OSR 45-10# (Rev 4-10-2002)

Statement of Work Cover Sheet

1. Title **Tank Closure Cesium Removal (TCCR) System**			
2. Document No. X-SOW-H-00002	3. Revision 3		4. Page 1 of 89
5. Functional Classification Safety Class (SC)	6. Requester Department Engineering	7. Requester Division SRR Engineering	
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TBC 1/4/2016

Statement of Work Revision History Sheet

1. Specification No	2. Revision	3. Page
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4. Date	5. Revision No.	6. Paragraph No.	7. Description of Changes
8/6/2015	0	Initial Issue	Issued for release
8/20/2015	1	3.1.3.3.I	Lubrication fluids with the potential to enter a process vessel must be submitted; formerly "documented."
		3.1.3.10.C.3.b	Clarified reference.
		3.1.3.14.A	Noted that the requirements for wind loads are at the PC-2 level. Deleted missile criteria.
		3.1.3.17.A.1	Revised wind loadings to be consistent with PC-2 criteria.
		3.1.3.17.A.6	Removed remarks to tornado forces and loads.
		3.1.3.17.A.7	Removed tornado wind and missile load requirement.
		Attachment 5.1, Page 1	Corrected specification paragraph references. Corrected wording for paragraph 3.1.3.10.K.13.m.3).
		Attachment 5.1, Page 2	Revised preliminary submittal schedule for requirements in paragraphs 3.1.3.18.C.9 through 11 from 50% design to 4 weeks after award.
		Attachment 5.1, Page 4	Corrected wording for paragraph 3.2.2.
		Attachment 5.1, Page 5 and 6	Corrected specification paragraph references.
		Attachment 5.2, Page 1	Corrected specification paragraph references.
		Attachments 5.4 through 5.8	Removed "draft" designation from headers.
9/10/2015	2	3.1.2.2.B	Changed aluminum concentration range from 0.2-0.3M to 0.2-0.4 M. Denoted aluminum anion as AlO^{2-}. Changed potassium concentration from 0.1-0.5 M to 0.02-0.05 M. Changed sulfate concentration from "trace" to 0.2-0.5 M.
		3.1.2.6.A.2	Changed container dose limits from less than 5 mR/hr on contact to less than 5 mR/hr measured at 30 cm.
		3.1.3.8.B	Typo
		4.1.5.2.E	New section to describe ion exchange testing.
		4.1.5.4	Added note on ion exchange column reporting
		Attachment 5.1 Page 1	Added requirement that physical and chemical composition of resin to be submitted before award.
		Attachment 5.6	Changed cesium-133 concentration from 0.1 M to be Supplier-provided. Changed sodium range from 5.6-6.4 M to 4.6-5.4 M. Increased carbonate concentration from 0.2 M to 0.4 M. Added note for Supplier to determine appropriate concentration if cesium-133 is used. Clarified that the concentrations listed are relative to the feed stream.

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4. Date	5. Revision No.	6. Paragraph No.	7. Description of Changes
12/31/2015	3	2.2.1.1.B.4 and 5	Revised and corrected exception to 10 CFR 851.27(b) to include the entire edition of the 2013 ASME Boiler and Pressure Vessel Code.
		2.2.2.19.D thru M	Deleted IEEE standards applicable to Class 1E circuits and components: IEEE-308, 323, 336, 338, 342, 344, 379, 382, 384, and 603.
		3.1.2.4.B.1	NEW: Provided clarification that spent ion exchange resin shall also be removable (i.e., sluicing) from the ion exchange column.
		3.1.2.4.C	Expanded on resin fine carryover requirement.
		3.1.2.4.F	NEW. Added a requirement to provide documentation on resin and column decontamination performance. This was previously part of the FAT.
		3.1.3.10.A	Deleted environmental qualification requirements per IEEE-323.
		3.1.3.10.B.1	Deleted seismic qualification requirements for electrical components and circuits per IEEE-323, IEEE-344, and IEEE-382.
		3.1.3.10.G.21.d and e	NEW. Clarified the requirements for primary connections.
		3.1.3.10.L.1	Deleted electrical design requirements per IEEE-308, 336, 338, 379, 384, and 603. Also deleted the phrase "National Electrical Code" (redundant with NFPA-70).
		3.1.3.10.O.1	Deleted instrumentation requirements per IEEE-323, 336, 338, 379, and 384.
		3.1.3.13.E (table)	Increased whole body total effective dose from 0.5 to 1 rem. Deleted limit requirement for internal committed effective dose.
		3.1.3.13.G	Rewritten in entirety.
		3.1.3.13.H and 3.1.3.13.H.1	Rewritten in entirety.
		3.11.1.3.B	Included discussion of the CGD implementation strategy as a topic in the prefabrication meeting.
		3.13.2.5	Changed procurement representative address.
		4.1.5.1	Clarified disposal requirement for materials and consumables.
		4.1.5.2.C.3	Rewrote requirement for clarification
		4.1.5.2.E.a and c	Deleted cesium removal and breakthrough testing as part of the FAT. Added option to allow the supplier to use a surrogate for FAT purposes only.
		Attachment 5.1 Page 1	NEW. Added documentation on resin and column decontamination performance.
		Attachment 5.1 Page 5	Revised the requirement to the CGD Plan issued at 90% Design.
		Attachment 5.3	Removed ISO 17025 as a requirement. Added ASME NQA-1 Subpart 2.7 as a requirement.
		Attachment 5.5	Added a note to Interface Node No. 3.
		Attachment 5.6	Revised and simplified salt simulant recipe. Eliminated species that could prematurely degrade the specified resin if used for the FAT.
		Attachment 5.9	Added Tank 10H transfer pump curve

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1.0 SCOPE

1.1 General Description of Service

1.1.1 The scope of this statement of work is to provide an ion exchange process (herein called the *TCCR System*) that will remove radioactive cesium-137 from aqueous high-level waste (i.e., dissolved salt solution).

1.1.1.1 Tank 10H is partially filled with a solidified waste mass, called *salt* (also called *saltcake*). The salt is a hardened waste byproduct of nuclear materials production and consists mostly of nitrates, nitrites, and hydroxides of sodium. The salt and the interstitial liquid are contaminated with radioactive cesium-137. Savannah River Remediation LLC (SRR) plans to dissolve the salt by adding water. The resultant mixture will be available for cesium removal.

1.1.1.2 SRR will pump the solution to the TCCR System through a jacketed transfer line. The TCCR System will decontaminate the solution and send the solution to nearby Tank 11H through an SRR-supplied jacketed transfer line.

1.1.1.3 The acceptable configuration is a "by-tank" arrangement. The configuration is expected to consist of temporary process structures located near Tank 10H and 11H so the cesium removal process would take place outside of the tank. Figure 1 summarizes the acceptable configuration and scope. The site (to be determined later) for Interim Safe Storage will be located away from the processing area.

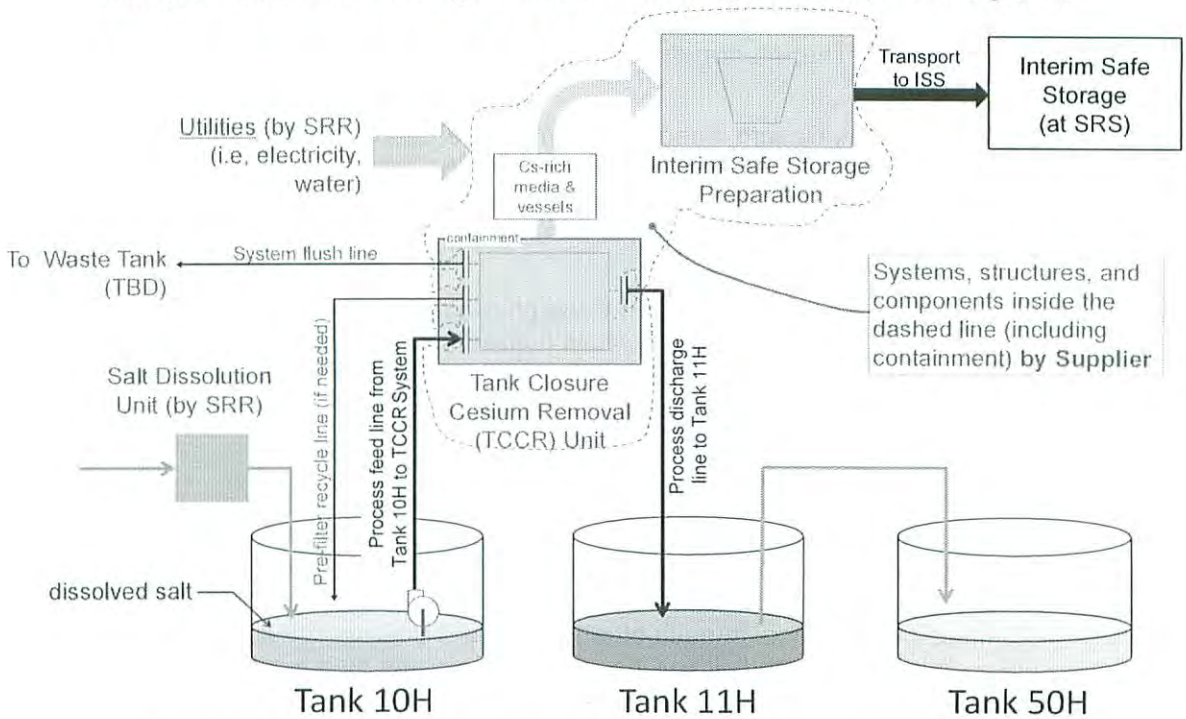

Figure 1. Cesium Ion Exchange System Configuration and Scope

1.1.1.4 The scope assumes delivering the TCCR System intact, with minimal onsite preparation work, start up, and final assembly. The TCCR System shall be delivered assembled, pre-tested, and inspected to the fullest extent practical.

1.1.1.5 The TCCR System shall be sited in the vicinity of Tanks 10H and 11H (see Attachment 5.4). Intrinsically, the TCCR System must be sufficiently compact to minimize:

A. The processing area footprint.

B. The length and number of above-grade transfer lines.

C. The volume of liquid radioactive material outside of the tank.

1.1.2 The scope includes the Supplier providing a method of preparing any spent ion exchange resin or eluted cesium for Interim Safe Storage (ISS). SRR will retain these materials in ISS until such time it is processed for final disposition.

1.1.3 The Supplier shall provide 1000 hours of technical support to assist SRR in the nuclear safety analysis, hazards analysis, installation, start-up testing, system acceptance, training of SRR operations personnel, and operating procedures development.

1.1.4 The Supplier shall provide enough materials and consumables (e.g., resin, vessels, containment systems and equipment) to process 625,000 gallons of salt solution, which will consist of approximately 100,000 Curies of cesium-137.

1.2 Background

1.2.1 SRR is contracted to manage and operate the legacy liquid waste (LW) system at the Savannah River Site (SRS) for the Department of Energy (DOE). The LW system consists of several facilities to safely receive, store, treat, and permanently dispose of radioactive waste. The mission of SRR is to treat and stabilize LW and close the older style LW tanks.

1.2.2 Acceleration of tank closure is required to meet the Federal Facility Agreement (FFA) commitments between DOE and the State of South Carolina (Reference: WSRC-OS-94-42). Closure of older style tanks starts with the bulk waste removal efforts. A cesium removal process to support bulk waste removal efforts is needed to support and accelerate tank closure.

1.2.3 The waste in the storage tanks are in three physical forms: supernatant liquid, sludge solids, and salt. Salt contains salt crystals (which form after the evaporated supernatant liquid is cooled), and entrapped interstitial liquid. The sludge, primarily insoluble hydroxides and oxides, settle and accumulate on the bottom of the tanks.

1.2.4 Tanks 10H and 11H Description

1.2.4.1 Tanks 10H and 11H are two of four underground LW tanks that are located in the oldest section of the H-area LW processing facility. The entrance to the four tanks is a narrow, curved road that limits access by long, multiple-axle vehicles with no area to turn around for exit. The four tanks are situated in a square footprint, with Tanks 10H and 11H diagonal to each other. Each tank is surrounded at its perimeter by a block wall approximately three feet high, with access by stairs built over the wall at various intervals.

1.2.4.2 Tanks 10H and 11H each have a 750,000-gallon nominal capacity with a diameter of 75 feet and height of 24.5 feet. Figure 2 shows a side view of the tank structure in relation to the grade and risers. Rolled carbon steel plates and sections are welded together to form the primary tank. The primary tank rests inside a buried concrete vault with an annular space surrounding the primary tank. Lining the bottom of the vault is a five-foot high carbon steel annulus pan to collect potential leakage from the primary tank. The top of the primary tank is approximately ten feet below grade with the tank roof supported by twelve internally and equally-spaced 24-inch diameter

columns, where the capitals are in contact with the roof and the pedestals resting on the tank bottom. Tank top openings (risers) are installed to allow equipment access to the primary tank and annulus interiors. The contents were cooled with approximately 22,800 feet of submerged cooling coils.

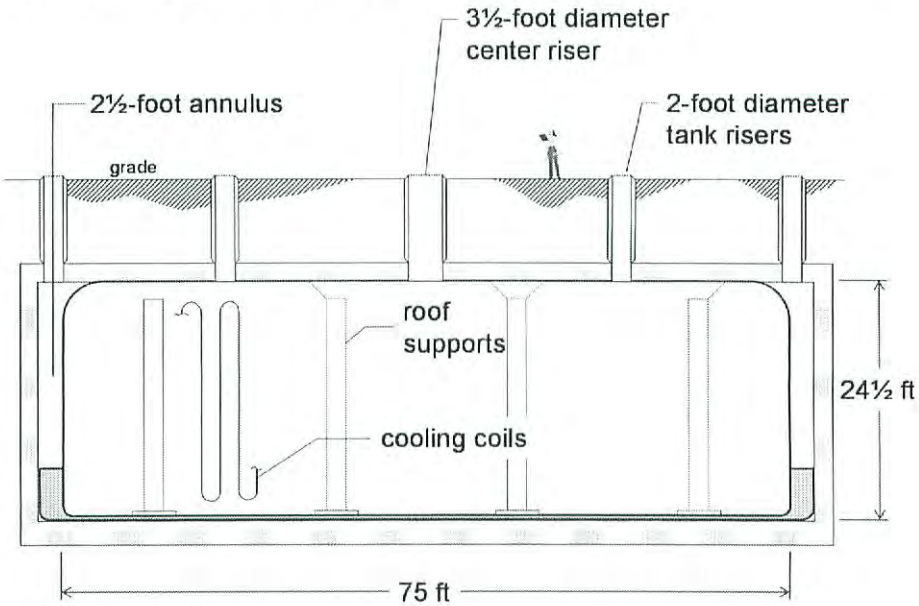

Figure 2. Elevation view representation of Tanks 10H and 11H

1.2.4.3 The current waste level in Tank 10H is approximately 77 inches, which corresponds to approximately 209,000 gallons. Approximately 15,000 gallons is dissolved salt (supernatant liquid); the remaining is 194,000 gallons of hardened salt with associated interstitial liquid. The total Cs-137 inventory in Tank 10H is approximately 100,000 Ci. When the salt is fully dissolved, the total volume of liquid is estimated to be 625,000 gallons.

1.2.4.4 Tank 11H is located roughly 75 feet from Tank 10H and has a working storage volume of 400,000 gallons.

1.2.4.5 There are two interior areas of each tank structure, a primary tank surrounded by a narrow annular space. Inside the primary tank is an intricate system of cooling coils that are attached to the top and bottom of the primary tank. Interior access to these two areas is through tank openings covered by various-sized concrete plugs. Typically, electrical and other services for LW tank processes are run above ground, creating numerous interferences to riser and tank-top access. Support services, including electrical power and service water, for implementation of work activities outside of LW tank processes are limited.

1.2.4.6 Because of the levels of radiation and contamination in the area of the four tanks, physical and administrative radiological controls are implemented. Depending on the location, personnel are required to wear protective clothing for contamination control and be monitored for radiation exposure so that limits established by SRR personnel are not exceeded. Controls are implemented to prevent the spread of radioactive contamination to outside of the tanks and to minimize personnel radiation exposure.

1.2.4.7 Because LW facilities have ongoing production processes, timely interface with Operations management relative to Tanks 10H and 11H activities is practiced.

Schedules for work implementation are strictly followed and have enough detail for integration with operations processes.

1.2.4.8 Applicable SRS drawings include: W145573, W146625, W146654, C-CX-H-0078, W715395, W711939, and W717535.

2.0 REFERENCES

2.1 Acronyms and Definitions

2.1.1 Acronyms

ALARA	as low as reasonably achievable
APC	atmospheric pressure change
ARO	after receipt of order
ASAD	after subcontract award date
BTU	British thermal unit
cfm	cubic feet per minute
CCW	counter clockwise
CED	committed effective dose
CFR	Code of Federal Regulations
CGD	commercial grade dedication
Ci	curie
CLD	control logic diagram
CLI	component location identification (or identifier)
CMP	configuration management plan
CQF	cognizant quality function
cP	centipoise
CTF	cognizant technical function
CW	clockwise
DAC	derived air concentration
DF	decontamination factor
DSA	documented safety analysis
EDR	engineering document requirements
FAT	factory acceptance test
FFA	Federal Facility Agreement
fpm	feet per minute
HEPA	high efficiency particulate air
HP	horsepower
ICD	interface control document
ID	inside diameter
I/O	input/output
ISS	interim safe storage
kcf	kilo cubic feet
KW	kilowatt
LW	liquid waste

M&TE	measuring and test equipment
MERV	minimum efficiency reporting value
mph	miles per hours
MTR	material test report
NDE	non-destructive examination
P&ID	piping and instrumentation diagram
PC	performance category
PDF	portable document format
PFD	process flow diagram
PLC	programmable logic controller
PRV	pressure relief valve
psf	pounds per square foot
psia	pounds per square inch (absolute)
psig	pounds per square inch (gauge)
QA	quality assurance
QAP	quality assurance program
QVDR	quality verification document requirements
S/CI	suspect/counterfeit items
SC	safety class
scfm	standard cubic feet per minute
SDC	seismic design category
SDDR	supplier deviation disposition request
SOW	statement of work
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
SRSS	square root of the sum of the squares
SS	safety significant
SSC	structure, system and component
SSR	supplier surveillance representative
TCCR	tank closure cesium removal
TLV	threshold limit value
UNS	unified numbering system
VAC	voltage alternating current
VFD	variable frequency drive
WG	water gauge
WPS	welding procedure specification

2.1.2 Definitions

2.1.2.1 As Low As Reasonably Achievable (ALARA): the approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. As used in this SOW, ALARA

is not a dose limit but a process that has the objective of attaining doses as far below the applicable controlling limits as is reasonably achievable.

2.1.2.2 Applicable Standards: SRR accepted standards governing the materials, design, fabrication, inspection, examination and testing of systems, structures and components.

2.1.2.3 Committed Effective Dose, E_{50} (CED): the sum of the committed equivalent doses to various tissues or organs in the body ($H_{T,\,50}$), each multiplied by the appropriate tissue weighting factor (w_T) - that is, $E_{50} = \Sigma w_T H_{T,\,50} + w_{Remainder} H_{Remainder,\,50}$ where $w_{Remainder}$ is the tissue weighting factor assigned to the remainder organs and tissues and $H_{Remainder,\,50}$ is the committed equivalent dose to the remainder organs and tissues. CED is expressed in units of rem (or SV).

2.1.2.4 Confinement Ventilation System: a ventilation system that provides the desired barriers and associated ventilation systems to maintain control over the spread of contamination.

2.1.2.5 Consequence of Failure (CF): A classification, where:

A. CF1: Service fluids that are either flammable, radioactive, toxic, safety class, or damaging to human tissue.

B. CF2: Service fluids that are not CF1, and have either an operating pressure and temperature above 150 psig / 366°F (185.6°C) or 275 psig / 200°F (93.3°C), or an operating temperature below –20°F (-28.9°C).

C. CF4: Service fluids that are neither CF1 nor CF2.

2.1.2.6 Decontamination Factor (DF): The ratio between initial and final specific radioactivity that results from a separation process. The percent of activity removed is determined by: *% of Activity Removed = (1 – 1 / DF) × 100*

2.1.2.7 Derived Air Concentration: the airborne concentration that results in a CED of 5 rem or organ dose of 50 rem if inhaled by a worker for 2000 hours in a year (continuous occupancy). DAC values are provided in SRS 5Q Manual, Chapter 4, Appendix 4B and will be made available to the Supplier upon request.

2.1.2.8 Documented Safety Analysis: a documented analysis of the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that form the basis for ensuring safety.

2.1.2.9 Eluate: the cesium-rich stream obtained from elution.

2.1.2.10 Elution: the process of extracting captured ions from loaded ion exchange resins. A resin capable of undergoing elution is *elutable*.

2.1.2.11 Hold Point: : a mandatory inspection activity beyond which work shall not proceed until (1) inspection is performed by an independent inspector/peer inspector and acceptance is authenticated, or (2) written release is authorized by the organization establishing the hold point.

2.1.2.12 Interim Safe Storage (ISS): is the location (provided by SRR) where spent ion exchange resin or eluted cesium (and their containment systems, equipment, and shielding) is stored until such time it is processed for final disposition.

2.1.2.13 Ion Exchange Resin: an insoluble matrix (or support structure) normally in the form of small beads or granulated powder, often fabricated from an organic polymer or an inorganic zeolite substrate, and are either elutable or non-elutable. The individual particles are typically porous, providing a high surface area where ion exchange occurs.

2.1.2.14 Material at Risk: Material used in hazard and accident analysis representing the documented maximum quantities for a given process or activity.

2.1.2.15 Module: a discrete processing unit. One or more modules may constitute the TCCR System.

2.1.2.16 Process Utilities: SRR provided services to the TCCR System.

2.1.2.17 Safety Class: SSCs whose preventive and mitigative function is necessary to limit radioactive hazardous material exposure to the public, as determined from the safety analysis.

2.1.2.18 Safety Significant: SSCs not designated as Safety Class, whose preventive or mitigating function is a major contributor to defense in depth and/or worker safety as determined from the safety analysis.

2.1.2.19 Spent Ion exchange resin: ion exchange resin used until it is no longer capable of effectively removing cesium.

2.1.2.20 Structure, System and Component (SSC): TCCR System equipment, piping system, tanks, supporting structure, and control systems.

2.1.2.21 Tank 10H: H Tank Farm Tank 241-910H.

2.1.2.22 Tank 11H: H Tank Farm Tank 241-911H.

2.1.2.23 TCCR System: The packaged process designed and fabricated to 1) receive radioactive salt solution from an LW feed tank planned for operational closure, 2) remove cesium ions, 3) and return the decontaminated stream to an LW receipt tank. The system includes the method and equipment to prepare and contain spent resins and/or eluate for ISS.

2.1.2.24 Unlisted Component(s): components as defined in ASME B31.3 (for example, paragraph 302.2.3).

2.1.2.25 Witness Point: an inspection activity beyond which work shall not proceed until an inspector is notified and (1) the inspection is performed and released, or (2) the inspection is deferred and can be completed at a later time.

2.2 Codes and Standards

2.2.1 General

2.2.1.1 Materials, design, fabrication, examination and testing shall be per SRR accepted national codes and standards.

A. The supplier shall select National Code and Standards applicable to the TCCR System SSCs.

B. Codes and standards listed in 10 CFR 851, §851.27(b) "List of standards incorporated by reference" shall exclusively be the specified edition identified in 10 CFR 851. Exceptions are applicable to SRS based on specific site approved Codes and Standards Evaluations:

1. 2010 edition of B31.1 Power Piping
2. 2010 edition of B31.3 Process Piping.
3. 2010 edition of B31.5 Refrigeration Piping and Heat Transfer Components.
4. 2013 edition of ASME BPVC.
5. DELETED.
6. 2008 edition of NFPA-70.

C. Using codes and/or addenda differing from those listed herein will require justification and acceptance by SRR before using. Furthermore, additional

national codes and standards not specifically referenced herein but required for the TCCR System shall be defined and documented by the supplier during the process development.

1. Unless otherwise referenced, apply the latest edition of applicable standards.

D. Some requirements cite a specific code and standard section to assist in the application of the code and standard or to identify a SRR preferred application. Emphasis of specific sections does not relieve the Supplier from compliance with the entire code or standard.

E. The Supplier shall notify SRR of conflicts between different codes and standards.

F. For the purpose of code interpretation, SRR is the Owner, Authority Having Jurisdiction.

2.2.1.2 Material Standards

A. Material standard editions dated within the previous 10 years from the date of Subcontract award are permissible as long as the Supplier verifies physical and chemical properties of material meet the requirements of the below cited standard editions.

2.2.2 National Codes and Standards

2.2.2.1 Air-Conditioning, Heating, and Refrigeration Institute (AHRI)

A. 300, Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment (2008)

B. 410, Forced-Circulation Air-Cooling and Air-Heating Coils (2001)

C. 430, Central Station Air Handling Units (2009)

2.2.2.2 Air Movement and Control Association International, Inc. (AMCA)

A. 201, Fans and Systems (2002).

B. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating (2007)

2.2.2.3 American Bearing Manufacturer Association (ABMA)

A. 8.2, Ball and Roller Bearing Mounting Accessories - Inch Design (1991, S2010).

2.2.2.4 American Concrete Institute (ACI)

A. 318, Building Code Requirements for Structural Concrete (2014)

B. 349, Code Requirements for Nuclear Safety-Related Concrete Structures (2013)

2.2.2.5 American Conference of Governmental Industrial Hygienists (ACGIH)

A. 2096, Industrial Ventilation: A Manual of Recommended Practice for Design, 27th Edition (2010).

2.2.2.6 American National Standards Institute (ANSI)

A. N42.18, Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents (2004)

2.2.2.7 American Nuclear Society (ANS)

A. 2.26, Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design (2004, R2010).

2.2.2.8 American Petroleum Institute (API)

A. 620, Design and Construction of Large, Welded, Low Pressure Storage Tanks, Twelfth Edition (2013).

B. 650, Welded Steel Tanks for Oil Storage, Twelfth Edition (2014, Add 2014).

C. 673, Centrifugal Fans for Petroleum, Chemical, and Gas Industry Services (2014).

D. 674, Positive Displacement Pumps – Reciprocating (2010, E2014, E2015).

E. 675, Positive Displacement Pumps-Controlled Volume for Petroleum, Chemical, and Gas Industry Services (2012, E2014).

2.2.2.9 American Society of Civil Engineers (ASCE)

A. 4, Seismic Analysis of Safety-Related Nuclear Structures and Commentary (2000).

B. 7, Minimum Design Loads for Buildings and Other Structures (2010).

C. 43, Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities (2005).

2.2.2.10 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

A. ASHRAE Fundamentals Handbook (2013).

B. ASHRAE Handbook - HVAC Applications (2015).

C. ASHRAE Handbook - HVAC Systems and Equipment (2012).

D. ASHRAE Refrigeration Handbook (2014).

E. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (2012).

2.2.2.11 American Society of Mechanical Engineers (ASME)

A. AG-1, Code on Nuclear Air and Gas Treatment (2012).

B. B16.5, Pipe Flanges and Flanged Fittings (2003).

C. B30.20, Below-the-Hook Lifting Devices (2010).

D. B31.1, Power Piping (2010)

E. B31.3, Process Piping (2010).

F. B31.4, Pipeline Transportation Systems for Liquids and Slurries (2012).

G. B31.5, Refrigeration Piping and Heat Transfer Components (2010).

H. B73.1, Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process (2012).

I. B73.1M, Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process (1991, R1992).

J. B73.2, Specification for Vertical In-Line Centrifugal Pumps for Chemical Process (2003, R2008).

K. B73.2M, Specification for Vertical In-Line Centrifugal Pumps for Chemical Process (1991, R1999).

L. B73.3, Specification for Sealless Horizontal End Suction Metallic Centrifugal Pumps for Chemical Process (2003, R2008).

M. B73.3M, Specification for Sealless Horizontal End Suction Metallic Centrifugal Pumps for Chemical Process (1997).

N. B73.5M, Thermoplastic and Thermoset Polymer Material Horizontal End Suction Centrifugal Pumps for Chemical Process (1995, R2007).

O. Boiler and Pressure Vessel Code (BPVC).

1. Section V, Nondestructive Examination (2013).
2. Section VIII, Pressure Vessels (2013).

3. Section IX, Welding and Brazing Qualifications (2013).
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2.2.2.16 Hydraulic Institute (HI)

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E. DELETED

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T. 110, Standard for Emergency and Standby Power Systems (2013).

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2.3.1.1 10 CFR 851, Worker Safety and Health Program.

2.3.1.2 29 CFR 1910, Occupational Safety and Health Standards.

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2.3.1.4 South Carolina COR Chapter 49, South Carolina State Board of Registration for Professional Engineers and Land Surveyors.

2.3.1.5 South Carolina Regulation 61-58, State Primary Drinking Water Regulation

2.3.1.6 South Carolina Regulation 61-62, Air Pollution Control Regulations and Standards

2.3.1.7 South Carolina Regulation 61-62.7, Good Engineering Practice Stack Height.

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2.3.2.2 DOE O 226.1B, Implementation of Department of Energy Oversight Policy.

