



RIVER PROTECTION PROJECT – WASTE TREATMENT PLANT

ENGINEERING SPECIFICATION

FOR

Ultrafilters

ISSUED BY
APP-WTP PDC
DJS 11/13/03
INIT DATE



11/13/03

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SPECIFICATION No. 24590-PTF-3PS-MLFP-TP001 Rev 1

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

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1 Scope

1.1 Project Description and Location

The River Protection Project-Waste Treatment Plant (RPP-WTP) is a complex of waste treatment facilities where the US Department of Energy (DOE) Hanford Site tank waste will be pretreated and immobilized into stable glass form via vitrification. The WTP Contractor will design, build, and start-up the RPP-WTP pretreatment and vitrification facilities for the DOE Office of River Protection (ORP). The waste treatment facilities will pretreat and immobilize the low-activity waste (LAW) and high-level waste (HLW) currently stored in underground storage tanks at the Hanford Site.

The Hanford Site occupies an area of about 560 square miles and is located along the Columbia River, north of Richland, WA in the U.S.A. The RPP-WTP Facility will be constructed at the east end of the 200 East Area of the Hanford Site. The counties of Benton, Franklin, and Grant surround the Hanford Site.

1.2 Equipment, Material, and Services Required

Crossflow Ultrafiltration will be employed in the pretreatment facility. These filters are similar in design to heat exchangers of the single-pass shell-and-tube type. The Ultrafilters incorporate porous filter tubes whereby suspended solids are concentrated.

Three ultrafilter assemblies will be operating in series. The second and third assembly will have lower slurry feed rate and lower inlet pressures.

This specification provides the requirements for the design, configuration, analysis, fabrication, quality assurance, inspection, testing and delivery of Ultrafilters and special tools for use in the RPP-WTP facility. The scope of work for the Seller includes all work specifically defined in this specification. Work shall include but is not limited to the following:

- 1.2.1 Provide fully detailed designs, drawings, supporting calculations, supporting analyses, procedures, and all labor, materials, tooling, shop drawings and services necessary to manufacture, inspect, test, package and ship Ultrafilters.
- 1.2.2 Provide certified material test reports, welding procedures, welder qualifications, testing procedures, testing results, quality assurance procedures, quality assurance inspection results, and all other procedures and documentation required per this specification.
- 1.2.3 Design Reviews will be held between buyer and seller representatives at 30%, 60% and 90% design stages.

1.3 Work by Others

The Buyer shall supply the following:

- 1.3.1 Unloading and storage of all material at jobsite.

- 1.3.2 Installation labor, valves and controls, and all piping to and from the Ultrafilter assemblies.
- 1.3.3 Remotely removable structural support frames.
- 1.3.4 Remotely removable piping connectors and remote connecting nozzles.
- 1.3.5 Supply of backflush reservoirs.

1.4 Acronyms and Definitions

1.4.1 Acronyms

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BBPt	Bubble Point
CCTV	Closed Circuit Television
CG	Center of Gravity
DOE	Department of Energy
HLW	High Level Waste
ID	Inside Diameter
LAW	Low Activity Waste
M	Molarity
MDS	Material Data Sheet
MT	Magnetic Particle Inspection
MTBF	Mean Time Between Failures
MR	Material Request
NaOH	Sodium Hydroxide
OD	Outside Diameter
O&M	Operating and Maintenance
ORP	Office of River Protection
PFD	Process Flow Diagram
PT	Liquid Penetrant
RFQ	Request for Quote
RPP	River Protection Project
SC	Seismic Category
SS	Stainless Steel
TBD	To Be Determined
WTP	Waste Treatment Plant

1.4.2 Definitions.

Hot Cell :One of the parts of the plant that is restricted from personnel. The hot cell is composed of concrete walls with an internal stainless steel liner. Process equipment located in the hot cell will be subjected to a radiation field, and must be designed with remote maintenance capabilities.

Seismic Category: Classification of vessels defining the required condition, status, and operating function after a seismic event. The seismic category states the analysis method and acceptance criteria appropriate for the intended service and safety function of the vessel. Refer to 24590-WTP-3PS-MV00-TP002, *Seismic Qualification Criteria for Pressure Vessels*, for further definitions and procedures. Buyer assigns category level.

