2. All in-cell carbon steel and forged steel piping shall be protected from decontaminant piping corrosion by epoxy coating all exposed external surfaces.

3. No gaskets are normally required between flanges with molded raised faces. Before disconnecting flanges, scribe match marks in flange sides to ensure exact line-up when reconnected.

4. The following pressure limitations shall be followed for diaphragm valves at 100°F.

Size	Max. Pressure
1" - 4"	150 psig
6" only	125 psig

5. Companion flanges are used for molded raised face and gasketed pipe joints with PVDF liner.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1" - 5"	Carbon Steel, Schedule 40, Lined with PVDF 150# ANSI B16.5 Cast Steel Flange Ends.	ASTM A587 ANSI B16.5
Fittings	1" - 6"	Cast Steel Flanged Fittings, 150# ANSI B16.5, Lined with PVDF, Molded Raised Face.	ANSI B16.5 ASTM A216 Grade WCB
Diaphragm Valves		150# Class Molded Raised Face PVDF Lined Cast Carbon Steel, Hand Wheel Operated with TFE Diaphragms (Outside Cell Only.) Diaphragm Material shall be specified for the particular service when in-cell.	See Note 4 ANSI B16.5 ASTM A216 Grade WCB
Check Valve	1" - 6"	150# Class Molded Raised Face Cast Steel, PVDF Lined, Diaphragm material shall be specified for the particular service when in-cell.	ASTM A216 Grade WCB ANSI B16.5
Flanges Companion	1" - 6"	150# ANSI B16.5, Forged Steel or Ductile Iron, Screwed, Chamfered.	See Note 6 ASTM A105 ASTM A395 ANSI B16.5
Flanges (Blind)	1" - 6"	150# ANSI B16.5, Forged Steel or Ductile Iron Blind Flanges, (use with PVDF Full Face Blind Spacer).	ASTM A105 ASTM A395 ANSI B16.5
Reducing Flanges (Filler)		PVDF Lined 150# ANSI B16.5, Forged Steel or Ductile Iron.	ASTM A105 ASTM A395 ANSI B16.5
Flanges		Solid PVDF 2" Thickness with Stainless Steel Back-up Washers.	
Gaskets		Viton A[R], 1/16" Thickness 60 Durometer	
Bolting		Use 304 SST Bolts ASTM A193 Gr B8 and Galling Resistant Nitronic 60[R] Nuts ASTM A194 Gr 8S (UNS S21800).	ASTM A193 Grade B8 ASTM A194 Grade 8S UNS S21800
Branches	1" - 6"	Use Full or Reducing PVDF Lined Flanged Fittings.	
Spacers		Use Standard Full-Face or Reducing Full-Face PVDF Spacer of 1/2" Minimum Thickness when Mating PVDF Lined Piping Items with all other type of Flanged Piping.	

PIPING MATERIAL STANDARDS

Polyvinyl Chloride (PVC), Temperature Limit 140EF, Line Class NW

Design Notes

1. When assembling nonmetallic flanges, flat washers shall be used under all bolt heads and nuts.

2. For use on cold potable water outside buildings only. Note maximum temperature for PVC is 140°F. For hot or cold potable water piping inside (or outside) buildings use CPVC (Line Class ND).

3. Bronze or iron body valves may be used at designers option where corrosion is not a problem.

4. Use PVC primer and cement for solvent Welding of SW fittings. (ASTM F656 ASTM D2564)

5. See manufacturers recommendations for cleaning and joining PVC pipe and fittings.

6. This line class shall not be used in contact with or within 10' of 300 series austenitic stainless steel line classes to avoid chloride contamination.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1/2" - 6"	PVC, Plain Ends for SW (preferred) or SCRD Schedule 80.	ASTM D1785
Fittings	1/2" - 3"	PVC Fittings, SW (preferred) or SCRD. Schedule 80.	ASTM D2464 ASTM D2467
	1" - 6"	PVC Fittings, 150# ANSI B16.5 Flanged, Schedule 80.	Same as above ANSI B16.5
Ball Valves	1/2" - 4"	PVC, SCRD, SW or Flanged. True Union Type.	See Note 3
Flanges	1/2" - 6"	PVC SW (preferred) or SCRD, 150# ANSI B16.5	ASTM A2464 ASTM D2467 See Note 1 ANSI B16.5
Gaskets		TFE, Full Face - Non-Radiation Use Only.	
Bolting		Carbon Steel Bolts and Nuts.	ASTM A307 Grade B See Note 1

PIPING MATERIAL STANDARDS

Asbestos - Cement Per AWWA C400, Line Class NX

Design Notes

1. This specification describes existing piping only. On future installations this material specification shall be prohibited.

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe		Asbestos - cement for water and other.	C400 AWWA
Fittings		Fitting shall be mechanical joint or taper fittings consistent with the manufacturer's recommendation for the piping used.	
Valves		Refer to piping manufacturers recommendation.	
Flanges		Same as above.	
Gaskets		Same as above.	
Bolting		Same as above.	

PIPING MATERIAL STANDARDS

Asbestos - Cement Per AWWA C400, Line Class NX

Design Notes

1. Use ABS solvent cement for joining pipe and fittings made to this specification. (ASTM D2235)

TYPE	PIPE SIZE	MATERIAL DESCRIPTION	CODE
Pipe	1-1/4" - 4"	Acrylonitrile - Butadiene - Styrene (ABS) Plastic Drain, Waste, and Vent Pipe or ABS Sch 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core.	ASTM D2661 ASTM F628
Fittings		ABS Plastic DWV Fittings SCRD or Solvent Weld ABS SCH 40 Plastic DWV Fittings with a Cellular Core, SCRD or Solvent Weld.	ASTM D2661 ASTM F628

APPENDIX C

Lockheed Martin Idaho Technologies Company

Technical Procedure TAN Operations	**TMI-2 CANISTER DRYING TESTING AND MONITORING – ASSEMBLY/DISASSEMBLY AND CHECKOUT**	Identifier: TPR-1187 Revision: 1 Page: **1** of 10
Document Control Center: (208) 526-6076	Document Owner/Approver: TANO Supervisor	Effective Date: canceled
Manual: Detailed Operating Procedures for Test Area North	**CATEGORY 3**	DAR Number: TANO-5517

Validation—This document must be validated prior to first use by one of the following:

[ ] Walkthrough
[ ] Using mockup or simulators
[ ] Tabletop validation by safety committee and craftsmen
[√] First time use of procedure

_____ _____
Signature Date

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	03/10/98	All	Initial release. See DAR TANO-5451.
1	05/26/98	Various	See DAR TANO-5517.

1. INTRODUCTION

1.1 Purpose

To provide instructions to assemble/disassemble and checkout the basic operation of the Heated Vacuum Drying System (HVDS) to be used to dry the TMI-2 canisters.

1.2 Scope and Applicability

The procedure provides HVDS testing operation within specified parameters including electrical, instrumentation, fluid transfer, and mechanical interfaces to existing systems and equipment. These interfaces include the existing dewatering system (DWS) and remote handling equipment. Checkout of the basic operation of the HVDS will ensure that all equipment is installed and aligned correctly such that testing and operation can be performed safely. The HVDS consists of the Vacuum Pump Skid (VPS), the Vacuum Condenser Skid (VCS), and the Vacuum Furnace (VF) (see Definitions).

This procedure applies only to those persons performing the HVDS assembly/disassembly or checkout.

2. PRECAUTIONS AND LIMITATIONS

2.1 All high temperature test equipment exposed to personnel during operations is clearly marked and proper precautions are taken when the equipment is approached.

2.2 The VF pressure relief valve (PRV3) and discharge line are clear of obstructions and connected to the DWS holding tank.