2.3.2.3 DOE O 420.1B, Facility Safety.

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2.3.2.6 DOE STD 1020, Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities (2012)

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A. Technical Paper No. 40, Rainfall Frequency Atlas Of The United States for Durations from 30 Minutes to 24 Hours and Return Periods from I to 100 Years (May 1961)

2.4 SRS Documents

2.4.1 Drawings

2.4.1.1 C-CX-H-0078 Tanks 9-12 Craneway Access and Setup.

2.4.1.2 W145573 Type I Tank General Arrangement.

2.4.1.3 W146625 Plan of Top of Type I Tank.

2.4.1.4 W146654 Concrete Plan Type I Tank Top.

2.4.1.5 W715395 Tanks 9-12 Layout, Grade, and Sewer.

2.4.1.6 W711939 Tanks 9-12 Craneway Pipe Crossings – Sections.

2.4.1.7 W717535 Tanks 9-12 Equipment Footings Concrete Plan.

2.4.2 Documents

2.4.2.1 M-DP-G-00006, Pressure Protection Design Guide (2002)

2.4.2.2 M-RVD-H-02662, Rupture Disk Verification Record (U), Ion Exchange Column (IXC) INEX-380 Relief Device (HM-241941-WTE-PSE-1) (Revision A) – USED AS AN EXAMPLE ONLY

2.4.2.3 M-RVD-H-02669, Pressure Relief Valve Verification Record (U), Resin Prep Filter WTS-FLT-423 Pressure Relief Valve (HM-241941-WTE-PSV-3) (Revision A) – USED AS AN EXAMPLE ONLY

2.4.2.4 OSR 8-193, Pressure Relief Valve Verification Record

2.4.2.5 OSR 8-213, Rupture Disk Verification Record

2.4.2.6 OSR 45-4 Supplier Deviation Disposition Request (SDDR)

2.4.3 Other

2.4.3.1 WSRC-OS-94-42, Federal Facility Agreement for the Savannah River Site.

3.0 WORK REQUIREMENTS

3.1 Task Requirements

3.1.1 The scope of this task is the following:

3.1.1.1 The Supplier shall 1) design, fabricate, test, and deliver a TCCR System to decontaminate cesium from dissolved salt solution from Tank 10H. The scope includes process development, process design, procurement of process SSCs, factory fabrication and assembly, pre-delivery acceptance testing, delivery to SRR; 2) provide a method of interim safe storage for ion exchange resins or cesium-rich eluate; 3) provide technical support to SRR for nuclear safety analysis, hazards analysis, installation, start-up testing, system acceptance, training of SRR operations personnel, and operating procedures development; and 4) materials and consumables (e.g., resin, vessels, safe storage containers) to process the cesium removed from Tank 10H.

3.1.1.2 The design life of the system shall be sufficient to process approximately 625,000 gallons of salt solution feed through the TCCR System in six (6) equal volume batches. Estimated downtime between batches can be assumed to be twenty (20) days, and the TCCR System shall be able to process each batch continuously.

3.1.2 TCCR System Features and Performance Requirements

3.1.2.1 Pre-filtration

A. Pre-filtration shall be provided to preclude particulates from fouling the ion exchange resin.

B. Backflush capability (see Section 3.1.3.8 for requirement) shall be provided to backflush the pre-filtration process to a nearby LW tank (e.g., Tank 10H; actual

tank to be determined by SRR after award) at a velocity equal to or greater than the feed velocity.

C. The pre-filtration shall be designed to be back-flushed and replaced with minimal expense and radiation dose to workers.

3.1.2.2 Feed

A. The design feed rate through the TCCR System shall be ≥ 5 gpm (average value).

NOTE: The installed transfer pump in Tank 10H can deliver a minimum of 30 gpm at a pressure of approximately 10-20 psig (datum elevation: 4 feet above grade).

1. The Supplier may request SRR for a different pump if the installed pump does not meet their needs.

B. The salt solution feed to the TCCR System shall have the following ranges of expected isotopic and chemical concentrations:

Isotope Constituent	Concentration (Ci/gallon)
Cs-137*	0.10 – 0.50
Sr-90	5.0 – 6.0E-02
Pu-241	3.0 – 3.2E-02
Pu-238	1.3 – 1.5E-03
Pu-239 / 240	2.3 – 2.4E-05
Am-241	2.4 – 2.6E-05
U-233	1.2 – 1.4E-05
Tc-99	7.0 – 7.2E-05
Np-237	6.8 – 6.9E-07
U-238	3.3 – 3.4E-08

Chemical Constituent	Concentration (moles per liter)
Na	4.0 – 6.0
Al (AlO^{2-})	0.2 – 0.4
K	0.02 – 0.05
OH	0.5 – 2.0
NO_3	1.0 – 3.0
NO_2	0.2 – 0.8
SO_4	0.2 – 0.5
CO_3	0.3 – 0.5

* Average Cs-137 concentration is 0.16 Ci per gallon

C. The salt solution feed to the TCCR System shall have the following properties:

Specific Gravity 1.1-1.3
Viscosity.....2-3 cP
Operating temperature range .... 20-50°C
pH ..... 12 to 14
Organics..... <10 mg per liter
Fluid behavior ..... Newtonian

EXCEPTION: For pump sizing, assume a specific gravity of 1.5 and viscosity of 3.1 cP

D. The particulate concentration is expected to be approximately 50-500 ppm with particles ranging from 5 microns to 177 microns. The mean particle size is expected to be 20 microns.

3.1.2.3 Cesium Removal Performance

A. The TCCR System shall have a minimum cesium-137 decontamination factor (DF) of 1000 cesium-137.

B. The TCCR System shall be able to determine when a column is no longer meeting the DF requirement.

C. The treated waste stream must have a pH greater than 12.

D. Columns shall be designed to minimize channeling.

3.1.2.4 Ion exchange resin

A. The Supplier shall provide enough materials and consumables (e.g., ion exchange resin) to process at least 100,000 Curies of cesium-137.

B. Spent ion exchange resin (or column filled with ion exchange resin) shall be removable from the treatment process and kept in ISS for up to 10 years, before disposition. Refer to Section 3.1.2.6 for ISS criteria.

1. Spent ion exchange resin shall also be removable (e.g., sluicing) from the ion exchange column for future disposal.

C. The TCCR System shall be designed to minimize resin and resin fines from entering <u>any</u> LW tank. Intentional transfer of resin into a SRR waste tank is not allowed. Unintentional carryover of resin particles shall be less than 80 microns (diameter - nominal).

D. Clarified resin flush water shall be to a nearby LW tank to be determined by SRR.

E. Submit the technical data and salient features that are used to purchase the following:

NOTE: SRR will use this information for future orders

1. Replacement ion exchange resin and processing consumables including physical description and chemical compositions.
2. Storage systems and equipment that will be sent to ISS.

F. Provide objective evidence, through testing or independent verification, and documented in a report, that the proposed column and resin design will meet the following:

1. The decontamination factor (paragraph 3.1.2.3.A).
2. Column capacity or determination of breakthrough (paragraph 3.1.2.3.B)
3. Resin compatibility with the feed stream delineated in paragraphs 3.1.2.2.B through D.
4. Optimal column efficiency.

3.1.2.5 Chemical and Volume Adjustments

A. The TCCR System shall be designed so that chemical adjustments to the feed (including dilution) are not necessary.

3.1.2.6 Interim Safe Storage

A. The equipment and methods used for systems shall have the following performance criteria:

1. The equipment and methods used for storing resin and/or eluate at ISS shall be capable of limiting releases to the environment for at least ten (10) years.
2. The equipment and methods used for storing resin and/or eluate at ISS is capable of storing the cesium removed by way of the process while maintaining an outside containment dose rate less than 5 mR/hour at 30 cm.
3. The waste form shall meet the following sub-criteria before being sent to ISS:
   a. Be encapsulated with a barrier.
   b. Be de-watered or in a non-liquid form. For example, resins shall be drained completely of any free liquid and eluate solutions shall be solidified.

c. Be characterized for disposal.

4. Gasses generated while at ISS shall either be absorbed by a getter or vented through a HEPA filter.

5. The equipment used at ISS shall be transportable using a flatbed trailer.

B. Submit to SRR the design of the equipment and the methods used to store the resin and/or eluate sent to ISS. This includes weights, dimensions, and point loads.

3.1.2.7 The TCCR System shall consider the multiple design and sizing parameters when selecting the ion exchange resin and equipment:

A. Equipment Design and Selection

1. Serviceability

2. Operability

B. Ion Exchange Resin

1. Resin loading

2. Frequency of replenishment

3. Cost

4. Amount of resin and/or eluate intended for disposal

5. Consideration for future repackaging, transportation and disposal.

C. Radiation Dose

1. ALARA

D. Nuclear Safety

1. Containment and confinement features

2. Overall source term and material at risk.

E. Process Operation

1. Operational complexity

2. Number of run cycles

F. Waste Minimization

1. Volume of additions to the TCCR System

3.1.2.8 The TCCR System shall be located in the TCCR system area defined in Attachment 5.4.

A. The TCCR System must fit and be serviceable with contact maintenance or remote operations within the available footprint. "Black Cells" are not allowed.

3.1.2.9 The TCCR System shall be controlled locally. Two sets of alarm contacts shall be provided for remote alarming capability: 1) process leak into secondary containment, and 2) system shutdown.

3.1.3 TCCR System Design Requirements

3.1.3.1 The TCCR System design shall comply with the requirements of 10 CFR 851, 29 CFR 1910, and DOE Order 420.1B.

3.1.3.2 The design shall prevent siphons, or include the means to stop a siphon for waste and non-waste liquids not through the use of valves (for example, use of an air gap or siphon break).

3.1.3.3 Materials

A. Coatings and their application shall follow SRR accepted procedures.

B. Elastomers utilized shall be compatible with the expected service conditions.

C. Materials (including gaskets, valve internals, hoses, etc.) shall be compatible with the service conditions defined in this SOW. Materials specified by the design of the TCCR system shall be capable of withstanding the total absorbed dose. If specific components are unable to withstand the total absorbed dose, provide for routine replacement. Identify such items in design documents.

1. The Supplier shall submit a list of materials that will have a limited life, their replacement frequency, and seek SRR approval for their use within the process.
2. The Supplier shall submit calculations determining the radiation dose for equipment being exposed to radiation service.

D. Process wetted parts including process vessels, piping, valves, etc. shall be constructed from erosion / corrosion-resistant materials and chemically compatible with or able to withstand the process solution, radiation exposure, or chemicals (or any combination of above) to which they are exposed.

E. Materials containing cobalt binder are not allowed.

F. Materials containing asbestos are not allowed.

G. Use of aluminum, brass, bronze, and copper-based materials in contact with the waste or waste vapor (including off-gas) is not allowed.

H. Use of Teflon™ and Viton®[1] is not allowed for radioactive service or in radiation areas.

I. Equipment and components that require lubrication fluids with the potential to enter a process vessel must be submitted for SRR to perform composite lower flammability limit calculations. Submit information on the fluid type, volume and location in the process.

1. If SRR finds the submittal unacceptable, the Supplier shall revise the equipment selection.

3.1.3.4 TCCR System layouts shall:

A. Include features for life safety, facility operation, maintenance, and monitoring in accordance with NFPA-101.

B. Provide access, access way covers, removable shielding, and securing mechanisms to components requiring maintenance or equipment expected to be replaced during operations and shall be based on maintenance practices using ALARA techniques such as extended length tools and quick disconnects, etc.

1. For supplier-supplied shielding, access covers to ports shall be stepped to prevent radiation streaming.
2. Provide lifting bail or other suitable means for covers weighing more than 35 lbs.
3. Access covers weighing less than 200 lbs. and protecting personnel from a high radiation area (>100 mrem per hour) shall be equipped with a device that allows the cover to be locked in place via a short shank pad lock.

C. The Supplier shall provide camera surveillance to support inspection of the TCCR System.

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[1] Teflon™ and Viton® are registered trademarks with E. I. du Pont de Nemours and Company, Wilmington, Delaware.

1. Camera port locations and number shall allow visual inspection of internal process areas and modules with special consideration provided to locations which have the potential to leak (e.g. flanges, valves, pumps, etc.), require periodic inspection and maintenance, require remote operation, or serve as leak containment.

D. Components that require routine maintenance shall be designed such that the component can be isolated, removed from service, replaced, and restored to service while maintaining ALARA practices.

E. Where feasible, equipment shall be instrumented such that loops and sensors can be maintained, calibrated, and replaced without requiring entry into a radiation area, reducing the radiation exposure to the worker ALARA.

3.1.3.5 Components requiring inspection, operator monitoring, calibration, and physical operation shall be installed in a location that allows those operations to be performed without exposure to safety hazards and shall meet ALARA requirements.

3.1.3.6 The TCCR System shall be designed to allow personnel access to the operational area after removal of batch inventory and appropriate system flushing using well water.

3.1.3.7 Assemblies that can come in contact with the waste shall be designed to minimize the collection or hold-up of solids and liquids, both externally and internally (e.g. provide drain back features, smooth surface finish and geometry, backing rings in vertical sections required for closure and tie-in joints, etc.).

3.1.3.8 System Flushing

A. Provide a 2-inch Class 150 raised face flange connection for receiving SRR-supplied well water for system flushing.

1. Provide a double check valve backflow preventer in accordance with South Carolina Regulation 61-58.

B. Provide a 1½-inch Class 150 raised face flange connection for discharging flush water to a nearby LW tank. This connection shall be able to receive and fit a 4-inch jacket.

1. Assume the LW tank used for flushing is 250 feet from TCCR System boundary at an elevation 25 feet above the grade.

C. Provide flushing, rinsing, and decontaminating capability (including exterior of process equipment within the TCCR System) to facilitate pre-filter backwash, column flushing, equipment maintenance, decommissioning, replacement and disposal at project completion.

1. Equipment, instrumentation, cable, raceway, and wiring located within processing areas shall be capable of withstanding external spray nozzle directed decontamination solutions.

2. SSCs that will be expected to be decontaminated shall be compatible with well water.

3. Flushing systems design shall minimize the possibility of cross connecting non-contiguous systems.

4. Flushing capability includes:

a. Able to flush waste systems at velocities sufficient to free sediments and debris. Mean velocity in piping shall be greater than 2 ft/sec.

b. Able to flush wetted surfaces (waste lines) in vessels, piping, and components with external flush connections.

5. Provide flushing capability to the feed and discharge transfer lines.

3.1.3.9 Drain and Vent Connections

A. Provide drain lines and connections at system low points, with manual and remote isolation to allow for system draining.

B. Provide vent lines and connections at system high points with manual and remote isolation to facilitate start-up and shut-down.

3.1.3.10 Components and Subsystems

The following codes and standards (referenced herein) are for use in the design and fabrication of the TCCR System. Codes and standards listed in the lower classifications are also requirements for the higher classifications. Where requirements in the lower classifications conflict with requirements in the higher classifications, the more restrictive requirement governs:

A. DELETED.

B. Seismic Qualifications: Applicable national codes and standards are listed in below:

1. ANS-2.26, API-650, ASCE-4, ASCE-7, ASCE-43, ASME-AG-1, ASME-B31.1, ASME-B31.3, ASME-BPVC, ASME-QME-1, ICC-IBC, ICC-ES-AC156, SMACNA-1520, SMACNA-1650, SMACNA-1922, and SMACNA-1966.

C. Secondary Containment Requirements

1. The Supplier shall provide secondary containment system(s) that are:

a. Designed, installed, and operated to prevent any migration of hazardous or radioactive constituents, hazardous substances, or accumulated liquid out of the system(s) to the soil, groundwater, or surface water at any time during the use of the TCCR system and maintenance (e.g., resin replacement, etc.).

b. Capable of detecting and collecting accidental releases and accumulated liquids until the collected material is removed.

2. The secondary containment system(s) shall meet the following minimum requirements:

a. Constructed of or lined with materials that are compatible with the hazardous or radioactive substance(s) to be placed in the TCCR system and shall have sufficient strength and thickness to prevent failure owing to pressure gradients (including static head and external hydrological forces), physical contact with the waste(s) or substances to which it is exposed, climatic conditions, maintenance activities, and the stress of daily operation (including stresses from nearby vehicular traffic).

b. Provided with a leak-detection system that is designed and operated so that it shall detect the failure of the primary containment structure.

c. The presence of any leak of hazardous or radioactive constituents, hazardous substances, or accumulated liquid in the secondary containment system shall be detected within 24 hours.

d. Sloped or otherwise designed or operated to drain and remove liquids resulting from leaks. Leaked substances shall be capable of being removed from the secondary containment system within 24 hours.

3. Secondary Containment Liner

a. Designed or operated to contain 100 percent of the capacity of the largest tank within its boundary.

b. Designed or operated to prevent run-off or infiltration of precipitation into the secondary containment system unless the collection system has sufficient excess capacity to contain run-off or infiltration. Such additional capacity shall be sufficient to contain precipitation from a 25-year, 24-hour rainfall event (Page 54 of Reference 2.3.3.1.A).

D. Process Equipment Vessels and Tanks

1. Pressure vessels in the scope of the ASME B&PV code must comply with the applicable ASME B&PV Code section, and be stamped accordingly.
   a. Lethal Service for radioactive material.
2. Fiber-reinforced Plastic Pressure Vessels (if used): ASME BPVC Section X.
3. Storage tanks for non-radioactive fluids shall conform to API-620.
4. Process tanks for flammable liquids shall conform to API-620, API-650, UL-142, NFPA-30, and NFPA-326.

E. Pressure Protection Devices

NOTE: The ASME Code dictates the necessity and implementation of overpressure protection. The pressure protection requirements of other codes and federal regulations (such as ASHRAE, CGA, and DOT) must also be considered in the selection of pressure relief devices.

1. Pressure equipment shall have pressure protection in accordance with ASME BPVC Section VIII, Division 1.

   EXCEPTIONS

   i. Small packaged refrigeration units that do not contain vessels within the scope of the ASME B&PV Code, may meet the pressure protection provisions of UL 1995 as an alternative to ASHRAE 15 and the ASME Code
   ii. Small vessels (≤ 5 ft^3) which release limited energy at failure (< 250,000 ft-lb or 321.26 BTU) need not be protected from fire. The energy calculation must consider phase change and ignition of a flammable fluid when applicable.
   iii. Piping systems need not be protected from fire unless the system is isolated more than 500 hours per year, the fluid is liquid, and the pipe is > 6 inches inside diameter.
2. Pressure relief devices with a set pressure at or above 15 psig must comply with the ASME B&PV

   EXCEPTIONS

   a. B31.3 compliant PRVs (but not "UV" stamped) protecting a B31.3 system provided the PRV capacity is de-rated (× 0.9) and B31.3 compliance is provided in the verification record.
   b. U.S. Department of Transportation compliant PRVs (but not "UV" stamped) on dewars (<120 gal) provided the PRV capacity is de-rated (× 0.9) and the set pressure tolerance ≤ 5%.
   c. PRVs not compliant to B31.3 used to protect a B31.3 piping systems with a failure flow < 1/25th of the manufacturer's capacity rating and the set pressure tolerance ≤ 5%.
3. Pressure relief devices shall be readily accessible to support maintenance and routine testing.

4. Thermal expansion and vaporization of trapped liquids caused by exposure to any heat source other than fire shall be considered in the design of piping systems. When fire exposure is possible, the installation of pressure relief devices is required for piping greater than 6" ID when liquid filled systems are isolated for more than 500 hours per year (e.g., batch operations).
5. Pressure liquid relief devices are to be directed into a suitable containment.
6. Pressure relief devices relieving radioactive gas or vapors shall be directed into a suitable ventilation system duct directly and upstream of any HEPA filter without discharging into the enclosed area.
7. Pressure relief device gags are not allowed. For outdoor PRVs, the designer shall consider the use of bug screens, packed levers, rain hats, no carbon steel internals, and stack/PRV body drains.
8. Selection of each pressure relief device utilized in the design shall be supported by design calculation(s) as required by the applicable national code/standard.

F. Pumps and Agitators

1. Chemical Process Pumps: ASME-B73.1, ASME-B73.1M, ASME-B73.2, ASME-B73.2M, ASME-B73.3, ASME-B73.3M, ASME-B73.5M, API-674, API-675.
2. Lubricated bearings shall be "lubed for life" (sealed bearings).
3. Pumps and agitators shall be designed to preclude, to the extent practical, those failure modes resulting in missiles capable of penetrating process vessels and compromising containment integrity.
4. Pumps may be controlled by a variable frequency drive.
5. Pumps shall be designed with minimal interferences to allow remote removal using a hoist.
6. Pumps shall have the ability to be self-draining and shall minimize waste entrapment.
7. Use of positive displacement pumps for the waste transfers must be approved for use by SRR.

G. Piping

1. Except for refrigeration piping, tubing and components shall be designed in accordance with ASME-B31.3.
2. Refrigeration Piping: ASME-B31.5.
3. The joints in the piping system shall be welded construction except where fit-up to equipment or instruments require alternative joint types.
4. Flange joints are allowed for fit up to piping components requiring removal for maintenance, such as valves. Weld neck raised face flanges are the preferred option.
5. Alternative joint types are allowed when fit-up to equipment and instruments require other joint types. Weld neck raised face flanges are the preferred option for fit up to equipment and instruments.
6. Where used in fit-up to piping components, equipment, and instruments, socket weld fittings, slip on flanges, threaded fittings, and compression fittings shall be restricted to sizes NPS 2 and smaller.

7. For pipes containing radioactive material, the joints both welded and mechanical shall receive 100% visual examination.
   a. Submit visual examination procedure for SRR acceptance.
   b. Perform visual examination per SRR accepted procedure.
   c. Submit visual examination report for SRR acceptance.
8. For pipes containing radioactive material, butt welded joints shall receive 100% volumetric examination.
   a. Submit volumetric examination procedure for SRR acceptance.
   b. Perform volumetric examination per SRR accepted procedure.
   c. Submit volumetric examination report for SRR acceptance.
9. Piping shall be supported or restrained to avoid vibration resulting from the flow of service medium.
   a. Transient loads under each mode of operation shall be considered in the design of the piping and supports.
10. Piping and equipment loads from acceleration from seismic events shall be evaluated using the seismic requirements in Section 3.1.3.17.
11. Piping specifications shall be developed and tabulated for specific materials and line sizes used by the project.
12. Liquid piping systems shall include physical design features to prevent damage from hydraulic transients in liquid and gas systems.
13. The provisions for corrosion and erosion control in ASME-B31.4 shall apply to piping and vessels with process flows.
14. Piping systems containing radioactive fluids cannot be classified as ASME-B31.3 Category D Fluid Service.
15. Unless otherwise specified, the piping shall be designed to comply with the parameters in Table 1.

TABLE 1

Fluid	ASME B31.3 Fluid Service	Design Pressure / Design Temperature (psig/°F)
Well Water	Normal	155/105
Plant Air	Normal	200/200
Instrument Air	D	110/120
Acid Service	Normal	See Note 1
Caustic Service	Normal	See Note 1
Waste Transfer (Core Pipe)	Normal (See Note 2)	260/167
Waste Transfer (Jacket Pipe)	Normal (See Note 2)	150/167

NOTE 1 For new and/or independent lines, or if specific criteria is not provided in the table, the design pressure and temperature shall be determined by the Supplier based on the most severe condition of coincident system pressure and temperature expected during service.

NOTE 2 For jacketed waste transfer lines, the core line requires 100% visual and 100% RT/UT examination using ASME-B31.3 Code Normal Fluid service weld inspection criteria. The jacket requires 100% visual examination and 5%

RT/UT. Severe cyclic criteria apply when the piping complies with the ASME B31.3 Code definition of severe cyclic.

16. Design calculations shall validate piping, tubing and component design(s) as required by the applicable code and standard.
17. Transfer line core pipes shall be constructed of Schedule 40 stainless steel and limited to ≤ 6″ nominal diameter.
18. ASME-B31.3 vent and drain piping cannot be excluded from design, materials, and fabrication requirements. Examination and leak testing can be omitted when the fluid is non-flammable, nontoxic, not damaging to human tissue, non-radioactive, has a design pressure between 0 and 15 psig, and has a design temperature between – 20°F and 366°F.
19. To limit the maximum release heights, waste transfer piping and vessel penetrations shall be less than 25 feet above grade.
20. Qualify unlisted components and materials in accordance with ASME-B31.3. Submit to SRR the qualification evaluation.
21. External TCCR Enclosure interface connections:
    a. Interface connections shall be accessible for connection and assembly.
    b. Transmit zero loads (force and torque) to the SRR piping and hoses.
    c. Provide piping end connections (e.g. flanges) for piping to and from the TCCR system.
    d. FOR RADIOACTIVE FLUIDS: Primary connections shall be placed inside of secondary containment.
    e. FOR RADIOACTIVE FLUIDS: Enclosure penetrations shall be at a higher elevation than the primary line connections so that any leakage is contained within secondary containment.
22. Internal and Interconnecting TCCR System Piping
    a. Hoses
        1) Flexible hoses are unlisted components. Metallic braided metal hoses require qualification in accordance with ASME-B31.3, paragraph 304.7.2 and non-metallic hoses require qualification in accordance with ASME-B31.3, paragraph A304.7.2.
        2) Non-metallic flexible hose shall be qualified for service in accordance with the requirements of ASME-B31.3 Chapter VII.
        3) The system design pressure and temperature shall not exceed the manufacturers published rating for the hose.
        4) Hoses, both core and jacket shall be designed for 150 psig minimum.
        5) When hoses are in non-radioactive systems, the hoses and fittings shall be radiation resistant (from external sources), explosion and fire resistant, non-combustible, abrasion resistant, and chemically compatible with the environmental and service conditions. Submit documentation to SRR demonstrating material compatibility including unlisted component evaluations in accordance with ASME-B31.3 for complete hose assembly. Hose assembly includes hose end and fittings.
        6) For personnel safety, hoses shall have hose whips installed at the connections and be restrained to prevent whipping should a hose rupture occur.

7) When used for unlisted component qualification, the burst pressure for metallic braided hoses shall be at least three times the design pressure of the piping system. The burst pressure shall be increased by the ratio of the allowable stress at the system design temperature to the allowable stress at the test temperature. The burst test shall include end connectors. External loads where applicable shall be considered in qualification of the hose.

8) Non-metallic hoses shall be supported such that no significant sustained or occasional external loads are imposed on the hose. When used for unlisted component qualification, the test pressure for the performance test as specified by ASME-B31.3, paragraph A304.7.2 (b) shall be two times the design pressure. The minimum duration of the test shall be 24 hours at a temperature that is within ± 5°F of the system design temperature. The design temperature shall consider contact surfaces. The performance test shall include end connectors. The hoses must show no signs of wear, degradation, or permanent deformation following the test.

   - Substantiation of extensive successful service experience under comparable design conditions with similarly proportioned components made of the same or like materials may be used in lieu of performance testing. Submit documentation of manufacturer's confirmation of service experience.

9) Hose materials shall conform to a published specification covering chemistry, physical and mechanical properties, method and process of manufacture, heat treatment, and quality control.

10) Flexible hoses must have the ability to be replaced on a routine basis to ensure that dynamic and creep effects do not detrimentally affect the service life. Submit a periodic replacement plan to SRR.

11) Design margins for non-metallic hoses between the B31.3 system design pressure and the burst pressure shall be as follows:

   - 3× Incompressible Category D fluid services less than 200°F (93.3°C).
   - 4× Compressible Category D fluid services less than 200°F (93.3°C) and incompressible Normal fluid services less than 200°F (93.3°C).
   - 5× Compressible Normal fluid services less than 200°F (93.3°C), incompressible High Pressure fluid services, and manually operated pneumatic power tools.

b. Process Utility Piping

1) Design piping to receive process utilities. See Attachment 5.7 for SRR process utilities supply, design conditions and ASME B31.3 fluid service.

2) Regulate each SRR process utility supply as required to support system function(s).

   - Any connection between waste process and clean chemical or utility systems within the Supplier's scope shall be designed to prevent back-flow. Back flow prevention shall maintain contamination within the waste process systems keeping the utility systems uncontaminated. Air gaps or other passive back-flow

preventive features are preferable over mechanical type isolation devices (check valves, etc.). Back-flow devices shall be testable to verify functionality.

H. Valves

1. Valves shall be compatible to the specific application requirements and comply with the requirements of ASME-B31.3.
2. Isolation valves shall be provided to isolate equipment and appurtenances for ease of maintenance.
3. Valve closing times will be dictated by considerations of water hammer and will be a part of the interface requirements for transfers into and out of the TCCR system.
4. Where practical, valves operated during normal operations shall be designed to be manually or remotely operated from outside the Shielded Confinement or Shielded Containment.
5. Valves used to control system flushing shall have valve actuators that allow manual or remote operation from outside the Shielded Confinement.
6. Manual or remotely actuated valves that are operated by "reach rod" assemblies comprised of solid bars and universal joints shall have adequate strength against torsional shear failure while operating and sufficient stiffness for ergonomic considerations. Angle of twist shall be calculated, documented and shown to be less than 1 degree.
7. Overhead manual valves with bolted-on chain wheel operators shall have a safety cable to prevent the chain-wheel operator from falling if it becomes loose.
8. Manual valves shall have local indication of valve position and direction of operation [i.e., clockwise (CW) to close and counter clockwise (CCW) to open] provided at the operating location.
9. Double isolation valves, providing "block and bleed" capability, shall be provided on utility services piping connecting to waste transfer piping to ensure positive isolation and to permit maintenance. Such valves shall have the same design requirements of the waste transfer core pipe at that location and be located to prevent the spread of contamination.
10. Ball valves are preferred.

I. Architectural

1. General Design: 29 CFR 1910, NFPA-1, NFPA-101, NFPA-220, and NFPA-221.

J. Fire Protection Systems

1. Fire Suppression: DOE Standard 1066.
2. Life Safety: NFPA-1, NFPA-70, NFPA-101, NFPA-102, NFPA-110, NFPA-111 and NFPA-170, (Guide NFPA-101A).
3. Portable Fire Extinguishers: 29 CFR 1910.157, NFPA-10, NFPA-30 and NFPA-51B.
4. Temporary Buildings and Structures: NFPA-102, DOE STD 1066, (Guide NFPA-80A).
5. Ventilation Systems: NFPA-90A, NFPA-90B, NFPA-91, NFPA-92, NFPA-204, NFPA-801, UL-586, UL-900, DOE-STD-1066 (Chapter 14).

