Please add to the file for Construction Permit No. 20150-IW. Return this info to me. Thanks
Barry

dhec
Healthy People. Healthy Communities.

January 21, 2020

Ms. Patricia M. Allen, Director
Savannah River Remediation, LLC
Bldg.-766H, Room 2308
Aiken, SC 29808

RE: (1) Permit, *SRS Tank Closure Cesium Removal System- Phase 1*, Construction Permit No. 20,150-IW, Aiken County, October 31, 2017
(2) Letter, Patricia M. Allen (SRR) to Barry S. Mullinax (SCDHEC), *Tank Closure Cesium Removal Unit 1 Phase 2 Deployment,* SRR-ESH-2019-00129, Dated December 17, 2019

Dear Ms. Allen:

The operation of Phase 1 of the Tank Closure Cesium (TCCR) system as a wastewater treatment/collection system was permitted under Construction Permit No. 20,150-IW (Reference 1) on October 31, 2017. Phase 1 of treatment via the TCCR Unit 1 was for wastes in Tank 10H and the Bulk Waste Removal Efforts for this tank were completed on October 31, 2019.

In Reference 2, Savannah River Remediation (SRR) on behalf of the Department Of Energy (DOE) submitted a letter to request SCDHEC approval for subsequent deployment of the TCCR Unit #1 for Phase 2, also known as TCCR 1A, treatment of the wastes in Tank 9H. The letter provided the information required by Construction Permit No. 20,150-IW for Department review and approval for another deployment for TCCR Unit #1. Based on the information provided in Reference 2, this information meets the permit requirements and is acceptable to the Department. The proposed Phase 2 deployment of the TCCR Unit #1 is hereby approved by the Department.

Please contact me at 803-898-4012 if have any questions and/or comments.

Sincerely,

Barry Mullinax

Barry Mullinax, P.E.
Industrial Wastewater Permitting Section
cc (via e-mail): Leslie Wooten, SRR
Shawn Clarke, Water Facilities Permitting Division – Columbia Office
Crystal Rippy, Industrial Wastewater Permitting Section – Columbia Office
Crystal Robertson, Midlands Region BEHS - Aiken Office
David Willis, Midlands Region BEHS - Aiken Office

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Savannah River Remediation
AECOM | BECHTEL | JACOBS | BWXT

DEC 17 2019

SRR-ESH-2019-00129
RSM Track #: 10666

Mr. Barry Mullinax, Professional Engineer
Bureau of Water
South Carolina Department of Health and
Environmental Control
2600 Bull Street
Columbia, South Carolina 29201-1208

Dear Mr. Mullinax:

TANK CLOSURE CESIUM REMOVAL UNIT 1 PHASE 2 DEPLOYMENT

References:

1. *Tank Closure Cesium Removal System – Phase 1 Construction Permit No. 20,150-IW*, Aiken County, October 31, 2017
2. *F and H Area High Level Radioactive Waste Tank Farms Construction Permit No. 17,424-IW*, Aiken and Barnwell county, January 25, 1993

Scope

This memorandum serves to define and request South Carolina Department of Health and Environmental Control (SCDHEC) approval for subsequent deployment of the Tank Closure Cesium Removal (TCCR) Unit 1 for Phase 2 treatment of Tank 9H High Level Waste (HLW). The operation of Phase 1 of the TCCR System as a wastewater treatment/collection system is permitted under construction permit 20,150-IW (Reference 1), dated October 31, 2017.

Discussion

The initial deployment of TCCR Unit 1 is located within the H-Tank Farm Facility in and around Tanks 9, 10, 11, and 12. Permitted under construction permit 20,150-IW, Phase 1 of treatment via the TCCR Unit 1 system was for wastes in Tank 10H. This permit is in addition to the Tank Farm Permit No. 17,424-IW (Reference 2). Tank 10H Bulk Waste Removal Efforts were declared completed on October 31, 2019 (Reference 3). Phase 2 redeployment of the TCCR Unit 1 system, also known as TCCR 1A, will be used in the treatment of wastes in Tank 9H.

Tank 9H is a Type I HLW tank that currently contains an estimated 550,000 gallons of saltcake waste. Tank 9H has a similar waste history to Tank 10H. Following removal of sludge waste

from both HLW tanks in the 1960's, the tanks served as concentrate receipt tanks for the 242-H Evaporator System, forming over 500,000 gallons of saltcake in each of these two HLW tanks. Efforts have been initiated to prepare Tank 9H to dissolve this saltcake waste and treat the resulting dissolved salt solution using TCCR Unit 1.

It is proposed that dissolved salt solution from Tank 9H will be transferred to Tank 10H, via H-Tank Farm facility Hose-in-Hose transfer lines, where it will be batched and sampled to determine processability through the TCCR Unit 1 ion exchange columns (IXCs). Once batched and qualified, the dissolved salt solution will be transferred to the TCCR system, first passing though the pre-filter then through the IXCs which will remove radioactive cesium-137 and yield a decontaminated salt solution (DSS) stream. The DSS will then pass through a Resin Trap before leaving the TCCR unit, after which the DSS will be transferred from the TCCR unit to the receipt tank (Tank 11H). The pre-filter and IXCs will be back flushed to Tank 10H when required. The existing equipment and transfer lines currently in use for Tank 10H dissolved salt solution processing feed to TCCR Unit 1 and those in use for transfer of the effluent DSS from TCCR Unit 1 to the receipt tank (Tank 11H) will continue to be used in Phase 2. See Attachment 1 for Summary Equipment, Hose and Piping Data.