3. PREREQUISITES

3.1 Planning and Coordination

3.1.1 Hoisting and rigging equipment load test is current.

3.1.2 Equipment operators are qualified and current.

3.1.3 Personnel performing this procedure are HVDS trained.

3.2 Performance Documents

None

3.3 Special Tools, Equipment, Parts, and Supplies

3.3.1 The equipment and materials given in Table 3.3.1 are available.

Table 3.3.1. Equipment List

Item	No.	Comments
Dewatering Skid	1	
Heated Vacuum Drying System	1	
Vacuum Furnace	1	Positioned in the shielding cask

Item	No.	Comments
Shielding Cask	1	The internals are removed
Bucket(s)	1-4	With a total capacity of 20 gallons
Hose Assemblies	17	The Hose Checklist is provided in Appendix B
Helium Supply	1	To be used to leak test the system

3.3.2 The equipment is positioned as shown in the appropriate drawing listed below (obtained from the Test Engineer):

- *Dwg. No. DWS SK-007, "Warm Shop Functional Test Layout."*
- *Dwg. No. DWS SK-011, "Layout Configuration for "Cold" S. O. Testing & TAN Operator Training."*
- *Dwg. No. DWS SK-012, "Layout Configuration for Canister Drying Test TAN Operator Training."*

3.3.3 The instruments shown in Table 3.3.2 have a current calibration.

Table 3.3.2 Instrument List

Item	No.	Comments
Temperature Sensors - Two on the VF (TIT1 & TIT2) and one on the common drain line (TI1)	3	All remotely indicated except TI1
Pressure Sensors - Two on the VF (PI5 & PI6), and one on the common drain line (PI3), and one to provide system pressure (PI2)	4	All but PI2 remotely indicated - PI5 & PI6 provide input for automatic shutoff based on over pressurization of the VF
He Detector (10^{-7} atm-cc/sec)	1	Used to detect leakage of the HVDS

Preparations

Test Engineer: Conduct a briefing with the test personnel and complete the following items:

A. A discussion of safety precautions and emergency actions associated with the operation of the HVDS.
B. A review of Section 4 of this test procedure.
C. The table, *Test Personnel Identification*, in Appendix H.

Test Engineer _____ Date _____

3.4 Approval and Notifications

Review this procedure. Sign space indicated and enter date for approval of work to commence**.**

TANO Shift Supervisor: _____ Date _____

4. INSTRUCTIONS

4.1 Assembly

____ 4.1.1 Test Engineer: Ensure the prerequisites for this procedure have been completed.

____ 4.1.2 Operations Technician (OP): Ensure the VF is seated completely into the shielding cask.

____ 4.1.3 Complete hose connections as follows:

A. Complete the DWS *Valve Checklist* provided in Appendix G of this procedure.
B. Connect the 17 hoses identified in the *Hose Checklist* provided in Appendix B.
C. Connect Hose ***½-HAD-03*** to a filtered shop air source of 80 psig or greater.
D. When Hose ***1 HAD-03*** is connected to DWS Line ***¾T-CDS-012***, open DWS V-34 (HVDS Condensate Interface Isolation Valve).

E. ____ 4.1.3.1 Visually inspect all hose connections to confirm that the correct connection have been made; initial the *Hose Checklist* for each connection as it is verified.

____ 4.1.4 Elect: Attach the following HVDS interconnecting electrical cables:

A. Attach 480 VAC cables (2) from the VF to the VCS.
B. Attach the temperature probe cables from the VF to the appropriate connection in the VCS control panel.
C. Attach cables (3) from the VCS to the VPS.

____ 4.1.5 Attach the cable from the VCS to its connection on the remote controller.

CAUTION

Check phases of 480 power to VPS and VCS to ensure proper pump and motor rotation.

____ 4.1.6 Attach the electrical cables to the shop supply as follows:

A. Ensure proper voltage of the supply source (480 volt +0 to -10%, 60 amp).
B. Ensure that cables 1 and 2 are connected to independent electrical sources.
C. Attach cable 1 to the electrical supply source (VPS cable).
D. Attach cable 2 to the electrical supply source (VCS cable).
E. Attach cable 3 to a 120 VAC receptical (PLC power cord).
F. Open VPS and VCS control panel doors and energize panels by closing all circuit breakers.

____ 4.1.7 Tech: Initiate the flow of regulated shop air to the HVDS by opening the Warm Shop or Hot Shop, as appropriate, air-supply valve.

____ 4.1.8 Visually check the level of DWS Holding Tank; IF the level is not near the bottom of the sight glass, THEN use the procedure given in Appendix F, *DWS Holding Tank Sampling and Pump Out*, to transfer the tank contents.

____ 4.1.9 Align switches (leave the vacuum pump switch in the ***Off*** position) to the manual operation position (Appendix D *Switch Checklist*).

____ 4.1.10 Align valves to the normal operation position (Appendix C *Valve Checklist*) then open V3.

____ 4.1.11 Close isolation valves, V1 and V7, (switches in the ***Off*** position) for vacuum pump warm-up.

____ 4.1.12 Start the vacuum pump (***Manual*** button on the VPS) for warm-up (one hour).

____ 4.1.13 VF head sweep system checkout.

A. Start the head sweep system.
B. Measure airflow around the VF head (minimum of 120 ft/min).
C. Stop the head sweep system.

____ 4.1.14 Check instrument installation and readability of the following:

A. Pressure gauge PI1 (system pressure, 30-0-30 psig on VPS)
B. Pressure gauge PI2 (system pressure, 0-100 torr on VPS)
C. Pressure sensor PI3 (remote indication, 0-30 psig drain line pressure sensor is located on VCS)
D. Pressure sensor PI5 (remote indication, 100-0 torr VF vacuum on VCS)
E. Pressure sensor PI6 (remote indication, 100-0 torr VF vacuum on VCS)
F. Temperature sensor TIT1 (remote indication, top of canister in VCS)
G. Temperature sensor TIT2 (remote indication, bottom of canister in VCS)
H. Temperature sensor TI1 (common drain line on VCS)
I. Sight level gauge LI-1 (dewatering tank level on the DWS)
J. Programmable controller (remote installation)

____ **4.1.15 Acceptance Criteria**

A. The VF is seated completely into the shielding cask.
B. Hose and cable connections were correctly made to the proper locations and where applicable to the proper voltage.
C. Switches are aligned to the manual operation position.
D. Valves are aligned to the normal operation position (except V1 and V7 are in the ***Off*** position and V3 is opened).
E. At least one hour of vacuum pump warm-up operation has been completed.
F. Instruments are installed and readable.
G. The airflow around the VF head during head-sweep system operation was at least 120 ft/min.

____ 4.1.16 The assembly of the HVDS has been completed and met the acceptance criteria.

Test Engineer _____ Date _____

Quality Inspector _____ Date _____

4.2 Helium Leak Test

_____ 4.2.1 OP: Attach a suitable (10^{-7} atm-cc/sec) helium detector to the He/N_2-supply port of V4 on the VPS.
_____ 4.2.2 Unseal and reseal the VF head as follows:

A. Open the VF head (press the remote ***Open/Close*** button).
B. Lift the VF head slightly.
C. Lower the VF head into position.
D. Close the VF head (press ***Open/Close*** button).

_____ 4.2.3 Manually evacuate the heated vacuum drying system as follows:

A. Open V1 on the VCS (V1 switch to the ***Manual*** position).
B. Open V7 on the VPS (V7 switch to the ***Manual*** position).

C. Evacuate the system until a vacuum of <0.5 torr is indicated on the VF gauges (PI5 and PI6) and the system pressure gauge (PI2).

_____ 4.2.4 Close V7 (V7 switch to the ***Off*** position).

_____ 4.2.5 Open V4.

_____ 4.2.6 Flood critical areas of the HVDS one at a time with helium [include at a minimum all hose connections (Appendix B), instrumentation to piping attachment points and closure of the VF head].

_____ 4.2.7 Use the helium detector connected to the helium supply port to monitor for helium leaks.

_____ 4.2.8 IF leakage is identified THEN, seal and/or repair all leaks and repeat steps 4.4.2 to 4.4.7.

_____ 4.2.9 Close V4 and remove the helium detector.

4.2.10 Acceptance Criteria

_____ 4.2.10.1 No leakage is detected.

4.2.11 The helium leak testing is completed without detecting leakage.

Test Engineer _____ Date _____

Quality Inspector _____ Date _____

4.3 Vacuum Leak Test

_____ 4.3.1 OP: Manually evacuate the heated vacuum drying system as follows:

A. Open\ensure-open V1 on the VCS (V1 switch to the ***Manual*** position).
B. Open V7 (V7 switch to the ***Manual*** position).
C. WHEN the vacuum is <0.5 torr, THEN:
   a. Close V7 (V7 switch to the ***Off*** position).
   b. Close V1 (V1 switch to the ***Off*** position).
   c. Monitor pressure from PI2, PI5, and PI6 to identify unacceptable leakage (inability to maintain at least 1.0 torr for 30 minutes).
D. IF unacceptable leakage occurs THEN, pressurize the system as given below, seal and/or repair all leaks, and repeat Step 4.5.1.
E. It is probable that some leakage will occur, if practicable determine the system leak rate (ΔP/time).