Sr: Strontium

Targeting: Refers to aligning dowels with dowel holes to correctly position parts.

TRU: Transuranic.

1.5 Safety/Quality/Seismic Classifications

For conservatism, the ultrafilter shall be designed and fabricated to satisfy Seismic Category 1 and Quality Level 1 requirements.

2 Applicable Documents

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

2.3 Codes

ASME B&PV Section VIII with Addenda, *Pressure Vessels*

ASME B&PV Section IX with Addenda, *Welding and Brazing Qualifications*

ASME B&PV Section V with Addenda, *Nondestructive Examination*

ASME B&PV Section II with Addenda, *Materials*

ASME NQA-1-1989 Quality Assurance Program Requirements for Nuclear Facility Applications

2.4 Related Documents and Drawings

24590-WTP-3PS-G000-T0001, *Supplier Quality Assurance Program Requirements*

24590-WTP-3PS-G000-T0003, *Packaging, Shipping, Handling and Storage Requirements*

24590-WTP-3PS-MVB2-T0001, *Welding of Pressure Vessels, Heat Exchangers and Boilers*

24590-WTP-3PS-MV00-TP001, *Pressure Vessel Design and Fabrication*

24590-WTP-3PS-MV00-TP002, *Seismic Qualification Criteria for Pressure Vessels*

24590-WTP-3PS-SS90-T0001, *Seismic Qualification of Seismic Category I/II Equipment and Tanks*

24590-PTF-M5-V17T-P0010, *Process Flow Diagram Ultrafiltration System UFP*

24590-WTP-3PS-PX04-T0004, *Epoxy Coating of Stainless Steel Items That Are Buried, Embedded, or Insulated*

3 Design Requirements

3.1 General Requirements

- 3.1.1 Unless otherwise specified, the Ultrafilter assembly shall be designed and fabricated per applicable documents listed in paragraph 2.0. No changes, substitutions, or deviations may be made without prior written approval of the Buyer.
- 3.1.2 The Ultrafilter assembly unit shall be designed for use in a horizontal orientation, as shown in the Figure 1 schematic. The assembly shall be sloped to allow for draining.
- 3.1.3 Design of the Ultrafilter assembly shall incorporate the latest and best proven technology, components, and materials for the required service conditions and performance.
- 3.1.4 The Seller shall provide an MTBF analysis for operating life showing all assumptions and references.
- 3.1.5 The Ultrafilter assembly shall be able to have the permeate (area outside the tubes) drained readily. Pockets or voids that could entrain the process fluid shall not be allowed.
- 3.1.6 All porous tube passages shall be capable of being back-flushed.
- 3.1.7 The Seller shall specify the dry weight of the Ultrafilter assembly and any tooling furnished.
- 3.1.8 Ultrafilters will be operated by the Buyer in a hot cell and removed remotely utilizing an overhead crane and CCTV camera. The Ultrafilters shall be designed to be easily installed and removed from the hot cell. The Ultrafilter lifting yoke (Seller provided) shall be designed to interface with the hot cell maintenance tools (Buyer provided). Buyer will provide drawings for remote crane interface, remotely removable jumper piping interface and ultrafilter saddle mounting interface.

- 3.1.9 The Ultrafilter assembly shall be designed to retain structural integrity for a drop on its bottom (saddle side) exhibiting 2.1 g deceleration. Verification will be by analysis only.
- 3.1.10 All design drawings, fabrication drawings, and procedures shall be submitted for review prior to release of manufacturing. This includes outline and assembly drawings, component fabrication drawings, weld maps, fitup, and assembly procedures.