To improve system operations of TCCR Unit 1, Phase 2 redeployment of TCCR Unit 1 equipment modifications will include:

- Installation of new IXCs with reduced outer diameters of 19-inches. Included with each of the 19-inch IXCs are the water jacket fill lines, shield plates, and two passive HEPA filters (for use at Interim Safe Storage (ISS) only) consistent with those employed in Phase 1. The IXCs will be filled with crystalline silicotitinante (CST) ion exchange media onsite.
- Design of new pre-filters with improved surface area and 7-micron absolute stainless steel mesh installed within the existing filter housing of the 8-inch diameter, 24-inch high pipe which will adhere to the specifications of the Phase 1 pre-filter.
- Like-for-like replacement of the failed Tank 10H pump with an identical Submersible Transfer Pump from Tank 15H, flowrates will remain the same as Phase 1 and therefore no new pump calculations or revisions are required.
- Installation of additional shielding, as needed, on the transfer line from Tank 10H feeding the TCCR Unit and the return line from the TCCR Unit back to Tank 10.
- Modification of piping inside TCCR Unit 1 to tie the Flush Water Header to the Drain Header to permit required IXC flushes to be returned directly to Tank 10 and reduce the amount of cesium-137 sent to Tank 11H. Two pneumatically actuated slow closing valves of the same make and model as existing actuated valves will be installed to provide isolation of this piping bypass during normal operation.
- Increased ISS capacity with support stanchions for cesium-laden columns at the Seven Springs Laydown Yard, located adjacent to H-Tank Farm.

Based on lessons learned from Phase 1, additional efforts will be made to improve the radiation detection capability for the DSS stream, improve the data historian archival capability, and improve the decontamination factor performance monitoring in Phase 2. Further, utilization of CST ion exchange media with a smaller particle size in Phase 2 will enhance cesium-137

adsorption. To stage and fill new IXCs with CST ion exchange media, a loading pad adjacent to TCCR Unit 1 enclosure will be also be constructed.

The TCCR Unit 1 modifications in support of Phase 2 will be completed in accordance with appropriate industrial and nuclear safety evaluations (e.g. Documented Safety Analysis (DSA)). Existing DSA related programs will be utilized and revised to reflect modifications to the TCCR Unit 1 and Tank 9H waste treatment. All system components and features have full supporting Calculations, Drawings, Specifications, and Datasheets, etc. The documentation is stored at Savannah River Site (SRS) and copies of these documents are retrievable upon request.

It is projected that Tank 9H will generate up to approximately 2.4 million gallons of DSS and will require approximately 12 to 16 ion exchange columns to treat the dissolved salt solution. In Phase 2 the TCCR system will be operated using both a single column in line and with columns in a series. Cesium-laden IXCs will be dewatered and placed in the Department of Energy (DOE) approved ISS (for up to 10 years) until the decision is made to allow it to go to an off-site repository or the material will be sluiced out of the column and sent to DWPF for vitrification. Any deviation from these disposition paths will be approved by SCDHEC prior to final disposition. These materials will be retained in ISS until such time it is processed for final disposition.

The SCDHEC local District Engineer or designee will be notified prior to the start of physical modifications to the TCCR Unit. The SCDHEC local District Engineer will be provided opportunities to visit and inspect the TCCR Unit 1 Phase 2 modification work while being completed. Once modification work has finished, a Professional Engineer's Certification Report will be submitted to SCDHEC stating that physical modification work has been completed and that appropriate industrial and nuclear safety evaluations (e.g., DSA) have been completed.

The SCDHEC local District Engineer or designee will be contacted to perform a final inspection and an Approval to Place in to Operation (APO) for TCCR Unit 1 Phase 2 Deployment operations will be requested.

Once the decision is made that the TCCR unit will no longer be deployed, it will be operationally closed within 180 days in accordance with a SCDHEC and DOE approved closure plan.

Your timely review and approval of the redeployment of TCCR Unit 1 for Phase 2 operations is requested.

If you have any questions, please contact Leslie Wooten of my staff at (803) 208-6665.

Sincerely,

Patricia M. Allen

Patricia M. Allen, Manager
Environment, Safety, Health, Quality Assurance and Contractor Assurance
Savannah River Remediation, LLC

lw/lw

Add'l Ref:

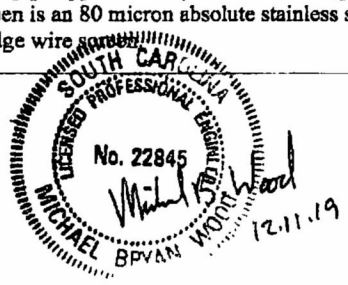
3. *Completion of Federal Facility Agreement Appendix L, Item 5 (SENS Number: 89),* Letter, DOE-SR to SCDHEC and EPA, October 31, 2019
4. *Industrial Wastewater Treatment Facility Construction Permit Application for the Tank Closure Cesium Removal System Installation*, Aiken County, May 31, 2017