_____ 4.3.2 Pressurize the system as follows:

A. Open V1 (V1 switch to the ***Manual*** position).
B. Open V11.
C. WAIT until atmospheric pressure is restored THEN, unseal and reseal the VF head as follows:
   a. Open the VF head (press the remote ***Open/Close*** button).
   b. Lift the VF head slightly.
   c. Lower the VF head into position.
   d. Close the VF head (press the remote ***Open/Close*** button).

D. Close V11.

4.3.3 Acceptance Criteria

_____ 4.3.3.1 HVDS maintains a vacuum of at least 1.0 torr for 30 minutes.

_____ 4.3.4 The vacuum leak testing is completed and met the acceptance criteria.

Test Engineer _____ Date _____

Quality Inspector _____ Date _____

4.4 Automatic (normal) Operation Test

____ 4.4.1 OP: Position the HVDS switches to the Normal Operation positions (Appendix D).

____ 4.4.2 Align valves to the normal operation position (Appendix C *Valve Checklist*).

____ 4.4.3 Press the remote ***Start*** button to begin automatic operation.

____ 4.4.4 Record temperature and pressure data in Test Log (Appendix E) at 15-minute increments UNTIL the system shuts down and the PLC temperature indicated a decay.

____ 4.4.5 Acceptance Criteria

When the remote ***Start*** button is pressed, the HVDS automatically begins the vacuum and heating process, senses drying completion, performs the Acceptance Test (<80 torr for 30 minutes) and shuts down the system.

____ 4.4.6 The automatic operation performed as expected and met the acceptance criteria.

Test Engineer _____ Date _____

Quality Inspector _____ Date _____

4.5 High-Pressure Automatic-Shutdown Test

____ 4.5.1 OP: Pressurize the system and load with water as follows:

A. Open V1 (V1 switch to the ***Manual*** position).
B. Open V4.
C. WAIT until atmospheric pressure is restored THEN, unseal, add buckets, and reseal the VF head as follows:
   a. Open the VF head (press the ***Open/Close*** button).
   b. Lift the VF head until it rests against the hinge stops.
   c. Place about 20 gallons (1 -4 buckets) of demineralized water into the VF.
   d. Lower the VF head into position.
   e. Close the VF head (press ***Open/Close*** the button).
D. Close V4.
E. Switch V1 to the ***Automatic*** position.

____ 4.5.2 Visually check the level of dewatering holding tank; IF the level is not at least seven inches below the ***Upper*** alarm sensor, THEN use the procedure given in Appendix F, *DWS Holding Tank Sampling and Pump Out*, to transfer the tank contents.

____ 4.5.3 Press the remote ***Start*** Button.

____ 4.5.4 Record temperature and pressure data in Test Log (Appendix E) at 15-minute increments UNTIL the PLC temperature reaches >200°F, THEN manually close V1 (V1 switch to the ***Off*** position) to simulate the loss of vacuum.

____ 4.5.5 CONTINUE to collect data UNTIL the system reduces temperature automatically when the upper pressure limit of 100 torr is reached (if possible).

____ 4.5.6 IF the system does not automatically begin to reduce temperature prior to it reaching 900 °F, THEN press the remote ***Stop*** button.

____ 4.5.7 Record temperature and pressure data in the Test Log at 15-minute increments UNTIL a positive indication of temperature decay is achieved.

____ 4.5.8 Reset V1 to the automatic position and complete the drying process.

____ 4.5.9 Pressurize the system and remove the buckets as follows:

A. Open V1 (V1 switch to the ***Manual*** position).
B. Open V4.
C. WAIT until atmospheric pressure is restored THEN, unseal, remove buckets, and reseal the VF head as follows:
   a. Open the VF head (press the ***Open/Close*** button).
   b. Lift the VF head until it rests against the hinge stops.
   c. Remove the bucket(s)
   d. Lower the VF head into position.
   e. Close the VF head (press ***Open/Close*** the button).
D. Close V4.
E. Switch V1 to the ***Automatic*** position.

____ 4.5.10 **Acceptance Criteria**

The system automatically reduces temperature when the upper pressure limit of 100 torr is reached.

____ 4.5.11 The system operated as expected and met the acceptance criteria.

Test Engineer _____ Date _____

Quality Inspector _____ Date _____

4.6 Disassembly

____ 4.6.1 OP: Shut off the flow of regulated shop air from the HVDS by closing the Warm Shop or Hot Shop, as appropriate, air-supply valve.

____ 4.6.2 If the vacuum pump is running, stop it (***Stop*** button).

____ 4.6.3 EL: Complete the electrical detachments from the electrical supply as follows:

A. Detach cable 1 from the electrical supply source.
B. Detach cable 2 from the electrical supply source.
C. Detach cable 3 from electrical supply source.

____ 4.6.4 Detach the remote controller cable from its connection on the VCS.

____ 4.6.5 Detach the following HVDS interconnecting electrical cables:

A. Detach cables from the VF to the VCS.
B. Detach cables from the VF to the VPS.
C. Detach cables from the VCS to the VPS.

____ 4.6.6 Tech: Detach hose connections as follows:

A. Disconnect the 17 hoses identified in the *Hose Checklist* (Appendix B).
B. WHEN Hose ***1-HAD-03*** is disconnected from DWS Line ***¾T-CDS-012***, THEN close DWS V-34 (HVDS Condensate Interface Isolation Valve).

5. POST PERFORMANCE ACTIVITIES

None

6. RECORDS

NOTE*:* *Records will be kept in the project file.*

Record	Retention	Disposition
This procedure, including all data sheets when completed.	Permanent	Destroy when no longer needed.

7. SOURCE REQUIREMENTS

See Appendix J for procedure basis.

8. APPENDICES

Appendix A, Figure
Appendix B, Hose Checklist
Appendix C, HVDS Valve Checklist
Appendix D, Switch Checklist
Appendix E, Drying Test Log
Appendix F, DWS Sampling and Pump Out
Appendix G, DWS Valve Checklist
Appendix H, Test Personnel Identification
Appendix I, Definitions
Appendix J, Procedure Basis

Technical Procedure TAN Operations	**TMI-2 CANISTER DRYING TESTING AND MONITORING – ASSEMBLY/DISASSEMBLY AND CHECKOUT**	Identifier: TPR-1187 Revision: 1 Page: **A1** of A1