3.2 Technical Requirements

- 3.2.1 For process conditions refer to the *Mechanical Systems Data Sheet 24590-PTF-MLD-UFP-P0007* in section 2 of the Material Requisition.
- 3.2.2 The Ultrafilter assembly shall be furnished to Buyer with 10 in. eccentric pipe stubs prepared for butt-welding at each end. The Buyer will attach remote connectors or process piping as necessary to each end of the 10 in. pipe. Three pipe stubs prepared for butt-welding shall be installed on the shell side. The Buyer will attach remote connectors as necessary. One 1 in. pipe stub is located on top of the filter for tube inlet pressure. The second pipe stub (4 in.) is also located on top and serves as permeate-outlet/backflush-inlet. The third pipe stub (1 in.) is located on the bottom at the low point of the shell, and is a permeate drain (volume outside of tubes).
- 3.2.3 Nozzle Loads: Refer to the *Nozzles and Manways* section of specification 24590-WTP-3PS-MV00-TP001, *Pressure Vessel Design and Fabrication*.
- 3.2.4 Porous Tube and Element Specifications
 - 3.2.4.1 Porous tube herein applies to the part that is sintered in one piece. A filter element will be made up of a single piece if possible, with metal end connectors at each end. If multiple lengths are required in order to achieve the required length, the pieces shall be welded. Tube end connectors shall have the same ID as the tubes and shall be of the same material as the tubes. Length of the end connector shall be approximately 2 in. long. A tube bundle shall be comprised of filter elements that are welded into a bundle and inserted into a containment shell.
 - 3.2.4.2 The metal powder used for the porous tubes shall be 316L SS.
 - 3.2.4.3 The tube dimensions shall be as specified in the Seller's base proposal. Seller shall submit tolerances for these dimensions for review by Buyer prior to proceeding with fabrication.
 - 3.2.4.4 The permeate-out/backflush-inlet nozzle shall be located at the high point of the ultrafilter to facilitate back pulse operations (no air volume is permitted).
 - 3.2.4.5 Filter tubes that are made up of welded assemblies shall have a finished length of 96 in. The Seller shall submit tolerances for overall length of the element and its straightness.
 - 3.2.4.6 The sintered tube bundle shall have a minimum usable surface area of 237 sq ft (252 sq ft nominal) a pore size of 0.1 micron (nominal), and a bubble point minimum of 7-9 in. Hg +/- 1 in. Hg.

3.2.5 Service Conditions

- Ultrafilter Design pressure/ temperature: 200 psig @ 200 F
- Normal system operating pressure/ temperature: 100 psig @ 77 ± 9 °F

During filtration (normal operating mode), the tubes have 100 psig inner pressure, and 50 psig outside pressure, for a resultant trans-membrane pressure of 50 psi. The trans-membrane pressure will fluctuate between 30 and 70 psi.

During backpulsing, the outside tube pressure will be 40 psig over the inside tube pressure or 100 psig plus 40 psig which results in a total outside tube pressure of 140 psig.

- Maximum backpulsing pressure: 180 psig
- Maximum slurry flow rate entering element bundle: 2400 gpm

3.2.6 Operating Functions

3.2.6.1 The Ultrafilter shall perform the following operating functions: separate, wash, or treat feed suspensions. The normal system operating temperature for these functions is 77 ± 9 °F with an internal filter tube pressure of 100 psig. Before separating, the slurry solid content will range from 0.41 % insoluble solids to 8.11 % insoluble solids. After separating, the slurry solid content will range from 15 % insoluble solids to 25 % insoluble solids. Design slurry flow rate into the Ultrafilter assembly is 2200 gpm, maximum is 2400gpm with a linear tube velocity of 12-15 ft per sec. The process flow is shown in 24590-PTF-M5-V17T-P0010, *Process Flow Diagram Ultrafiltration System UFP*.

3.2.6.2 Paragraph Deleted.

3.2.6.3 Another operating function is the separation of solids from wash solutions. The wash is diluted caustic (0.01 M NaOH (sodium hydroxide) solution) or process condensate. The solids may be treated by adding 19 M sodium hydroxide to the feed vessel to make the liquid 3 M NaOH which has a normal operating temperature of 85°C. This solution will be filtered by the Ultrafilter.

3.2.6.4 During the filtration cycle the Ultrafilter tubes may come in contact with 2 M nitric acid, and/or 2 M caustic. In addition, the Ultrafilter will require cleaning by backpulsing (reverse flow) and backflowing. There are 3 mechanisms for cleaning. The first method requires backpulsing with process air at 140 psig. The second method is to wash the Ultrafilter loop and it involves backflowing with 2 M nitric acid at 40 psig over slurry pressure. The third method is to backflow with 2 M caustic at 40 psig over slurry pressure.