Attachment: 1. Table, Summary Equipment, Hose, and Piping Data

c:
M.C. Reece, SCDHEC, Columbia, SC
C.D. Rippy, Columbia SC
J.E. Blalock, Columbia, SC
J.T. Koon, Columbia, SC
T.R. Fuss, Aiken, SC
J.L. Folk Jr., DOE, 704-S
S.M. Blanco, 704-S
J.L. Bentley, 704-S
P.C. Suggs, 704-S
A.J. White, 704-S
C.L. Bergren, SRNS, 730-4B
A.J. Meyer, 730-4B
T.F. Kmetz, 730-4B
V.E. Millings III, 730-4B
A.G. Hammett, 730-B
A.I. Hemmingway, 730-B
T.A. Foster, SRR, 766-H
M.A. Schmitz, 766-H
S.P. Fairchild, 766-H
P.J. Breidenbach, 766-H
R.E. Edwards Jr., 766-H
F. Meyer, 766-H
R.W. Blackmon, 704-Z
E.J. Freed, 766-H
W.P. Mayson, 707-18E
M.N. Borders, 704-56H
J.E. Occhipinti, 704-56H
D.C. Bumgardner, 704-56H
G.C. Arthur, 241-284H
S.K. Smith, 766-H
J.S. Kirk, 766-H
D.P. Skiff, 766-H
K.R. Liner, 704-S
M.B. Wood, 742-13G
A.R. Redwood, 241-154H
T.F. England, 705-1C
G.D. Barker, 766-H
C.D. Hammond, 766-H
A.A. Chabaud, 766-H
P.S. Moutzouris, 766-H
M.L. Overstreet, 705-1C
Records Administration, 773-52A

Attachment 1. Summary Equipment, Hose, and Piping Data

Description	Type Size Capacity	Specification
Process Hoses Hose-in-Hose	Hose will be EPDM (ethylene propylene diene monomer), EPR (Ethylene-Propylene Rubber) Hose will have helical wire reinforcement and a fabric reinforced cover. Hoses will be supported to maintain slope and will be shielded with lead blankets.	Designed to *Hose Handbook (RMA IP-2)* Qualified for: - Service in accordance with the requirement of ASME B31.3 Chapter VII. - As unlisted components in accordance with ASME B31.3, paragraph 304.7.2. Tested per ASME B31.3, paragraph A304.7.2(b). (Including end fittings.)
Process Piping	Piping will be schedule 40 seamless pipe	Designed and tested in accordance with ASME B31.3 for normal fluid service. Type 304L stainless steel ASTM A312.
Automatic Valve Data	Fisher Vee-Ball V150	See Attachment 9.6 of the TCCR IWT Construction Permit Application (Ref. 4)
Manual Valve Data	Worcester Controls Series 59 Full Port Ball Valve	See Attachment 9.6 of the TCCR IWT Construction Permit Application (Ref. 4)
Tank 10H Pump	100 gpm for dissolution 5 to 10 gpm to TCCR system 25 gpm filter backflush Summary Hydraulic Calculation	Manufacturer: Tsurumi Pump Model: LH311W-60 See Attachment 9.6 of the TCCR IWT Construction Permit Application (Ref. 4) for Pump Data Sheet and Summary Hydraulic Calculation
Pre-filter	The filter housings are 8" diameter pipe with a height of approximately 24". The filter media is a 7 micron absolute sintered metal (stainless steel) mesh.	Qualified as an ASME B31.3 piping component.
Ion Exchange Column	Approximately 10 ft tall, 19-inch diameter	ASME B&PVC Section VII Div 1 100% RT ASTM A240, Grade 304L
Resin Trap	The resin trap hosing is a 6" diameter stainless steel pipe approximately 19.5 inches long. The screen is an 80 micron absolute stainless steel wedge wire screen.	Qualifies as an ASME B31.3 piping component.



dhec
Healthy People. Healthy Communities.

September 24, 2019

Put in file for Construction Permit No. 20,150-IW BSM

Ms. Patricia M. Allen, Director
Savannah River Remediation, LLC
Bldg-766H, Room 2308
Aiken, SC 29808

RE: (1) Letter, Patricia M. Allen (SRR) to Barry t for Reclassification *of Salt Waste Processing Facility Operator Classification,* SRR-ESH-2019-00108, Dated September 23, 2019
(2) Letter, M. F. Sadler to W.L. Payne, *Wastewater Treatment Plant Classification for Specialized Facilities at SRS*, Dated August 14, 1995.

Dear Ms. Allen:

In Reference 1, SRR submitted a letter to request that the State-certification Classification for operators of specialized radioactive waste treatment facilities at SRS be established as "Not Applicable". This classification was previously established by South Carolina Department of Health and Environmental Control (SCDHEC) in Reference 2. The Department agrees with your request since the operator classifications in the South Carolina Pollution Control Act, Section 48-1-110, do not address the SRS specialized radioactive waste treatment facilities. This "NA" classification applies to the following SRS waste treatment facilities: (e.g., the Actinide Removal Process (ARP), the Modular Caustic Side Solvent Extraction Unit (MCU), the Defense Waste Processing Facility (DWPF), the Saltstone Production Facility (SPF), the Salt Waste Processing Facility (SWPF), and the Tank Closure Cesium Removal (TCCR) facility. While there are no State-certification classifications for operators of the SRS specialized radioactive waste treatment facilities, the Department of Energy (DOE) requires that operators of these specialized SRS treatment facilities receive training and obtain qualifications required by the appropriate administrative procedures. As SCDHEC has previously acknowledged (See Reference 2), the successful completion of the required training and qualification program is considered as an appropriate certification for operators of these SRS facilities.