APPENDIX A
Figure

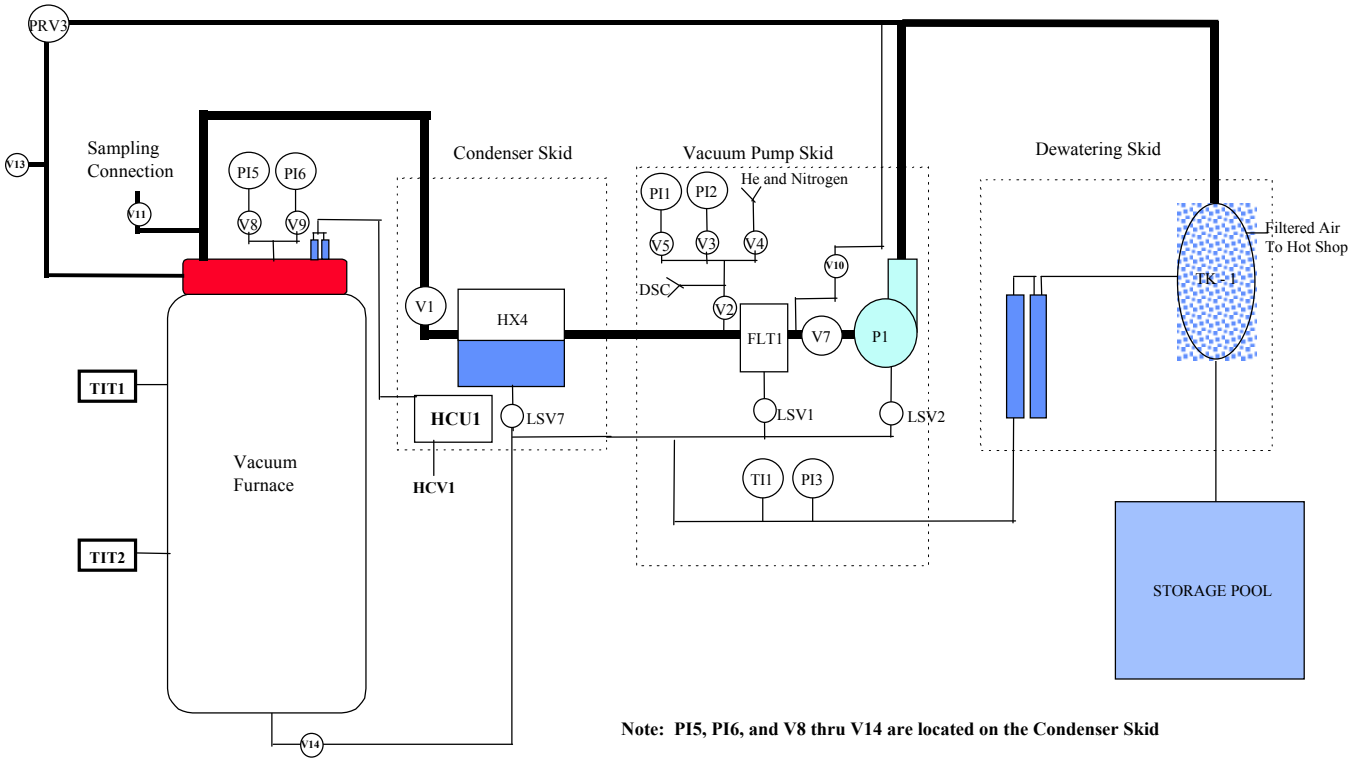

Figure 1. Heated Vacuum Drying System (HVDS) Schematic.

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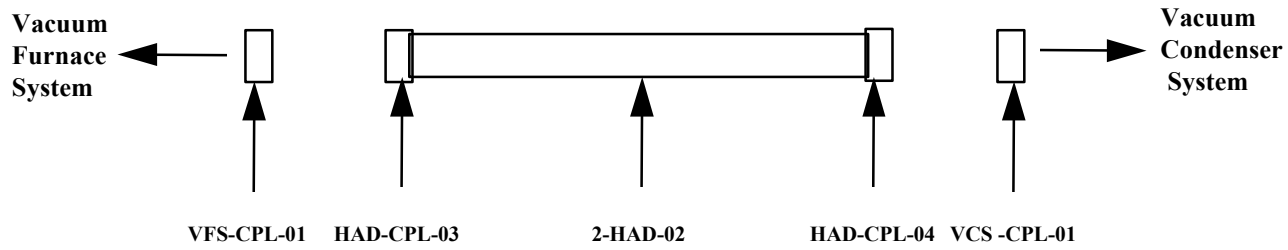
APPENDIX B
Hose Checklist

Procedure Step _____

Assembly/Disassembly Dates(s)_____ Location _____

Order	Hose Assembly Diagram #	Vacuum Furnace Skid (VFS)		Vacuum Condenser Skid (VCS)		Vacuum Pump Skid (VPS)		Other Systems		Initials	Independent Verification
		VFS-CPL	HAD-CPL	VCS-CPL	HAD-CPL	VPS-CPL	HAD-CPL	SYSTEM	HAD-CPL		
1	2-HAD-02	-01	-03	-01	-04						
2	3/4-HAD-01	-04	-09	-06	-10						
3	1/2-HAD-07	-05	-27	-09	-28						
4	1/2 HAD-06	-06	-26	-10	-25						
5	1/2-HAD-08	-07	-29	-08	-30						
6	1/2-HAD-09	-08	-31	-12	-32						
7	1/2-HAD-10	-09	-33	-13	-34						
8	1-HAD-01	-02	-08			-01	-07				
9	1/4-HAD-04			-02	-21	-09	-22				
10	2-HAD-01			-03	-01	-04	-02				
11	1/2-HAD-02			-04	-17	-02	-18				
*12	3/4-HAD-02			-05	-11	-08	-12				
13	1-HAD-02			-14	-13			DWS	-14		
14	11/2-HAD-01					-06	-05	DWS	-06		
15	1/2-HAD-03					-03	-20	Shop Air	-19		
16	1/2-HAD-05					-07	-24	He/N_2	-23		
17	1-HAD-03					-10	-35	DSC	-36		



CONNECTION EXAMPLE

*** Hose 12 it not to be connected. The condensate outlet at valve V15 is to be routed to an independent container to check for oily residue.**

APPENDIX C
HVDS Valve Checklist

Procedure Step _____

Test Name_____ Test Dates _____ Test Number _____

Valve Number	**Normal Operation**	**Acceptance Testing**	**Furnace Pressurization**	**Vacuum Furnace Sampling**	**Initials**
V1	Opened	Closed	Opened	Closed	
V2	Opened	Opened	Opened	Opened	
V3	Closed	Closed	Closed	Closed	
V4	Closed	Closed	Closed	Closed	
V5	Opened	Opened	Opened	Opened	
V7	Opened	Closed	Closed	Closed	
V8	Opened	Opened	Closed	Closed	
V9	Opened	Opened	Closed	Closed	
V10	Closed	Closed	Closed	Closed	
V11	Closed	Closed	Closed	Opened	
V14	Closed	**Closed**	Closed	May be used to purge furnace	
*V15	Opened	**Opened**	Opened	Opened	
V16	Closed	**Closed**	Closed	Normally Closed (Handle Removed)	
V17				Preset (Handle Removed)	
V18	Closed	**Closed**	Closed	Closed	

Notes:
1. Valves are identified in Appendix A Figure 1.
2. Ensure that the Air Sampler is installed prior to opening valve V11 when performing "Canister Testing"
3. Valve indication lights are illuminated when valves are opened.

* Valve V15 is to be opened for this test. The condensate from the VPS is to be routed to a separate location to check for oily residue.

APPENDIX D
Switch Checklist

Procedure Step _____

Test Name_____ Test Dates _____ Test Number _____

Switch Name	**Switch Location**	**Switch Label**	**Normal Operation (Automatic)**	**Manual Operation**	**Off Position**	**Initial**
Coolant Circulation Motor	VCS	Coolant Pump	On	On	Off	
Refrigeration System Motor	VCS	Refr System	Auto	Manual	Off	
Valve V1 Operator	VCS	V1	Auto	Manual	Off	
Heater 1	VCS	Heat Bank 1	Auto	Off	NA*	
Heater 2	VCS	Heat Bank 2	Auto	Off	NA*	
Hydraulic Closer Operation	VCS	Vessel Open --Closed	Open or Closed as appropriate	Open or Closed as appropriate	Off	
Oil Pump	VPS	Oil Pump	Auto	Manual	Off	
Vacuum Pump	VPS	Vacuum Pump	Auto	Manual	Off	
Valve V7 Operator	VPS	V7	Auto	Manual	Off	

*NA = Not Applicable

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APPENDIX E
Drying Test Log

Procedure Step _____

Test Name_____ Test Dates _____ Test Number _____

TIME (min)	PLC TEMP (^{o}F)	TT1 (^{o}F)	TI1 (^{o}F)	PI3 (psi)	PI5 (torr)	PI6 (torr)	CV	INITIAL	COMMENTS

Page ____ of _____

Technical Procedure TAN Operations	**TMI-2 CANISTER DRYING TESTING AND MONITORING – ASSEMBLY/DISASSEMBLY AND CHECKOUT**	Identifier: TPR-1187 Revision: 1 Page: **F1** of F2

APPENDIX F
DWS Holding Tank Sampling and Pump Out

NOTE: *If uncertain about the TK-1 contents, it is necessary to obtain a sample and analyze it to determine the pump-out route. Water from the DWS that is planned for return to the TAN storage pool must meet the following criteria:*

Conductivity	*<120 μmhos/cm[1]*
pH	*6.0 - 8.5*
Specific Activity	*<0.001 μCi/ml[2]*
Chloride	*<10 ppm*
Fluorides	*<1 ppm*
Suspended Solids	*<100 ppm*
(1) This value exceeds the present pool specification of <60 μmhos/cm but is considered acceptable for the TAN pool.	
(2) This value does not include the activity due to Tritium	

Pumping out the DWS Holding Tank (TK-1) Contents

_____ 1. If necessary, determine where TK-1 contents will be discharged based on the TK-1 sample results (Step *Circulating and Sampling of the DWS Holding Tank (TK-1) Contents*, given below).
_____ 2. Connect, or ensure connected, FH-9 to QC-13.
_____ 3. Depending on the discharge location complete one of the following for routing FH-9:
a. TAN Pool - route FH-9 to the pool vestibule.
b. Radioactive Waste Tanks - obtain approval and route to a waste collection system.
_____ 4. Record LI-1 level _____ inch
_____ 5. Ensure open or open V-15 and open V-26.
_____ 6. Start P-1 (SW2, ***Pump On***).
_____ 7. Monitor flow on FI-4.
_____ 8. P-1 will trip off when the ***Lower*** level sensor activates; record LI-1 level _____ inch.
_____ 9. Close V-26.
_____ 10. Record the amount of water discharged _____ gallons; (level from Step 4 minus level from Step 6 [should be zero] times 4.25).