3.2.7 Design Standardization

The Ultrafilters shall be standardized to the fullest extent by detailed mechanical design and fabrication methods.

3.2.8 The Ultrafilter assembly shall meet or exceed a 10-year design life. The design basis shall be provided by the Seller.

- 3.2.9 Each ultrafilter assembly shall be designed to ASME Section VIII including “U” Stamping and board registration.

3.3 Environmental Conditions

The Ultrafilters shall be able to withstand the following environmental conditions inside the hot cell:

Temperature	59 to 113 °F
Relative Humidity	0 to 100 %
Radiation Exposure in Rads	Per hour - 5.5e02 R 5 years - 2.4e07 R

3.4 Lifting Requirements

- 3.4.1 Installation of the Ultrafilter assembly into the hot cell will be by a single crane operation and a rigid lifting yoke (Seller-furnished). The Ultrafilter assembly will be lifted using the lifting yoke. Handling procedures shall accompany the submittal data and be included in the Seller’s instruction manual. “C G”(Center of Gravity) shall be marked on the lifting yoke.
- 3.4.2 The Seller shall provide 2 lifting points per Ultrafilter unit, as specified by the Buyer-furnished drawings, and that are compatible with the remote crane.
- 3.4.3 All lifting attachments shall have either a safety factor of 3, based on the material yield strength, or 5, based on the material ultimate strength, whichever is most conservative.
- 3.4.4 The lifting lugs and yoke shall be designed to permit lifting the Ultrafilter unit without distortion or damage to the components of the Ultrafilter assembly.
- 3.4.5 The Lifting lugs shall be designed to meet or exceed the requirements of 24590-WTP-3PS-G000-T0003, *Packaging, shipping, Handling, and Storage Requirements*.

3.5 Seismic Analysis

- 3.5.1 Ultrafilters shall be designed and fabricated to SC-1 and seismic analysis shall be performed per the requirements of specifications 24590-WTP-3PS-MV00-TP001, *Pressure Vessel Design and Fabrication*; 24590-WTP-3PS-SS90-T0001, *Seismic Qualification of Seismic Category I/II Equipment and Tanks*; and 24590-WTP-3PS-MV00-TP002, *Seismic Qualification Criteria for Pressure Vessels*.
- 3.5.2 The detail and extent of the criteria for acceptance are as follows: The contents of the Ultrafilter assembly are to be retained; no permanent deformation of body, supports, or mountings; and no attachment (pipework, nozzles, brackets) deformation that will prevent retrieval of the Ultrafilter assembly by the normal operating procedures for the event.
- 3.5.3 A vibration analysis shall be performed in addition to the seismic analysis to ensure the design is adequate when the seismic event is combined with the 2400 gallon per minute slurry flow.

- 3.5.4 A vibration and seismic analysis shall be performed under normal operating conditions to ensure the design is adequate.

4 Materials

Materials shall be furnished to the specifications and grades shown on 24590-PTF-MLD-UFP-P0007 Ultrafilter MDS, and as specified per 24590-WTP-3PS-MV00-TP001, *Pressure Vessel Design and Fabrication*.

5 Fabrication

The Seller shall obtain written Final Design Review from the Buyer prior to the start of fabrication activities.

5.1 General

- 5.1.1 Fabrication shall be as specified per 24590-WTP-3PS-MV00-TP001, *Pressure Vessel Design and Fabrication*.
- 5.1.2 Metallic material handling devices in contact with stainless steel shall be made of stainless steel. Surfaces resulting from the removal of temporary welded attachments shall be ground flush. It is acceptable to use high-strength carbon steel clamping devices such as machine chuck jaws on stainless steel, provided the Seller has a program or procedure for ensuring that the stainless steel has not been contaminated by the carbon steel. This procedure shall be available at the Seller's facility for the Buyer's review.
- 5.1.3 The Seller shall develop, and have reviewed by the Buyer, a fabrication, inspection, and examination plan. Inspections and examinations shall be documented and reviewed at random by the Buyer.

5.2 Welding

Welding of piping, pressure containing parts, and wetted parts (except structural items), as well as any weld repairs to such parts, shall be performed and inspected in accordance with ASME Section VIII Division 1, and specification 24590-WTP-3PS-MVB2-T0001, *Welding of Pressure Vessels, Heat Exchangers, and Boilers*. No surface preparation such as descaling, etc is required or applicable.