6. Fire-Rated Construction: NFPA-80A, NFPA-90A, NFPA-101, NFPA-105, NFPA-220, and NFPA-221.
7. Structural Design: NFPA-220.
8. Cable Installations: NFPA-13 (for sprinkler protection), NFPA-70, NFPA-70E, NFPA-90A, NFPA-262, and NFPA-496, (Guides NFPA-497, and NFPA-499).
9. Electronic, Computer, and Data Processing Systems: NFPA-75 and NFPA-76.
10. Hazardous Materials: NFPA-30, NFPA-430, NFPA-704, and NFPA-801.

K. Heating, Ventilation, and Air Conditioning for Nuclear Air Treatment Systems

1. HVAC General

NOTE: Stored radioactive aqueous wastes release flammable vapors (hydrogen) into vapor spaces.

a. HVAC systems conform to ASME-AG-1 and ASME-N509.
b. System design and selection criteria for HVAC system(s) shall be in accordance with:
   1) DOE HDBK 1169
   2) ASHRAE Fundamentals Handbook
   3) ASHRAE Handbook - HVAC Applications
   4) ASHRAE Handbook - HVAC Systems and Equipment
   5) ASHRAE Refrigeration Handbook
   6) ACGIH-2096, Handbook of Industrial Ventilation
c. Air handling units shall meet the requirements of AHRI-430, AHRI-300, and AHRI-410.
d. HVAC equipment and systems shall be designed to accommodate testing, adjustment and balancing within the guidelines contained in:
   1) ASHRAE Handbook – HVAC Applications.
   2) AABC National Standards for Total System Balance
e. HVAC dampers and louvers for air flow control shall meet the design, fabrication, materials, performance, and acceptance testing requirements of SMACNA-1996 standards and guidelines.
f. The TCCR System shall be designed to ensure hydrogen concentrations are maintained below the lower flammability limit by process controls and forced ventilation.

2. Confinement Ventilation Design Requirements

a. General
   1) Walls, floors, ceilings and penetrations (piping, ductwork, electrical trays, conduit, etc.) of confinement barriers require adequate seals to prevent migration of contamination out of the confinement zone and to maintain differential pressure requirements between the confinement zones.
   2) Secondary confinement ventilation shall be designed such that supplemental ventilation (e.g., Coppus® Portable Ventilator[2]) can be

[2] Coppus® Portable Ventilator is a registered trademark of the Dresser-Rand Group, West 8 Tower, Suite 1000, 10205 Westheimer Road, Houston, Texas 77042.

connected to perform the ventilation requirements. This connection shall be accessible during upset conditions.

3) Airlocks between the outside and the secondary confinement are required for personnel access ways.
4) Exhaust ventilation system shall be sized to ensure adequate inflow of air direction and velocity in the event of the largest credible breach of confinement.
5) Minimum differential pressure shall be at least -1.0 inch WG between primary and secondary confinement zones.
   a) Primary Confinement air flow shall be adequate for the maximum credible accident and heat load and/or dilution requirements of operations conducted in the zone.
   b) The maximum permissible leak rate shall not exceed 1 percent of space volume per minute at a differential pressure of 2 inches WG.
   c) Seals and doors shall withstand (i.e., no permanent distortion or breach in integrity) a differential pressure of at least 10 inches WG.
6) The TCCR Primary Confinement System shall be capable of removing flammable vapors to prevent a deflagration or detonation.
7) Secondary differential pressure shall be maintained at -0.1 to -0.30 inch WG relative to atmosphere.
8) Liquid shall not enter any gas treatment system, and a means of condensate or excess accumulated liquid removal shall be employed for air systems.
9) Condensate collection systems and drains shall be designed to ensure confinement integrity is maintained.
10) Exhaust air re-heaters (if required) shall be designed in accordance with:
    a) ASME-AG-1
    b) UL-1996
    c) NFPA-70
11) Provide 99% efficient demister, for liquid droplet sizes of 5 microns or greater, installed as close as possible to the liquid vessel for venting. Liquid from the moisture separator, including the demister flushing liquid, shall be directed back into the vessel of origin.
12) Liquid vessels and other vessels with a flammable vapor generation potential shall be maintained as primary confinement using vapor space sweeping in accordance with NFPA-69.
13) Confinement ventilation shall be designed with the ability to be periodically balanced.
14) Dampers for confinement isolation shall meet the requirements of ASME-N509, and NFPA-801.

3. Airflow Direction
   a. Airflow shall be maintained to ensure that contamination migration will be from zones of lower hazard toward zones of higher hazard.

b. The airflow direction will be maintained by providing a differential pressure between the zones.

c. Airflow shall be sufficient to provide the necessary degree of contaminant dilution, cooling, and heating.

d. Pressure differentials between zones shall be maintained to prevent backflow of air to spaces of lower contamination, even under process upset conditions.

4. Recirculation

a. Recirculation within a zone or from a zone of higher contamination back to a zone of lesser contamination is prohibited.

5. Low Differential Alarm

a. Where an airflow reversal could occur, local, visual, and audible alarms shall be provided that will alarm if a low differential pressure exist between confinement zones.

6. Supply Air

a. The method for supplying air to processes with confinement ventilation shall be 100% outside air with a once-through ventilation system. Any supply air for the primary ventilation system shall be provided by the secondary confinement space.

b. Supply air shall be from a vertical wall region close to the ceiling through a laminar flow air system to minimize air velocity into the zone and to provide downdraft ventilation to reduce the potential inhalation of contamination.

c. To prevent dust accumulation, thus reducing the load on other filters in the facility, pre-filters shall be used in any new supply air unit(s) upstream of cooling and/or heating coils. Pre-filters shall have a Minimum Efficiency Reporting Value 8 (MERV 8) or greater (per ASHRAE-52.2).

d. When part of the supply air to an occupied zone is from air cascaded into the zone, airflow from the supply system shall be sufficient to provide the necessary degree of contaminant dilution and cooling.

e. A loss of negative pressure or airflow in the confinement ventilation exhaust system shall shut off the supply air to the affected zone.

f. When any one fan is inoperative, in a multi-fan system, a backflow damper shall automatically operate to isolate the idle fan from the system.

g. Supply air distribution shall be designed to prevent any stagnant air conditions in the confinement zone.

h. During upset conditions, where the supply air is shut off or greatly reduced, the design shall consider the consequence of the supply duct acting as a transfer duct and allowing contaminated air to be pulled into a clean zone through the supply duct. This condition is not acceptable and provisions shall be made in the design to eliminate it.

i. Testable HEPA filters at the supply air inlets (including air cascaded from the secondary confinement zone) are required for backflow protection.

7. Exhaust Air

a. Corrosive materials or moisture in the exhaust capable of damaging, degrading, or unduly loading the HEPA filters (or other equipment) shall

be removed or neutralized before they can reach components that can be affected.

b. An automatic balancing device shall be used to adjust airflow as the HEPA filter becomes loaded with manual adjustment capability.

c. Exhaust ductwork that has the potential to convey hazardous material shall be designed to be under negative pressure with respect to zones that it passes through.

d. HEPA filters are required in exhaust systems.

e. The exhaust ductwork prior to HEPA filtration is considered to be of the same confinement classification as the zone it exhausts.

f. Vessel vent ventilation systems shall have adequate capacity and appropriate controls to maintain (50 minimum) fpm-face velocity inward airflow through the maximum credible breach and thereby prevent the escape of particulate.

g. Exhaust from a primary confinement zone shall be through pre-filters and two testable stages of HEPA filtration. The transport velocity shall be sufficient to prevent solids build-up or accumulation in the duct and to convey any particulate contamination to the filter unit while minimizing settling and in accordance with ACGIH-2096.

h. Exhaust from a secondary confinement zone shall be through pre-filters and one testable stage of HEPA filtration as close to the source as practical. The transport velocity shall be sufficient to prevent solids build-up or accumulation in the duct and to convey any particulate contamination to the filter unit while minimizing settling and in accordance with ACGIH-2096.

i. Exhaust air shall not tie into any other lesser confinement exhaust systems until it has passed through HEPA filtration.

j. The preliminary height of the exhaust stack shall be 35 feet. The final height shall be determined by SRR from dispersion modeling results to ensure the maximum exposure limit for components listed in 29 CFR 1910 Subpart Z is not exceeded, and is consistent with South Carolina Regulation 61-62.7, "Good Engineering Practice Stack Height."

k. Air sampling capability shall be provided for exhaust stacks to comply with the requirements of South Carolina Regulation 61-62 with guidance from HPS-N13.1

   1) Provide a 2-inch diameter pipe coupling and full port ball isolation valve on the exhaust ductwork at the same location as the exhaust gas instrumentation. The location of the sampling port fitting shall be inside a "clean area" and accessible by sampling personnel without requiring a ladder.

8. Air Changes Per Hour

   a. A minimum of 2 air changes per hour during normal operation (4 per hour for maintenance) are required for a secondary confinement ventilation zone.

   b. Air changes per hour may be higher in primary and secondary zones than the minimum specified above if needed to satisfy any of the following requirements:

1) Maintain airflow direction from zones of lower potential contamination to zones of higher potential contamination under normal, maintenance and upset conditions.
2) Maintain face velocities through any enclosure opening under normal operating conditions.
3) For maintenance and upset conditions, supply and exhaust air shall be provided for in the design on an as needed basis. Air changes per hour requirements are not applicable in these cases.
4) Maintain differential pressures between confinement zones.
5) Maintain airflow to control the concentration of hazardous material in the air through proper mixing and dilution to levels ALARA for radioactive materials and to below the threshold limit values (TLVs) for toxic and noxious materials.
6) Maintain airflow needed to dissipate heat and moisture for equipment that must operate within a specified temperature and humidity range and for worker comfort during maintenance conditions.

9. Maintenance Flow
   a. When the ventilation system is required to provide confinement during maintenance, additional supply and exhaust airflow (maintenance airflow) shall be provided to an enclosure when panels are removed. The ventilation system shall be designed to provide this capability in order to maintain the required airflow [equivalent 100-150 feet per minute face velocity] through the open maintenance panel(s). The use of a single fan is not required.

10. HEPA Filter Systems
    a. HEPA filter housings shall comply with the requirements of:
       1) ASME-AG-1 (Section HA)
       2) ASME-N509
       3) ASME-N511 (in-service testing)
    b. HEPA filter stages in single or multi-stage installations shall be individually leak testable.
    c. HEPA filter installations shall provide adequate working space for personnel to perform filter change out and leak test.
    d. Exhaust HEPA filter installations shall provide pre-filters for dust protection. Pre-filters shall have a MERV 13 rating or greater (per ASHRAE-52.2).
    e. Bypassing HEPA filters is prohibited.
    f. If the HEPA filter load-up results in radionuclide accumulation, the design shall consider shielding or isolation of the filters to minimize personnel dose.
    g. Housings shall be designed and fabricated such that replacement of filters will use the "bag-in/bag-out" method.
    h. Gas entering the HEPA housing shall be less than 212°F (100°C).

i. HEPA filter housings shall accommodate Flanders®[3] models Fluid Seal, Type B (Nuclear Grade) HEPA elements (size defined by Table 2). Filter-to-housing seal shall be affected by means of a "knife-edge" frame in the housing that engages with a continuous perimeter channel on the face of a filter element that has been filled with a viscous, nondrying fluid.

TABLE 2

Dimensions, Nominal Airflow Ratings, and Maximum Resistance For Rectangular (Type B) HEPA Filters			
Size	Dimensions (inches)	Nominal Airflow (cfm)	Maximum Resistance (a) (inches WG)
1	8×8×3-1/16	25	1.3
2	8×8×5-7/8	50	1.3
3	2×12×5-7/8	125	1.3
5	24×24×11-1/2	1000	1.0
6	24×24×11-1/2	1250	1.0
7	24×24×11-1/2	1500	1.3
8	24×24×11-1/2	2000	1.3
9	12×12×11-1/2	250	1.0

Table 2 Notes: (a) Airflow Resistance: A resistance greater than 1 inch water gage (WG) across the filter pack is not permitted for new rectangular, open HEPA filters, Sizes 4 thru 6 and 9, and cylindrical HEPA filters regardless of filter pack construction. However, sizes 1-3, 7 and 8, and special filters designed for specific facility operation and small cylindrical HEPA filters with a normal rated flow below 35 cfm may have a resistance of 1.3 inch WG.

j. Provide design of housings based upon normal rated capacity of the filter as established per ASME-AG-1.

k. Provide design to accommodate separator-less type filters unless otherwise noted.

l. Use of enclosed (encapsulated, nipple-connected, closed-faced, self-contained) HEPA filters is not acceptable.

m. Each HEPA filter shall be in-place tested with the aerosol baseline established between the pre-filter (when present) and the HEPA filter.

n. HEPA filter enclosures shall be designed to allow personnel access to perform surveys and monitor filter loading from the exterior of the filter enclosure.

o. HEPA filters shall be located outside secondary containment.

11. Ductwork

a. General

1) Ductwork for confinement ventilation systems shall comply with duct levels specified in DOE Handbook 1169, except as noted below.

[3] Flanders® is a registered trademark of the Flanders Corporation, 531 Flanders Filters Road Washington, NC 27889.

a) Materials of construction for ductwork shall not be degraded by external or internal exposure to corrosive atmospheres, and shall conform to SMACNA-1966.

b) For sealing, only duct sealer or approved gaskets per the DOE Handbook 1169 are allowed.

c) Duct tape is not allowed.

2) Primary Confinement Ventilation (Process Ventilation if Needed)

a) Isolation (physical separation) from neighboring facilities, laboratories, shop areas, and operating areas is required.

b) Exhaust ductwork shall be a minimum of Level 4. Supply and transfer ductwork shall be a minimum of Level 3.

c) Supply and exhaust ductwork routed through a primary confinement zone not servicing that zone is prohibited.

d) Unavoidable breaches in the primary confinement barrier shall be compensated for by an adequate inflow of air.

3) Secondary Confinement Zone

a) The building (structure) shall be designed to prevent the dispersal of airborne contamination to the environment in the event of an accident.

b) Exhaust ducts shall be a minimum of Level 3. Supply and transfer ducts shall be a minimum of Level 2.

c) Where the differential pressure requirement is not possible (or practical), then the following constraints apply:

- Provisions shall be made to permit the construction of temporary containment huts with double stage access.
- Positive air flow must be confirmed from the atmosphere to secondary confinement through the temporary double-staged access structure described above.

4) Confinement ventilation system designs shall include sufficient test ports to accomplish the required system testing. Duct air flow test port quantities and locations per AABC National Standards for Total System Balance shall be used to determine the number of and locations for required test ports.

5) Provide HEPA test ports in accordance with DOE Handbook 1169, Chapter 8, "Testing."

12. Confinement Ventilation System Design Requirements

a. The filter housings shall be adequately reinforced to withstand the system structural capability pressure as defined in ASME AG-1 (or ASME N509).

13. Fan Design

a. Fan design shall be in accordance with the provisions of ASME-AG-1.

b. Drive arrangement for centrifugal fan shall be Arrangement 8SWSI in accordance with AMCA-201. Belt drives are not acceptable.

c. Fans shall be variable speed.

d. The maximum allowable rotational speed of the fan shall be limited to 1800 RPM.

e. Equipment shall be designed to permit rapid and economical maintenance. Major parts such as machined fan components and bearing housings shall be designed (shouldered or cylindrically doweled) and manufactured to ensure accurate alignment (per Supplier's manual) upon re-assembly after maintenance.

f. Basic design shall be in accordance with API-673.

g. Bearing pedestal mounting plates for the fan bearings and motor shall have a minimum thickness of ½ inch plate and a minimum of ¼ inch for side plates for up to 25 HP and ¾ inch mounting plate with ½ inch side plate on pedestal for above 25 HP.

h. Fan pedestal mounting surfaces shall be in the same plane within 0.002 inch/foot. Alignment jackscrews are required for the motor. Mounting feet of the bearing pedestal and fan housing shall be in the same plane within 0.002 inch/foot.

i. Fan Housing

   1) Accessible drain connections with valve shall be provided at the low point of the fan housing.

j. Shaft and Shaft Seals

   1) Shafts shall be cold rolled steel, turned, ground, and polished to 32 micro-inches per API-673.

   2) Seals shall be provided to comply with leakage criteria specified in ASME AG-1, Article BA-4142.2.

k. Bearings and Bearing Housings

   1) Antifriction bearings shall be split pillow block spherical roller bearings.

   2) Selection of the bearing shall be such that the temperature rise at the bearing under loaded conditions does not exceed 60°F (15.5°C).

   3) Lubrication: use either Exxon Polyrex EM (preferred) or Chevron SRI (acceptable). Grease lubricated bearing speed shall not exceed the bearing manufacturer's published maximum allowable speed for grease lubrication.

      NOTE: Moly-based EP additive is recommended over sulfur-based for light load bearing conditions

   4) Accessories

      a) Drivers: If operated by VFD motors, need to be in accordance with NEMA-MG-1 Part 31. Motors shall have a minimum service factor of 1.0. Motor bearings shall have a minimum L10 life of 100,000 hrs.

         - For driver sizing, at an extra 20% HP at all operating points for pumps including those using a VFD with voltage-to-frequency turndown setup.

      b) Couplings and Guards: couplings shall be non-lubricated dry disc type with a restrained center element (Examples: Rexnord®[4]

[4] Rexnord® and Thomas® Series are registered trademarks with Rexnord Corporation, LLC 247 Freshwater Way, Suite 200 Milwaukee, WI 53204.

Thomas® Series 71 or Metastream®[5] T Series). The guard should be fabricated in such a manner that it will allow access for temperature and vibration monitoring and meet the minimum requirements of 29 CFR PT 1910, Standard 1910.217, Subpart O, Table 10. The guard must provide protection from inadvertent contact with the operation of the mechanical components.

l. The equipment covered by these requirements shall be designed and constructed for a minimum 2 years of uninterrupted service between maintenance.

m. Dynamics

1) First bending critical speed must be at least 20% above the fan's maximum allowable continuous running speed.

2) A torsional analysis may be required where a variable frequency drive (VFD) is supplied. If a torsional analysis is required, the un-damped torsional natural frequency of the complete train must be at least 10% above or below any possible excitation frequencies within the specified operating speed range.

3) Operating speed must be at least 20% below rotor element first lateral critical speed, including vanes, impeller, shaft, bearings or shaft coupling. A rotor lateral modal analysis shall be submitted to the purchaser as a part of the Supplier's supplied data supporting compliance with this requirement.

4) The entire fan and support structure shall be free of resonant frequencies within the operating and speed range.

n. Fan wheels shall be statically and dynamically balanced.

L. Electrical

1. Electrical design and installation shall conform to NFPA-70, and NFPA-70E.

2. Electrical materials and equipment shall be tested and listed by Underwriters Laboratories (UL) or approved by Factory Mutual Engineering and Research (FM) or a similarly recognized nationally testing laboratory.

3. Supplier Electrical Requirements

NOTE: Maximum supply voltage to the TCCR System is 480 VAC (3 phase).

a. Identify power load requirements using a single line diagram.

b. Identify termination provisions using a single line diagram. Include interface point(s) for SRR-provided 480 V power cables outside of the TCCR System.

4. Harmonic suppression or mitigation shall be employed for non-linear (VFD's, heater controllers, etc.).

5. Overcurrent protection of the TCCR System power supply system shall comply with NFPA-70, IEEE-242 and IEEE-1015.

6. Wiring and/or terminals shall be labeled to facilitate ease of installation for SRR interface.

[5] Metastream® T Series is a registered trademark of the John Crane Company, 227 West Monroe Street, Suite 1800, Chicago, Illinois 60606.

7. Equipment, cable, raceway and wiring shall be capable of performing the intended function when exposed to environmental a condition (radiation, temperature, etc.) in which it is installed.
8. Label wiring at both ends of each cable with "to-from" information.
9. Grounding and Lightning Protection
   a. General equipment shall be grounded per NFPA-70, IEEE-80, IEEE-142, and IEEE-C2.
   b. Lightning protection shall be in accordance with NFPA-70 and NFPA-780.
   c. Grounding for computer/control and data processing equipment shall comply with the requirements of NFPA-70 and IEEE-1100, NFPA-75 and IEEE-1050.
   d. Cables between variable frequency drives (VFD) and motors shall comply with the recommendations of VFD Manufacturer.
10. Electric Motors
   a. Electric motors shall comply with the applicable requirements of NEMA-MG-1 and IEEE-841.
   b. AC motor protection shall comply with NFPA-70 and IEEE-242.
   c. Electrical motors subject to radiation exposure shall be manufactured utilizing class H insulation (minimum).
   d. Electrical motors being operated by a VFD shall be inverter duty rated, meet NEMA-MG-1 part 31, and NFPA-70 (specifically, Sections 430.126).
11. Station Batteries and Battery Rooms
   a. Station batteries and battery rooms shall comply with NFPA-70E, Article 320 (safety requirements related to batteries and battery rooms).
12. New variable frequency drives (VFD) shall be Allen Bradley PowerFlex (or equal). The variable frequency drive (VFD) shall provide the following:
   a. Appropriate communication hardware to communicate with the control system programmable logic controller (PLC).
   b. Fused disconnect switch on the incoming feed, sized not less than 115% of the VFD rated input current.
   c. Transfer pumps and ventilation fans may be powered using a VFD.
   d. A remote/off/local switch and a Normal/Maintenance hand switch.
   e. Input line reactors, 480 VAC input sized in accordance with VFD KW rating.
   f. Disconnect switch on the load side. Disconnect handle shall be operable from exterior of equipment.
13. Provide 120VAC convenience outlets per NFPA-70 for each processing area for use with test equipment, inside and outside of area.

M. Process Controls
1. Remote Failsafe Alarms
   a. Provide a set of dry contacts (rating: 5A @ 115V) denoting a presence of a leak into secondary containment.
   b. Provide a set of dry contacts (rating: 5A @ 115V) for a general system alarm that represents a shutdown of the TCCR System.

2. Provide interlocks to prevent overflows of the TCCR Systems vessels, columns, and secondary containment. At a minimum, provide the following:
   a. Tk-10H material feed to the TCCR System interlock on secondary containment leak detection device(s).
   b. TCCR System processing pumps interlock on secondary containment leak detection device(s).
3. The Supplier shall determine and supply any additional system interlocks to prevent equipment damage.
4. Provide local controls and monitoring (e.g., temperature, flow rate, etc.), interlocks, and alarms for safe operation.
   a. Local control panels shall be located in a clean, low radiation area.
5. Provide capability to stop equipment operation and place in safe condition during an upset condition(s).
6. The TCCR System shall shutdown to a safe state in the event of loss of electrical power.
7. Primary and Secondary Ventilation Systems Controls
   a. Instrumentation monitoring and indication signals shall be wired for local display.
   b. Fans
      1) Instrumentation
         a) Local indicators, as applicable, shall be provided to identify the operational status (Off / On / Standby, etc.) of ventilation system fans.
         b) Instrumentation shall be provided to monitor the following fan data: Exhaust Fan Inlet Static Pressure (referenced to atmosphere), Supply Fan Outlet Static Pressure (referenced to atmosphere), Fan Airflow (If only one exhaust fan system is connected to the exhaust stack, the stack exhaust airflow instrument will provide the total exhaust system airflow and an airflow instrument near the exhaust fans is not required), Variable Inlet Vane or Volume Damper Percent Open (graduated scale mounted on damper adjustment lever or positioner), and Fan RPM (Variable Speed Drives only).
      2) Alarms

         NOTE: Local only.

         a) Low Differential Alarm -where an airflow reversal could occur, local, visual, and audible alarms shall be provided that will alarm due to low differential pressure between confinement zones.
      3) Controls
         a) Exhaust ventilation systems shall be constant volume systems that account for filter loading. An automatic control system shall be provided to maintain the design airflow regardless of the particulate load on the filters.
         b) Provide local and remote fan on/off/remote switch.

4) Interlocks
   a) Interlocks shall be provided which will activate in response to the following operational conditions:
      - Supply fans shall shut down when an unacceptable decrease in primary confinement zones exhaust system airflow/system pressure occurs, such as shutdown of exhaust fan due to power loss, electrical overload, mechanical failure, etc.
      - Exhaust dampers shall be designed to fail open on loss of signal to the dampers.
   b) A loss of negative pressure or airflow in the confinement ventilation exhaust system shall shut off the supply air to the affected zone.

c. HEPA Filters
   1) Instrumentation
      a) Differential pressure across each filter, if single filter is used, and across each individual bank of filters in a filter housing with indication locally.
      b) Where multiple stages of HEPA filters are installed, differential pressure reading is required at each stage.
      c) Static pressure (referenced to atmosphere) in duct, upstream of the filter housing for the facility's main supply (not required if air enters supply filter housing inlet directly from outside at atmospheric pressure) and exhaust systems.
      d) Process off-gas and enclosure inlet temperature.
   2) Alarms
      a) Out-of-range filter differential pressure.
      b) Process off-gas and enclosure high exhaust system filter inlet air temperature with indication locally.
   3) Interlocks
      a) Submit a list of recommended interlocks to protect equipment and to limit radioactive releases.

d. Pre-filters and Roughing Filters
   1) Instrumentation
      a) Differential pressure across the filter.
      b) Static pressure (referenced to atmosphere) in duct, upstream of filters in the facility's main exhaust discharge system.

e. Individual TCCR System Modules
   1) Instrumentation
      a) Differential pressure between confinement zones.
   2) Alarms
      a) Out-of-range differential pressure between confinement zones.

f. Exhaust Stack (if used)
   1) Instrumentation
      a) Exhaust stack airflow.

b) Static pressure (referenced to atmosphere) in exhaust stack at the location of the exhaust.

N. Microprocessors and Programmable Logic Controllers (PLC)

NOTE: Microprocessors, PLCs, and associated software shall not perform a safety-related function.

1. The Supplier shall submit documentation for software controlling the process.
2. If a micro-processor based control system is provided, the micro-processor operating system and components furnished must be selected and configured to preclude any non-commanded or unwanted operations.

O. Instrumentation

1. Instrumentation and controls systems design shall conform to ISA-84.00.01 (Safety Significant systems only).
2. Setpoints and scaling shall be in accordance with ISA-67.04.01.
3. Controls systems for environmental monitoring shall be in accordance with HPS-N13.1, ANSI-N42.18, and NFPA-70.
4. The Supplier shall provide TCCR System sensors, associated cabling, associated transmitters, and I/O interface modules.
5. Components with controllers shall have their process variables tuned to provide stability during normal and abnormal conditions.
6. Indicating transmitters shall be preferred over non-indicating transmitters, if available.
7. Field temperature displays shall be standardized to indicate degrees Celsius.
8. The process control system shall be designed "fail-safe" to bring the process to a safe state. This requirement applies to discrete and analog controls.
9. Instrumentation shall be suitable for the environmental conditions
10. Instrument accuracy shall be +/- 2% or better, unless justified by availability or application.
11. Instrument symbology shall be per ISA-5.1, unless specified otherwise.
12. Confinement ventilation system instrumentation and controls shall meet the design, manufacture, installation, testing, and documentation requirements of ASME AG-1, Section IA.
13. Label wiring at both ends with "to-from" information.
14. Non-fiber optic signal cables shall not be run in close proximity to power cables or other cables that could induce voltages into the signal cables, if applicable.
15. Instrumentation shall be designed to provide easy accessibility for maintenance, calibration, periodic on-line surveillance, testing, and trouble shooting. Modular construction is recommended to permit quick replacement of failed components.
16. Instruments shall be located in areas where exposure to radiation or contamination is ALARA.

3.1.3.11 Process Utilities

A. Process utilities such as electrical power and well water are available at the H-Area Tank Farm and are denoted in Attachment 5.7.

B. The Supplier shall submit utility requirements to SRR at the earliest stage in the design to allow for an evaluation of each utility to determine if sufficient capacity is available.

1. Electrical Power: the Supplier shall specify the electrical power needs (if any) including voltage, phase, minimum circuit amps, maximum over-current protection, and overall kW.
2. Water: the Supplier shall specify the water requirements (if any) including flowrate, pressure, temperature.

3.1.3.12 TCCR System Interface Connections

A. The transmitted support loads to the SRR process connections shall be zero.

B. Provide a single interface connection for each SRR process utility, unless otherwise noted.

C. Feed Line and Return Lines: the process feed and return lines shall be provided to the TCCR System in jacketed flexible hoses (with built-in leak detection).

1. The end connections for the primary line shall be a Class 150 raised-face flange per ASME-16.5, size 1½ inches.
2. The design shall provide for fittings to receive a 4-inch diameter jacket (Class 150 raised-face flange).
   a. Final end connection design and setup for the jacket shall be designed in cooperation with SRR.
3. The connection height shall be 4 feet above grade or higher to accommodate sloping away from the TCCR System equipment to the feed and receipt tanks.
4. Provisions shall be made to ensure secondary containment and leak detection around each flange connection.

D. If needed to support pre-filtration and column operations, a recycle line may be used to return to Tank 10H.

1. The connections shall be Class 150 raised-face flange per ASME-16.5.
2. Submit to SRR the size of the core line (not to exceed 1½ inches diameter).
3. The design shall provide for fittings to receive a 4-inch diameter jacket for the recycle line (Class 150 raised-face flange).
   a. Final end connection design and setup for the jacket shall be designed in cooperation with SRR.
4. The connection height shall be 4 feet above grade or higher to accommodate sloping away from the TCCR System equipment to Tank 10H.
5. Provisions shall be made to ensure secondary containment and leak detection around each flange connection.

E. For flushing connections, see Section 3.1.3.8

3.1.3.13 Radiological Design Requirements

A. Submit a shielding, containment, confinement, and ventilation plan for SRR approval.

B. Lead shielding intended for SRS disposal shall be encapsulated in stainless steel.

C. The TCCR System shall be designed to the appropriate codes and standards as specified to ensure that, under normal operating conditions, no worker will

receive a deliberate intake of radionuclides (i.e., committed effective dose (CED) = 0 rem).