It should be noted that the South Carolina Pollution Control Act, Section 48-1-110, requirements apply to the Effluent Treatment Project (ETP) and the DWPF Chemical Treatment Facility (through the Central Sanitary Wastewater Treatment Facility). Therefore, State-certified operators of the appropriate grade are required for these facilities.

Please contact me at 803-898-4012 or at mullinbs@dhec.sc.gov if you have any questions and/or comments.

Sincerely,

Barry Mullinax

Barry Mullinax, P.E.
Industrial Wastewater Permitting Section

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cc (via e-mail): Keith Liner, SRR
Shawn Clarke, SCDHEC - Columbia
Crystal Rippy, SCDHEC - Columbia
Crystal Robertson, SCDHEC - Aiken Office

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dhec
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October 31, 2017

Patricia M Allen
US DEPT OF ENERGY SAVANNAH RIVER SITE
BLDG 766-H RM 2308
Aiken, SC 29808

Re: Construction Permit No. 20150-IW
SRS/TANK CLOSURE CESIUM REMOVAL SYSTEM - PHASE 1
Aiken County

Dear Patricia M Allen:

Enclosed is a SC Wastewater Construction Permit for the above referenced project. Construction is to be performed in accordance with this permit and supporting engineering report, plans, and specifications approved by this Office.

This system cannot be placed into operation until final approval is granted by the appropriate Bureau of Environmental Health Services (BEHS) Regional Office. Your Regional contact is Joshua C Yon, in the MIDLANDS REGION BEHS AIKEN. This regional office should be notified when construction begins at the following address and phone number: 206 BEAUFORT ST NE, AIKEN SC 29801-4476, 803-642-1637.

Upon completion of any construction, a letter must be submitted to the BEHS Regional Office from the registered engineer certifying that the construction has been completed in accordance with the approved plans and specifications. An inspection may then be scheduled. The BEHS Regional Office will approve the system for operation upon successful completion of this project.

Sincerely,

Barry S. Mullinax

Barry S Mullinax
Industrial Wastewater Permitting Section
Water Facilities Permitting Division

cc: Joshua C Yon, MIDLANDS REGION BEHS AIKEN
Michael B Wood, SRR

Wastewater Construction Permit
Bureau of Water

dhec
Healthy People. Healthy Communities.

PROJECT NAME: SRS/TANK CLOSURE CESIUM REMOVAL SYSTEM - PHASE 1	COUNTY: AIKEN

PERMISSION IS HEREBY GRANTED TO: **US DEPT OF ENERGY SAVANNAH RIVER SITE**
Bldg 766-H Rm 2308
Aiken SC 29808

for the construction of a new wastewater treatment plant in accordance with the construction plans, specifications, engineering report and the Construction Permit Application signed by: Michael B Wood, Registered Professional Engineer, S.C. Registration Number: 22845: Eric A. Anderson; Registered Professional Engineer, S.C. Registration Number: 32165; and Thomas B. Caldwell, Registered Professional Engineer, S.C. Registration Number: 14164.

PROJECT DESCRIPTION:

The Tank Closure Cesium Removal (TCCR) system will use an ion exchange process to remove radioactive cesium-137 from high level waste. This facility is a skid-mounted system on a concrete slab with four ion exchange columns with prefilters, resin trap, Tank 10H pump, hose-in-hose process hoses (6 hoses of varying sizes), and piping and appurtenances.

For Phase 1, the dissolved salt waste in Tank 10H will be transferred to the TCCR unit to remove radioactive cesium-137 at a nominal flowrate of 5 to 10 gpm with a maximum flowrate of 10 gpm (daily maximum rate of 14400 gallons per day) *There will be no discharge of wastewater to Waters of the State.* Processed wastewater (decontaminated salt solution) will be transferred to Tank 11H. Shielded cesium-laden resin columns will be transferred to Interim Safe Storage.

CONDITIONS: See page 2.

In accepting this permit, the owner agrees to the admission of properly authorized persons at all reasonable hours for the purpose of sampling and inspection. This is a permit for construction only and does not constitute DHEC approval, temporary or otherwise, to place the system in operation. An Approval to Place in Operation is required and can be obtained following the completion of construction by contacting the MIDLANDS REGION BEHS AIKEN at 803-642-1637. Additional permits may be required prior to construction (e.g., Stormwater).

PERMIT NUMBER:	**20150-IW**
ISSUANCE DATE:	**October 31, 2017**
EXPIRATION DATES:	**October 31, 2019** (to begin construction) **October 31, 2020** (to obtain Approval to Place in Operation)

Jeffrey P. deBessonet, P.E., Director
Water Facilities Permitting Division

BSM

CONDITIONS

1. This construction permit is in addition to the Tank Farm Permit (Construction Permit No. 17,424-IW).

2. This construction permit is for the treatment of dissolved salt waste in Tank 10H by the TCCR unit to remove radioactive cesium-137 at a minimum decontamination factor of 1,000. Once treatment of Tank 10H dissolved salt waste by TCCR is completed, SRS will have 180 days, unless otherwise approved by the Department, to decide if the TCCR unit will be deployed for another tank or if TCCR will be subject to final closure. If TCCR will be redeployed, TCCR will by placed into a layup configuration until redeployed for another tank. If the layup configuration requires modifications other than column removal, revised drawings will be required to be submitted to the Department for review and approval prior to being modified. After Department approval and modifications are completed, the District Engineer will be requested to perform an inspection to verify that an acceptable configuration has been achieved while the TCCR unit is awaiting future deployment. If no physical changes are required, the Department shall be notified by letter and the District Engineer will not be required to perform an inspection of the layup configuration. If TCCR is to be redeployed, see Condition #3. If TCCR will not be redeployed, see Condition #4.