6 Special Tools

Each special tool shall be labeled with a drawing number and its intended use, with instructions in the manual on its use.

7 Inspection and Examination

- 7.1 Inspection and examination of the Ultrafilter shall be in accordance with ASME Section VIII and specification 24590-WTP-3PS-MV00-TP001 *Pressure Vessel Design and Fabrication*.
- 7.2 Liquid penetration examination shall be in accordance with the ASME Section V. All defects found shall be repaired and re-examined by the Seller. The Seller shall use an approved procedure for all liquid penetrant examination. This procedure shall be submitted to the Buyer for review prior to fabrication.
- 7.3 The welds between tube elements and tube sheets of the tube bundles shall be liquid penetrant tested at final assembly.
- 7.4 Seller shall perform onsite inspection at his place of fabrication for the following items:
 - 7.4.1 First tube production
 - 7.4.2 Bubble point testing (BBPt)
 - 7.4.3 Gas flow testing
 - 7.4.4 Tensile testing
 - 7.4.5 First element production welding
 - 7.4.6 First element bubble point testing
- 7.5 Surveillance inspection of the Ultrafilters during fabrication, assembly, and testing shall be performed by the Buyer as described in Section 5.1 of the MR.
- 7.6 All lifting yoke and lifting attachment welds shall be liquid penetrant (PT) or magnetic particle (MT) inspected in accordance with ASME Section V.
- 7.7 The Seller shall inspect all welds inside the filter elements including porous to solid connector welds using a borescope, closed circuit television camera and Cathode Ray Tube. The Seller shall also select and similarly inspect approximately 10 % of the elements. In addition, 1 % of the porous to porous welds shall be tensile tested to destruction.
- 7.8 Welds which are rejected must have the entire filter element discarded.
- 7.9 Records of the PT and MT and other tests shall be submitted to the Buyer as described in G-321-E included in document, 24590-QL-MRA-MVEF-00001.

8 Testing

8.1 General

- 8.1.1 The Seller shall submit the test procedures to the Buyer for review. Any deviations to the specified test requirements require Buyer review before the tests are started.
- 8.1.2 The Buyer reserves the right to witness all tests and shall be given a minimum of 72 hours written notice prior to each test date.
- 8.1.3 The lifting yoke shall be load tested to 1.5 times the design load.

8.2 Pneumatic Testing

- 8.2.1 Pneumatic testing shall be conducted with the Ultrafilter fully assembled with the filter bundle installed in the filter housing. Dry, filtered and oil-free gas shall be used.
- 8.2.2 The Ultrafilter assembly shall be pneumatically tested in accordance with ASME Section VIII. The results shall be recorded, documented, and submitted to the Buyer for review.

8.3 Tube Testing

- 8.3.1 All tubes shall be bubble point tested (BBPt) and seller will submit BBPt data and the procedure for liquid filtration in 0.1 micron grade media in stainless steel to Buyer for review. In addition, the assembled element comprising 4 tubes and two end connectors shall be BBPt tested to assure that the joining and welding does not create holes larger than specified. The minimum BBPt is 7-9 inches Hg and the wetting fluid shall be isopropyl alcohol solution. 100 % of the tubes and filter elements shall be bubble tested.
- 8.3.2 The finished tubes shall be gas-flow tested for both performance and integrity. Seller shall submit procedures and data for review. 100 % of the tubes shall be gas-flow tested.
- 8.3.3 Tubes shall be tested for tensile strength at a rate of 1 % per batch sintered. Seller shall submit data on tensile strengths.
- 8.3.4 All powders used in the sintering shall be documented by lot for their chemical composition and powder fraction sizes and certified.

9 Cleaning and Painting

- 9.1 The Ultrafilter, including parts, shall be delivered to the Hanford Site clean and free of any oils, tape adhesives, weld splatter, dirt, loose debris, and other contaminants.
- 9.2 Solvents and cleaning solutions used on stainless steel shall be chloride free.
- 9.3 A 1 1/2 in. yellow band shall be painted around the top of dowel holes for targeting. The requirements for the epoxy coating, surface preparation, application, testing, and inspection

shall be per 24590-WTP-3PS-PX04-T0004, *Epoxy Coating of Stainless Steel Items That Are Buried, Embedded, or Insulated*.