Circulating and Sampling of the DWS Holding Tank (TK-1) Contents

_____ 1. Ensure that TK-1 water level is visible in the sight glass LI-1.
_____ 2. Open or ensure DWS V-21 is ¼ turn open to establish a circulation flow back to the TK-1.
_____ 3. Shut or ensure shut DWS valves V-15, V-23, V-24 and V-26.
_____ 4. Start DWS pump P-1 (SW2, ***Pump On***) and ensure circulation flow on DWS FI-5.
_____ 5. WAIT 15 minutes, THEN position a sample bottle at the outlet of V-16 to obtain a sample using V-16.
_____ 6. Shut off the DWS pump P-1 (SW1, ***Pump Off***).
_____ 7. Have the TK-1 sample analyzed.
_____ 8. IF suspended solids and/or specific activity are too high,
THEN complete Step *Circulating the DWS Holding Tank (TK- 1) Contents Through FLT-1 and IX Module*, given below.

Technical Procedure TAN Operations	**TMI-2 CANISTER DRYING TESTING AND MONITORING – ASSEMBLY/DISASSEMBLY AND CHECKOUT**	Identifier: Revision: Page:	TPR-1187 1 **F2** of F2

Circulating the DWS Holding Tank (TK- 1) Contents Through FLT-1 and IX Module

_____ 1. Turn DWS V-10 to the ***B*** position.
_____ 2. Start DWS pump P-1 (SW2, ***Pump On***).
_____ 3. Ensure flow of about one gpm on FI-5. If necessary, adjust V-21 to obtain one gpm flow.
_____ 4. Open V-23.
_____ 5. Adjust V-15 and/or V-21 to obtain a flow of 2.0 to 2.4 gpm as on FI-4.
_____ 6. Continue circulating for the period specified by the Test Engineer (Will depend on the amount of liquid and the amount of solids and activity).
_____ 7. Shut of P-1 (SW1, ***Pump Off***),
_____ 8. Close V-23.
_____ 9. Adjust V-21 to ¼ turn open.
_____ 10. Fully open V-15, if necessary.
_____ 11. Turn V-10 from position ***B*** to ***A***.
_____ 12. Resample per Step *Circulating and Sampling of the DWS Holding Tank (TK-1) Contents*.

Technical Procedure TAN Operations	**TMI-2 CANISTER DRYING TESTING AND MONITORING – ASSEMBLY/DISASSEMBLY AND CHECKOUT**	Identifier: TPR-1187 Revision: 1 Page: **G1** of G1

APPENDIX G
DWS Valve Checklist

Procedure Step _____

Test Name_____ Test Dates _____ Test Number _____

Valve #	Function	Normal Position	Initial
V-1	Air Supply Solenoid Isolation	Closed *(De-Energized)*	
V-2	Demineralized Water Supply	Closed	
V-3	Demineralized Water to TK-1 Spray	Closed	
V-4	Canister Back-Flush	Closed	
V-5	Canister Dewatering	Open	
V-6	Back-Flush PI-2 Gauge Isolation	Open	
V-7	Canister Depressurization	Closed	
V-8	Dewatering PI-3 Gauge Isolation	Open	
V-9	Canister Inlet 3-Way	Position ***A***	
V-10	Canister Outlet 3-way	Position ***A***	
V-11	Canister Outlet PI-4 Gauge Isolation	Open	
V-12	Canister Outlet Sample	Closed	
V-13	Filter FLT-1 Outlet	Open	
V-14	FLT-1 Outlet PI-5 Gauge Isolation	Open	
V-15	Pump P-1 Discharge Throttle	Open *(Throttled)*	
V-16	Pump P-1 Discharge Sample	Closed	
V-17	Pump P-1 Discharge PI-6 Gauge Isolation	Open	
V-18	Tank TK-1 Drain	Closed	
V-19	Automatic Vent Valve VTV-1 Vent Loop Isolation	Open	
V-20	IX-1 Outlet to Tank	Open	
V-21	Pump Discharge to Tank Recirculation Throttle	Open *(Throttled)*	
V-22	Pump Suction From Tank	Open	
V-23	Pump/FLT-1/IX-1/TK-1 Recirculation Isolation	Closed	
V-24	Pump/IX-1/TK-1 Recirculation Isolation	Closed	
V-25	QC-15 Interface Line Isolation	Closed	
V-26	Pump Discharge to QC-13	Closed	
V-27	HEPA Filter Housing Drain	Closed	
V-28	Air Supply Manual Isolation	Closed	
V-29	Liquid Drain Valve Bypass	Closed	
V-30A	Liquid Drain Valve DR-1A Isolation	Open	
V-30B	Liquid Drain Valve DR-1B Isolation	Open	
V-30C	Liquid Drain Valve DR-1C Isolation	Open	
V-30D	Liquid Drain Valve DR-1D Isolation	Open	
V-31	Auto Vent Valve VTV-1 Vent Loop Isolation	Open	
V-32	VTV-2 Liquid Drain Valve DR-2 Isolation	Open	
V-33	VTV-2 Outlet Back pressure Throttle Valve	Open *(Throttled - Do not close)*	
V-34	HVDS Condensate Interface Isolation	Closed	

Technical Procedure TAN Operations	**TMI-2 CANISTER DRYING TESTING AND MONITORING – ASSEMBLY/DISASSEMBLY AND CHECKOUT**	Identifier: TPR-1187 Revision: 1 Page: **H1** of H1

APPENDIX H
Test Personnel Identification

Name			**Assignment**
Printed	**Signature**	**Initials**	
			Test Engineer
			Quality Inspector
			Technician
			Others

APPENDIX I
Definitions

Acceptance Criteria – *A canister is defined to be dry at a moderator density (H_2O) of 8.8×10^{-5} g/cc or less.*

Acceptance Test – Testing which allows for the inference that a canister is dry. For this procedure, the acceptance test for a canister to be inferred dry is the maintenance of < 80 torr vacuum for 30 minutes at 120°F.

Dewatering Skid – The equipment that removes water from the TMI-2 canisters; after removal the water is passed through a filter and ion exchanger to remove suspended solids and radioactivity.

Lower Explosive Limit (LEL) – The boundary mixture (minimum concentration of the material) of a gas (hydrogen) which, if ignited, will just propagate a flame. The lower explosive limit of hydrogen at atmospheric temperature and pressure is 4 percent by volume in air. The terms "flammable limits' and "explosive limits" are interchangeable.

Radiolysis – Chemical decomposition by the action of radiation; for these tests this is determined by the measurement of hydrogen evolution from the decomposition of residual water in a canister due to the radioactive energy emitted by the contents of a canister.

Vacuum Condenser Skid – Refrigeration equipment for removing water vapor from the TMI-2 canisters off gas from the Vacuum Furnace.

Vacuum Furnace – A vessel capable of heating one to four TMI-2 canisters in a vacuum environment.

Vacuum Pump Skid – Equipment capable of developing a vacuum on (or pressurizing) a closed system (Vacuum Furnace, shielding Cask, or Dry Shielded Canister.