3. The treatment of Tank 10H waste by TCCR will be Phase 1. Subsequent deployment of TCCR for other HLW tanks will represent an additional phase for each additional tank to be treated. For each subsequent deployment of TCCR, a letter shall be submitted to SCDHEC for review and approval. If the redeployment is approved, the Department will issue a Letter of Approval (LOA) for the next phase. The updated information in the submittal letter for the next TCCR phase will:

    a. Identify the new location of the TCCR unit, if necessary.

    b. Identify the tank containing dissolved salt waste to be treated.

    c. Identify the receipt tank for the decontaminated salt solution.

    d. Provide revised or new plans and specifications for a required modification if the TCCR configuration for the additional phase is not consistent with the approved design including drawings and specifications.

    e. Include a statement that TCCR complies with the current Documented Safety Analysis (DSA) or the revised DSA .

    f. Include new calculations, if needed.

    g. Obtain written SCDHEC approval for the new deployment of the TCCR unit before making any modifications for the new phase.

    h. After installation is completed for the new phase, request an inspection by the District Engineer for the TCCR configuration for the new deployment.

    i. Obtain an Approval to Place into Operation (APO) from the District Engineer before TCCR can process the dissolved salt waste in the new Tank.

4. In accordance with Regulation 61-67, Standards for Wastewater Facility Construction, the TCCR system shall be closed out within 180 days, unless otherwise approved by the Department, when a phase is completed and the decision has been made that no other TCCR deployments will be made. Closure of wastewater

treatment facilities necessitates the submittal of a closure plan and approval of the plan by the Department in accordance with R.61-82 prior to closure of any wastewater treatment unit(s).

Construction Permit Application
Water/Wastewater Facilities

BUREAU OF WATER

DELEGATED REVIEW PROJECT SUBMITTAL: Yes ☐ EXPEDITED REVIEW PROGRAM SUBMITTAL: Yes ☐

SELECT ONE ➧ ☐ Water Facilities ☑ Wastewater Facilities ☐ Combined Water & Wastewater Facilities

I. **Project Name:** Tank Closure Cesium Removal System Installation **County:** Aiken

II. **Project Location** (street names, etc.): Savannah River Site, Aiken SC

III. **Project Description(s):** *Water System:*

Wastewater System: The Tank Closure Cesium Removal System project installs an ion exchange system to remove cesium from waste stored in High-Level Waste Tanks at the Savannah River Site. Phase 1 of the Tank Closure Removal System will be deployed in the H-Area Tank Farm. Future deployments may be within the H-Area or F-Area Tank Farms.

Project Type (A-Z): Water: ____ Wastewater: Z *(See instructions for the appropriate project code)*

IV. ***Initial* Owner:** [Time of Application] Name/Organization: USDOE-Owner

Address: Bldg. 766-H, Room 2308 (Attn: P.M. Allen for DOE) City: Aiken State: SC Zip: 29808

Phone #: (803) 208-3152 E-mail (Initial Owner): patricia.allen@srs.gov

V. ***Final* Owner:** [After Construction] Name/Organization: USDOE-Owner

Address: Bldg. 703-B, Room 321 (Attn: J. Demass) City: Aiken State: SC Zip: 29808

Phone #: (803) 952-8261 E-mail (Final Owner): jim.demass@srs.gov

VI. **Entity Responsible for Final Operation & Maintenance of System:**

Water System: Name: N/A Address:

City: State: Zip: Phone#: ( ) Fax#: ( )

Wastewater System: Name: USDOE-Owner Address: Bldg. 703-B, Room 321 (Attn: J. Demass)

City: Aiken State: SC Zip: 29808 Phone#: (803) 952-8261 Fax#: ( )

VII. **Engineering Firm:** Name: N/A Address:

City: State: Zip: Phone #: ( ) Fax #: ( )

E-mail (Design Engineer):

VIII. **Is this project:** A) Part of a phased project? No ☑ Yes ☐. If Yes, Phase ____ of ____

B) A revision to a previously permitted project? No ☐ Yes ☑. If Yes, Permit#: 17,424-IW

Date Approved: 1/25/93 Project name (if different): F and H-Area High Level Radioactive Waste Tank Farms

C) Submitted based on a Schedule of Compliance or Order issued by DHEC? No ☑ Yes ☐. Order #:

D) Anticipating funding by the State Revolving Fund (SRF)? No ☑ Yes ☐.