D. Personnel exposure levels from external sources of radiation in areas of continuous rad worker occupancy (2000 hours per year) shall be maintained below an average of 0.25 mrem/hr and ALARA.

E. Exposure rates for potential exposure to a radiological worker where occupancy differs from the above shall be ALARA and shall not exceed the external limits in the table below.

Type of Exposure	Limit (rem)
Whole Body Total Effective Dose	1
[DELETED]	
Lens of Eye	3
Extremity	10
Any Organ (other than eye) or Tissue	10

F. The radiological design criteria of shielded structures and penetrations for operation and maintenance are as follows. (These exposure rate limits apply to the contribution from the Supplier-designed TCCR SSCs).

1. Continuously Occupied Areas:
   a. Exposure Rate ≤ 0.25 mrem/hr @ 30cm (gamma)
2. Intermittently Occupied Areas:
   a. Exposure Rate ≤ 5 mrem/hr @ 30cm (gamma)

G. The system shall be designed so that personnel doses are less than 1 rem per year per person and ALARA for normal operations and maintenance.

H. The design objective shall be, under normal conditions, to avoid internal radiation exposures:

1. Engineered features (i.e. confinement and ventilation) shall be used to prevent the release of airborne radioactive material to the work area, and when that is not possible, to control releases to levels that are ALARA. The design or modification of a facility and the selection of materials shall include features that facilitate operations, maintenance, decontamination, and decommissioning.
2. The design shall not take credit for the use of respiratory protection.

I. Selection of shield materials shall minimize use of hazardous materials (e.g. lead) or such material shall be encased to preclude the generation of a mixed waste. When lead is used, it shall receive a coating to prevent oxidation and the resulting lead handling risk such materials would pose.

J. Straight-line penetrations of shield walls shall be avoided to the extent necessary to prevent radiation streaming.

K. Consider specialized tools and remote handling equipment, such as remote manipulators, where elevated exposures are anticipated.

L. The design shall include features that facilitate operations, maintenance, decontamination, and decommissioning.

1. For routinely operated valves located in inaccessible areas, consider remote or extended handle operators.

a. Remote (manual or automatic) valves shall have their valve position indicator visible by camera inspection. For extended handle valves, position marking "Open" and "Closed" in a permanent manner outside of any shielding will suffice.

1) The position marking will be used for normal operations. The capability of camera inspection shall enable confirmation of valve position in the case of operational issues.

M. The equipment design shall incorporate measures to simplify decontamination of areas that may become contaminated with radioactive materials.

1. Items such as service piping, conduits, and ductwork shall be kept to a minimum in potentially contaminated areas.
2. Equipment shall be arranged to facilitate decontamination.
3. The module design shall incorporate features that will facilitate decontamination to achieve facility decommissioning.

N. The modules shall be provided with a confinement system to prevent the migration of airborne radioactive materials from confinement enclosures, containment vessels, process equipment, and their associated ventilation systems to occupied and unoccupied work areas.

O. Design shall minimize the potential for spilled radioactive liquid to migrate into cracks or crevices.

P. There shall be no interconnection among storm water systems, the sanitary waste systems, and the radioactive or other hazardous material handling systems or areas.

Q. The design shall possess features preventing and controlling the possibility of accidentally releasing radioactive material to the environment.

R. Selection of shield materials shall minimize use of hazardous materials (e.g., lead) or shall include the encasing of such materials to preclude the generation of a mixed waste. For any lead that is used, a coating shall be applied to prevent oxidation.

S. The TCCR System design shall prevent the migration of radioactive material into process utilities.

3.1.3.14 Safety Related Requirements

A. The highest possible functional classification is Safety Class (SC). The Supplier, together with SRR, will perform a nuclear safety analysis and hazards analysis to identify the SSCs important to safety. The requirements presented here are intended to encompass the design requirements for anticipated safety systems. After the analysis, additional requirements may have to be imposed to protect safety. (For SRS use only: the requirements for wind loads are at the PC-2 level).

3.1.3.15 Safety Significant Requirements (Instrumentation)

A. For any components as identified as being Safety Significant (SS) shall be designed in accordance with ISA-84.00.01 Part 1.

3.1.3.16 Human Factors Engineering shall follow the requirements in IEEE-1023, IEEE-845, and NUREG-0700.

3.1.3.17 Structural Design Requirements

A. Structural design criteria shall be as follows:

1. Wind Loads
   a. Wind Loads (W) shall be per ASCE-7
      1) Wind Speed (Three Second Gust), V = 100 mph
      2) Exposure "C"
      3) Importance Factor, I_p = 1.15
      4) Topographic Factor, K_{zt} = 1.43
   b. DELETED
2. Seismic Loads (E)
   a. a_h = horizontal acceleration = 0.5 g
   b. a_v = vertical acceleration = 0.5 g
   c. Seismic loads shall be combined using SRSS or the 100%-40%-40% Rule per DOE-STD-1020.
   d. F_u = 1.0
   e. Overturning shall be checked.
3. Flood: the SSCs being provided shall withstand a flood height of 4 feet.
4. Geotechnical Data
   a. System location: Savannah River Site in Aiken County, South Carolina
   b. Modulus of subgrade reaction for 1 ft^2: K = 15 to 40 kcf
   c. Frost penetration depth: 5 inches below finished grade
   d. Allowable soil bearing capacity at grade: because of the limits of buried commodities, specific bearing loads will have to be submitted and accepted. Use 1500 psf for estimating.
5. Design Loads for Structures: design loads for structures shall be per IBC. All design load types per IBC and ASCE-7 (e.g. dead, live, snow) must be considered. Unless stated otherwise in project documents, load combinations shall be per IBC.
6. No Sliding or Overturning
   a. Unanchored components can be shown to not slide or overturn by applying the building sliding and overturning provisions of ASCE-43 as amended below:
   b. The nominal sliding resistance shall be the component's normal force times the static coefficient of friction. The normal force shall be the contact force between the component and the sliding plane, which is generally the component weight reduced to account for (1) vertical acceleration; (2) suction due to wind forces; or (3) buoyancy. For wind loading, 90% of the component weight shall be used.
   c. For sliding, the coefficient-of-sliding-friction shall be set at the 95% exceedance level. For rocking, the coefficient-of-sliding-friction shall be set at the 5% exceedance level. Alternately, pure rocking (i.e., no slide-rock) can be assumed (ASCE-43). A concrete or steel rigid body sliding on a dry broom-finished concrete surface has a 95% exceedance level coefficient-of-sliding-friction of 0.3 and a 5% exceedance level coefficient-of-sliding-friction of 0.7.

7. DELETED.
8. SSCs which are required to function during or after a seismic event must be proven through testing or analysis
9. Exhaust stacks shall conform to ASME-STS-1.

B. Lift Points

1. For procured load rated items, use a minimum safety factor of "3" on yield strength and "5" on ultimate strength.
2. Locate and mark the center of gravity for lifted items on the submitted drawings.
3. A dynamic impact factor or *DLF* of 2.0 on the factored load of the lifted component shall be included. This load case need not be combined with NPH events.
4. Dead load shall be taken as 1.25 times the rated lift load.
5. Rigging attachment and lift points and structural assemblies for lifting shall be designed in accordance with ASCE 7 §4.9, the applicable material code (ACI, AISC, etc.) with the following clarifications and additional requirements: Rigging attachment and lift points shall be designed for the factored load (impact) of the item. The weight of the structural assembly and any other rigging items shall be considered as dead load. The weight of the item being lifted shall be considered as live load per ASCE 7 §4.9. The weight of the item being lifted shall be increased to account for impact forces – typically 25% per ASCE 7 §4.9.3.
6. Concrete anchorage of rigging attachment and lift points shall be designed for the above factored load in accordance with the provisions of ACI-318 Appendix D, or ACI-349 Appendix D, as applicable.
7. Structural assemblies shall be designed for 1.25 times the rated lift load plus the factored load of the assembly, i.e., 1.25 × rated lift load × dynamic impact factor + code factor × dead load of the structural assembly.

C. Vibration

1. Equipment and commodity supports subjected to vibration shall be designed to avoid resonance between the operating frequency and the natural frequency of the equipment support.

3.1.3.18 Design Documentation Requirements

A. General Requirements

1. A Professional Engineer of the appropriate discipline registered in the state of South Carolina shall seal engineering documents according to South Carolina COL Title 40 Chapter 22 and South Carolina COR Chapter 49 before forwarding to SRR.
2. Electronic signatures of sealed drawings are acceptable provided South Carolina COR 49, paragraph 207(A)(2) is followed.
3. Assign each design document, procedure and report with a unique document number and revision number.

B. Documentation Hierarchy

1. The hierarchy of design deliverables shall not impact, negate, or alter in any way the requirements for the document deliverables per this SOW.

2. The Interface Control Document (ICD) is deemed the highest in the hierarchy of document deliverables under this SOW. Some of the important features of the ICD are:
   a. The ICD depicts schematically the physical location, type, and dimensions of the connections between the SRR interfaces to the Supplier's system.
   b. The ICD fixes design location and connections to allow the Supplier and SRR to generate design output in a parallel effort.
   c. Upon SRR acceptance of the ICD, the Supplier shall maintain process connection information of the ICD as fixed locations, values and quantities in design.
3. In the event that any document and information conflicts with the SRR accepted ICD, the SRR accepted ICD is deemed as correct.
   a. The Supplier shall revise the documentation to conform to information contained in the SRR accepted ICD.
   b. The Supplier shall not revise the ICD in lieu of correction to lesser affected documents.

C. Drawing Requirements

1. Verify each electronic file is virus free and indicate the following on each disc label or on the transmittal document (for electronically submitted files.):
   a. Drawing number(s).
   b. Virus checking application used.
   c. Date of virus definition update used.
2. Provide electronic files for each drawing identified in Attachment 5.1.
   a. Submit electronic drawing files as MicroStation®[6] Version 7 (or later), dgn and Abode Acrobat®[7], PDF format.
3. Provide drawings suitable for as produced size image as well as producing readable ANSI B size (11″ × 17″) image.
4. Physical, arrangement and assembly drawings shall be produced as scale drawings, dimensioned and tolerance in accordance with ASME Y14.5.
5. Weld symbols shall be displayed on assembly and shop drawings in accordance with AWS A2.4.
6. Interface Control Document (ICD): submit an ICD that is a compilation of drawings that provides the following information for each processing module and SSC:
   a. Identify system inputs and outputs
      1) Identify the input and outputs as a result of TCCR System operation.
   b. Identify connection details.
      1) Identify the coordinates at centerline of the each connection.
      2) Identify the orientation of each connection that is not normally oriented in plan or elevation view.

[6] MicroStation® is a registered trademark of Bentley Systems, Inc., 685 Stockton Drive Exton, Pennsylvania 19341
[7] Adobe Acrobat® is a registered trademark of Adobe Systems, Inc., 345 Park Avenue, San Jose, California 95110

3) Identify connection type, size, and schedule for piping and tubing.
4) Identify relevant interface dimensions for each other type of mechanical appendage (e.g. for conveyer attachments, hopper discharge, etc.).
5) Identify connection type and size of electrical, instrument, controls, and software cabling.

7. Document Index: a composite list of the Supplier documents including, but not limited to, drawings, calculations, SDDRs, reports, studies, M&O manuals, etc., submitted to SRR. Documents listed in the Document Index shall reflect, at a minimum:
   a. Document titles
   b. Unique document numbers
   c. Document revisions
8. Drawing Legend: Submit a drawing legend defining standard symbology and nomenclature utilized in process and instrumentation diagrams (P&IDs). Define, utilize, and adhere consistently throughout the P&IDs the following:
   a. Uniform symbols for each component.
   b. Piping and Instrument symbols: SRS specific templates, cells, flow and P&ID legend sheets will be provided after award of contract and upon request.
9. Block Flow Diagrams
   a. Submit block flow diagrams representing the flow between associated processing areas (e.g., tanks, columns, treatment filters, unit operations, etc.).
      1) Identify equipment and process streams
         a) Include discussions of operational information which may include, but is not limited to the following:
            - Process transfer path
            - Process cycle times
            - Equipment, stream compositions (chemical and radioactive), physical properties
            - Process flow rates
            - Mass and energy balance
10. Process Flow Diagrams (PFD)
   a. A PFD shall be submitted and meet the following requirements:
      1) Schematically represent the following on a process flow sheet:
         a) Display essential equipment and components (e.g., no logic or wiring, only instruments that cause a change in pressure, temperature, flow and mass/mechanical energy).
         b) Numbered or lettered segments between key components, enclosing number or letter in a diamond.
         c) Tabulate pressure, temperature, flow, and volumes in the dissolution and destruction lines on the drawing, corresponding to the numbered or lettered diamond.

11. Piping and Instrumentation Diagrams (P&ID): submit piping and instrument diagrams as follows:
    a. P&IDs shall depict processes delineated by the system.
        1) Where multiple systems interface:
            a) Designate system breaks
            b) Locate piping and components of secondary systems on connecting P&IDs
        2) Schematically represent the following on the P&IDs:
            a) Mechanical equipment
            b) Valves and dampers (including vent and drain valves)
            c) Test connections
            d) Instruments and Control Systems in sufficient detail to delineate function and interface with the process. Instrument symbols shall be in accordance with ISA 5.1.
            e) Manual switches and push buttons
            f) Piping (define line weights utilized)
            g) Ductwork with delineation of duct levels
            h) Instrument piping/tubing as a necessary aid in understanding system operation
        3) Display the following types of information on the P&IDs:
            NOTE: Items marked with an asterisk are applicable for P&IDs.
            a) CLI numbers
            b) Piping identification and size
            c) Instrument designations and basic control schemes
            d) Interlocks with explanatory notes (use for complex or critical interlocks only.) Control logic diagrams and electrical schematics are the main source for this information.
            e) Control system interface(s)
            f) Boundaries where pipe materials, schedule, diameter and system changes
            g) Module boundaries
            h) Direction of flow
            i) Piping material
            j) Measuring and restriction orifices
            k) Equipment name
            l) Tanks/wall nozzles with identification
            m) Thermal insulation
            n) Heat tracing and tracing type with end lights
            o) Special physical arrangement requirements (e.g., minimum slope, relative elevations, no pockets, critical dimensions, etc.)
            p) Interconnection references to other drawings including grid coordinates
            q) Valve type and actuator type (if applicable)
            r) Valve size (if size is different from line)

s) Valve failure state (e.g., fails open, closed)
t) Actuated valves shown in the normal (shelf) state
u) Status indicating lights
v) Annunciator inputs/outputs
w) Supplier interface boundary of module mounted equipment
x) Piping connection type (i.e., removable spool pieces and flanges at equipment)
y) Use notes to impose requirements, which cannot be shown diagrammatically
z) Use notes on a limited basis to avoid clutter and excessive revision to P&IDs
aa) Common notes for many P&IDs can be shown on a general notes drawing
bb) Primary and secondary confinement ventilation system boundaries.
cc) Secondary containment boundaries

4) General System P&ID Flow
   a) Left to right
   b) Top to bottom
   c) Utility or supporting process lines: enter and exit wherever appropriate to improve the presentation of the P&IDs.
5) Do not display the following information on the P&IDs:
   a) Supplier equipment that is not provided as part of the TCCR System.
   b) Instrument set points.
   c) Equipment rating and capacity.
   d) Supplier document and procedure numbers.
   e) Electrical control relays.
   f) Pressure, temperature, flow or other process data (except notes may detail where no other option is available).
   g) Standard pipe fittings (in-line pipe size changes shall be shown with a reducer-type symbol).
   h) Valve locked open.
   i) Radiation shielding.
   j) Test / startup boundaries.
   k) Extensive explanatory notes such as equipment, valve, and instrument sequence number lists.
   l) Physical details and dimensions.
   m) Site jurisdictional boundaries.
   n) Pipe test requirements.

12. Equipment Location Drawing: submit the module arrangement within the space available displaying the following minimum information (as applicable):
    a. Outlines of equipment drawn to their actual shape with clearance requirements.

b. Equipment pull spaces.
c. Dimensionally locate equipment.
d. Actual elevation referenced to plant grade.
e. Interface points with SRR utilities.

13. Assembly Drawings: submit for each module to include at a minimum the following:
    a. Equipment, components and instrumentation
    b. Process connections
    c. Bill of materials or parts list
    d. Assembly weight: dry (empty) and wet (maximum)
    e. Center of gravity (dry and wet)
    f. Locations and dimensions
14. Layout Detail Drawings: submit drawings for each module displaying the following minimum information (as applicable):
    a. Materials
    b. Nominal pipe size(s)
    c. Equipment and components
    d. CLI numbers
    e. Camera ports, camera port covers and fastening mechanisms
    f. Maintenance access ways, covers, and fastening mechanisms
    g. Lighting information: layout, intensity, illumination level, power consumption, etc.
    h. HVAC details
    i. Ventilation details
    j. Local instrumentation
    k. Areas for piping with valve reach rod reserve space
    l. Raceways
    m. Conduits and electrical / instrument termination boxes
    n. Pull spaces to support maintenance
    o. Dimensional locations for equipment and components
    p. Electrical panel layout and wiring diagram
    q. Cable and conduit routing/schedule
15. Architectural Drawings: submit drawings for each enclosed module including the following:
    a. Foundation plans and weights
    b. Dimensional locations for major equipment and components.
    c. Access and egress paths.
    d. Plans, Sections, elevations and details.
    e. Penetration locations.
    f. Materials of construction.
16. Vessel and Tank Drawings: submit drawings for each vessel to include:
    a. Details to facilitate fabrication, manufacture, and assembly.

b. Indicate that the vessel shall be fabricated and tested to the ASME BPV Code, Section VIII (cite year and addenda).
c. Indicate maximum allowable working pressure and design temperature.
d. Identification of welds and details of welding including weld type, location, extent, finish, and NDE.
e. Detailed dimensions of vessel envelope and structural supports.
f. Detailed dimensions of parts (e.g., cooling coil, nozzles, piping and associated supports).
g. Thickness of shell and end head material.
h. Material descriptions of assembly components by their ASME and ASTM designation, alloy designation, and Unified Numbering System (UNS) number
i. Tolerances and reference datum planes
j. Provide units of linear measurement in fractional or decimal inches
k. Capacity in gallons and tank weight (empty and full)
l. Center of gravity
m. Centerlines and details of the lifting lugs and nozzles
n. Dimensions and weights of modular frames
o. Location of nameplates.
p. Parts list

17. Structural Drawings: submit drawings for each module, including (as a minimum) the following:
    a. Materials of construction
    b. Plans, sections, elevations, details
    c. Installation, erection, assembly, rigging and inspection requirements or restrictions.
    d. Bolting and welding requirements
    e. Design loads
    f. Dimensional locations for equipment and components
    g. Reference supporting structural calculations
18. Instrument Location Drawing: submit location drawings for the following items
    a. Instruments
    b. Major instrument racks
    c. Field panels
19. Control Logic Drawings (CLDs): CLDs shall prepared per the methodology of ISA 5.2, for discrete logic including discrete sequential operations, pre-start conditions, interlocks, etc. for TCCR devices (automatic on/off, valves, pumps, heaters, etc.) and submitted to SRR. Include basic system operation in conjunction with P&ID.
    a. Drawing Requirements

       Identify SRR input requirements.

       1) Include units for each input

2) The terminology for set-points and interlocks shall be in English Standard Gauge Units, based upon 60°F (15.5°C) and atmospheric pressure of 14.7 psia for standard units as appropriate.

b. Format

1) CLD shall be arranged such that it is not overcrowded or cluttered, is easily readable, and has some extra space for future alterations. The CLD shall clearly delineate field devices, controller logic, and any hard-wired interlocks which may exist. Operator interface shall also be shown on the drawing.
2) Provide drawings suitable for as produced size image as well as producing readable ANSI B size (11″ × 17″) image
3) Overall logic flow shall be from left to right.
4) Solid right angle lines shall be used to connect the logic symbols. Line connections shall be indicated by dots.
5) Arrowheads shall be used where flow of logic is not in the normal direction, and where increased clarity will result.
6) Notes and references shall be included to clarify the specific and overall system function.

c. Contents

1) Use graphic symbols consistent with Attachment 5.8.
2) Show only one or two items of equipment per drawing.
3) Instruments, control switches, and equipment shall be identified by component identification numbering.
4) Process inputs shall indicate the condition at which they will function, such as low pressure. Setpoints shall be included if required to understand the logic.
5) Show each input circuit or contact as a separate logic input.
6) Show logic for each operating state of the equipment.
7) Output actions shall be clearly defined, i.e., "stop main pump."
8) Show operator displays, indicating lights, annunciator inputs, and computer inputs along with the location.
9) Following terminology shall be used:
   a) "Start" and "Stop" – applied to mechanical equipment such as pumps or fans
   b) "On" or "Off" shall be used for equipment such as heaters
   c) "Close" and "Trip" shall be used for circuit breakers
   d) "Electrical Protection" shall be used to describe process logic inputs that involve any short-circuit current, over-current, torque protection, or motor high temperature protection for electrical equipment.
   e) "Mechanical Protection" shall be used to describe process logic inputs that protect mechanical equipment such as loss of suction pressure or high vibration.

20. Electrical Single Line Requirements: submit single line electrical drawings that provides the following minimum information:

a. Breaker/fuse size and type

b. Starter size
c. Cable information
d. Overloads
e. Electrical equipment size
f. Voltage level
g. Reference drawings

21. Schematic Diagrams: submit schematic electrical drawings that provides the following minimum information:
    a. Voltage levels
    b. Controlled transfer information
    c. Breaker/fuse size and type
    d. Cable information
    e. Line reference
    f. Line description
    g. Terminal points
    h. Reference drawings
22. Analog Control Logic Documents:
    a. "Simple" analog loop logic shall be configured from P&ID depiction.
    b. For "complex" analog control logic, submit separate documents labeled with the process unit operation name, i.e. "Analog Control Logic Descriptions". Each document shall include the Analog Control Logic information required to configure in the PLC for each of the "complex" analog loops in that process system.
23. I/O Summary: submit and input-output summary diagram as follows:
    a. Show instrument tag
    b. I/O Type
    c. System designation
24. Instrument Data Sheets: submit instrument data sheets for each instrument showing the CLI number, service description, P&ID number, process data, and salient features of the instrument, including the following:
    a. Include scope
    b. Specification, codes and standards (including exceptions)
    c. Preliminary design requirements

D. Calculation Requirements

Submitted calculations shall meet the following requirements

1. General
    a. Each calculation shall be prepared and signed by an originator, competent in the relevant engineering field.
    b. Each calculation shall be prepared independent of any assistance by the checker.
    c. Each calculation shall be checked and signed by a checker.
    d. Checker shall possess the following qualifications:
        1) Did not participate in the development of the document being checked.

2) Competent in the area of the design or analysis for which they review and capable of performing similar design or analysis activities.
3) Checker shall verify the following calculation attributes:
   a) Mathematical correctness
   b) Correctness of technical input and conclusions
   c) A review of the approach used and reasonableness of the output

e. Prepare and submit calculations in sufficient detail to ensure that allowable criteria and proper factors of safety have been followed. Provide each calculation with:
   1) Sufficient detail to allow an individual competent in that discipline to understand the methodology, inputs and results.
   2) Objective
   3) Statement of its problem
   4) Logical description of calculation methodology
   5) Design inputs and assumptions (including a sensitivity analysis) with explanation of assumption bases
   6) Codes and standards governing its design, including formulas
   7) Calculations and computations, including units
   8) References
   9) Results
   10) Conclusions
   11) Attachments: attach inputs relied upon not commonly available in copyrighted print (e.g., component manufactured data, written correspondence).

2. Structural Calculations
   a. Include, as a minimum, the following information:
      1) Analysis and design of each structure.
      2) Shielding structure design and its anchorage.
      3) Design of commodity supports.
      4) Design of lift points and yokes.
      5) Provide an electronic copy of the computer model input and output files.
   b. Submit lifting, rigging, and lifting lug calculations
3. HVAC Calculations
   a. Analysis of heat loads from each process system or area.
   b. Analysis of process off-gas shall include, at a minimum:
      1) Temperature - °F
      2) Flow - standard cubic feet per minute (scfm)
      3) Composition - volume %
      4) Relative Humidity - %
      5) Velocity - feet per minute (fpm)
      6) Differential pressure - inches of water column
      7) Maximum and nominal operating pressures.

8) Structural capability pressures.

c. Analyze the above for the following conditions:

1) Normal operations
2) Maintenance
3) Largest credible breach of the primary confinement

d. HVAC equipment sizing (ductwork, blowers, re-heater, stacks, etc.)

e. Perform stress calculations for ductwork exceeding 150°F (65.5°C) and for outdoor ductwork.

4. Hydraulic Calculations

a. For each system (waste, air, water, etc), prepare a calculation demonstrating that system will meet the Supplier hydraulic performance requirements.

1) Include basis for:

a) Line sizing
b) Material selection

b. For SRR provided process utilities, utilize input values provided at the interface point (refer to Attachment 5.6).

5. Pressure Vessel Calculations

a. Submit to SRR for acceptance pressure vessel calculations prepared in accordance with ASME BPVC Section VIII, Division 1.

b. Submit a verification record for each pressure vessel to SRR before shipment of the TCCR System.

EXCEPTION: A pressure vessel verification record and periodic inspections are not required for safeguarded CF4 vessels with: (1) incompressible liquid non-flashing at atmospheric condition, or (2) gas (including air) with a volume less than 5 ft^3.

The verification record includes

1) CLI Number (provided by SRR)
2) Equipment description
3) Equipment status
4) Functional class
5) Verification record number (provided by SRR)
6) Verification record status
7) Working Fluid
8) An identifier code (provided by SRR)
9) Consequence of failure
10) ASME certification code
11) ASME Data Report (U-1, U-1A, etc. for ASME VIII Div.1 vessels).
12) National Board registration number (if applicable)
13) Manufacturer
14) Model number (if applicable)
15) Serial number (if applicable)
16) Year built

17) Design pressure
18) Design temperature
19) Set pressure or relief device CLI number
20) Size (diameter, height, volume in ft^3)
21) Tube design pressure (if applicable)
22) Tube design temperature (if applicable)
23) Type of Inspection
24) Inspection frequency
25) Code required minimum wall for shell and heads t_{min} (if needed for periodic maintenance)

c. Submit to SRR an overpressure protection report when provisions of ASME Section VIII UG-140 are applied.

6. ASME B31.3 Code Calculations

a. Include, at a minimum, piping specifications that include the following:

1) Minimum Wall Thickness Calculations:

a) Evaluate each pipe and tube utilized in design.

b) Base minimum wall thickness for each service upon the pressure and temperature at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service.

c) Segregate evaluation by materials, fabrication methodology, pipe diameter, schedule, and service.

2) Piping and System Stress Calculation(s):

a) Address system and piping flexibility due to fatigue loading, thermal loading, and other conditions as required by code.

b) Perform calculation for lines exceeding 150°F (65.5°C) and for outdoor lines. However, when using the ASME B31.1 methodology, the allowable stresses from ASME B31.1 shall also be used.

3) Unlisted Component Calculations

a) For each unlisted component utilized in the TCCR piping system, demonstrate that the component meets or exceeds ASME B31.3 requirements.

b) Present results (pipe schedule, material, etc,) in tabular format.

7. Pressure Relief Device Calculations

a. Include, at a minimum, the following information:

1) Sizing analysis
2) Stability analysis.
3) Each calculation shall identify credible failure flows (e.g. flow rate as a result of an independent single failure or multiple common mode failures).
4) Manufacturer data for each selected relief device.
5) Isometric drawings showing configuration.

b. Pressure relief devices calculations shall document the set/cracking pressure plus % overpressure required to relieve the failure flow for overpressurization event(s).

c. Overflow lines shall have calculations documenting each line relieves the failure flow for overpressurization event(s).

d. Submit to SRR the design and sizing calculation(s) for each pressure protection device following the calculation requirements of stated herein (refer to examples M-RVD-H-02662 and M-RVD-H-02669). Use reference M-DP-G-00006, Pressure Protection Design Guide, with the following exceptions:

   1) When stated in the Design Guide to refer to the "PEPC," instead consult with the CTF.
   2) When stated in the Design Guide to refer to "Y1-7" for test type, test frequency, and rationale for test type & frequency, instead, refer to the CTF.
   3) When stated in the Design Guide to refer to "Y1-7" for the Consequence of Failure Code, instead refer to the definition stated in this SOW.

e. Submit to SRR a verification record (reference OSR 8-193 or OSR 8-213) for each pressure protection device. The verification record shall contain the following information:

   1) CLI Number (provided by SRR)
   2) Equipment description
   3) Equipment status
   4) Functional class
   5) Verification record number (provided by SRR)
   6) Verification record status
   7) Working Fluid
   8) An identifier code (provided by SRR)
   9) Consequence of failure
   10) ASME certification code
   11) Manufacturer and model number
   12) Set or nominal burst pressure
   13) Rupture disk class (if used)
   14) Inlet size and type
   15) Outlet size and type (if applicable)
   16) Capacity (if applicable)
   17) Blowdown [max and min] (if required in the verification record)
   18) PM testing frequency

8. Emission Rate Calculation: submit a calculation that will estimate the amount of pollutants discharge from the TCCR System. A full characterization of the feed stream will be provided to the Supplier after award.

   Include at a minimum the following:

   a. Radioactive particulates (in curies per cesium-137) in the exhaust stream.
   b. Non-radiological pollutants (in pounds per hour) in the exhaust stream.