Technical Procedure TAN Operations	**TMI-2 CANISTER DRYING TESTING AND MONITORING – ASSEMBLY/DISASSEMBLY AND CHECKOUT**	Identifier: TPR-1187 Revision: 1 Page: **J1** of J1

APPENDIX J
Procedure Basis

Step Number	Step Basis	Information Source
Entire procedure	Develop test procedures.	PRD-101, Section 10.3.1.3 **PRD-101, Section 10.3.2.1** PRD-101, Section 10.3.2.3
Entire procedure	Test requirements and acceptance criteria.	PRD-101, Section 10.3.1.2

Technical Procedure TAN Operations	**TMI-2 CANISTER DRYING TESTING AND MONITORING – FUNCTIONAL TESTING**	**Identifier:** TPR-1188 **Revision:** 0 **Page:** 1 of 11
Document Control Center: (208) 526-6076	Document Owner/Approver: TANO Supervisor	Effective Date: canceled
Manual: DOP	CATEGORY 3	DAR Number: TANO-5452

Validation—This document must be validated prior to first use by one of the following:

[ ] Walkthrough
[ ] Using mockup or simulators
[ ] Tabletop validation by safety committee and craftsmen
[ ] First time use of procedure

_____ _____

Signature Date

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	03/10/98	All	Initial release. See DAR TANO-5452.

1. INTRODUCTION

1.1 Purpose

Definition of the systematic actions required for performing Functional Testing of the heated vacuum drying system (HVDS) will ensure satisfactory completion of the testing program.

1.2 Scope and Applicability

Functional testing is performed to determine drying temperatures and times for various Vacuum Furnace operations and configurations (type and/or number of canisters). These tests are performed on "Cold" canisters filled with demineralized water plus simulated debris and then dewatered to assess the drying process. The HVDS consists of the Vacuum Pump Skid (VPS), the Vacuum Condenser Skid (VCS), and the Vacuum Furnace (VF) (see Definitions).

This procedure applies only to those persons performing the HVDS TMI-2 Canister Drying Testing And Monitoring – Functional Testing.

2. PRECAUTIONS AND LIMITATIONS

2.3 All high temperature test equipment exposed to personnel during operations is clearly marked and proper precautions are taken when the equipment is approached.

2.4 Personnel restrictions apply in the TAN Warm Shop while a TMI canister is being handled.

3. PREREQUISITES

3.5 Planning and Coordination

3.1.1 Hoisting and rigging equipment load test is current.

3.1.2 Equipment operators are qualified and current.

3.1.4 Personnel performing this procedure are trained.

3.1.5 The HVDS has been assembled in the Warm Shop (Procedure TPR-1187).

3.1.6 HVDS checkout (Procedure TPR-1187) has been successfully completed in the TAN Warm Shop.

3.1.7 Instruments calibrated in Procedure TPR-1187 are still in calibration.

3.6 Performance Documents

None

3.7 Special Tools, Equipment, Parts, and Supplies

The equipment and materials given in Table 3.3 are available.

Table 3.3 Equipment List

Item	No.	Comments
"Cold" Fuel and Knockout Canisters	2 each	Contains measured and recorded amounts of simulated debris and demineralized water that have been allowed to sit for a minimum of 24 hours prior to testing
Nitrogen Supply	1	To be used to pressurize the system (minimum of 500 ft^3)
TMI Canister short grapple assembly	1	**Calibration Verification** Expiration Date _____ Quality Inspector _____ Date _____
Slings and shackles		Rigging for TMI grapples
TMI storage module vertical lift rigging	1	**Calibration Verification** Expiration Date _____ Quality Inspector _____ Date _____
Dynamometer to 5,000 lb. S/N _____	1	**Calibration Verification** Expiration Date _____ Quality Inspector _____ Date _____

3.8 Preparations

Test Engineer: Conduct a briefing with the test personnel and complete the following items:

A. A discussion of safety precautions and emergency actions associated with the operation of the HVDS.
B. A review of Section 4 of this test procedure.
C. The table, *Test Personnel Identification*, in Appendix F.

Test Engineer _____ Date _____

3.9 Approval and Notifications

Review this procedure. Sign space indicated and enter date for approval of work to commence**.**

TANO Shift Supervisor: _____ Date _____

Operations Technician _____ Date _____

4. INSTRUCTIONS

4.1 Test Instructions

4.1.1 The Test Engineer:

A. Verifies the test operation by collecting data and signing where called for.
B. Signs and dates the completion of test sub-sections; checks or signatures do not imply complete data evaluation.
C. May collect data generated for test sections.
D. Maintains the master copy of the procedure and logs for report generation.
E. May alter the sequence in which the test is conducted if needed.
F. Makes test procedure changes as needed.
G. Designates an alternate to act for him/her if desired.
H. Establishes authority by identifying the responsibility and initials of the test participants (Appendix F).

4.1.2 The Quality Inspector:

A. Verifies the data and performance of the test.
B. Verifies test procedure changes made by the Test Engineer.
C. Signs and dates the completion of test sub-sections.

4.1.3 The Technician:

A. Verifies the test operation by filling the blanks in the tables and by checking off at spaces provided at the left of procedure steps.
B. Prepares copies of appendixes as needed for test sections.
C. Collects data generated for test sections.

4.1.4 All test personnel check other non-specified items during the test, including but not limited to the labeling of piping, electrical conduits, and instruments and components.

4.1.5 Test Description

The HVDS is designed to be fully automatic using programmable control logic (PCL) technology. The sequence of operation is as follows:

1) The remote ***Start*** button is pushed.
2) V7 is opened.
3) Furnace heaters are controlled to 180°F.
4) V1 is opened when a pump temperature of 150°F is reached.
5) Furnace heaters are allowed to increase when a vacuum pressure of 80 torr is reached.
6) A working temperature of 900°F is maintained using pressure compensated control heaters.
7) Completion is signaled when a vacuum pressure of <1 torr is achieved at 900°F.
8) The heaters are shut off and the vacuum furnace is allowed to cool until the temperature is stabilized (about two hours with a furnace temperature of 700-800°F or the temperature change is <20°F/hour).
9) V1 is closed.
10) If vacuum pressure is not maintained at <3 torr for 30 minutes, V1 is opened and after stable temperature, the test is repeated; this is repeated two times, if necessary, before the process continues.
11) The system is allowed to cool to 120°F.
12) Acceptance testing is performed (120°F and <80 torr for 30 minutes).
13) The system is shutdown whether or not acceptance criteria were met.
14) The design includes logic for performing manual acceptance testing.

This test consists of the following sections: Pretest Preparation, Vacuum Furnace Canister Loading, Canister Drying Operation, and Vacuum Furnace Canister Unloading. The test engineer determines the type of canisters to be used, combination, and number of drying operations.

Functional Testing is performed in the TAN Warm Shop using “Cold” canisters to demonstrate HVDS operation. Additionally, the testing provides a mechanism for hands-on operator training prior to testing “Hot” canisters.

4.2 Pretest Preparation

____ 4.1.17 Tech: Align switches (Appendix C *Switch Checklist*) and valves (Appendix B *Valve Checklist*) for Normal (Automatic) Operation.

____ 4.1.18 Close isolation valves, V1 and V7, (switches in the ***Off*** position) for vacuum pump warm-up.

____ 4.1.19 Start the vacuum pump (***Manual*** button on the VPS) for warm-up (1-hour).

____ 4.1.20 Visually check the level of DWS Holding Tank; IF the level is not near the bottom of the sight glass, THEN use the procedure given in Appendix E, *DWS Holding Tank Sampling and Pump Out*, to transfer the tank contents.

____ 4.1.21 Connect a regulated nitrogen supply (at least 500 ft^3) to the V4 fitting location (V4 should be closed).

4.3 Vacuum Furnace Canister Loading

____ 4.3.1 Tech: Prepare to open the VF head by pressing the remote ***Open/Close*** button.

____ 4.3.2 EO: Lift the head until it rests against the hinge stops using the Warm Shop crane lift.

____ 4.3.3 Attach the Warm Shop bridge crane hook to the 5,000-lb. dynamometer and the TMI short grapple.

NOTE: *The maximum allowable weight of the loaded canister during handling operations is 2,940 lb.*

____ 4.3.4 Lift the TMI short grapple out of its support stand.

____ 4.3.5 Tech: Record the grapple weight _____ lbs.

____ 4.3.6 Attach the TMI short grapple to a test canister to be loaded.

____ 4.3.7 EO: Use an observer during lifting, lowering or moving the canister in the following steps to ensure all obstacles are cleared.

____ 4.3.8 Carefully lift the canister while the technician accomplishes the following step.

____ 4.3.9 Tech: Obtain the canister weight as follows:

A. Observe the weight of canister as it is lifted.
B. IF weight exceeds 2,940 lb.,
   THEN STOP, lower and secure canister,
   AND correct the problem before proceeding.
C. Record the combined weight of canister and grapple assembly _____ lbs.
D. Record the canister weight (combined weight minus grapple weight) ____ lbs.