E) Crossing a water body (e.g., river, creek)? No ☑ Yes ☐. If Yes, Name of waterbody:

IX. **Are Standard Specifications approved by DHEC being used on this project?** No ☑ Yes ☐. If Yes:

Water: Date Approved: Approved for whom:

Wastewater: Date Approved: Approved for whom:

X. **Wastewater Systems:** A) Type: Domestic ☐ Process (Industrial) ☑ Combined (Domestic & Process) ☐

B) *Average Design Flow* 1. Project: 14,400 GPD 2. Treatment system: N/A GPD

C) *Sewers or Pretreatment* 1. Name of facility (e.g., POTW) treating the wastewater: USDOE/SRS

2. NPDES/ND Number of facility in Item #1: SC0000175

Treatment Systems 3. Date Preliminary Engineering Report (PER) approved: N/A

4. NPDES/ND application submitted? No ☑ Yes ☐. If Yes, Date:

Disposal Sites 5. Effluent Disposal Site (Description): N/A

6. Sludge Disposal Site (Description): N/A

XI. **Water Systems:** Project located within city limits? No ☑ Yes ☐.
Public water system providing water. Name: _____ System #.: _____
New water system (including master meter)? No ☐ Yes ☐. If Yes, System name: _____

XII. **Type of Submittal:** Complete **Section A (Standard)** *or* **Section B (Delegated Review Program - DRP).**
A) Standard Submittal *must* include the following:

☑ 1. A transmittal letter outlining the submittal package.
☑ 2. The **original** construction permit application, properly completed, with one (1) copy.
☑ 3. Three (3) sets of signed and sealed plans and one (1) set of construction specifications. Specifications may be omitted if approved standard specifications are on file with DHEC. Four (4) sets of plans are required for a combined submittal, if the project includes a wastewater treatment facility.
☐ 4. One (1) set of the appropriate design calculations. WASTEWATER: Design flow (based on R.61-67, Appendix A), pump station calc's. and pump curve. WATER: Recent flow test from a location near the tie-on site, design calc's. indicating pressure maintained in the distribution system during max. instantaneous demand, fire flow and flushing velocities achieved. Number/types of service connections, well record form, pumping test results, etc.
☑ 5. Three (3) copies of a detailed 8½" x 11" location map, separate from the plans.
☐ 6. Two (2) copies of construction easements unless the project owner has the right of eminent domain.
☐ 7. A letter(s) from the entity supplying water and/or providing wastewater treatment stating their willingness and ability to serve the project, (state the flow, number of lots, etc.), including pretreatment permits, if applicable.
☐ 8. A letter(s) from the entity agreeing to be responsible for the operation and maintenance (O&M) of the systems.
☑ 9. Application fee enclosed $ 400.00. (Refer to Instructions).
☐ 10. WATER SYSTEMS: a) A letter from the local government which has potable water planning authority over the area, if applicable, in which the project is located, stating project consistency with water supply service plan for area.
b) For wells, four (4) copies of a well head protection area inventory.
c) For new wells, a viability demonstration is required in accordance with Regulation 61-58.1.B.(4).

Note: Other approvals may include 208 (wastewater only) and OCRM CZC Certification, and navigable waterway permitting. *To expedite the project review, the 208 and OCRM CZC Certification may be included with the project submittal.*

B) DRP submittal *must* include the following:

☐ 1. A transmittal letter, signed by the professional engineer representing the DRP entity, noting this is a DRP submittal. The letter should state that the project has been reviewed and complies with R.61-58 and or R.61-67.
☐ 2. The **original** construction permit application, properly completed, with one (1) copy.
☐ 3 Two (2) sets of the signed and sealed plans.
☐ 4. One (1) set of the appropriate design calculations. WASTEWATER: Same information as required under Section XII.A.4. above. WATER: Same information as required under Section XII.A.4. above.
☐ 5. One (1) copy of a detailed 8½" x 11" location map, separate from the plans.
☐ 6. Two (2) copies of construction easements, unless the project owner has the right of eminent domain.
☐ 7. DHEC's OCRM CZC Certification (for water and/or wastewater facilities, in the eight coastal counties).
☐ 8. DHEC's Water Quality permit or conditions for placement in navigable waters, and other Agency approvals.
☐ 9. WASTEWATER SYSTEMS: a) A letter of acceptance from the entity providing the treatment of the wastewater that includes the specific flow and, when applicable, the specific number of lots being accepted.
b) A letter from the organization agreeing to be responsible for the O&M of the wastewater system.
c) The 208 Plan certification from the appropriate Council of Governments (designated 208 areas), or from DHEC on the non-designated 208 areas.
☐ 10. WATER SYSTEMS: A letter from the local government which has potable water planning authority over the area, if applicable, in which the project is located, stating project consistency with water supply service plan for area.
☐ 11. Fee of $75 for water and $75 for wastewater ($150 if combined).

Note: The DRP entity should ensure that a copy of the final approved plans are returned to the design engineer.

XIII. Construction plans, material and construction specifications, the engineering report including supporting design data and calculations are herewith submitted and made a part of this application. I have placed my signature and seal on the engineering documents submitted, signifying that I accept responsibility for the design of this system, and that I have submitted a complete administrative package.

Engineer's Name (Printed): Michael B. Wood, P.E. Signature: _____
S.C. Registration Number: 22845 Registered Professional Engineer

XIV. Prior to final approval, I will submit a statement certifying that construction is complete and in accordance with the approved plans and specifications, to the best of my knowledge, information and belief. This certification will be based upon periodic observations of construction and a final inspection for design compliance by me or a representative of this office who is under my supervision.