9. Mass and Energy Balance Calculations
   a. Submit mass and energy balance calculations accounting for the materials and energy, demonstrating the conservation of mass and energy. These calculations shall be performed for the bounding ranges of anticipated flow rates and weight percent solids in the feed.
10. Radiation Shielding Calculations

    Submit a bounding shielding calculations and thickness estimates for the TCCR System.
    a. Include the assumptions used for source term(s), durations, dimensions, and shielding materials utilized (including shielding material density and/or ASTM designation).
    b. Include shielding thicknesses for lead, steel, and concrete. Document the selection methodology of the bounding condition including which mode of facility operation is considered bounding; i.e. normal operations, maintenance, shutdown, or anticipated upset conditions.
    c. Include an estimate of effective dose equivalent.

E. Indices and Technical Information Requirements
1. Indices
   a. Submit the following indices in in Microsoft®[8] Excel format.
   b. Instrument Index: submit a composite list of system instruments including the following information (as a minimum):
      1) CLI number
      2) Service description
      3) Drawing references (P&ID, and other available drawing references)
      4) Comments field
      5) Functional class
      6) Instrument location
      7) Instrument type description
      8) Manufacturer
      9) Model number
      10) Instrument accuracy
      11) Calibration range with units
      12) I/O type
      13) Instrument (span) range with units (manufacturer supplied)
      14) Set-point information for control system and hardwired alarms and interlock set-points to include the following information as a minimum. The set-point information shall be listed with the applicable CLI record, as applicable.
         a) Set-points
         b) Set-point basis
         c) Set-point units

[8] Microsoft® is a registered trademark with the Microsoft Corporation, Microsoft Redmond Campus, Redmond, Washington.

d) Set-point type (for example, low, low-low, high, high-high)
e) Set-point action (for example, "A" for alarm, "I" for interlock)

c. Piping Index: a composite list of the Supplier's designed piping including the following information at a minimum:
   1) CLI Number (line number)
   2) Material
   3) Schedule
   4) Size
   5) Design pressure
   6) Design temperature
   7) Description (to and from)
   8) Test type
   9) Test pressure
   10) Logical boundaries
   11) Material coatings
   12) Cleanliness classification
   13) Run joint types
   14) Maintenance joint types
   15) ASME B31.3 fluid service
   16) ASME B31.3 code calculation number

2. Submit a Component Location Identifier (CLI) and Master Equipment List (MEL) Datasheet (CLI/MEL Datasheet)
   a. A CLI number will be assigned to components by SRR during the 50% design review. The minimum information required for CLI number assignment is:
      1) type of component
      2) description
      3) manufacturer
      4) model
   b. The Supplier shall incorporate the CLI numbers after the completion of the 50% design review and before the 90% design review.
   c. A CLI number will be assigned to a component if any of the following conditions apply:
      1) It requires preventative maintenance.
      2) It is operated, manipulated, or will otherwise be uniquely identified in an operating or maintenance procedure.
      3) It is used either as a point of lockout or isolation or as either (electrical, pressure, or vacuum isolation).
      4) It is involved in predictive maintenance.
      5) It is installed process instrumentation
   d. CLI Number Format (refer to example below): the CLI number will consist of five (5) fields. The data fields are left to right justified and provide the following information:
      1) Site Area and Site Unit Clarifier (2 Characters)

2) Building Number in which the Component is located (6 Characters)
3) System (Maximum 4 Characters)
4) Equipment Type (Maximum 4 Characters)
5) Equipment Sequence Number (Maximum 15 Characters, 5 typical)

CLI Number Format Example:

HI - 241010 - WTP - V - 10000

(1) (2) (3) (4) (5)

e. Master Equipment List (MEL) information to be included in the database shall include the following:
   1) Operating ranges (temperature, flow, pressure, etc.).
   2) Design parameters
   3) Materials
   4) Special Features (e.g. metal seals instead of elastomeric)
   5) In addition to the aforementioned information, provide the following for pressure relief devices:
      a) Set or nominal burst pressure
      b) Inlet size and type
      c) Outlet size and type (if applicable)
      d) Capacity (if applicable)
      e) Blowdown (max and min)
      f) PM testing frequency

      NOTE: Instrumentation does not need to be included in the MEL Report. Information for instrumentation shall be included in the Instrument Index.
   6) The CLI/MEL Datasheet shall be maintained by the Supplier
f. Cable and Raceway Numbering System
   1) Refer requirements for CLI numbers.

3. Reports
   a. Provide in Microsoft® Word format
4. Calibration Requirements Document
   a. Submit calibration requirements for each calibrated instrument.
   b. Calibrate instruments in accordance with:
      1) The National Institute of Standards and Testing (NIST)
      2) Manufacturer's instructions
5. Parts and Spare Parts List
   a. Submit a parts list for the TCCR System to include the following information:
      1) Part identification (including manufacturer, and manufacturer's part number)
      2) Approximate cost of part
   b. Identify and submit a recommended critical spare parts list.

6. System Description Document
   a. Submit a detailed description including:
      1) System Summary
         a) Functions and design requirements
         b) Performance and operational requirements
         c) System configuration and essential features requirements
         d) Maintenance requirements
         e) Power, instrumentation and controls requirements
         f) Quality assurance requirements
         g) Reliability/availability requirements
         h) Human factors requirements
         i) Facility and system transient requirements
         j) Equipment qualification requirements
      2) Detailed System Description
         a) System parameters and performance characteristics
         b) System arrangement
         c) Component design bases
         d) Component design description
         e) Instrumentation and control
      3) Principles of Operation
         a) Initial configuration
         b) Startup
         c) Normal operation
         d) Shutdown
         e) Infrequent operations
         f) Operating procedures
      4) System Limitations, and Precautions
      5) System Upsets and Recovery Sequences
      6) References
         a) Drawings and specifications
         b) Vendor documents
         c) Procedures
7. Applicable Standards Identification Report
   a. Submit the codes used for this SOW (as required by Section 2.2.1) in an applicable standards and identification report for SRR approval. The report shall identify the proposed National Code and/or Standard for each SSC that contains, at a minimum, the following information:
      1) A logical description of the SSCs
      2) Additional National Codes or Standards beyond those invoked by this SOW.
         a) Provide reference by code and standard including edition (e.g., ANSI/HI 1.6-1994).

b. Identify for each module and SSC the following:
   1) Applicable design requirement (may reference by code and standard, edition and paragraph)
   2) Calculations
   3) Material requirements
   4) Fabrication requirements
   5) Examination requirements
   6) Testing requirements
   7) Qualification requirements
   8) All other requirements

c. Submit justification and obtain SRR acceptance for other editions and/or addenda of National Codes / Standards required before using

8. Manufacturers' Component Information

a. Cross reference component data sheets to applicable CLI numbers.

b. Submit component data sheets that contain the following information (at a minimum) for each component:
   1) Electric Motors: for each electrical motor, including manufacturer and part number, nameplate data, radiation resistance capability for the motors, and motor components.
      a) Provide motor supplier's vibration test data for the purchased motor or of a representative design
      b) Provide compliance with NEMA MG-1 Part 31 or NFPA 70 Section 430.126, for motors being connected to VFD's
   2) Actuators: for each actuator, include manufacturer and part number, weight, physical dimensions, radiation resistance capability for actuators and actuator components.
   3) Instrumentation and Lighting: include manufacturer, part number, calibration requirements and radiation resistance capability in a generic ISA-20.00.01 format, or equivalent.
   4) Electrical and Instrumentation Cables: include information for radiation resistance capability.
   5) Valves: include manufacturer and part number, size, type, end connections, materials (internal and external), weight
   6) Fans and Blowers: include manufacturer and part number, physical dimensions, weight, power, voltage, current, rated flow, pressure differential and fan operations curve.
      a) Include documents containing unfiltered and filtered vibration spectral data for the axial, horizontal transverse and vertical directions during shop testing as well as field startup testing.
      b) Provide fan curve over full range of fan operation with static pressure, flow rate, brake horsepower, static efficiency, current, speed, and temperature data for each point in accordance with AMCA-210.
      c) Provide torsional analysis documentation.

7) HEPA Filter Housing: include internal and external physical dimensions, filter size, manufacturer and part number, rated flow, capacity, weight.
8) Refractory Material Datasheet: for refractory materials utilized in fabrication.
9) Elastomer Technical Datasheets: for elastomers used in the design.
10) Surface Coating Technical Datasheets: where applicable, for surface coatings (e.g. paints, overlays, films etc. / applied physically, electrodeposited, diffusion coated, etc.).
11) Lubricant Datasheets: for equipment and components which require lubrication fluids. Identity quantities contained in each. Sealed bearing lubricant quantities are not required,
12) Pumps: include pump and driver outline drawing, centrifugal pump data sheet, mechanical seal drawing (if applicable), mechanical seal piping drawing (if applicable), vendor's cooling/heating piping drawing (if applicable), performance curve with rated point, cross-section drawing with parts list, instruction manual, and coupling data. Provide a standard and specific pump curve over full range of operation with head, flow rate, brake horsepower, efficiency, speed, and temperature in accordance with HI-14.6.
13) Hoses: catalog information, manufacturer's confirmation of service experience, and/or performance test

9. Reliability, Availability, Maintainability and Inspectability Analysis Report
   a. Not applicable for this SOW
10. Ergonomic Analysis Report
   a. Submit an Ergonomic Analysis Report in accordance with 10 CFR 851.
11. Matrix of Applicable Standards Tests
   a. Submit a matrix of applicable standards tests that contains, at a minimum, the following information:
      1) The specific commodity or component identification.
      2) The applicable standard requiring the test.
      3) The type of test required.
      4) Description of the test.
12. Pressure Protection Design Study
   a. Submit as a pressure protection design study to include as minimum, the following information:
      1) Identification of Applicable National Consensus Codes.
      2) Pressure equipment categorization:
         a) Code Pressure Vessels with Code Pressure Relief Devices.
         b) Code Pressure Vessels without Pressure Relief: Pressure vessels in this category are not preferred for use at SRS, and will require additional analysis, calculations, and documentation submittals. If a pressure vessel in this category is to be used for the TCCR System, the Supplier shall request prior approval from SRR via a SDDR. If the application is accepted by SRR, the additional requirements will be defined at that time.

c) Code Piping Systems with Pressure Relief Devices.
d) Code Piping Systems without Relief Devices.
e) Non-Code Components with Code Pressure Relief.
f) Non-Code Components without Pressure Relief.

3) Design pressure/temperature and operating pressure/temperature for each piping system and vessel.
4) Jurisdictional Approval Constraints
   a) Applicable for implementation of code cases and deviations from the BPVC requirements and this SOW.
5) Vessel Failure Consequence Category, including at a minimum the following information:
   a) Vessel name and (anticipated) physical location.
   b) Define the Consequence of Failure (CF) classification (CF1, CF2 or CF4) for each vessel utilized in design.
   c) Working fluid with ASME B31.3 Fluid Service.
   d) Credible modes of failure.
   e) Design Basis Accidents
      - Identification of specific activities, e.g., development of worst-case failure flow scenarios including operating and upset scenarios, fire, operator error, and equipment and/or instrumentation malfunctions. Provide an in-depth description of all scenarios for each process/utility system and vessel.
      - Set pressure of each relief device along with boundaries of systems evaluated for worst-case failure flow scenarios.
      - Recommended scenario bounding failure flow for pressure relief device selection and sizing.
      - Detailed TCC System P&IDs showing pertinent elements of the system associated with the vessel.
      - References to applicable design documents and calculations, e.g. mass/energy balance, fluid flow calculations, studies, P&IDs, PFDs.

13. Requirements Compliance Matrix
    a. Submit a matrix documenting compliance of the TCCR System design with the requirements in this SOW. The matrix shall be in tabular format and include as a minimum the following attributes:
       1) The SOW requirement text, section number, and SOW revision.
       2) The TCCR System design documents (e.g., drawing, calculation, report, etc.) that address the requirement and demonstrate that the requirement has been satisfied by the design.
          a) The SRR assigned document numbers (submittal number) shall be listed. The Supplier document numbers may also be included.
          b) In general, list the highest level documents that clearly demonstrate compliance; not every document related to the requirement.
       3) A remarks column providing any additional clarification required to confirm compliance.

3.1.3.19 The design schedule shall include SRR design reviews at 50%, and 90% design complete stages, allowing for a minimum of ten (10) working days for each SRR review based on a 5 work days per week schedule calendar.

A. The documents associated with each design review shall be delivered electronically as a package in "pdf."

B. The following drawings, diagrams, reports, and calculations, in preliminary form, shall be submitted in the 50% design review package (as a minimum):

1. Block flow diagram
2. Process flow diagram (PFD)
3. Mass and energy balance calculation
4. Process and instrument diagrams (P&ID's)
5. Electrical single line diagrams and schematics
6. Control logic diagrams
7. Instrument data sheets
8. Assembly drawings [including equipment drawings and submittals (e.g., fans, motors, pumps, etc.)]
9. Pressure relief device calculations
10. Lifting, rigging, lifting lug calculations
11. Shielding, containment, confinement, and ventilation plan
12. Utility interface requirements
13. Layout drawings and siting plan
14. Architectural plans
15. Installation instructions
16. Applicable standards identification report
17. Shielding calculations

C. The following information shall be included in the 90% design review package as a minimum:

1. Completion of the documents in Section 3.1.3.19.B if not already complete at the 50% review.
2. Revisions to any documents included in the 50% design review packages.
3. Technical data for resin, consumables, and ISS storage equipment
4. Design of equipment stored at ISS
5. Equipment exposure radiation dose calculations
6. Information on lubrication fluids
7. Pre-filter recycle line size (if applicable)
8. Interface control document
9. Document index
10. Drawing Legend
11. Equipment location drawing
12. Vessel and tank drawings
13. Structural drawings
14. Instrument location drawings
15. Electrical schematics

16. Analog control logic documents
17. I/O summary diagram
18. Structural calculations
19. HVAC calculations
20. Hydraulic calculations
21. Pressure vessel calculations
22. Overpressure protection report for vessels meeting ASME Section VIII UG-140 provisions (if applicable)
23. ASME B31.3 code calculations (minimum wall thickness, pipe stress, unlisted component)
24. Emission rate calculation
25. Instrument index
26. Piping index
27. CLI / MEL datasheet
28. Parts list
29. Spare parts list
30. System design description
31. Justification for using other codes and addenda
32. Component datasheets
33. Ergonomic analysis report
34. Pressure protection design study
35. Startup instructions
36. Operations and maintenance manuals
37. Functional acceptance test procedures

3.2 Installation, Startup, Operations, and Maintenance Requirements

3.2.1 The Supplier shall submit installation instructions to include:

3.2.1.1 Unpacking, hoisting, and rigging

3.2.1.2 Siting and placement

3.2.1.3 Connections and assembly

3.2.2 The Supplier shall submit an initial startup procedure to include:

3.2.2.1 System lineups

3.2.2.2 Energization

3.2.2.3 Calibration check

3.2.2.4 Column charging

3.2.2.5 Fill and vent

3.2.2.6 Ramp up sequence

3.2.3 The Supplier shall submit operations and maintenance manuals for the TCCR System, which shall include the following minimum information:

3.2.3.1 General description of the TCCR System

3.2.3.2 Start-up procedure

3.2.3.3 Normal operation monitoring and control procedure

3.2.3.4 Shut down procedure

3.2.3.5 Response to abnormal conditions procedure

3.2.3.6 Routine maintenance procedures

3.2.3.7 Preventative maintenance schedule for equipment

3.2.3.8 Manufacturers' operation and maintenance manuals for components and equipment.

3.3 Environmental Requirements

3.3.1 SRR shall coordinate all activities involving environmental regulators (SC DHEC, EPA, etc.).

3.3.2 The Supplier shall provide requested supporting information.

3.4 Site Conditions

3.4.1 Environmental Conditions

3.4.1.1 Outside

A. Temperature extremes: 5°F (Winter) to 110°F (Summer)

B. Humidity: 15-100%

C. Open to the environmental elements of wind, snow, rain, hail, ice and sun (UV).

3.4.1.2 Precipitation Values

A. 25-Year, 24 Hour Rain Event: up to 7 inches.

B. Snow Loading: 6 inches

C. Wind loads shall follow ASCE 7.

3.4.2 The TCCR System shall be installed near Tank 10H and 11H located in the H Area Tank Farm at SRS as shown on Attachment 5.4. The location is an industrial complex area subject to common industrial traffic such as vehicles and heavy equipment (Reference C-CX-H-0078 Tanks 9-12 Craneway Access and Setup).

3.5 Roles, Responsibilities, Authorities, and Accountabilities

3.5.1 Table 4 summarizes the roles, responsibilities, authorities, and accountabilities for some of the work performed:

Table 4

Activity	Supplier	SRR
Design, fabricate, and deliver the TCCR System	✓	
Submit documentation for the TCCR System	✓	
Conduct nuclear safety analysis	◊	✓
Conduct hazards analysis	◊	✓
Assign safety classification to SSCs		✓
Conduct factory acceptance testing of TCCR System per SRR-accepted procedures (includes purchasing, preparation and disposition of simulant)	✓	
Install TCCR System at Tank 10H and 11H	◊	✓
Perform site acceptance testing of TCCR System	◊	✓
Conduct training of SRR operations personnel	◊	✓

✓ Responsible (lead)

◊ Support role only (e.g., technical assistance – no hands-on work)

3.6 SRR Furnished Material, Equipment, Services

3.6.1 Equipment

3.6.1.1 HEPA filter media noted in Table 2 for site installation only.

3.7 Quality Requirements

3.7.1 Quality Assurance Program

3.7.1.1 Work performed in the execution of this procurement shall be according to the SRR accepted Supplier's Quality Assurance Program (QAP). The QAP shall address the criteria identified in Attachment 5.3.

A. The Supplier's work processes/procedures shall provide for the identification, control, and reporting of suspect/counterfeit items (S/CI) to ensure that items supplied to SRR are free of S/CIs.

3.7.1.2 The Supplier shall submit their QA program manual that addresses the QA requirements as identified in this procurement to SRR with the proposal for review.

A. SRR review and acceptance of the Supplier's QA program manual is required before award of the contract.

3.7.1.3 Subsequent revisions to the Supplier's Quality Assurance Program Manual shall be reviewed and accepted by SRR before using in the execution of this SOW.

3.7.1.4 When subcontracting any portion of this contract or when procuring structures, systems, components, items and materials, the Supplier is required to flow down the applicable QA program requirements to sub-tier supplier(s). SRR reserves the right, at any time, to verify that the applicable QA requirements have been correctly selected and imposed on Supplier's sub-tier suppliers. Access to lower tier sub-supplier facilities will be requested through the Supplier prior to access and may be performed jointly.

A. The flow down of requirements encompasses verification that the sub-tier supplier has been appropriately qualified for performance of activities complying with this procurement.

B. The Supplier shall maintain objective evidence of the flow down of requirements to sub-tier suppliers, subsequent successful implementation of requirements, and provide such evidence to SRR upon request.

C. The Supplier is furthermore responsible to flow down the commercial Terms and Conditions, including articles incorporated by reference, to the sub-tier suppliers.

D. This flow down is also required at each level if the sub-tier supplier to the prime Supplier deems it necessary to further subcontract its parts of this SRR subcontract.

3.7.1.5 Submit key sub-tier suppliers and experience with ASME-NQA-1 as part of the bid proposal and sub-tier supplier oversight plans.

3.7.1.6 Submit a configuration management plan (CMP) for SRR approval. The CMP shall identify design output document types and define the change control process for controlling changes to the TCCR System related SSC. The CMP shall be prepared following the principals of DOE STD 1073

3.7.2 Quality Control Inspection Plan

3.7.2.1 Prepare and execute a Quality Control Inspection Plan that addresses the following:

A. Fabrication

B. Material control and traceability

C. Inspection, examination, and testing

D. Integration of SRR Supplier Surveillance Representative (SSR) hold points at the Supplier's manufacturing facility, including lead time for notification of the SSR.

E. Submit the Quality Control Inspection Plan.

F. Work to the accepted plan.

G. Submit a Final Quality Control Inspection Report after completion of the inspection activities, including:

1. Confirmation that inspections and related activities identified in the plan have been completed.
2. Cross reference the activities in the plan to the individual inspection, examination, and testing records.

3.7.3 Quality Program Evaluation

3.7.3.1 SRR will evaluate the Suppliers QA program before contract award. This evaluation may include an evaluation of QA program implementation at the Supplier's facilities. If a change to the Supplier's QA is required, it will be identified to the Supplier for resolution before contact award. A deficient or inadequate QA program may be used as the basis to deny award of contract.

3.7.3.2 The Supplier shall, during the performance of the contract, implement, maintain, and perform work in accordance with the accepted QA program and implementing procedures; and shall provide proposed changes to their QA program to SRR for review and approval before implementation and performance of subsequent work activities. SRR reserves the right to verify Supplier compliance to the accepted quality program during the performance of the Contract.

3.7.3.3 The Supplier's documented quality system shall provide for issuance of a Stop Work order when the Supplier or SRR identifies significant conditions adverse to quality or safety during the performance of the work.

3.7.3.4 SRR reserves the right to review aspects of the design, fabrication, inspection, examination and testing of the equipment to the extent necessary to ensure compliance to this SOW and code requirements.

3.7.3.5 Review includes the right to access to the Supplier's facilities, including sub-tier suppliers and vendors, for the purpose of review, audit, surveillance, and witnessing of fabrication, inspection, examination, and testing activities.

3.7.3.6 Technical and quality changes to the contract are only valid and executable in written form as defined in the contract documents.

3.7.3.7 Quality verifications are only valid and executable by the designated SRR Supplier Surveillance Representative as defined in the contract documents.

3.7.4 Quality Assurance Program Implementation

3.7.4.1 Work performed shall be in accordance with the SRR accepted QAP. The QAP shall address the criteria identified in Attachment 5.3.

3.7.4.2 The Supplier shall work to accepted procedures required for implementing their accepted Quality Assurance Program. These procedures shall be accepted by the Supplier with SRR option to review prior to receiving Notice to Proceed for that particular phase of work.

3.7.4.3 Supplier shall develop and submit a QA overview briefing that will be accepted by SRR. Personnel performing quality related work will be required to receive this QA overview. Minimum attributes of this briefing shall include:

A. Quality control inspection procedure – development, reports, records
B. Nonconformance's
C. Design control
D. Training and qualifications
E. Nuclear culture requirements for performing nuclear grade work
F. Development and importance of document control and configuration control
G. Methods to ensuring trained personnel on compliance to procedures
H. Need for corrective action program
I. Critical need for work planning systems
J. Importance of timeliness
K. Expectation to apply graded approach in Nuclear Safety Related SSC versus critical components for reliability, attainability, code compliance, and low risk components
L. Expectation on high quality technical and quality submittals
M. Subcontractors review responsibilities

3.7.4.4 SRR will perform periodic audits and assessments to ensure work performance of suppliers meets the applicable requirements for environment, safety, and health, and quality assurance. The Supplier shall support the execution of these audits by attending meetings, supporting interviews, and supplying information and documents as requested.

3.7.5 Commercial Grade Dedicated Systems, Structures, and Components

3.7.5.1 When used by the Supplier, dedication of commercial grade items shall be performed in accordance with their SRR accepted procedure per ASME-NQA-1. Supplier shall submit for SRR approval their procedure describing the dedication process, the plan/approach for the affected item, and the results from implementation of the plan. Items subject to this process must be accepted by SRR before use in the final assembly.

A. Submit commercial grade dedication (CGD) process / procedures.
B. Submit commercial grade dedication plan, including:
   1. Identify the items to be procured via CGD.
   2. Identify the item's critical characteristics (as derived by the nuclear safety analysis), which will be verified for acceptance of the item.
   3. Identify the proposed source for procurement of the item, including any source evaluation/selection planned or previously performed.
C. Submit CGD packages for each item or groups of items, including the following:
   1. Identify the critical safety and design functions performed by the item.
   2. Describe the item's suitability to meet required safety and design functions.
   3. Identify the item's critical characteristics required to be verified for acceptance of the item.
   4. Identify the source for procurement of the item, including any source evaluation/selection process performed.

5. Identify the method(s) used to verify the item's critical characteristics for acceptance.

D. Submit a CGD close-out package at the completion of procurement activities, including:

1. A listing of items upgraded.
2. Cross reference each item to the individual CGD packages.
3. Records of acceptance activities for each item.

3.7.6 Quality Inspection Plans (QIP) for TCCR System Installation at Site

3.7.6.1 The Supplier shall submit a QIP for TCCR System installation at the Site.

3.7.6.2 Requirements to be specified for inspections delineated in the QIP shall include but are not limited to:

A. Inspection and test requirements
B. Method to be used to conduct the inspections and tests
C. Witness and Hold points, In-Process and Final Inspection, as applicable
D. Acceptance criteria, including tolerances

3.7.6.3 Requirements for documenting results:

A. Identification of the organization responsible for performing the inspection (i.e., implementing agency)
B. Independent Inspection and Peer Inspection consistent with guidance in section 4 and 5 below and the Supplier's QAP.

3.7.6.4 The Supplier shall evaluate the processes, activities, and items to establish the level, extent and acceptance criteria for inspections. Examples of attributes that may require inspection are:

A. Item or system completeness
B. Markings
C. Calibration and adjustments
D. Protection from damage

3.7.6.5 The basis for assignment, level, and intensity of inspection applied to processes, activities, and items shall be directly related to the functional classification. The basis shall also be commensurate with the importance of a process, activity, or item's function to human health, safety, nuclear safety, effect on the environment, reliability, maintainability, and operability. Factors to be included in establishing inspection activities are:

A. Requirements of codes and standards.
B. The consequence of malfunction or failure.
C. The design and fabrication complexity or uniqueness.
D. The need for special controls and surveillance over processes and equipment including In-Service Inspection of specified structures, systems, components, and related activities.
E. The degree to which functional compliance can be demonstrated by inspection or test.
F. The quality history and degree of standardization.
G. The difficulty of correction, repair, or replacement.

H. The requirements of applicable instructions, procedures, drawings, specifications, codes and standards.

3.8 Welding Requirements

3.8.1 Welding shall be in accordance with applicable codes referenced herein.

3.8.1.1 Pipe welding shall be performed per the requirements of ASME B31.3.

A. For jacketed waste transfer lines, the core line requires 100% visual and 100% RT/UT examination using ASME B31.3 Normal Fluid service weld inspection criteria. The jacket requires 100% visual examination and 5% RT/UT. Severe cyclic criteria apply when the piping complies with the ASME B31.3 definition of severe cyclic.

3.8.1.2 Pressure vessel welding shall be performed in accordance with ASME BPVC Section IX.

3.8.1.3 Tanks shall be welded according to the requirements of API-620 or API-650 depending on applicability.

3.8.1.4 Structural Welding

A. Carbon steel structural components shall be welded according to AWS-D1.1 or ASME BPVC Section IX.

B. Aluminum structural components shall be welded according to AWS-D1.2 or ASME BPVC Section IX.

C. Sheet steel structural components shall be welded according to AWS-D1.3 or ASME BPVC Section IX.

D. Stainless steel structural components shall be welded according to AWS-D1.6 or ASME BPVC Section IX.

3.8.1.5 Welding of steel sheet for HVAC ducting (not for pipe used as ducts) shall be done in accordance with AWS-D9.1 or ASME BPVC Section IX.

3.8.1.6 Lifting frame(s) welding shall meet the requirements of AWS D14.1/D14.1M.

3.8.1.7 External welds that could come in contact with radioactive material shall be ground smooth and have a surface finish suitable to perform penetrant examinations.

3.8.1.8 Stainless steel brushes, free of dirt and grease and either new or only previously used on stainless steel or nickel alloys shall be used to clean between passes and on completed welds.

A. Weld filler material shall match the base material being joined.

B. Thermal cutting process: the cut surface shall be ground or machined to remove adhering slag, gouges, and discoloration to produce a bright clean surface.

C. Temporary carbon steel clamps, supports, braces, etc. shall not be welded directly to any stainless steel used for fabrication.

D. Use Gas Tungsten-Arc Welding process on containment or pressure retaining components.

3.8.1.9 Do not exceed the maximum preheat and inter-pass temperature of 350°F (176.7°C) for the welding of austenitic stainless steels.

3.8.1.10 Welding Procedures and Verification

A. Submit Welding Procedure Specifications (WPS)

B. Submit procedure qualification records per the requirements of ASME BPVC Section IX.

C. Submit weld repair procedures to SRR before any repairs are performed (if needed).

D. Submit welding verification reports.

3.8.1.11 Weld Maps

A. Prepare weld maps for piping, piping components, vessels and structural components.

1. List each weld joint and identify the WPS and nondestructive examination procedures to be used for the joint.

2. Each weld map is to contain the following information, as a minimum:

a. WPS and PQR for each joint

b. Base metal type, grade, and thickness at each joint

c. Type of joint (B-full penetration butt-weld, P-partial penetration weld, O-overlay, C-cladding, F-Fillet) including weld symbols in accordance with AWS-A2.4.

d. Whether back gouge and back welding will be performed

e. Post weld heat treatment, if required

f. Notch toughness testing, if required

B. Submit preliminary weld maps for each system assembly.

C. Following weld map acceptance perform fabrication recording welder identification on weld map in appropriate location for each weld segment.

D. Submit final weld map report.

3.9 Special Processes

3.9.1 Material Control

3.9.1.1 Materials of construction are required to bear identification markings.

3.9.1.2 Wire brushes, steel wool or similar items or tools used for conditioning and cleaning the surfaces, shall be made from 300 series stainless steel and shall not have been previously used.

3.9.1.3 The exterior surface of components may be used for material control markings.

A. Restrict exterior markings to electro-etching or vibro-etching.

B. Crayon markings are not permissible, except for temporary markings.

3.9.1.4 Minimize chloride induced stress corrosion cracking to stainless steel materials by employing the following:

A. Coatings, gaskets, o-rings, v-rings, tape, coverings, insulation, markers, adhesives, sealants, lubricants; and any other material that comes in to contact with stainless steel (including packaging) shall contain less than 250 ppm total chloride content.