- 9.4 Stainless steel components do not require painting except as needed for identification or for targeting.
- 9.5 The top 8 in. of lifting attachments shall be painted yellow.

10 Marking

- 10.1 The Ultrafilter shall have a manufacturer's name plate with information identified in ASME Section VIII. In addition to the information required by ASME, the name plate shall include the assembly weight (dry and wet), purchase order number, and plant item number.
- 10.2 All attached plates and their attachment hardware shall be of corrosion resistant metal with stamped or etched characters.

11 Instruction Manuals and Drawings

- 11.1 The Seller shall prepare and provide copies of operating and maintenance manuals (O&M), including: operating and maintenance instructions for all the equipment supplied; parts list; arrangement drawings; recommended spares; and preventive maintenance for 10 years of operation.
- 11.2 Instruction manuals shall be provided for container storage, installation, startup, and maintenance instructions for the Ultrafilter and all associated equipment.
- 11.3 Ultrafilter lifting requirements shall be provided in detail along with any special precautions related to either handling or operating the equipment furnished. The use of any special tooling provided shall be explained in detail. All drawings and procedures required for Ultrafilter installation and operation shall be included in the manual for quick reference.
- 11.4 Any assembly methods shall be demonstrated to the Buyer. These methods shall be explained in detail in the Seller's instruction manual and the process recorded on video for future training purposes.
- 11.5 All drawings shall be provided to the Buyer as specified in Section 15 of this specification.

12 Quality Assurance

- 12.1 QA requirements specific to item(s) or service

- 12.1.1 The Seller shall have in place a QA program meeting the requirements of ASME-NQA-1-1989, marked as applicable in Supplier Quality Assurance Program Requirements Data Sheet attached to the MR, and Buyer specification 24590-WTP-3PS-G000-T0001. The Seller shall submit its Quality Assurance Manual with its bid.
- 12.1.2 The successful bidder must pass a pre-award survey by the Buyer. Seller shall demonstrate that its quality program is in compliance with the procurement quality requirements listed in the Supplier Quality Assurance Program Requirements Data Sheet. The Seller shall allow the Buyer, its agent, and DOE access to their facility and records pertaining to this purchase order for the purpose of QA Audits and Surveillance at mutually agreed times.
- 12.1.3 All items shall be manufactured in accordance with the Seller's Quality Assurance Program that meets the requirements of ASME NQA-1-1989, and has been previously evaluated and accepted by the RPP-WTP Quality Assurance organization.
- 12.1.4 Seller shall submit their QA program and work plan to Buyer for review prior to commencement of work. The plan shall include documents and procedures to implement the work and include a matrix of essential Quality Assurance elements cross referenced with the documents/procedures.

13 Compliance Matrix

A compliance matrix shall be provided with the proposal indicating how each specification requirement will be met by the seller.

14 Preparation for Delivery

Preparation for delivery shall be in accordance with 24590-WTP-3PS-G000-T0003, *Specification for Packaging, Shipping, Handling, and Storage Requirements*.

15 Seller Documentation Submittals

15.1 General

- 15.1.1 Seller shall submit to Buyer all detailed designs, drawings, documentation, procedures, instructions, calculations, analyses, manufacturer documentation, manufacturer data, inspection reports, test reports, certifications, certificates, manuals, MSDSs, video tapes, and drawings required per the MR (see G-321-E &/or G-321-V), the applicable codes, standards, and reference documents in section 2 of this specification.
- 15.1.2 All detailed designs, drawings, assembly drawings, shop drawings, MDSs, supporting calculation, supporting analyses, and all other requirements in the 60 % design stage shall be issued to the Buyer for review prior to fabrication of Ultrafilters and equipment.