Engineer's Name (Printed): Andrew Redwood Signature: _____
S.C. Registration Number: 20525 Registered Professional Engineer

XV. I hereby make application for a permit to construct the project as described above. I have read this application and agree to the requirements and conditions and agree to the admission of properly authorized persons at all reasonable hours for the purpose of sampling and inspection.

Owner's Name (Printed): (By Patricia M. Allen for DOE) Signature: _____
Owner's Title: USDOE Date: 8/25/17

ON BEHALF OF DOE, APPLICANT FOR

DHEC 1970 (09/2016)

XI. **Water Systems:** Project located within city limits? No ☑ Yes ☐.
Public water system providing water. Name: _____ System #.: _____
New water system (including master meter)? No ☐ Yes ☐. If Yes, System name: _____

XII. **Type of Submittal:** Complete **Section A (Standard)** *or* **Section B (Delegated Review Program - DRP).**

A) Standard Submittal *must* include the following:

☑ 1. A transmittal letter outlining the submittal package.
☑ 2. The **original** construction permit application, properly completed, with one (1) copy.
☑ 3. Three (3) sets of signed and sealed plans and one (1) set of construction specifications. Specifications may be omitted if approved standard specifications are on file with DHEC. Four (4) sets of plans are required for a combined submittal, if the project includes a wastewater treatment facility.
☐ 4. One (1) set of the appropriate design calculations. WASTEWATER: Design flow (based on R.61-67, Appendix A), pump station calc's. and pump curve. WATER: Recent flow test from a location near the tie-on site, design calc's. indicating pressure maintained in the distribution system during max. instantaneous demand, fire flow and flushing velocities achieved. Number/types of service connections, well record form, pumping test results, etc.
☑ 5. Three (3) copies of a detailed 8½" x 11" location map, separate from the plans.
☐ 6. Two (2) copies of construction easements unless the project owner has the right of eminent domain.
☐ 7. A letter(s) from the entity supplying water and/or providing wastewater treatment stating their willingness and ability to serve the project, (state the flow, number of lots, etc.), including pretreatment permits, if applicable.
☐ 8. A letter(s) from the entity agreeing to be responsible for the operation and maintenance (O&M) of the systems.
☑ 9. Application fee enclosed $ 700.00. (Refer to Instructions).
☐ 10. WATER SYSTEMS: a) A letter from the local government which has potable water planning authority over the area, if applicable, in which the project is located, stating project consistency with water supply service plan for area.
b) For wells, four (4) copies of a well head protection area inventory.
c) For new wells, a viability demonstration is required in accordance with Regulation 61-58.1.B.(4).

Note: Other approvals may include 208 (wastewater only) and OCRM CZC Certification, and navigable waterway permitting. *To expedite the project review, the 208 and OCRM CZC Certification may be included with the project submittal.*

B) DRP submittal *must* include the following:

☐ 1. A transmittal letter, signed by the professional engineer representing the DRP entity, noting this is a DRP submittal. The letter should state that the project has been reviewed and complies with R.61-58 and/or R.61-67.
☐ 2. The **original** construction permit application, properly completed, with one (1) copy.
☐ 3 Two (2) sets of the signed and sealed plans.
☐ 4. One (1) set of the appropriate design calculations. WASTEWATER: Same information as required under Section XII.A.4. above. WATER: Same information as required under Section XII.A.4. above.
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Engineer's Name (Printed): Thomas B. Caldwell, PE Signature: _____
Registered Professional Engineer
S.C. Registration Number: 14164

XIV. Prior to final approval, I will submit a statement certifying that construction is complete and in accordance with the approved plans and specifications, to the best of my knowledge, information and belief. This certification will be based upon periodic observations of construction and a final inspection for design compliance by me or a representative of this office who is under my supervision.

Engineer's Name (Printed): Andrew Redwood, PE Signature: _____
Registered Professional Engineer
S.C. Registration Number: 20525

XV. I hereby make application for a permit to construct the project as described above. I have read this application and agree to the requirements and conditions and agree to the admission of properly authorized persons at all reasonable hours for the purpose of sampling and inspection.

Owner's Name (Printed): (By Patricia M. Allen for DOE) Signature: _____
Owner's Title: USDOE Date: _____

DHEC 1970 (09/2016)

XI. **Water Systems:** Project located within city limits? No ☑ Yes ☐.
Public water system providing water. Name: _____ System #.: _____
New water system (including master meter)? No ☐ Yes ☐. If Yes, System name: _____

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c) For new wells, a viability demonstration is required in accordance with Regulation 61-58.1.B.(4).

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☐ 3 Two (2) sets of the signed and sealed plans.
☐ 4. One (1) set of the appropriate design calculations. WASTEWATER: Same information as required under Section XII.A.4. above. WATER: Same information as required under Section XII.A.4. above.
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☐ 11. Fee of $75 for water and $75 for wastewater ($150 if combined).

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Engineer's Name (Printed): Eric A. Anderson, PE Signature: _____
S.C. Registration Number: 32165 Registered Professional Engineer

XIV. Prior to final approval, I will submit a statement certifying that construction is complete and in accordance with the approved plans and specifications, to the best of my knowledge, information and belief. This certification will be based upon periodic observations of construction and a final inspection for design compliance by me or a representative of this office who is under my supervision.