B. Primary materials used in the following applications are excluded from the scope of this requirement:

1. Structural steel

3.9.1.5 Material Control Procedure

A. Prepare a material control procedure, to define (at a minimum) methods for the following:

1. Segregation

2. Material control

3. Identification of the pressure retaining materials.

4. Traceability of material to the Supplier purchase order numbers, part numbers, material type or grade.

B. Submit material control procedure.

3.9.2 Material Test Reports

3.9.2.1 Submit Material Test Reports (MTRs) for each heat and lot of materials used for:

A. Metallic parts used in fabrication of safety significant and safety class pressure boundary systems, components and module structures (including pressure boundary parts and the piping, tubing and nozzle supports).

3.9.3 Cleaning and Surface Finish Requirements

3.9.3.1 Surface Finish Requirements

A. All surfaces in contact (or potentially in contact) with radioactive material shall be finished smooth, free of pits, gouges, crevices, porosity, inclusions and indentations to facilitate decontamination.

B. Remove weld splatter, sharp edges, corners, projections, pits, scratches, or other sharp depressions, and surface irregularities.

1. All nicks and gouges less than or equal to 0.012 inch deep may be removed by blend grinding.
2. All nicks and gouges greater than 0.012 inch deep shall be filled with weld metal and ground smooth.

C. Smooth bumps or depressions on welds and other non-machined surfaces are acceptable.

D. Blend grinding is permitted as long as the metal thickness is not reduced more than 12% of the nominal material thickness.

E. Unless otherwise required by a code or standard invoked by this SOW, standard mill surface finish is acceptable.

F. Coatings

1. Submit coating procedures to SRR for acceptance.
2. The exterior surface of all process components shall be provided with a chemically resistant coating.
3. Coat carbon steel exterior surfaces that could be in contact (or potentially in contact) with radioactive materials.
4. Apply one coat Poxy Coat® II[9] (or equal) per manufacturer instructions.
5. Balance of exterior surfaces shall be coated with a suitable coating compatible with environmental conditions.

3.9.3.2 Pressure Vessels Surface Finish Requirements

A. Sheet metal: 7 GA or less shall be No. 2B mill finishes in accordance with ASTM-A480/A480M.

B. Plate: greater than 7 GA, #1 hot rolled annealed pickled finish in accordance with ASTM-A480/A480M.

C. Structural shapes: standard mill finish.

D. Machined surfaces: 125 RMS or better.

[9] Poxy Coat® is registered trademark of K. Coatings, LLC, P.O. Box 241037, Cleveland, Ohio 44124.

3.9.3.3 Cleaning Requirements

A. Submit system and pipe cleaning instructions or procedures to SRR.

B. Cleaning methods and materials (cleaning solutions) used for cleaning shall be compatible with the materials of construction of the piping system and component being cleaned. Special consideration should be given to nonmetallic and nonferrous materials.

C. Use of tools (such as those used for grinding, polishing, filing, deburring, and brushing) shall be controlled during fabrication when surface contamination of the component from such tools is considered an important factor.

D. Consideration shall be given in the design of piping systems and components that require cleaning to minimize the presence of crevices, pockets, blind holes, undrainable cavities, and other areas in which dirt, cleaning solutions, or sludge might lodge or become trapped, and to provide for effective circulation and removal of cleaning solutions.

E. Consideration shall be given in the design of piping systems and components for piping systems or components that are cleaned in place to:

1. Slope lines for drainage.
2. Provide vents at high points and drains at low points of system.
3. Arrange for removal or isolation of components that might be damaged by the cleaning solution or fumes from the cleaning solutions.
4. Provide means for attaching temporary fill and circulation lines.
5. Provide for examination of cleaned surfaces.

3.9.3.4 Required Cleanliness Levels

NOTE: It is difficult in maintaining the level of cleanliness delineated below for carbon steel and low-alloy steel surfaces after cleaning.

A. For Corrosion Resistant Alloys - The surface shall appear metal clean and free of organic films and contaminants when examined in accordance with Paragraph 7.2.1 of ASTM A380, except light deposits of atmospheric dust are permissible and shall show no evidence of deleterious contamination when subjected to the wipe test of Paragraph 7.2.2 of ASTM A380. When visual inspection is impossible but surfaces are accessible for wipe tests, sufficient wipe tests in different areas of the item shall be made to evaluate the general cleanness level of the surface. Scattered areas of rust are permissible, provided the aggregate area does not exceed 2 in^2 in any 1 ft^2 area (14 cm^2 per 1000 cm^2). Temper films and discolorations resulting from welding are acceptable.

B. For Carbon and Low-Alloy Steels -The surface shall appear metal clean when examined in accordance with Paragraph 7.2.1 of ASTM A380, except light deposits of atmospheric dust are permissible, and shall show no harmful contamination when subjected to the wipe test of Paragraph 7.2.2 of ASTM A380. Wipe tests shall be made prior to the application of any preservative film (some type of protective film may be required in order to maintain a clean carbon or low-alloy steel surface at Class B level). When visual inspection is impossible, but surfaces are accessible for a wipe test, sufficient wipes of different areas of the item shall be made to evaluate the general cleanness of the surface. Scattered areas of rust are permissible, provided the aggregate area does not exceed 2 in^2 in any 1 ft^2 area (14 cm^2 per 1000 cm^2).

C. For Corrosion-Resistant Alloys and Carbon and Low-Alloy Steels - If flushing is the only practical method for evaluating the cleanness of internal surfaces, a 20-

mesh (850 µm, ASTM E11) or finer filter (or the equivalent) shall be installed and the item flushed with water, air, inert gas, or other fluid as accepted by Engineering. The item shall be flushed at the design velocity or other flow velocity if specified by Engineering until the screen shows no more than slight speckling (as specified in the cleaning instruction in qualitative or quantitative terms, such as the number of particles per unit surface of the screen) and no more than slight rust staining. There shall be no particles larger than 1/32 in. × 1/16 in. long (0.8 mm x 1.6 mm). In water-flushed systems there shall be no visual evidence of contamination (e.g., oil, discoloration) of the effluent flush water or screen.

D. Small Diameter Tubing - Cleanness criteria for small diameter piping and tubing systems shall be taken from ASME NQA-1.

3.9.3.5 Cleaning Methods

A. Cleaning procedures shall address, at a minimum, the following requirements:

1. Identification of equipment cleaning to be performed prior to shipping.
2. Identification of equipment cleaning to be performed at SRS prior to tie-in operation.
3. Cleaning methods to be employed.
4. Inspection methods to be employed for the determination of cleanliness.
5. Acceptance criteria with specific limits.
6. Cleaning verification report contents
7. Clean the inner and outer surfaces of the system components to remove foreign matter such as grease, oil, dirt, tape adhesives, weld splatter, paint, metal chips, filings, slag, flux, scale, rust and other types of contamination.
   a. Cleanliness Class B in accordance with ASME NQA-1, Part II, Subpart 2.1.
8. Use new mechanical cleaning tools (e.g. grinding wheels) or tools previously used only on austenitic stainless steel or nickel alloys.
9. Clean, descale and passivate stainless steel parts in accordance with ASTM-A380.
10. Clean stainless steel prior to, during, and after fabrication by employing one or more of the following cleaning methods:
    a. A detergent wash followed by thorough water flush.
    b. Solvent solutions containing less than 250 ppm total chlorides followed by thorough water flush.
    c. Steam and detergent.
    d. If contamination of the steel is such that acid cleaning is required, the cleaning method employed to remove the contamination shall be dependent upon the composition and heat treatment condition of the stainless steel.
11. Stainless steel components shall not be sand blasted, bead blasted or painted. During the cleaning process of all assemblies, controls shall be exercised during all stages of stainless steel equipment fabrication to minimize exposure of the metal to contaminants, particulates, and chlorides that can cause stress corrosion cracking.

3.9.3.6 Cleaning Verification

A. Visually examine cleaned system components and stainless steel parts to verify cleanliness requirements are met and record results in a cleaning verification report.

B. Submit Cleaning Verification Reports that contain the following, at a minimum:

1. Equipment identification
2. Supplier's procedure used
3. Specific inspection results
4. Signature of inspector
5. Date of inspection.

3.10 Supplier Records

3.10.1.1 Retain documents and other records generated during the course of the subcontract, to include but not limited to:

A. Contract documents and associated SDDR (OSR 45-4).

B. Engineering and quality documentation submittals.

C. Any document generated for this contract (e.g. procedures, reports, certifications, qualifications, letters, etc.) not required as a submittal (e.g. "in-process" quality assurance records).

3.10.1.2 The records shall be accessible to SRR, upon request, during fabrication and the retention period.

3.10.1.3 Records shall be retained by the Supplier for not less than five (5) years after completion.

A. Make retained records available to SRR upon request within 45 days during the retention period.

B. Dispose of retained records after the retention period in accordance with Supplier's records management program.

C. SRR shall be notified no less than 90 days before the end of the retention period.

3.11 Schedule

3.11.1 Submit a manufacturing schedule.

3.11.1.1 The schedule start date shall be based on the purchase order award date. The schedule shall include summary level activities and detailed activities.

A. Material procurements

B. Supplier Submittals

C. Fabrication

D. Inspection, testing, report preparation and execution

E. Packaging

F. Delivery

3.11.1.2 The Supplier shall participate in a weekly teleconference meeting with SRR to review the following:

A. Supplier performance over the previous period, including a review and update of the Supplier's Manufacturing Schedule. The Supplier shall update and issue the schedule weekly before the weekly teleconference.

B. Identification of technical issues and action items.

C. Status of previously defined action items. The Supplier shall update and issue an Action List weekly before the weekly teleconference.

3.11.1.3 The following review and progress meetings shall be held at the Supplier's facility or as required to facilitate the manufacturing progress.

A. Conceptual technical review and schedule meeting, 15 days After Receipt of Order (ARO).

B. Prefabrication review meeting. Topics of discussion to include:

1. Requirements of drawings and this specification.
2. Details of inspection and surveillance activities associated with this specification.
3. Required inspections will be planned and coordinated so as not to jeopardize the promised delivery date.
4. Specific contact points (name, address, telephone number) will be identified at this meeting for each SSR expected to be involved through completion of the subcontract.
5. Verification of SRR accepted EDR documents that require submittal prior to fabrication and Supplier personnel qualifications.
6. CGD implementation strategy.

C. Ad Hoc meetings, as needed, as issues arise which need resolution.

3.12 Personnel Qualification and Certification

3.12.1 Personnel performing activities affecting quality shall be qualified or certified in accordance with the Supplier's Quality Assurance Program.

3.12.2 Submit the following personnel qualification and/or certification records:

A. Welder qualifications
B. NDE personnel qualifications
C. Hydrostatic test personnel qualifications
D. System test personnel qualifications
E. Applicable standards personnel qualification(s)
F. Quality control personnel qualifications
G. Lead auditor certifications

3.13 Deliverables (including submittals)

3.13.1 Deliver the TCCR System and any special tools (if any) to:

Savannah River Site
H-Tank Farm, Bldg. 241-910H
SRR Purchase Order No.: _____ (Defined on Award)
Aiken, SC 29808
Attention: _____(Defined on Award)

3.13.1.1 Submit the documents identified on the Quality Verification Documents (Attachment 5.2) to SRR at the time of shipment.

A. Itemize the documentation according to the listing in Attachment 5.2.
B. Enclose the complete set in a weather resistant envelope.

C. Mark the envelope "Receipt Inspection Documentation"

D. Include the envelope with the shipment.

3.13.2 Submittals

3.13.2.1 The Supplier shall submit Engineering Documentation as identified on Engineering Document Requirements (EDR) form (Attachment 5.1). The identified documents shall be provided for the components and subcomponents provided by the Supplier as part of this Purchase Order.

3.13.2.2 Engineering Document Requirements (EDR) submittals shall be directed by email to Cognizant Technical Function (CTF) _____ and Buyer _____ (defined upon award). Supplier shall place the purchase order number and EDR document Description in the email title. It is preferred to have only one EDR document per email; however multiple PDF files may be combined into a one ZIP file to reduce transmittal size. A maximum of 30 MB per email is allowed. The SRR Purchase Order number, SRR Project Number, and EDR Document Description shall be included in the body of the email. Supplier shall attach a PDF version of the document to the body of the email. The native file(s) shall be labeled original media.

3.13.2.3 Resubmittal of documents must include the SRR document number. This document number can be found on cover page status strip formatted as purchase order number, sheet number and revision number. Any corrections made to document submitted previously shall be made by revision of the document with appropriate reviews and signatures. Resubmit entire document with new revision.

3.13.2.4 Each document listed on the QVDR, Attachment 5.2 shall be included with the shipment including the QVDR.

3.13.2.5 Other communications shall be directed to:

Savannah River Site
Building 707-9B, Room 1
Aiken, SC 29808
Attention: Procurement Representative (Name to be provided at time of award)

3.13.2.6 Engineering documents submitted per the EDR, Attachment 5.1, shall be processed as follows:

A. Engineering documents will be reviewed and processed by SRR within 15 calendar days from the date of receipt.

B. The documents will be returned to the suppliers with status as follows:

Status 1: Work may proceed.

Status 2: Submit final documentation. Work may proceed.

Status 3: Revise and resubmit. Work may proceed subject to resolution of indicated comments.

Status 4: Revise and resubmit. Work may not proceed.

Status 5: Permission to proceed not required

C. Documents with a status of 2, 3, or 4 shall be revised to incorporate the SRR comments and resubmitted to SRR for review and acceptance within 15 calendar days from the date of Supplier receipt.

3.13.2.7 Status 1 or Status 5 Engineering Documents shall not be changed without notifying SRR.

A. Status 1 or Status 5 Engineering Documents that are changed shall be resubmitted to SRR for review and acceptance.

3.13.2.8 Assignment of Status 1 or Status 5 to the Engineering Documents by SRR does not relieve the Supplier of any part of their obligation:

A. To satisfy the requirements defined in this SOW.

B. For the correctness of Engineering Documents.

C. For the adequacy and suitability of material and equipment represented.

3.13.2.9 The use of recycled paper with a maximum of 25% recycled content is acceptable.

A. Provide reproducible documentation, where specified in Attachment 5.1, suitable for image scanning, using black lines on white background.

3.14 Packaging, Handling, Shipping, and Storage Requirements

3.14.1 Submit a packaging, handling, and shipping procedure including, at a minimum, the following:

3.14.1.1 Items and their containers shall be identified in accordance with the marking requirements.

3.14.1.2 Packaging

A. Before packaging an item, dirt, oil, residue, water, metal chips, or other forms of contamination shall be removed using SRR-accepted packaging procedures.

B. Equipment openings shall be sealed to prevent entry of foreign material and humidity.

C. Items not immediately packaged shall be protected from the environment.

D. The equipment shall be mounted as necessary to prevent damage.

1. The equipment shall be protected by means of padded dunnage, plastic wrappings, or equal to prevent damage during shipment and storage at SRS.
2. Shipping containers or crates shall be of sufficient structural integrity to enable unloading and transportation by a crane or forklift without failure.
3. Items packaged in containers shall be blocked, anchored, braced, and/or cushioned to prevent physical damage to the item.
4. Carbon steel shall not come in direct contact with stainless steel components.

3.14.1.3 Handling

A. Any special handling devices needed for assembly or installation of equipment shall be identified as special equipment and supplied with the TCCR System.

3.14.1.4 Shipping

A. Parts/pieces shall be labeled and traceable to applicable drawings, Supplier purchase orders and MTRs (when applicable).

B. In addition to the documentation of Attachment 5.2, submit a detailed packing list for each container in the shipment.

1. The packing list shall identify every item in the shipment and, at a minimum, include the following:
   a. Shipping container in which item is shipped.
   b. Manufacturer and model number, as applicable
   c. Material type, as applicable
   d. Installation drawing reference
   e. Weight of item
   f. Quantity of item

C. Boxed or crated components shall be blocked and securely fastened on the carrier vehicle to prevent shifting, crushing, or bumping during transport.

D. Documentation required per 5.2 shall be packaged and included with the final shipment.

3.14.2 Submit a storage procedure including, at a minimum, the following

A. Any special storage requirements and conditions for the TCCR System SSC.

B. Include periodic maintenance requirements for SSCs in storage.

3.15 Marking and Identification Requirements

3.15.1 The English language shall be used for markings and identification.

3.15.2 Item Marking

3.15.2.1 General Nameplate or tag requirements:

A. Nameplate and tag identification shall be stamped on 300 series stainless steel tag using minimum ¼" high lettering.

B. The nameplate shall depict the following minimum information:

1. Plant: Savannah River Site
2. Tank Closure Cesium Removal System
3. SRR purchase order number
4. Weight (only for components requiring lifting device handling)

C. Printing or stencil marking directly on the equipment is not acceptable.

D. The nameplate shall be attached by seal welding (not on pressure retaining components), permanent adhesive, or stainless steel wire to the equipment.

3.15.2.2 Lifting and Hoisting Marking Requirements

A. Lifting points shall be permanently marked on SSC.

B. Identify on each SSC requiring lifting device (crane, forklift, jib) handling:

1. Lifting points
2. Total weight (dry weight).
3. Lifting method.

3.15.2.3 The direction of shaft rotation shall be permanently marked on each TCCR System motor casing.

3.15.2.4 Loose equipment: nameplate(s) shall be attached to loose equipment with stainless steel (300 series) wire.

3.15.3 Shipping container markings shall be in accordance with the following:

3.15.3.1 Container markings shall appear on a minimum of two (2) sides of the container, preferably on one side and one end.

3.15.3.2 References to weights shall be in pounds.

3.15.3.3 Container markings shall be applied with waterproof ink or paint in characters that are legible.

3.15.3.4 Information relative to handling and special instructions shall be shown and such information shall be preceded by the word CAUTION in letters that are at least 1 inch (25.4 mm) high, as permitted by the container size.

3.15.3.5 Where container tags or labels are used, they shall be affixed to the container using a waterproof adhesive, tacks where practical or a corrosion-resistant wire.

3.15.3.6 Container markings are to include the following minimum information:

A. Destination

B. Return address

C. Package number showing the SRR purchase order number, followed by the package number and the total number of packages

D. Handling instructions (e.g., Fragile, Center of Gravity, Keep Dry, This Side Up, Sling Here, Do Not Freeze) and stacking limitations, as appropriate

E. Weight of package

3.16 Deviations

3.16.1 After award of the contract, a SDDR form (OSR 45-4) shall be prepared for each supplier proposed deviation from the technical or quality requirements of this procurement.

3.16.2 SDDRs (OSR 45-4) shall be submitted to SRR for review and disposition. For each deviation, the Supplier shall:

3.16.2.1 Identify the SOW and revision number.

3.16.2.2 Identify the criteria that cannot be met by item and SOW section number.

3.16.2.3 Present an explanation for the deviation.

3.16.2.4 Present a proposal for resolution of the deviation.

3.16.2.5 Provide a supporting technical justification.

3.16.2.6 Present a price and schedule adjustment for resolution of the deviation.

3.16.3 Do not perform any work or make delivery of any item for which an SDDR (OSR 45-4) is submitted until a written disposition of the SDDR is received from SRR.

3.16.4 After award of the contract, an SDDR form (OSR 45-4) shall be prepared and submitted to document disposition of non-conformances from the SOW (including accepted drawings and documents) where the Supplier wishes to request a "Use-As-Is" or "Repair" disposition.

NOTE: A Nonconformance (disposition status: USE AS IS or Repair) shall be identified on an SDDR and SRR notified within 5 working days of discovery.

3.16.4.1 For each nonconformance where a "Use-As-Is" or "Repair" disposition is being requested, the Supplier shall submit the following information on the associated SDDR (OSR 45-4) for SRR for review and disposition:

A. Identify the drawing and/or document number and revision number.

B. Identify the criteria that cannot be met. Include SOW section number as applicable.

C. Present an explanation for the nonconformance.

D. Present a proposed disposition for the nonconformance.

E. Submit a supporting technical justification for the adequacy of the proposed disposition.

F. Present a price and schedule adjustment for resolution of the nonconformance.

3.16.4.2 Replacement of rejected materials or other rework of equipment such that it is restored to a configuration that meets the SOW/approved design does not require an SDDR (OSR 45-4).

4.0 ACCEPTANCE OF EQUIPMENT AND SERVICES

4.1 Inspection / Examination / Testing Requirements

4.1.1 General Requirements

4.1.1.1 SRR shall be notified at least 5 working days in advance of any SRR Hold Points.

4.1.2 Inspections

4.1.2.1 Requirements for the Quality Control Inspection Plan and Final Quality Control Inspection report are delineated in Section 3.7.2.1.

4.1.2.2 Cross reference the activities in the plan to the individual inspection, examination, and testing records transmitted periodically to SRR on an agreed-to schedule (e.g., weekly, monthly).

4.1.2.3 Applicable Standard Inspections

A. Prepare Applicable Inspection/Examination Procedures that comply with the requirements of the applicable standards and this SOW.

B. Submit Applicable Standard Inspection Procedures.

C. Perform inspections using accepted procedures.

D. Submit Applicable Standard Inspection reports signed by the Supplier's quality assurance representative.

4.1.3 Examinations

4.1.3.1 Applicable Standard Examinations

A. For examinations required by applicable standards, prepare applicable examination procedures that comply with the requirements of the applicable standards and this SOW.

B. Submit Applicable Standard Examination Procedures.

C. Perform examinations using accepted procedures.

D. Submit Applicable Standard Examination reports signed by the Supplier's quality assurance representative.

4.1.4 Tests

4.1.4.1 Applicable Standard Test(s)

A. Submit Applicable Standard Test Procedures.

B. Perform applicable standard test using accepted procedures **(Hold Point)**

C. Submit Applicable Standard Test Reports.

4.1.4.2 Lifting Lug, Bails and Yokes Proof Test

A. Prepare a lifting lug, bails and yokes proof test procedure that includes:

1. Compliance with ASME-B30.20 and DOE STD 1090.
2. Use 125% of the weight of assembled component.
3. Hold for a minimum of 10 minutes.
4. Plumb test for SSCs:
   a. Lift using the lifting yoke to verify achievement of plumb and level orientation.
   b. Verify each SSC hangs plumb within +/- ¼ inch over a 10 ft. span when in the vertical position.

B. Submit Lifting Lug, Bails and Yokes Proof Test Procedure.

C. Perform lifting lug, bails and yokes proof test using accepted procedure **(Hold Point)**

D. After proof test, perform NDE inspections to determine if any deformation or stress cracking has occurred at the trunnions, lifting lugs, or at the TCCR System attachments or reinforcements.

1. Visually examine 100% of the welds on the trunnions, lifting lugs, attachments or reinforcements to the TCCR System.
2. Perform 100% liquid penetrant examination of the welds on the trunnions, lifting lugs, attachments or reinforcements to the TCCR System.

E. Submit Lifting Lug, Bails and Yokes Proof Test Report.

4.1.4.3 Measuring and Test Equipment (M&TE)

A. Submit M&TE calibration procedures to SRR for acceptance

B. Calibrate M&TE instruments according to SRR accepted procedures.

C. Submit M&TE calibration records to SRR for acceptance.

4.1.5 Factory Acceptance Test

4.1.5.1 As part of the FAT, the Supplier shall supply sufficient salt waste simulant to conduct the test. The Supplier is responsible for disposing materials and consumables used in the performance of the FAT.

A. Submit to SRR

1. The simulant preparation and verification procedure acceptance before manufacture.
2. Certified composition of the simulant before performing the FAT.

4.1.5.2 The Supplier shall submit a detailed FAT procedure for SRR for acceptance. As the minimum, the following items shall be included.

A. Pre-Startup

1. Mechanical system integrity tests
2. Instrumentation calibration
3. Leak detection and confinement tests
4. Electrical wiring verification and continuity
5. System logic and interlock testing
6. Valve operation and alignment

B. Cold Run

1. Confinement ventilation system tests
2. Normal operations using simulant
   a. Flow testing, hydraulics, and calibration
3. Filter performance
4. Column performance
   a. Verification of bed integrity throughout column life
5. Abnormal operations tests (trips, etc.)
6. Infrequent operations (e.g., flushing)
7. Safe shut down demonstration
8. Pre-filter cleaning or flushing capability

C. Maintenance

1. Pre-filter removal or replacement demonstration
2. Disconnect, removal and replacement of the ion exchange column (for non-elutable resin systems)
3. Resin removal from the column, replenishment of the ion exchange resin, and (for elutable resin systems) removal of the cesium-rich eluate from the system.
4. De-watering or solidification demonstration.

D. Storage System Testing

1. Demonstration of preparing and packaging of the resin and/or eluate for storage at ISS.
2. Demonstrate packaged resin and/or eluate meets the performance requirements in Sections 3.1.2.6.A.1, 2, 3.a, 3.b, 4, and 6.

E. Ion Exchange Column Testing

1. Demonstrate or record the following:
   a. Column differential pressure and flow (including face velocity and interstitial velocity).
   b. Absence of channeling.
   c. DELETED

OPTION: A suitable surrogate exhibiting similar physical and hydraulic characteristics to the proposed resin may be used in lieu of the proposed resin for the FAT with permission from SRR.

4.1.5.3 The Supplier shall perform an FAT **(Hold Point)**

4.1.5.4 The Supplier shall submit a report of the results of the FAT.

NOTE ON REPORTING COLUMN PERFORMANCE TESTING: Documentation shall address that differences in the TCCR feed stream versus prior R&D or operational experience are insignificant to the overall performance of the resin.

4.2 SRR Surveillance and Audits

4.2.1 SRR will perform audits, assessments, or surveillances during the fabrication and testing

4.2.2 SSR Activities

4.2.2.1 The SSR will perform the following actions defined as Hold Points before release for shipment:

A. Witness Supplier testing and review reports to ensure compliance with this SOW. **(Hold Point)**

B. Verify marking and identification is in accordance with Marking and Identification Requirements (Section 3.15). **(Hold Point)**

C. Visually examine items that are accessible without disassembly for general workmanship, cleanliness, and quality (Section 3.9.3). **(Hold Point)**

D. Verify packaging and shipping preparation to ensure SOW compliance before shipment. **(Hold Point)**

E. Verify that each component of Supplier packing list is included in the shipment. **(Hold Point)**

F. Verify the following:

1. The documents in Attachment 5.2 (Quality Verification Document Requirements) to ensure SOW compliance before shipment. **(Hold Point)**
2. The documents in Attachment 5.1 (Engineering Document Requirements) to ensure compliance to this SOW. **(Hold Point)**

NOTE: Verification may be accomplished via mail or electronic document transfer (e.g., email, FAX) at the discretion of the SSR.

4.2.2.2 After completion of the above, the SSR will sign the QVDR prior to release for shipment. **(Hold Point)**

4.3 Final Acceptance

4.3.1 SRR acceptance is defined as:

4.3.1.1 SRR assignment of Status 1 or 5 (in accordance with the "Submittals" section of this SOW) of Documents identified in the EDR (Attachment 5.1).

4.3.1.2 Successful completion of the Factory Acceptance Test (FAT).

4.3.1.3 Receipt inspection at the Savannah River Site which will consist of the following:

A. Verify SRR assignment of Status 1 or 5 (in accordance with the "Submittals" section of this SOW) of Documents identified in Attachment 5.1.
B. Verify acceptance of the documents list on the QVDR form (Attachment 5.2) has been included with the shipment and signed by the Supplier and SSR.
C. Visual inspection of equipment, structures, welds for shipping damage, oil or other forms of contaminants.
D. Verify that items are received as listed by the Supplier enclosed packing list.
E. Verify that items are received as listed by the purchase order.

5.0 ATTACHMENTS

5.1 Engineering Document Requirements with Instructions (7 pages)

5.2 Quality Verification Document Requirements with Instructions (2 pages)

5.3 Supplier Quality Assurance Program Requirements (4 pages)

5.4 TCCR System Process Area and Access (2 pages)

5.5 Responsibilities and Interfaces (3 pages)

5.6 Simulated Salt Solution Composition for TCCR Systems (1 page)

5.7 Process Utilities (1 page)

5.8 CLD Graphic Symbols (1 page)

5.9 Tank 10H Transfer Pump Curve (1 page)

Engineering Document Requirements

NOTE: Once accepted, the Baseline Schedule completion dates for individual deliverables will supersede the submittal schedule shown here in column 5.