- 15.1.3 Seller shall submit to Buyer Engineering and Quality Verification documents in the forms and quantities shown in Form G-321-E, *Engineering Document Requirements*, and Form G-321-V, *Quality Verification Document Requirements* attached to the MR, section 3.
- 15.1.4 Seller shall submit a report identifying any deviations and/or conflicts per section 2 of the MR to the Buyer for review.
- 15.1.5 Each documentation transmittal package shall have a documentation inventory sheet attached listing all documents and the number of pages each.
- 15.1.6 All documents submitted for review (e.g., General Arrangement, Shop Details, Calculations must contain their own unique NAME AND IDENTIFICATION NUMBER) Example:

Calculations for Item:
Document No: Calc UFP-FLT-00001-0001
- 15.1.7 Data sheets in section 2 of the MR shall be marked up by the Seller and submitted to the Buyer for review with the detailed design.
- 15.1.8 All drawings shall be produced per the drawing practices set forth in ASME Y14.100, *Engineering Drawing Practices*.

15.2 Calculations

All calculations to be provided shall be orderly, complete, and sufficiently clear to permit verification. The body of the calculations shall include:

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

15.3 As-Built Drawings

15.3.1 Progress As-Builts

During construction, the Seller shall keep an updated marked-up set of progress as-built drawings on the jobsite as an accurate record of all deviations between the work, as shown on the Buyer reviewed drawings, and work as fabricated. These drawings shall be available to the Buyer for inspection at any time during regular business hours.

15.3.2 Final As-Builts

Seller shall furnish to Buyer final as-built drawings with AS-BUILT clearly printed on each sheet for all final work left in place. Seller shall accurately and neatly transfer all deviations from progress as-builts to final as-builts.

15.4 Project Start

Seller shall submit drawing index and detailed schedule of engineering document submittals, material purchases, fabrication, shop test, and ready for shipment. Include bar charts or critical path method diagrams, which detail the chronological sequence of activities.

15.5 30 % Design Review

- 15.5.1 Provide drawings with outline dimensions. Drawings shall show external envelope, including lugs, centerline(s), isometrics, and details related to mountings.
- 15.5.2 Provide preliminary dimension, location, and layout for components.
- 15.5.3 Identify all items of equipment to ensure lifting capability during construction, maintenance, and decommissioning.

15.6 60 % Design Review

- 15.6.1 Provide assembly drawings.
- 15.6.2 Provide shop detail drawings with sufficient detail to facilitate fabrication, manufacture, or installation. This includes a complete Bill of Materials (BOM), pipe spool drawings, internal piping details, cross-section details, and structural details.
- 15.6.3 Submit all final detailed drawings, calculations, analyses, and information necessary for equipment fabrication.
- 15.6.4 Submit all FMEA documentation.

15.7 90 % Design Review

- 15.7.1 Provide detailed written procedures, instructions, and drawings (including all lifting requirements) for system installation.
- 15.7.2 Provide list of required spares.
- 15.7.3 Provide startup and commissioning spares list, including all components or equipment that may be needed during startup and commissioning.

- 15.7.4 Provide operation manuals with detailed written instructions describing how the unit and components should be operated. Manuals shall include specific instructions, procedures, and illustrations for the following:
 - 15.7.4.1 Safety Precautions – List personnel hazards and equipment or product safety precautions for all operating conditions.
 - 15.7.4.2 Operator Service Requirements – Include instructions for services to be performed by the operator, such as adjustments, and inspections.
 - 15.7.4.3 Environmental Conditions – Include a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.
 - 15.7.4.4 Lay-up Instructions – Include step-by-step instructions for lay-up.
- 15.7.5 Provide maintenance manuals with detailed written instructions to disassemble, reassemble, and maintain systems or components in an operating condition. Manuals shall include specific instructions, procedures, and illustrations for the following phases of maintenance:
 - 15.7.5.1 Preventive Maintenance - Include the following information for preventive and scheduled maintenance to minimize corrective maintenance and repair:
 - 15.7.5.1.1 Preventive Maintenance Plan and Schedule – Include manufacturer’s schedule for routine preventive maintenance, inspections, testing, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer’s projection of preventive maintenance frequency of work, and hours to complete the task. Provide surveillance and in-service inspection recommendations.
 - 15.7.5.2 Corrective Maintenance – Include manufacturer’s schedule for procedures and instructions for correcting problems and making repairs. Include the following information for performing corrective maintenance:
 - 15.7.5.2.1 Maintenance and Repair Procedures – Include instructions and list tools required to restore product or equipment to proper condition or operating standards.
 - 15.7.5.2.2 Removal and Replacement Instructions – Include step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide all tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of text and illustrations.
 - 15.7.5.2.3 Recommended Spare Parts and Supply Lists – Include list of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Include the cost of each item.
 - 15.7.5.2.4 Parts Identification – Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering

without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustration and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