____ 4.3.10 EO: After the canister is about 1-foot from the floor, move it near the VF prior to continuing the lift.

____ 4.3.11 Lift the canister high enough to clear the top of the VF.

____ 4.3.12 Move the canister over one of the receiving positions.

____ 4.3.13 Carefully lower the canister into the VF.

____ 4.3.14 Tech: Visually ensure that the canister is seated correctly into the VF (the canister should be less than 4-inches above the top alignment-plate).

____ 4.3.15 After the canister is properly seated, detach the TMI short grapple.

____ 4.3.16 Repeat steps 4.3.4 through 4.3.15 until the desired number of canisters (up to four) have been loaded.

____ 4.3.17 Remove the 1/4- and 3/8-inch Hansen couplings from each of the canisters (fittings must be saved for reinstallation).

____ 4.3.18 EO: Lower the VF head to its closed position using the Warm Shop crane lift.

____ 4.3.19 Tech: Complete the closure of the VF head by pressing the remote ***Open/Close*** button.

4.4 Canister Drying Operation

____ 4.4.7 Tech: Align the HVDS switches for Normal Operation (Appendix C).

____ 4.4.8 Press the remote ***Start*** button to begin automatic operation.

____ 4.4.9 Record temperature and pressure data in Test Log (Appendix D) at 15-minute increments UNTIL the system shuts down and the PLC temperature is below 120°F.

____ **4.4.10 Acceptance Criteria**

When the remote ***Start*** button is pressed, the HVDS automatically begins the vacuum and heating process, senses drying completion, performs the Acceptance Test (<80 torr for 30 minutes) and shuts down the system.

____ 4.4.11 The operation performed as expected and met the acceptance criteria.

Test Engineer _____ Date _____

Quality Inspector _____ Date _____

4.5 Vacuum Furnace Canister Unloading

____ 4.5.1 Tech: Align valves for Furnace Pressurization (Appendix B).

Note: *For V1 to be open, its switch is in the **Manual** position.*
*For V7 to be closed, its switch is in the **Off** position.*

____ 4.5.2 Adjust V4 to slowly purge N_2 to the system UNTIL PI1 reads about +2 psig, THEN close V4.

____ 4.5.3 Obtain particulate sample (for training and checkout only).

A. Attach the sample apparatus to the sampling connection at V11.
B. Close V1 (***Off***).
C. Open V11 to obtain the sample, THEN close V11.
D. Open V1 (***Manual***).

____ 4.5.4 Open V10 until the pressure at PI1 returns to atmospheric, THEN close V10.

____ 4.5.5 Start the head sweep system.

____ 4.5.6 Prepare to open the VF head by pressing the remote ***Open/Close*** button.

____ 4.5.7 EO: Lift the head until it rests against the hinge stops using the Warm Shop crane lift.

____ 4.5.8 Tech: Stop the head sweep system.

____ 4.5.9 Reinstall the 1/4- and 3/8-inch Hansen couplings in all the canisters.

____ 4.5.10 EO: Attach the Warm Shop bridge crane hook to the 5,000-lb. dynamometer and the TMI short grapple.

____ 4.5.11 Lift the TMI short grapple out of its support stand.

____ 4.5.12 Tech: Record the grapple weight _____ lbs.

____ 4.5.13 EO: Use an observer during lifting, lowering or moving the canister in the following steps to ensure all obstacles are cleared.

____ 4.5.14 Move the grapple to a test canister to be removed and make the attachment.

____ 4.5.15 Carefully lift the canister while the technician accomplishes the following step.

____ 4.5.16 Tech: Obtain the canister weight as follows:

A. Observe the weight of canister as it is lifted.
B. IF weight exceeds 2,940 lb.,
   THEN STOP, lower and secure canister,
   AND correct the problem before proceeding.
C. Record the combined weight of canister and grapple assembly _____ lbs.
D. Record the canister weight (combined weight minus grapple weight) ____ lbs.

____ 4.5.17 EO: Lift the canister high enough to clear the top of the VF.

____ 4.5.18 Lower the canister to about 1-foot from the floor as soon as it has cleared the VF.

____ 4.5.19 Move the canister to a storage position (lift as necessary to place the canister in the storage position).

____ 4.5.20 Tech: After the canister is properly secured, detach the TMI short grapple.

____ 4.5.21 Repeat steps 4.5.9 through 4.5.15 until all the canisters have been removed.

____ 4.5.22 EO: Lower the VF head to its closed position using the Warm Shop crane lift.

____ 4.5.23 Tech: Complete the closure of the VF head by pressing the remote ***Open/Close*** button.

____ 4.5.24 Realign valves (Appendix B) and switches (Appendix C) for Normal Operation.

4.6 Additional Canister Drying (if called for by the Test Engineer)

____ 4.6.1 Tech: Use the procedure given in Appendix E, *DWS Holding Tank Sampling and Pump Out*, to transfer the tank contents.

____ 4.6.2 If bottled N_2 is used, check to verify the N_2 supply is adequate (500 ft^3).

____ 4.6.3 Repeat Sections 4.3 through 4.5 for each additional drying test.

5. POST PERFORMANCE ACTIVITIES

None

6. RECORDS

NOTE: *Records shall be kept in the project file.*

Record	Retention	Disposition
This procedure, including all data sheets when completed	Permanent	Destroy when no longer needed

7. SOURCE REQUIREMENTS

None

8. APPENDICES

Appendix A, *Figure 1*
Appendix B, *HVDS Valve Checklist*
Appendix C, *Switch Checklist*
Appendix D, *Drying Test Log*
Appendix E, *DWS Sampling and Pump Out*
Appendix F, *Test Personnel Identification*
Appendix G, *Definitions*

APPENDIX A

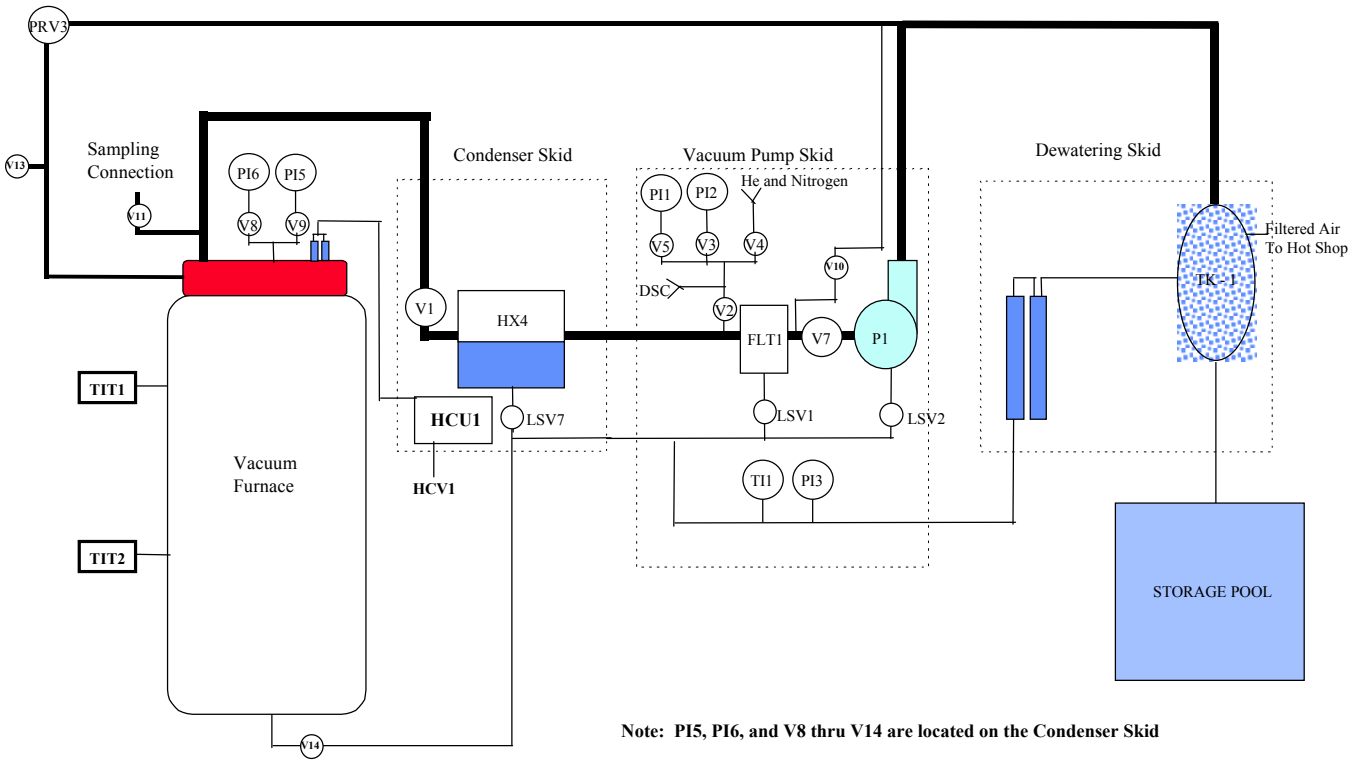

Figure 1 Heated Vacuum Drying System (HVDS) Schematic.