1. Document Category Number	2. Specification Paragraph Reference	3. Document Description	4. Permission to Proceed Required		5. Submittal Schedule	6. Quantity Required		7. Kind of copies	8. Remarks
			Yes	No		Init	Final		
8.0	3.1.2.4.E	Technical data for resin, consumables, and ISS storage equipment	X		Physical and chemical composition of resin submitted BEFORE AWARD Remaining data at 90% Design	1	1	Repro-ducible	
8.0	3.1.2.4.F	Report on resin and column design performance.	X		At 50% Design	1	1	Repro-ducible	
1.0	3.1.2.6.B	Design of equipment stored at ISS	X		At 90% Design	1	1	Repro-ducible	
8.0	3.1.3.3.C.1	Limited life materials list	X		Before fabrication	1	1	Repro-ducible	
8.0	3.1.3.3.C.2	Equipment exposure radiation dose calculations	X		At 90% Design	1	1	Repro-ducible	
8.0	3.1.3.3.I	Information on lubrication fluids	X		At 90% Design	1	1	Repro-ducible	
22.0	3.1.3.10.G.7.a	Visual examination of pipe welds procedure	X		Before fabrication	1	1	Repro-ducible	
6.0	3.1.3.10.G.7.c	Visual examination of pipe welds report	X		Before FAT	1	1	Repro-ducible	
20.0	3.1.3.10.G.8.a	Volumetric examination of pipe welds procedure	X		Before fabrication	1	1	Repro-ducible	
6.0	3.1.3.10.G.8.c	Volumetric examination of pipe welds report	X		Before FAT	1	1	Repro-ducible	
8.0	3.1.3.10.G.20	Unlisted component evaluation	X		Before fabrication	1	1	Repro-ducible	
17.1	3.1.3.10.G.22.a.5)	Material compatibility documentation	X		Before fabrication	1	1	Repro-ducible	
8.0	3.1.3.10.G.22.a.8)	Manufacturer's confirmation of service experience	X		Before fabrication	1	1	Repro-ducible	
8.0	3.1.3.10.G.22.a.10)	Periodic replacement plan for hoses (if applicable)	X		Before fabrication	1	1	Repro-ducible	
8.0	3.1.3.10.K.13.m.3)	Rotor lateral modal analysis	X		Before fabrication	1	1	Repro-ducible	
8.0	3.1.3.10.M.7.c.3) a)	List of recommended interlocks to protect equipment and to limit radioactive releases	X		Before fabrication	1	1	Repro-ducible	

Engineering Document Requirements

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1. Document Category Number	2. Specification Paragraph Reference	3. Document Description	4. Permission to Proceed Required		5. Submittal Schedule	6. Quantity Required		7. Kind of copies	8. Remarks
			Yes	No		Init	Final		
8.0	3.1.3.10.N.1	Process control software documentation	X		Before fabrication	1	1	Reproducible	
8.0	3.1.3.11.B	Utility requirements	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.2	3.1.3.12.D.2	Pre-filter recycle core line size (if applicable)	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.13.A	Shielding, containment, confinement, and ventilation plan	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.C.6	Interface control document	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.C.7	Document index	X		At 90% Design	1	1	Reproducible	
1.6	3.1.3.18.C.8	Drawing Legend	X		At 90% Design	1	1	Reproducible	
1.6	3.1.3.18.C.9	Block flow diagrams	X		4 weeks after award	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.6	3.1.3.18.C.10	Process flow diagrams	X		4 weeks after award	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.6	3.1.3.18.C.11	P&IDs	X		4 weeks after award	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.1	3.1.3.18.C.12	Equipment location drawing	X		At 90% Design	1	1	Reproducible	
1.2	3.1.3.18.C.13	Assembly drawings	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.1	3.1.3.18.C.14	Layout drawings	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.1	3.1.3.18.C.15	Architectural drawings	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.3	3.1.3.18.C.16	Vessel and tank drawings	X		At 90% Design	1	1	Reproducible	
1.1	3.1.3.18.C.17	Structural drawings	X		At 90% Design	1	1	Reproducible	
1.1	3.1.3.18.C.18	Instrument location drawings	X		At 90% Design	1	1	Reproducible	

Engineering Document Requirements

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1. Document Category Number	2. Specification Paragraph Reference	3. Document Description	4. Permission to Proceed Required		5. Submittal Schedule	6. Quantity Required		7. Kind of copies	8. Remarks
			Yes	No		Init	Final		
1.5	3.1.3.18.C.19	Control logic drawings	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.4	3.1.3.18.C.20	Electrical single line drawings	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.4	3.1.3.18.C.21	Electrical schematics	X		At 90% Design	1	1	Reproducible	
1.5	3.1.3.18.C.22	Analog control logic documents	X		At 90% Design	1	1	Reproducible	
1.5	3.1.3.18.C.23	I/O summary diagram	X		At 90% Design	1	1	Reproducible	
1.6	3.1.3.18.C.24	Instrument data sheets	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.2.a	Structural calculations	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.2.b	Lifting, rigging, and lifting lug calculations	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.3	HVAC calculations	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.4	Hydraulic calculations	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.5.a	Pressure vessel calculations	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.5.b	Pressure vessel verification record	X		Before fabrication	1	1	Reproducible	
8.0	3.1.3.18.D.5.c	Overpressure protection report for vessels meeting ASME Section VIII UG-140 provisions (if applicable)	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.6	ASME B31.3 code calculations (minimum wall thickness, pipe stress, unlisted component)	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.7.d	Pressure relief device calculations	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.7.e	Pressure relief device verification record	X		Before fabrication	1	1	Reproducible	
8.0	3.1.3.18.D.8	Emission rate calculation	X		At 90% Design	1	1	Reproducible	

Engineering Document Requirements

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1. Document Category Number	2. Specification Paragraph Reference	3. Document Description	4. Permission to Proceed Required		5. Submittal Schedule	6. Quantity Required		7. Kind of copies	8. Remarks
			Yes	No		Init	Final		
8.0	3.1.3.18.D.9	Mass and energy balance calculations	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.D.10	Shielding calculations	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
1.6	3.1.3.18.E.1.b	Instrument index	X		At 90% Design	1	1	Reproducible	
1.6	3.1.3.18.E.1.c	Piping index	X		At 90% Design	1	1	Reproducible	
3.0	3.1.3.18.E.2	CLI / MEL datasheet	X		At 90% Design	1	1	Reproducible	
4.0	3.1.3.18.E.4	Calibration requirements document	X		Before FAT	1	1	Reproducible	
2.0	3.1.3.18.E.5.a	Parts list	X		At 90% Design	1	1	Reproducible	
2.0	3.1.3.18.E.5.a	Spare parts list	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.E.6	System design description	X		At 90% Design	1	1	Reproducible	
25.0	3.1.3.18.E.7	Applicable standards identification report	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.E.7.c	Justification for using other codes and addenda	X		At 90% Design	1	1	Reproducible	
3.0	3.1.3.18.E.8.b	Component datasheets	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.E.10	Ergonomic analysis report	X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.E.11	Matrix of applicable standards tests	X		Before fabrication	1	1	Reproducible	
8.0	3.1.3.18.E.12	Pressure protection design study	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
8.0	3.1.3.18.E.13	Requirements compliance matrix	X		Before fabrication	1	1	Reproducible	
4.1	3.2.1	Installation instructions	X		At 50% Design	1		Reproducible	Preliminary
			X		At 90% Design	1	1	Reproducible	
4.1	3.2.2	Startup procedure	X		At 90% Design	1	1	Reproducible	
4.2 4.3	3.2.3	Operations and maintenance manuals	X		At 90% Design	1	1	Reproducible	
6.0	3.7.1.2	QA program manual	X		Before award	1	1	Reproducible	

Engineering Document Requirements

NOTE: Once accepted, the Baseline Schedule completion dates for individual deliverables will supersede the submittal schedule shown here in column 5.

1. Document Category Number	2. Specification Paragraph Reference	3. Document Description	4. Permission to Proceed Required		5. Submittal Schedule	6. Quantity Required		7. Kind of copies	8. Remarks
			Yes	No		Init	Final		
8.0	3.7.1.5	Submit NQA-1 experience of key sub-tier suppliers	X		Before fabrication	1	1	Repro-ducible	
6.0	3.7.1.6	Configuration management plan	X		Before Design	1	1	Repro-ducible	
6.0	3.7.2.1.E	Quality control inspection plan	X		Before fabrication	1	1	Repro-ducible	
6.0	3.7.2.1.G	Final quality control inspection report	X		Before shipment	1	1	Repro-ducible	
6.0	3.7.4.3	QA overview briefing	X		Before Design	1	1	Repro-ducible	
6.0	3.7.5.1.A	CGD process and procedures	X		Before Design	1	1	Repro-ducible	
6.0	3.7.5.1.B	CGD plan	X		At 90% Design	1	1	Repro-ducible	
6.0	3.7.5.1.C	CGD packages	X		Before fabrication	1	1	Repro-ducible	
6.0	3.7.5.1.D	CGD close-out packages	X		Before shipment	1	1	Repro-ducible	
6.0	3.7.6.1.A	QIP for TCCR System installation at the Site	X		Before shipment	1	1	Repro-ducible	
12.0	3.8.1.10.A	Welding procedure specification	X		Before fabrication	1	1	Repro-ducible	
12.0	3.8.1.10.B	Welding procedure qualification records	X		Before fabrication	1	1	Repro-ducible	
12.0	3.8.1.10.C	Welding repair procedures (if applicable)	X		Before fabrication	1	1	Repro-ducible	
12.0	3.8.1.10.D	Welding verification reports	X		Before FAT	1	1	Repro-ducible	
12.0	3.8.1.11.B	Preliminary weld map report	X		Before shipment	1	1	Repro-ducible	
12.0	3.8.1.11.D	Final weld map report	X		Before FAT	1	1	Repro-ducible	
13.0	3.9.1.5	Material control procedure	X		Before fabrication	1	1	Repro-ducible	
13.0	3.9.2.1	Material test reports	X		Before FAT	1	1	Repro-ducible	
15.0	3.9.3.1.F.1	Coating procedures	X		Before fabrication	1	1	Repro-ducible	
15.0	3.9.3.3.A	System and pipe cleaning instructions or procedures	X		Before fabrication	1	1	Repro-ducible	
15.0	3.9.3.6	Cleaning verification reports	X		Before shipment	1	1	Repro-ducible	
5.0	3.11.1	Manufacturing schedule	X		Before Design	1	1	Repro-ducible	
28.0	3.12.2	Personnel qualification and certification records	X		Before fabrication	1	1	Repro-ducible	

Engineering Document Requirements

NOTE: Once accepted, the Baseline Schedule completion dates for individual deliverables will supersede the submittal schedule shown here in column 5.

1. Document Category Number	2. Specification Paragraph Reference	3. Document Description	4. Permission to Proceed Required		5. Submittal Schedule	6. Quantity Required		7. Kind of copies	8. Remarks
			Yes	No		Init	Final		
29.0	3.14.1	Packaging, handling, and shipping procedure	X		Before shipment	1	1	Repro-ducible	
29.0	3.14.1.4.B	Packing list	X		Before shipment	1	1	Repro-ducible	
8.0	3.14.2	Storage procedure	X		Before shipment	1	1	Repro-ducible	
25.0	4.1.2.3.B	Applicable standard inspection procedures	X		Before fabrication	1	1	Repro-ducible	
6.0	4.1.2.3.D	Applicable standard inspection reports	X		Before FAT	1	1	Repro-ducible	
25.0	4.1.3.1.B	Applicable standard examination procedures	X		Before fabrication	1	1	Repro-ducible	
6.0	4.1.3.1.D	Applicable standard examination reports	X		Before FAT	1	1	Repro-ducible	
25.0	4.1.4.1.A	Applicable standard test procedures	X		Before fabrication	1	1	Repro-ducible	
6.0	4.1.4.1.C	Applicable standard test reports	X		Before FAT	1	1	Repro-ducible	
26.1	4.1.4.2.B	Lifting lug, bails and yokes proof test procedure	X		Before fabrication	1	1	Repro-ducible	
26.1	4.1.4.2.E	Lifting lug, bails and yokes proof test report	X		Before shipment	1	1	Repro-ducible	
6.0	4.1.4.3.A	M&TE calibration procedures	X		Before fabrication	1	1	Repro-ducible	
6.0	4.1.4.3.C	M&TE calibration records	X		Before FAT	1	1	Repro-ducible	
8.0	4.1.5.1.A.1	Simulant preparation and verification procedure	X		Before fabrication	1	1	Repro-ducible	
8.0	4.1.5.1.A.2	Certified composition of the simulant	X		Before FAT	1	1	Repro-ducible	
26.0	4.1.5.2	Functional acceptance test procedures	X		At 90% Design	1	1	Repro-ducible	
6.0	4.1.5.4	Functional acceptance test results report	X		Before shipment	1	1	Repro-ducible	

Engineering Document Requirements
Form Instructions

Purpose The Engineering Document Requirements (EDR) form is prepared by the originator establishes a basis for actions required of a Supplier and provides the schedule for the submittal of engineering documents by the Supplier.

Legend Entry

No.	Information Required
1	Document category number – see below.
2	Applicable Specification number and appropriate paragraph.
3	Description corresponding to document category number.
4	Permission to proceed with fabrication or other specific processes is marked yes, if required.
5	List a milestone after award i.e., before fabrication, before test, before shipment, or with shipment that the listed document is to be submitted by Supplier.
6	Number of copies required for submittal.
7	Reproducible, Mylar, Vellum, etc.
8	Enter remarks when appropriate.

Document Category Number and Descriptions

1.0 Drawings
- 1.1 Outline Dimensions, Services, Foundations and Mounting Details – Drawings providing external envelope, including lugs, centerline(s), location and size for electrical cable, conduit, fluid, and other service connections, isometrics and details related to foundations and mountings.
- 1.2 Assembly Drawings – Detailed drawings indicating sufficient information to facilitate assembly of the component parts of an equipment item.
- 1.3 Shop Detail Drawings – Drawings which provide sufficient detail to facilitate fabrication, manufacture, or installation. This includes pipe spool drawings, internal piping and wiring details, cross-section details and structural and architectural details.
- 1.4 Wiring Diagrams – Drawings which show schematic diagram equipment, internal wiring diagrams, and interconnection wiring diagram for electrical items.
- 1.5 Control Logic Diagrams – Drawings which show paths which input signals must follow to accomplish the required responses.
- 1.6 Piping and Instrumentation Diagrams – Drawings which show piping the System scheme and control elements.

2.0 Parts Lists and Costs – Sectional view with identified parts and recommended spare parts for one year's operation and specified with unit cost.

3.0 Complete SRR Data Sheets – Information provided by Supplier on data sheets furnished by SRR.

4.0 Instructions
- 4.1 Erection/Installation – Detailed written procedures, instructions, and drawings required to erect or install material or equipment.
- 4.2 Operations – Detailed written instructions describing how an item or the System should be operated.
- 4.3 Maintenance – Detailed written instructions required to disassemble, reassemble and maintain items or the Systems in an operating condition.
- 4.4 Site Storage and Handling – Detailed written instructions, requirements and time period for lubrication, rotation, heating, lifting or other handling requirements to prevent damage or deterioration during storage and handling at jobsite. This includes shipping instruction for return.

5.0 Schedules: Engineering and Fabrication/Erection – Bar charts or critical path method diagram which detail the chronological sequence of activities, i.e., Engineering submittals, fabrication and shipment.

6.0 Quality Assurance Manual/Procedures – The document(s) which describe(s) the planned and the Systematic measures that are used to assure that structures, the Systems, and components will meet the requirements of the procurement documents.

7.0 Seismic Data Reports – The analytical or test report which provides information and demonstrates suitability of material, component or the System in relation to the conditions imposed by the stated seismic criteria.

8.0 Analysis and Design Reports – The analytical data (stress, electrical loading, fluid dynamics, design verification reports, etc.) which demonstrate that an item satisfies specified requirements.

9.0 Acoustic Data Reports – The noise, sound and other acoustic vibration data required by the procurement documents.

10.0 Samples
- 10.1 Typical Quality Verification Documents – A representative data package which will be submitted for the items furnished as required in the procurement documents.
- 10.2 Typical Material Used – a representative example of the material to be used.

11.0 Material Descriptions – The technical data describing a material which a Supplier proposes to use. This usually applies to architectural items, e.g., metal siding, decking, doors, paints, coatings.

12.0 Welding Procedures and Qualifications – The welding procedure, Statement of Work and supporting qualification records required for welding, hard facing, overlaying, brazing and soldering.

13.0 Material Control Procedures – The procedures for controlling issuance, handling, storage and traceability of materials such as weld rod.

14.0 Repair Procedures – The procedures for controlling materials removal and replacement by welding, brazing, etc., subsequent thermal treatments, and final acceptance inspection.

15.0 Cleaning and Coating Procedures – The procedures for removal of dirt, grease or other surface contamination, and preparation and application of protective coatings.

16.0 Heat Treatment Procedures – The procedures for controlling temperatures and time at temperature as a function of thickness, furnace atmosphere, cooling rate and methods, etc.

19.0 UT – Ultrasonic Examination Procedures – Procedures for detecting discontinuities and inclusions in materials by the use of high frequency acoustic energy.

20.0 RT – Radiographic Examination Procedures – Procedures for detecting discontinuities and inclusions in materials by x-ray or gamma ray expose of photographic film.

21.0 MT – Magnetic Particle Examination Procedures – Procedures for detecting surface or near surface discontinuities in magnetic materials by the distortion of an applied magnetic field.

22.0 PT – Liquid Penetrant Examination Procedures – Procedures for detecting discontinuities in materials by the application of a penetrating liquid in conjunction with suitable developing materials.

23.0 Eddy Current Examination Procedures – Procedures for detecting discontinuities in materials by distortion of an applied electromagnetic field.

24.0 Pressure Test – Hydro, Air, Leak, Bubble or Vacuum Test Procedures – Procedures for performing hydrostatic or pneumatic structural integrity and leakage tests.

25.0 Inspection Procedures – Organized process followed for the purpose of determining that specified requirements (dimensions, properties, performance results, etc.) are met.

26.0 Performance Test Procedures – Test performed to demonstrate that functional design and operational parameters are met.
- 26.1 Mechanical Tests – e.g., pump performance, data, valve stroking, load, temperature rise, calibration, environmental, etc.
- 26.2 Electrical Test – e.g., impulse, overload, continuity, voltage, temperature rise, calibration, saturation, loss, etc.

27.0 Prototype Test Reports – Reports of a test which is performed on a standard or typical examination of equipment or item, and which is not required for each item produced in order to substantiate the acceptability of equal items. This may include tests which result in damage to the item(s) tested.

28.0 Personnel Qualification Procedures – Procedures for qualifying welders, inspectors and other special process personnel.

29.0 Supplier Shipping Preparation Procedures – Procedures used by a Supplier to prepare finished materials or equipment for shipment from its facility to the jobsite.

Quality Verification Document Requirements

1. Document Category Number	2. Specification Paragraph Reference	3. Document Description	4. SSR Release	5. SRR Receipt Inspection Check-In	6. Remarks	7. DOC Supplier Page Count
22.0	3.1.3.10.G.7.c	Visual examination of pipe welds report	Y			
20.0	3.1.3.10.G.8.c	Volumetric examination of pipe welds report	Y			
17.1	3.1.3.10.G.22.a.5)	Material compatibility documentation	Y			
18.0	3.1.3.18.D.5.b	Pressure vessel verification record	Y			
18.0	3.1.3.18.D.5.c	Overpressure protection report for vessels meeting ASME Section VIII UG-140 provisions (if applicable)	Y			
18.0	3.1.3.18.D.7.e	Pressure relief device verification record	Y			
25.0	3.7.2.1.G	Final quality control inspection report	Y			
25.0	3.7.5.1.C	CGD packages	N			
25.0	3.7.5.1.D	CGD close-out packages	Y			
12.0	3.8.1.10.B	Welding procedure qualification records	Y			
12.0	3.8.1.10.D	Welding verification reports	Y			
12.0	3.8.1.11.D	Final weld map report	Y			
17.1	3.9.2.1	Material test reports	Y			
15.0	3.9.3.6	Cleaning verification reports	Y			
25.0	3.12.2	Personnel qualification and certification records	N			
25.0	4.1.2.3.D	Applicable standard inspection reports	Y			
25.	4.1.3.1.D	Applicable standard examination reports	Y			
25.0	4.1.4.1.C	Applicable standard test reports	Y			
26.1	4.1.4.2.E	Lifting lug, bails and yokes proof test report	Y			
25.0	4.1.4.3.C	M&TE calibration records	Y			
26.0	4.1.5.4	Functional acceptance test results report	Y			
25.0	3.14.1.4.B	Packing list	N			

Quality Verification Document Requirements
Form Instructions

Purpose The Quality Verification document Requirements (QVDR) is initiated by SRR and completed by the Supplier when providing quality verification documents. The QVDR is a multipurpose form to

Transmit quality verification documents from the Supplier,
Provide evidence of SSR release of documentation and /or work, and
Provide evidence of an SRR inspection check of documentation received at SRS.

SRR Entries

Entry No.	Information Required
1	Enter Document Category Number – see below.
2	Enter Specification Number and Paragraph Reference.
3	Enter Description corresponding to the Document Category Number.
4	SSR to initial upon item release.
6	Enter "Remarks: as appropriate.
16	SSR and dates release.

Field Entries

Entry No.	Information Required
5	SRR inspector at the jobsite to complete check-in.
17	The SRR inspector will review the quality verification documentation package. If found satisfactory, he signs and dates the check-in statement.

Supplier Entries

Entry No.	Information Required
7	Enter number of pages of quality verification document being submitted.
8	Enter information required.
9	Enter information required.
10	Enter information required.
11	Enter the quantity of units covered by the documents submitted. For each item on Entry No. 12 being released, provide a separate copy of this completed form and the supporting quality verification documents.
12	Enter information required.
13	Enter information required.
14	Enter information required.
15	Supplier – Signature of an employee authorized to sign such documents.

Document Category Numbers and Descriptions

12.0 Welding Verification Reports – Reports of welding performed to include weld identification, and certification that qualified welding procedures and welders were used.
13.0 Material Verification Reports – Reports relative to material which confirm, substantiate or assure that an activity or condition has been implemented in conformance with code and material Statement of Works imposed by the procurement documents.
14.0 Major Repair Verification Reports – Reports may include weld repair locations (maps), material test reports for filler metal, pre- and post-weld heat treatment records, NDE records, etc. The resolution of whether a repair is major or not is an SRR responsibility.
15.0 Cleaning and Coating Verification Reports – Reports include a certification of visual examination for surface preparation, surface profile, materials, etc.; and also humidity data, temperature data and coating thickness data as required by the procurement documents.
16.0 Heat Treat Reports – Reports normally include furnace charts and similar records which identify and certify the item(s) treated, the procedure used, furnace atmosphere, time at temperature, cooling rate, etc.
17.0 Material Property Reports
- 17.1 MTR (Material Test Reports) – These reports include chemical, physical, mechanical, and electrical property test data required by the material Statement of Work and applicable codes. These are applicable to cement, concrete, metals, cable jacket materials, rebar, rebar splices, etc.
- 17.2 Impact Test Data – Reports of Charpy or drop weight tests including specimen configuration, test temperature and fracture data.
- 17.3 Ferrite Data – Reports of the ferrite percentage for stainless steel materials used, including castings and welding filler metals as deposited.
- 17.4 Materials Certificate of Conformance – Documents which certify conformance to the requirements of the applicable material Statement of Work.
- 17.5 Electrical Property Reports – Reports of electrical characteristics, e.g., dielectric, impedance, resistance, flame tests, corona, etc.

18.0 Code Compliance – Verifying documents (such as data Forms U-1, M-2, State, etc.), which are prepared by the manufacturer or installer and certified by the Authorized Code Inspector.
19.0 UT – Ultrasonic Examination and Verification Reports – Examination results of certain characteristics of discontinuities and inclusions in material by the use of high frequency acoustic energy.
20.0 RT – Radiographic Examination and Verification Reports – Examination results of certain characteristics of discontinuities and inclusions in materials by x-ray or gamma ray exposure of photographic film, including film itself.
21.0 MT – Magnetic Particle Examination and Verification Reports – Examination results of surface (or near surface) discontinuities in magnetic materials by distortion of an applied magnetic field.
22.0 PT – Liquid Penetrant Examination and Verification Reports – Examination results of surface discontinuities in materials by application of a penetrating liquid in conjunction with suitable developing techniques.
23.0 Eddy Current Examination and Verification Reports – Examination results of discontinuities in material by distortion of an applied electromagnetic field.
24.0 Pressure Test – Hydro, Air, Leak, Bubble or Vacuum Test and Verification Reports – Results of hydrostatic or pneumatic structural integrity and leakage tests.
25.0 Inspection and Verification Reports – Documented findings resulting from an inspection.
26.0 Performance Test and Verification Reports – Reports of Test Results
- 26.1 Mechanical Test, e.g., pump, performance data, valve stroking, load, temperature rise, calibration, environment, etc.
- 26.2 Electrical Tests, e.g., load, impulse, overload, continuity, voltage, temperature rise, calibration, saturation, loss, etc.

27.0 Prototype Test Report – Report of the test which is performed on a standard or typical example of equipment, material or item, and which is not required for each item produced in order to substantiated the acceptability of equal items. This normally includes tests which may, or could be expected to, result in damage to the item(s) tested.
28.0 Certificate of Conformance – A document signed or otherwise authenticated by an authorized individual certifying the degree to which items or services meet specified requirements.

Supplier Quality Assurance Program Requirements

Attachment No. 5.3
Spec/Req No. X-SOW-H-00002
Revision No. 3

Note to the CTF/CQF:

Level 1 — Procurements require verification of the supplier's quality program through the performance of an evaluation or audit that compares against the national or international consensus standard designated in Section A. Additional verification methods may also be designated in Section C.

Level 2 — Procurements that invoke a supplier quality assurance program, shall require the supplier to provide a copy of their Quality Assurance Manual for an adequacy/concurrence review and may apply the same consensus standard verification process as designated in Section A, otherwise designate at least one alternate evaluation method in Section C. (Ref. 1Q, 7-2; 1Q, 18-3; and 3E, 1.1)

Section A

National Consensus Standards for Supplier Quality Program Requirements are identified, but not limited, to the ones below:

- ☒ ASME/NQA-1 Part I - Nuclear Quality Assurance Program Requirements (Pages 2-4 must be completed)
- ☐ ISO 17025 (Calibration/Testing Standard)
- ☒ ASME Section VIII Division I (Appendix 10)
- ☒ NQA-1, Part II
  - ☒ 2.1 Fluid/Comp Clean
  - ☐ 2.2 Pack/Ship/Rec/Store/Handle
  - ☐ 2.3 Housekeeping
  - ☐ 2.4 IIT Power/Instr/Control Equipment
  - ☐ 2.5 IIT Con/Steel/Soils/Foundation
  - ☒ 2.7 Software
  - ☐ 2.8 IIT Mechanical
  - ☒ 2.14 CGD
  - ☐ 2.15 Hoist/Rig/Transport
  - ☐ 2.18 Maintenance
  - ☐ 2.20 Subsurface
- ☐ Other _____
- ☐ Other _____

NOTE: When necessary, use an attachment to define additional requirements and/or details.