- 15.7.5.2.5 Other than Seller's Commercial Practice – End item manufacturer may add a cross-reference to implement component assemblies and parts requirements when implementation in manual form varies significantly from the style, format, and method of Seller's standard commercial practice.
- 15.7.5.2.6 Warranty Information – List and explain the various warranties and include the servicing and technical precautions prescribed by the Seller or contract documents to keep warranties in force.
- 15.7.5.2.7 Personnel Training Requirements – Provide information available from the Seller to use for training designated personnel to operate and maintain the equipment properly.
- 15.7.5.3 Calibration Testing Equipment and Special Tool Information – Include information on test equipment required to perform specific tests and on special tools needed for the operation, maintenance, and repair of components.
- 15.7.5.4 Provide Component Descriptions – Include comprehensive component descriptions describing, in detail, how each individual process component functions and the basic design basis.
- 15.7.6 Provide design and operational requirements per the following:
 - 15.7.6.1 Design requirements – Include a list or table describing the maximum design limits and conditions required to safely operate the equipment (i.e., temperatures, pressures, etc.).
 - 15.7.6.2 Operational requirements – Include a list or table describing the normal operating ranges for equipment (i.e., temperatures, pressures, etc.).
- 15.7.7 Provide analysis and design reports, including analytical data (stress, fluid dynamics, etc.) which demonstrates that an item satisfies all specified requirements.
- 15.7.8 Provide seismic analysis or test data reports providing data and demonstrating suitability of materials, components, or systems in relation to the conditions imposed by the stated seismic criteria.
- 15.7.9 Provide thermal stress analysis or test data reports providing data and demonstrating suitability of materials and components, in relation to the conditions imposed by thermal stresses.
- 15.7.10 Provide site storage and handling manuals including the requirements for lifting, or other handling requirements to prevent damage or deterioration during storage and handling at job site. Include return shipping instructions.
- 15.7.11 Provide inspection and test plan including detailed descriptions of the inspections and tests planned during the receipt, manufacturing, and conformance verification activities. Include identification of witness and hold points.

- 15.7.12 Provide welding procedures, specifications, and supporting qualification records required for welding, hard facing, overlaying, brazing, and soldering.
- 15.7.13 Provide material control procedures including controlling issuance, handling, storage, and traceability of materials such as weld rod.
- 15.7.14 Provide PMI procedures for performing PMI testing of materials.
- 15.7.15 Provide repair procedures including controlling material removal and replacement by welding, brazing, etc., subsequent thermal treatments, and final acceptance inspection.
- 15.7.16 Provide pressure testing procedures including hydro, air, leak, separation, or vacuum test procedures for performing hydrostatic or pneumatic structural integrity and leakage tests.
- 15.7.17 Provide inspection procedures for the purpose of determining that specified requirements (i.e., dimensions, properties, performance results, etc.) are met.
- 15.7.18 Provide radiographic testing procedures for identifying the presence and certain characteristics of discontinuities and inclusions in materials by x-ray or gamma ray exposure of photographic film.
- 15.7.19 Provide liquid penetrant testing procedures for detection of surface discontinuities in materials by application of a penetrating liquid in conjunction with suitable developing techniques.
- 15.7.20 Provide functional shop test procedures.
- 15.7.21 Provide integrated acceptance test requirements document per engineering specifications to demonstrate design function and operational parameters for the complete Ultrafilter.
- 15.7.22 Provide shipping preparation procedures for cleaning, packaging, and handling.

15.8 Final Design Review

Provide final design report including all design documents, manuals, and drawings that are specified in this specification. All procedures and instructions shall be completed and submitted to the Buyer a minimum of eight (8) weeks prior to Ultrafilter components and skid shipment.

Figure 1 Ultrafilter Schematic

Note: 10-in inlet and outlet shall be eccentric i.e. flush with bottom of shell for proper draining.