APPENDIX B

HVDS Valve Checklist

Test Name_____ Test Dates _____ Test Number _____

Valve Number	Normal Operation	Acceptance Testing	Furnace Pressurization	Vacuum Furnace Sampling	Initials
V1	Opened	Closed	Opened	Closed	
V2	Opened	Opened	Opened	Opened	
V3	Closed	Closed	Closed	Closed	
V4	Closed	Closed	Closed	Closed	
V5	Opened	Opened	Opened	Opened	
V7	Opened	Closed	Closed	Closed	
V8	Opened	Opened	Closed	Closed	
V9	Opened	Opened	Closed	Closed	
V10	Closed	Closed	Closed	Closed	
V11	Closed	Closed	Closed	Opened	
V14	Closed	**Closed**	Closed	May be used to purge furnace	
V15	Closed	**Closed**	Closed	Closed	
V16	Closed	**Closed**	Closed	Normally Closed (Handle Removed)	
V17				Preset (Handle Removed)	
V18	Closed	**Closed**	Closed	Closed	

Notes:
4. Valves are identified in Appendix A Figure 1.
5. Ensure that the Air Sampler is installed prior to opening valve V11 when performing "Canister Testing"
6. Valve indication lights are illuminated when valves are opened.

APPENDIX C

Switch Checklist

Test Name_____ Test Dates _____ Test Number _____

Switch Name	**Location**	**Label**	**Normal Operation (Automatic)**	**Manual Operation**	**Off Position**	**Initial**
Coolant Circulation Motor	VCS	Coolant Pum0	On	On	Off	
Refrigeration System Motor	VCS	Refr System	Auto	Manual	Off	
Valve V1 Operator	VCS	V1	Auto	Manual	Off	
Heater 1	VF	Heat Bank 1	Auto	Off	NA*	
Heater 2	VF	Heat Bank 2	Auto	Off	NA*	
Hydraulic Closer Operation	VF		Open or Closed as appropriate	Open or Closed as appropriate	Off	
Oil Pump	VPS	Oil Pump	Auto	Manual	Off	
Vacuum Pump	VPS	Vacuum Pump	Auto	Manual	Off	
Valve V7 Operator	VPS	V7	Auto	Manual	Off	

*NA = Not Applicable

APPENDIX D

Drying Test Log

Test Name__________________ Test Dates ____________ Test Number _______

TIME (min)	PLC TEMP (°F)	PI1 (psi)	PI2 (torr)	PI3 (psi)	PI5 (torr)	PI6 (torr)	INITIAL	COMMENTS

APPENDIX E

DWS Holding Tank Sampling and Pump Out

Note: *If uncertain about the TK-1 contents, it is necessary to obtain a sample and analyze it to determine the pump-out route. Water from the DWS that is planned for return to the TAN storage pool must meet the following criteria:*

Conductivity	*<120 μmhos/cm[1]*
pH	*6.0 - 8.5*
Specific Activity	*<0.001 μCi/ml[2]*
Chloride	*<10 ppm*
Fluorides	*<1 ppm*
Suspended Solids	*<100 ppm*
(1) This value exceeds the present pool specification of <60 μmhos/cm but is considered acceptable for the TAN pool.	
(2) This value does not include the activity due to Tritium	

Pumping out the DWS Holding Tank (TK-1) Contents

1. If necessary, determine where TK-1 contents will be discharged based on the TK-1 sample results (Step *Circulating and Sampling of the DWS Holding Tank (TK-1) Contents*, given below).
2. Connect, or verify connected, FH-9 to QC-13.
3. Depending on the discharge location complete one of the following for routing FH-9:
   a. TAN Pool - route FH-9 to the pool vestibule.
   b. Radioactive Waste Tanks - obtain approval and route to a waste collection system.
4. Record LI-1 level _____ inch
5. Verify open or open V-15 and open V-26.
6. Start P-1 (SW2, ***Pump On***).
7. Monitor flow on FI-4.
8. P-1 will trip off when the ***Lower*** level sensor activates; record LI-1 level _____ inch.
9. Close V-26.
10. Record the amount of water discharged _____ gallons; (level from Step 4 minus level from Step 6 [should be zero] times 4.25).

Circulating and Sampling of the DWS Holding Tank (TK-1) Contents

1. Verify that TK-1 water level is visible in the sight glass LI-1.
2. Open or verify DWS V-21 is ¼ turn open to establish a circulation flow back to the TK-1.
3. Shut or verify shut DWS valves V-15, V-23, V-24 and V-26.
4. Start the DWS pump P-1 (SW2, ***Pump On***) and verify circulation flow on DWS FI-5.
5. WAIT 15 minutes, THEN position a sample bottle at the outlet of V-16 to obtain a sample using V-16.

6. Shut off the DWS pump P-1 (SW1, ***Pump Off***).
7. Have the TK-1 sample analyzed.
8. IF suspended solids and/or specific activity are too high, THEN complete Step *Circulating the DWS Holding Tank (TK- 1) Contents Through FLT-1 and IX Module*, given below.

Circulating the DWS Holding Tank (TK- 1) Contents Through FLT-1 and IX Module

1. Turn DWS V-10 to the ***B*** position.
2. Start DWS pump P-1 (SW2, ***Pump On***).
3. Verify flow of about 1-gpm on FI-5. If necessary, adjust V-21 to obtain 1-gpm flow.
4. Open V-23.
5. Adjust V-15 and/or V-21 to obtain a flow of 2.0 to 2.4 gpm as on FI-4.
6. Continue circulating for the period specified by the Test Engineer (Will depend on the amount of liquid and the amount of solids and activity).
7. Shut of P-1 (SW1, ***Pump Off***),
8. Close V-23.
9. Adjust V-21 to ¼ turn open.
10. Fully open V-15, if necessary.
11. Turn V-10 from position ***B*** to ***A***.
12. Resample per Step *Circulating and Sampling of the DWS Holding Tank (TK-1) Contents*.

APPENDIX F

Test Personnel Identification

Name			
Printed	**Signature**	**Initials**	**Assignment**
			Test Engineer
			Quality Inspector
			Technician
			Others

APPENDIX G

Definitions

Acceptance Criteria – A canister is defined to be dry at a moderator density (H_2O) of 8.8×10^{-5} g/cc or less.

Acceptance Test – Testing which allows for the inference that a canister is dry. For this procedure, the acceptance test for a canister to be inferred dry is the maintenance of < 80 torr vacuum for 30 minutes at 120°F.

Dewatering Skid – The equipment that removes water from the TMI-2 canisters; after removal the water is passed through a filter and ion exchanger to remove suspended solids and radioactivity.

Lower Explosive Limit (LEL) – The boundary mixture (minimum concentration of the material) of a gas (hydrogen) which, if ignited, will just propagate a flame. The lower explosive limit of hydrogen at atmospheric temperature and pressure is 4 percent by volume in air. The terms "flammable limits' and "explosive limits" are interchangeable.

Radiolysis – Chemical decomposition by the action of radiation; for these tests this is determined by the measurement of hydrogen evolution from the decomposition of residual water in a canister due to the radioactive energy emitted by the contents of a canister.

Vacuum Condenser Skid – Refrigeration equipment for removing water vapor from the TMI-2 canisters off gas from the Vacuum Furnace.

Vacuum Furnace – A vessel capable of heating one to four TMI-2 canisters in a vacuum environment.

Vacuum Pump Skid – Equipment capable of developing a vacuum on (or pressurizing) a closed system (Vacuum Furnace, shielding Cask, or Dry Shielded Canister.