Section B

Clarifications/Exceptions *(as needed)*

Section C

For Level 2 procurements, methods of evaluating supplier's quality assurance program are:

1. The supplier will provide a copy of their Quality Assurance Manual for an adequacy/concurrence review, and
2. One or more of the boxes marked below will also be applied.
   - ☐ Performance of an audit as defined in Section A
   - ☐ Submittal of current applicable ASME certificate
   - ☐ Review of the Suppliers last 12 months of performance history
   - ☐ Supplement audit/evaluation
   - ☒ Document submittals identified on EDR document (e.g., process procedures, welder qualifications, etc.)
   - ☒ Supplier surveillance activities
   - ☐ Receiving Inspection
   - ☒ Other Provide audits and assessments

Attachment No. 5.3
Spec/Req No. X-SOW-H-00002
Revision No. 3

Supplier Quality Assurance Program Requirements *(Continued)*

Applicable Sections of NQA-1-2008, Addenda 2009 Part I Requirements		
Requirements	Required Y / N	**"N" entries - Provide explanation / justification for exclusion "Y" entries - Provide more detail as necessary**
Requirement 1 — Organization		
100 – Basic	Y	
200 – Structure and Responsibility	Y	
300 – Interface Control	Y	
Requirement 2 — Quality Assurance Program		
100 – Basic	Y	
200 – Indoctrination and Training	Y	
300 – Qualification Requirements	Y	
400 – Records of Qualification	Y	
500 – Records	Y	
Requirement 3 — Design Control		
100 – Basic	Y	
200 – Design Input	Y	
300 – Design Process	Y	
400 – Design Analyses	Y	
500 – Design Veritification	Y	
600 – Change Control	Y	
700 – Interface Control	Y	
800 – Software Design Control	Y	
900 – Documentation and Records	Y	
Requirement 4 — Procurement Document Control		
100 – Basic	Y	
200 – Content of the Procurement Documents	Y	
300 – Procurement Document Review	Y	
400 – Procurement Document Changes	Y	
Requirement 5 — Instructions/Procedures/Drawings		
100 – Basic	Y	
Requirement 6 — Document Control		
100 – Basic	Y	
200 – Document Control	Y	
300 – Document Changes	Y	
Requirement 7 — Control of Purchased Items/Services		
100 – Basic	Y	
200 – Supplier Evaluation and Selection	Y	
300 – Bid Evaluation	Y	
400 – Control of Supplier Generated Documents	Y	
500 – Acceptance of Item or Service	Y	
600 – Control of Supplier Nonconformances	Y	
700 – Commercial Grade Items and Services	Y	
800 – Records	Y	

Supplier Quality Assurance Program Requirements *(Continued)*

Attachment No. 5.3
Spec/Req No. X-SOW-H-00002
Revision No. 3

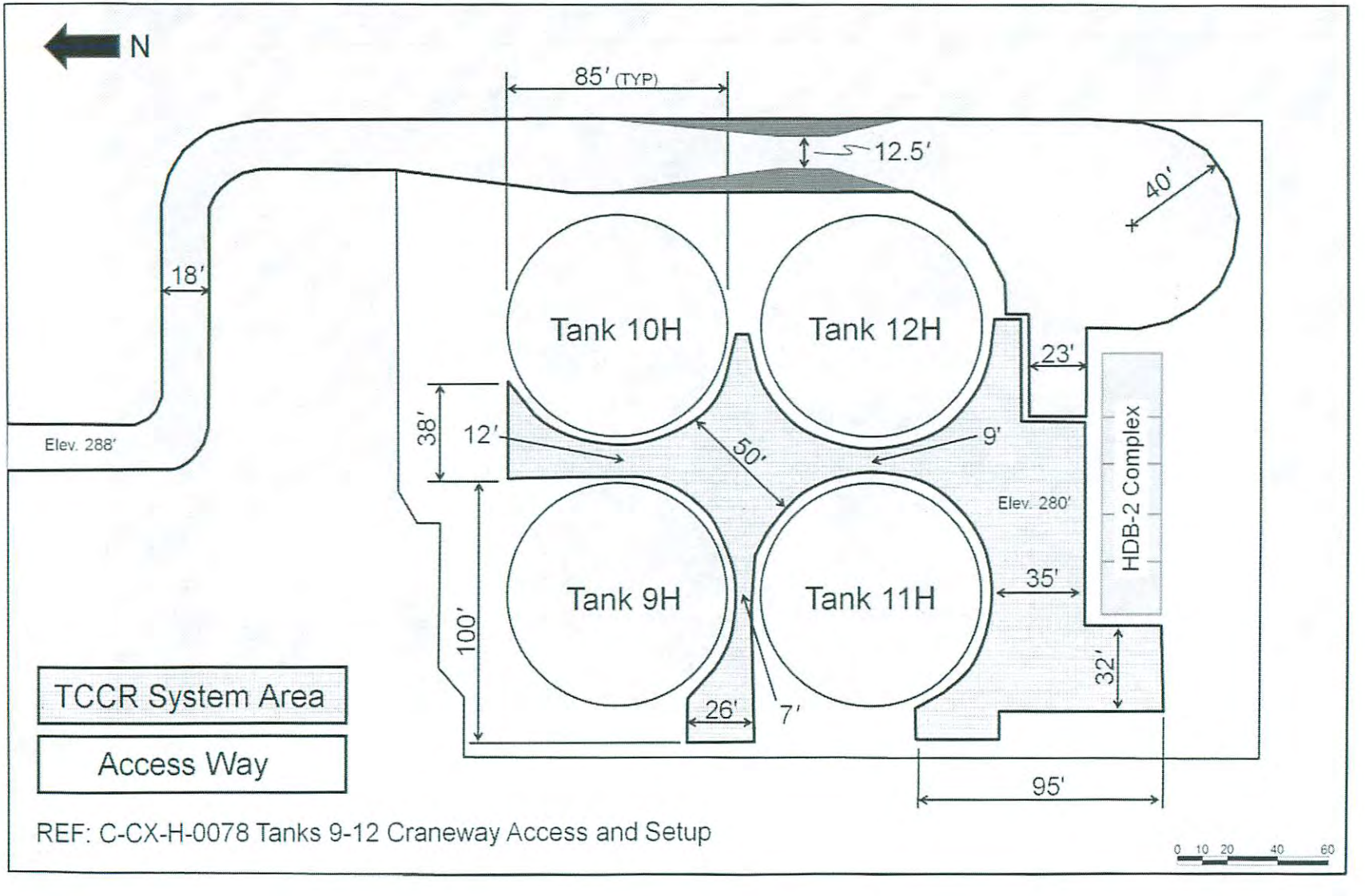
Applicable Sections of NQA-1-2008, Addenda 2009 Part I Requirements *(Continued)*		
Requirements	**Required Y / N**	**"N" entries - Provide explanation / justification for exclusion "Y" entries - Provide more detail as necessary**
Requirement 8 — Identification and Control of Items		
100 – Basic	Y	
200 – Identification Methods	Y	
300 – Specific Requirements	Y	
Requirement 9 — Control of Special Processes		
100 – Basic	Y	
200 – Process Control	Y	
300 – Responsibility	Y	
400 – Records	Y	
Requirement 10 — Inspection		
100 – Basic	Y	
200 – Inspection Requirements	Y	
300 – Inspection Hold Points	Y	
400 – Inspection Planning	Y	
500 – In-Process Inspection	Y	
600 – Final Inspections	Y	
700 – Inspections During Operations	Y	
800 – Records	Y	
Requirement 11 — Test Control		
100 – Basic	Y	
200 – Test Requirements	Y	
300 – Test Procedures	Y	
400 – Computer Program Test Procedures	Y	
500 – Test Results	Y	
600 – Test Records	Y	
Requirement 12 — Control of M&TE		
100 – Basic	Y	
200 – Selection	Y	
300 – Calibration and Control	Y	
400 – Records	Y	
Requirement 13 — Handling, Storage and Shipping		
100 – Basic	Y	
200 – Special Requirements	Y	
300 – Procedures	Y	
400 – Tools and Equipment	Y	
500 – Operators	Y	
600 – Marking or Labeling	Y	
Requirement 14 — Inspection, Test & Operating Status		
100 – Basic	Y	

Attachment No. 5.3
Spec/Req No. X-SOW-H-00002
Revision No. 3

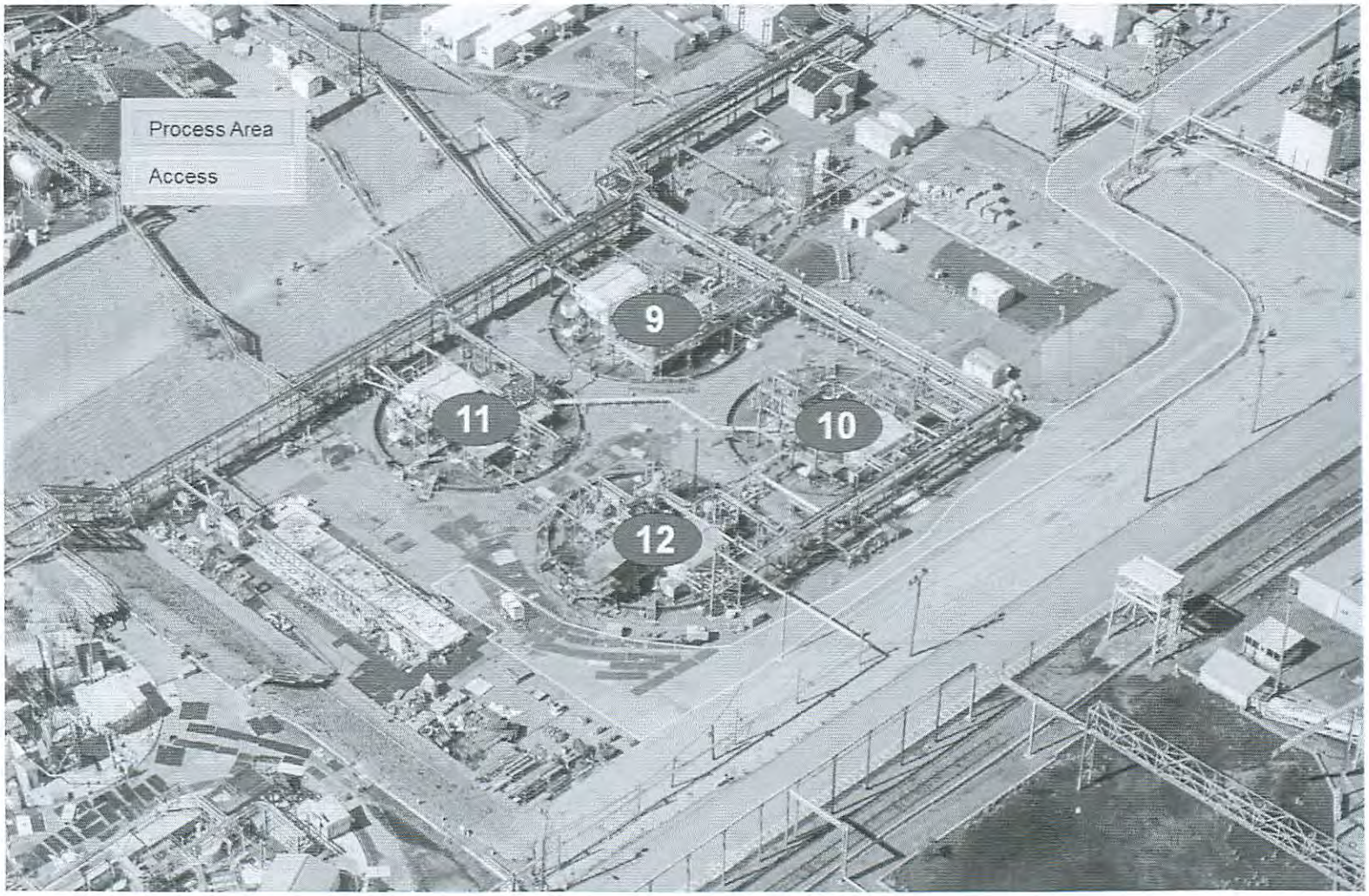
Supplier Quality Assurance Program Requirements *(Continued)*

Applicable Sections of NQA-1-2008, Addenda 2009 Part I Requirements *(Continued)*		
Requirements	**Required Y / N**	**"N" entries - Provide explanation / justification for exclusion "Y" entries - Provide more detail as necessary**
Requirement 15 — Control of Nonconforming Items		
100 – Basic	Y	
200 – Identification	Y	
300 – Segregation	Y	
400 – Disposition	Y	
Requirement 16 — Corrective Action		
100 – Basic	Y	
Requirement 17 — Quality Assurance Records		
100 – Basic	Y	
200 – Generation of Records	Y	
300 – Authentication of Records	Y	
400 – Classification	Y	
500 – Receipt Control of Records	Y	
600 – Storage	Y	
700 – Retention	Y	
800 – Maintenance of Records	Y	
Requirement 18 — Audits		
100 – Basic	Y	
200 – Scheduling	Y	
300 – Preparation	Y	
400 – Performance	Y	
500 – Reporting	Y	
600 – Response	Y	
700 – Follow-up Action	Y	
800 – Records	Y	

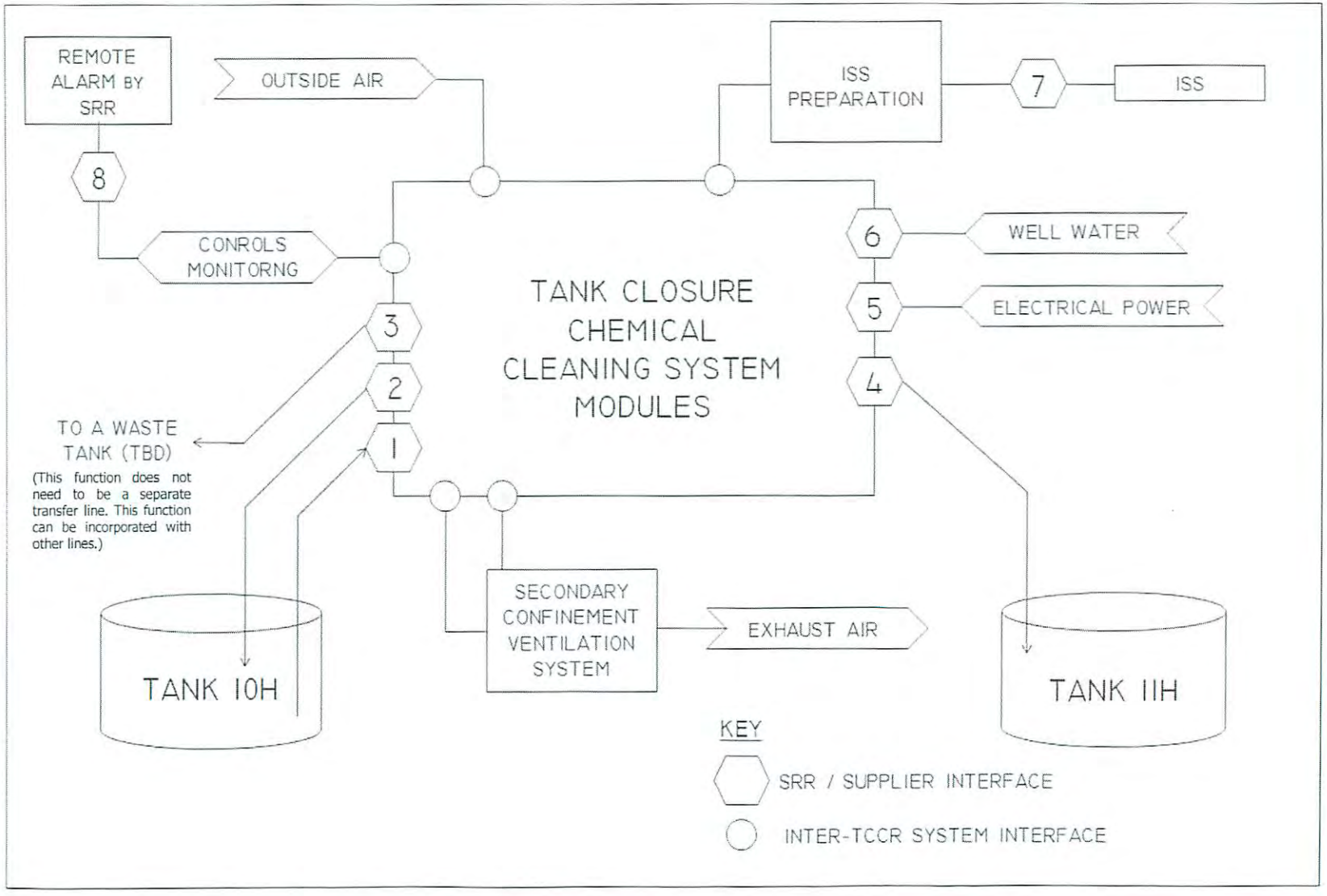
TCCR System Process Area and Access - Plan View



TCCR System Process Area and Access - Aerial View (Looking Northwest)



Responsibilities and Interfaces



Responsibilities and Interfaces

Number	Interface	Interface Connection		Responsibility	
		Size	Type	SRR	Supplier
1	Process feed core pipe from Tank 10H to TCCR System feed line.	1½"	Raised Face Flange	Pump 10H dissolved salt solution to Tank 10H through above grade hose-in-hose to TCCR System boundary.	Provide receiving flange located inside of secondary containment.
	Process feed jacket from Tank 10H to TCCR System secondary containment.	4"	Raised Face Flange	Tank 10H above grade hose-in-hose to TCCR System boundary.	Design jacket line interface at secondary containment.
2	Pre-filtration recycle return core line to recycle return core pipe to Tank 10H.	TBD	Raised Face Flange	Tank 10H above grade hose-in-hose to TCCR System boundary.	If needed, the Supplier to pump pre-filter recycle back to Tank 10H. Provides receiving flange located inside of secondary containment
	TCCR System secondary containment to recycle line jacket to Tank 10H.	TBD	Raised Face Flange	Tank 10H above grade hose-in-hose to TCCR System boundary.	Design jacket line interface at secondary containment.
3	System flush core line to system flush core pipe to LW Tank (TBD)	1½"	Raised Face Flange	LW tank (above grade hose-in-hose) to TCCR System boundary.	Supplier to pump flushing solutions (for pre-filter, column, decon, etc.) to a nearby LW tank (TBD). Provides receiving flange located inside of secondary containment. (Note that this function does not need to be a separate transfer line and can be incorporated with other lines).
	TCCR System secondary containment to system flush line jacket to LW Tank (TBD).	4"	Raised Face Flange	LW tank (above grade hose-in-hose) to TCCR System boundary.	Design jacket line interface at secondary containment.
4	Process discharge core line to process discharge core pipe to Tank 11H.	1½"	Raised Face Flange	Tank 11H above grade hose-in-hose to TCCR System boundary.	Supplier to pump cesium-decontaminated salt solution to Tank 11H. Provides receiving flange located inside of secondary containment.
	TCCR System secondary containment to process discharge line jacket to Tank 11H.	4"	Raised Face Flange	Tank 11H above grade hose-in-hose to TCCR System boundary.	Design jacket line seal.

Number	Interface	Interface Connection		Responsibility	
		Size	Type	SRR	Supplier
5	Electrical Supply connection to TCCR System.	N/A	N/A	Provide 480 VAC	Provide SRR with electrical power needs.
6	Well water flush connection to TCCR System.	2"	Raised Face Flange	From well water header to TCCR System boundary.	Provide receiving flange.
7	Containerized resin and/or eluate to Interim Safe Storage.	N/A	N/A	Provide transportation of containerized resin and/or eluate to ISS.	Provide systems and equipment that will prepare the resin and/or eluate for storage at ISS.
8	Remote alarm contacts at local control panel.	N/A	N/A	Provide signal connection if needed	Provide two sets of dry contacts to support two alarms: 2) system leak into secondary containment; 1) general shutdown.

Simulated Salt Solution Composition for TCCR Systems

Summary

Realistic non-radioactive simulants are needed to perform component testing of the Tank Closure Cesium Removal system. Presented is the average solution that represents a blend of soluble waste in the feed tank. The nominal sodium ion concentration is 4.6-5.4 molar for the feed to the ion exchange column for salt disposition.

Table 1 lists the concentrations the major components.

NOTE: Actual waste will have numerous minor components, particularly hazardous metals such as chromium, but are not included for this simulant composition.

TABLE 1. Composition of Simulated Waste Salt Solutions

Component	Concentration (molar) Average*
Na^+	4.6-5.4
OH^-	2.00 (min)
NO_3^-	2.20
NO_2^-	0.50
Inert solids	400-500 ppm***

* Feed stream concentrations

** DELETED

***Inert insoluble solids with particle sizes ranging from 5-177 microns

Requirements and Notes

1. Filter insoluble solids to remove particles greater than 177 microns (nominal)
2. Ensure solutions are cooled to room temperature and aged for at least 24 hours before filtering.
3. DELETED
4. The solution should equilibrate long enough after preparation to avoid concerns from slow precipitation (24 hours). Best practice will include a second hold period and a second filtration.

Process Utilities

Fluid	Operating Conditions	ASME Fluid Service	Design Pressure and Temperature (psig/°F)
Well Water (WW)	100 gpm @ 60 psig and ambient °F	Normal	155 / 105

Well Water Characteristics

pH 4.2-4.7
Iron ..... 0.8 mg/l
Total suspended solids ..... < 5 mg/L
Total dissolved solids ..... 35 mg/L
Silica ..... 10 mg/L
Magnesium ..... 0.4 mg/L
Manganese ..... 0.02 mg/L
Chloride ..... 2.5 mg/L
Sulfate ..... 12 mg/L
Nitrate ..... 0.02 mg/L
Carbon dioxide ..... 35 mg/L
Total hardness ..... 4 mg/l as $CaCO_3$

Electrical Power: The Supplier to provide requirements. Limit voltage to 480 VAC (3 phase)

FUNCTION	SYMBOL	DEFINITION
MANUAL INPUT		MOMENTARY HAND SWITCH INPUT TO LOGIC MAINTAINED HAND SWITCH INPUT TO LOGIC
AND		OUTPUT EXISTS ONLY WHEN ALL INPUTS ARE PRESENT
OR		OUTPUT EXISTS ONLY WHEN ONE OR MORE INPUTS ARE PRESENT
NOT		OUTPUT EXISTS ONLY WHEN INPUT IS NOT PRESENT
ON DELAY	SEC	OUTPUT EXISTS ONLY WHEN INPUT HAS BEEN CONTINUOUSLY PRESENT FOR A PRESET TIME AND REMAINS PRESENT.
OFF DELAY (TIMED MEMORY)	SEC	OUTPUT EXISTS ONLY WHEN INPUT IS PRESENT AND FOR A PRESET TIME AFTER THE INPUT IS NOT PRESENT.
MEMORY	S R	SET OUTPUT EXISTS WHEN SET INPUT IS PRESENT AND CONTINUES UNTIL THE RESET INPUT IS PRESENT.
COINCIDENCE MATRIX	A/B	OUTPUT EXISTS ONLY WHEN AT LEAST A OUT OF B INPUTS ARE PRESENT SIMULTANEOUSLY.
PULSE GENERATOR	P (*)	*PULSE WIDTH, TIME, AND/OR FREQUENCY MAY BE SPECIFIED
LOW BISTABLE	L SP	DIGITAL OUTPUT EXISTS ONLY WHEN ANALOG INPUT IS LOWER THAN SET POINT.
HIGH BISTABLE	SP H	DIGITAL OUTPUT EXISTS ONLY WHEN ANALOG INPUT IS HIGHER THAN SET POINT.
ISOLATION	ISO	OUTPUT IS ELECTRICALLY ISOLATED FROM INPUT.
TEST DEVICE	T TEST	TEST SIGNAL CAN BE INSERTED MANUALLY IN PLACE OF NORMAL SIGNAL.
LIGHT		FOR LENS COLOR , SEE TABLE THIS DRAWING.
ANNUNCIATOR		INPUT TO ANNUNCIATOR
OUTPUT ACTION STATEMENT	START	ACTION DESCRIPTOR
	START STOP	LOGIC "1" (PREFERRED FOR DCS) LOGIC "0"
DISTRIBUTED CONTROL SYSTEM (DCS)	DI DCS	DIGITAL INPUT TO DCS
	DCS DO	DIGITAL OUTPUT FROM DCS
	A A	LOGIC CONTINUATION WITHIN DRAWING. ARROW ALWAYS POINTS IN DIRECTION OF CONTINUATION. ALPHA CHARACTER APPEARS IN BUBBLE TO DISTINGUISH MULTIPLE SETS OF CONTINUATIONS (SHOULD ONLY USE UNIQUE PAIRS) ALPHA CHARACTER
	J-J2-X-XXXX(XX)	LOGIC CONTINUATION TO ANOTHER DRAWING DRAWING COORDINATES DRAWING NUMBER

AUTOMATED CONTROL SYSTEM SYMBOLS

SYMBOLOGY TO BE USED IN OPERATOR INTERFACE SECTION OF CONTROL LOGIC DIAGRAMS

	PRIMARY LOCATION NORMALLY ACCESSIBLE TO OPERATOR	AUXILLARY OPERATOR INTERFACE DEVICE	NOT NORMALLY ACCESSIBLE TO OPERATOR
SHARED DISPLAY/ SHARED CONTROL (DCS)			
COMPUTER FUNCTION (NON-DCS)			
PROGRAMMABLE LOGIC CONTROL (PLC)			
DCS OPERATOR INTERFACE - HAND SWITCH INPUT			

INDICATOR LIGHT COLORS

EXISTING PLANT CONVENTION: MODIFICATION TO OR NEW DESIGN IN EXISTING FACILITIES WHERE THIS CONVENTION IS USED, SHALL OBSERVE THE SAME CONVENTION SHOWN IN THIS TABLE.

FACILITIES	SYMBOL	COLOR	DEFINITION
NONPOWER	R	RED	ABNORMAL OPERATION, ALL INSTRUMENT ALARMS, EQUIPMENT NOT OPERATING OR IS DE-ENERGIZED, VALVE CLOSED, SWITCHGEAR BREAKER CLOSED AND TRIP CIRCUIT CONTINUOUS (LOCAL)
	G	GREEN	NORMAL OPERATION, EQUIPMENT OPERATING OR IS ENERGIZED, VALVE OPEN, SWITCHGEAR BREAKER OPEN AND CONTROL POWER AVAILABLE (LOCAL)
POWER 4000-OTHER	R	RED	NORMAL OPERATION, EQUIPMENT OPERATING OR IS ENERGIZED, VALVE OPEN, SWITCHGEAR BREAKER CLOSED AND TRIP CIRCUIT CONTINUOUS
	G	GREEN	ABNORMAL OPERATION, EQUIPMENT NOT OPERATING OR IS DE-ENERGIZED, VALVE CLOSED, SWITCHGEAR BREAKER OPEN AND CONTROL POWER AVAILABLE
ALL	W	WHITE	GENERAL INFORMATION OR INSTRUCTIVE
	A	AMBER	CAUTION, WARNING OR ALERT. ABNORMAL OPERATION UNDER SUCH CONDITIONS AS LIMIT SWITCHES OR SAFETY INTERLOCKS BEING BYPASSED FOR START-UP, EMERGENCY OPERATION, ETC.
	B	BLUE	MOTOR NOT RUNNING OR EQUIPMENT DE-ENERGIZED, AS A NORMAL NONALARM OR NONFAILURE SITUATION.
	C	CLEAR	OTHER FUNCTIONAL OPERATIONS AS INDICATED ON DRAWINGS WHICH SHOW DETAILED FUNCTIONAL DESCRIPTION.

NEW FACILITY DESIGN: THE CONVENTION BELOW CONFORMS TO EXISTING POWER FACILITIES AND ANSI C37.11 AND NEMA ICS-2, IT SHALL BE USED FOR THE DESIGN OF NEW FACILITIES.

ALL	R	RED	NORMAL OPERATION, EQUIPMENT OPERATING OR IS ENERGIZED, VALVE OPEN, SWITCHGEAR BREAKER CLOSED AND TRIP CIRCUIT CONTINUOUS (NOTE 11)
	G	GREEN	ABNORMAL OPERATION, EQUIPMENT NOT OPERATING OR IS DE-ENERGIZED, VALVE CLOSED, SWITCHGEAR BREAKER OPEN AND CONTROL POWER AVAILABLE (NOTE 11)
	W	WHITE	GENERAL INFORMATION OR INSTRUCTIVE
	A	AMBER	CAUTION, WARNING OR ALERT. ABNORMAL OPERATION UNDER SUCH CONDITIONS AS LIMIT SWITCHES OR SAFETY INTERLOCKS BEING BYPASSED FOR START-UP, EMERGENCY OPERATION, ETC.
	B	BLUE	SPECIAL USE ONLY.
	C	CLEAR	OTHER FUNCTIONAL OPERATIONS AS INDICATED ON DRAWINGS WHICH SHOW DETAILED FUNCTIONAL DESCRIPTION.

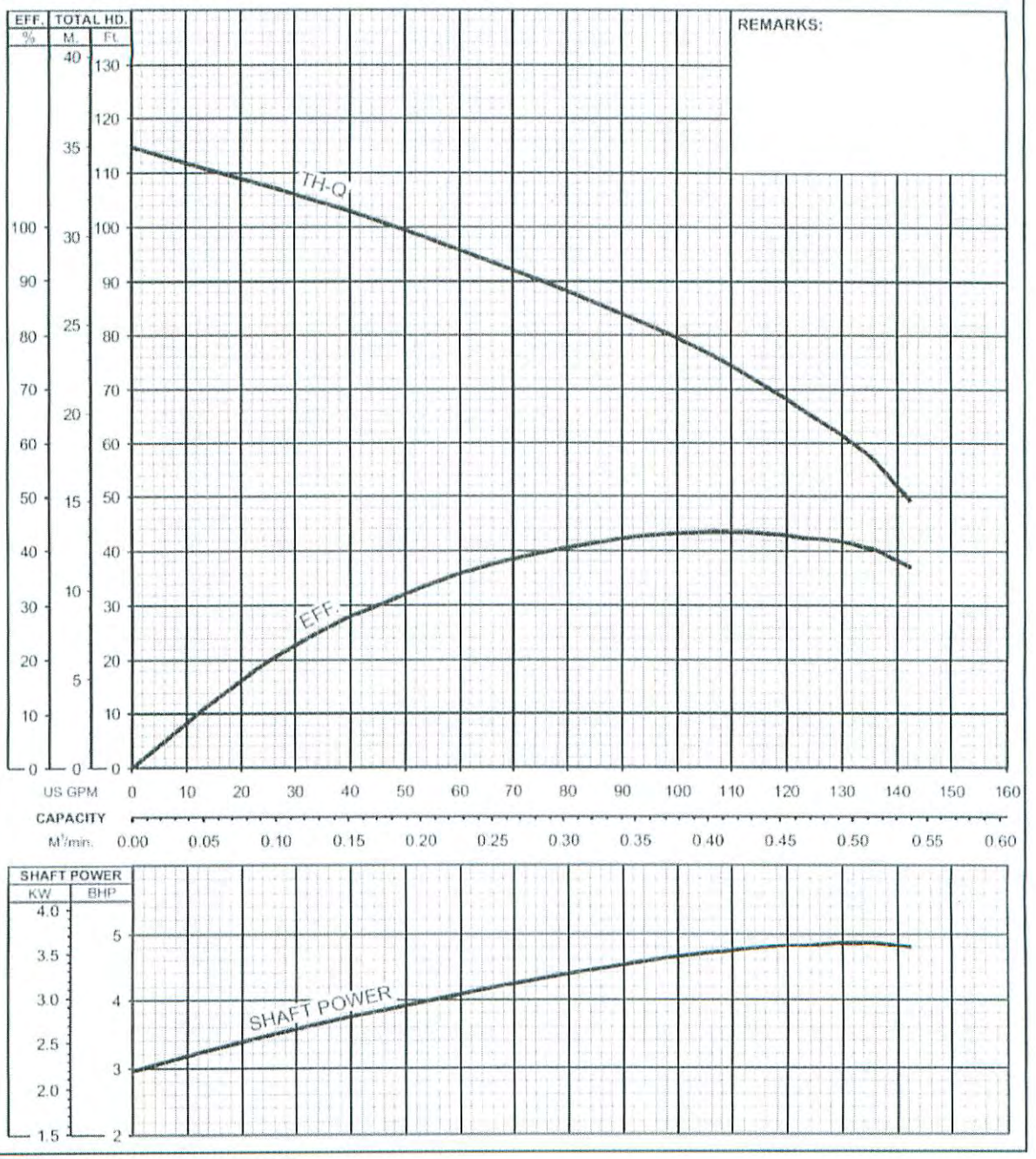
Dec. 00 — 60-PC-KTZ-05

TSURUMI PUMP

KTZ - SERIES PERFORMANCE CURVE

KTZ23.7-62

MODEL	BORE	HP	KW	RPM	SOLIDS DIA	LIQUID	SG.	VISCOSITY	TEMP.
KTZ23.7-60	2"/50mm	5	3.7	3410	0.334"/8.5mm	Water	1.0	1.81 CST	60°F

PUMP TYPE	PHASE	VOLTAGE	AMPERAGE	HZ	STARTING METHOD	INS. CLASS
Dewatering Pump	3	208/230/460/575	14.5 / 13.0 / 6.5 / 5.3	60	Direct On Line	E

CURVE No.	DATE	PHASE	VOLTAGE	AMPERAGE	HZ	STARTING METHOD	INS. CLASS
-	-	-	-	-	-	-	-