Engineer's Name (Printed): Andrew Redwood, PE Signature: _____
S.C. Registration Number: 20525 Registered Professional Engineer

XV. I hereby make application for a permit to construct the project as described above. I have read this application and agree to the requirements and conditions and agree to the admission of properly authorized persons at all reasonable hours for the purpose of sampling and inspection.

Owner's Name (Printed): (By Patricia M. Allen for DOE) Signature: _____
Owner's Title: USDOE Date: _____

DHEC 1970 (09/2016)

dhec
Healthy People. Healthy Communities.

BUREAU OF WATER

September 26, 2017

Patricia M. Allen, Director
Environment, Safety, Health, Quality Assurance and Contractor Assurance
Savannah River Remediation LLC
Bldg. 766-H, Room 2398
Aiken, SC 29808

Re: **SRS/TANK CLOSURE CESIUM REMOVAL SYSTEM - PHASE 1**
Aiken County

Dear Ms. Allen:

The Industrial Wastewater Permitting section received an engineering submittal including the application fee of $400 on the above project on 09/19/2017. In accordance with R.61-30 we have reviewed your application for completeness. Based on our review, your project application package is administratively incomplete. For this reason, your project will not be in line for a technical review until you satisfy the deficiencies noted below. As a courtesy, we have logged in your project and will keep it here pending your complete response. To complete your application package, please provide the following items:

1. The additional application fee in the amount of $300 must be submitted. The application fee is based on the fee schedule specified in the application form. See link for form: http://www.scdhec.gov/administration/library/D-1970.pdf .

Please return the above noted items as soon as possible. Failure to submit these items will result in significant delays in the review process.

Also, please note that any land clearing activity that is being performed in relation to this project must be permitted under the State Sediment and Erosion Control Program. For more information contact Ann Clark at (803) 898-4028.

If you have any questions, please do not hesitate to contact this office at 803-898-4235.

Sincerely,

Julie J. Song

Julie J. Song
Industrial Wastewater Permitting Section
Water Facilities Permitting Division

dhec
Healthy People. Healthy Communities.

MEMORANDUM

September 26, 2017

TO: Joshua C Yon
MIDLANDS REGION BEHS AIKEN

FROM: Crystal D Rippy
Industrial Wastewater Permitting Section
Water Facilities Permitting Division

RE: Construction Permit Application
SRS/TANK CLOSURE CESIUM REMOVAL SYSTEM - PHASE 1
Aiken County

Are you aware of any problems with, or do you have any comments on, the referenced project? Copies of the application and location map are enclosed.

Please return any comments that you may have by: October 06, 2017. An e-mail response is suitable if you prefer. If you have no comments, please just note so. Thanks.

COMMENTS:

dhec
Healthy People. Healthy Communities

September 26, 2017

TO: Richelle Tolton – 208 Planning Contact

SUBJECT: 208 plan conformance (INFORMATION ONLY)
Recommendation NOT required

1. Project Name: SRS/TANK CLOSURE CESIUM REMOVAL SYSTEM - PHASE 1
2. County: Aiken
3. Type of Project: WWC NEW WWTP +
4. Type Waste: INDUSTRIAL Volume (GPD): 14400
5. Disposal Method: US DOE/SAVANNAH RIVER SITE (NPDES SC0000175)
6. Consulting Engineer: Keith Liner 803-208-6466
7. DHEC contact: Crystal D Rippy
Industrial Wastewater Permitting
Water Facilities Permitting Division
Bureau of Water

dhec
Healthy People. Healthy Communities.

BUREAU OF WATER

October 06, 2017

Patricia M. Allen, Director
Environment, Safety, Health, Quality Assurance and Contractor Assurance
Savannah River Remediation LLC
Bldg. 766-H, Room 2398
Aiken, SC 29808

Re: **SRS/TANK CLOSURE CESIUM REMOVAL SYSTEM - PHASE 1**
Aiken County
Application Tracking # 1222389

Dear Ms. Allen:

The Industrial Wastewater Permitting section received an engineering submittal on the above project on 09/19/2017. In accordance with R.61-30 we have reviewed your application for completeness. Based on our review, your project application package is administratively incomplete. For this reason, your project will not be in line for a technical review until you satisfy the deficiencies noted below. As a courtesy, we have logged in your project and will keep it here pending your complete response. To complete your application package, please provide the following items:

1. A SC-registered PE, the design engineer that signs the application, must sign and seal and date **all** plans and design drawings and the Certificate of Authorization (COA) from the engineering firm must also be affixed near the PE seal. Several of the plans and design drawings were signed and sealed by engineers other than the design engineer who signed the application. This can be remedied by either having the application's design engineer also sign, seal, date, etc. each of the design drawings and plans; or by submitting additional application signature pages (i.e. Page 2 of DHEC Form 1970) to include the names and signatures of the other engineers as additional design engineers. Please resubmit these documents with the appropriate seals. Please note: Each page of design drawings or plans must include the COA and the PE seal/signature with the date regardless of whether or not they are in a bound document that is signed, sealed, dated, and affixed with the COA.

Please return the above noted items as soon as possible. Failure to submit these items will result in significant delays in the review process.

If you have any questions, please do not hesitate to contact this office at 803-898-4235.

Sincerely,

Julie J. Song

Julie J. Song
Industrial Wastewater Permitting Section
Water Facilities Permitting Division

Savannah River Remediation
AECOM | BECHTEL | CH2M | BWXT

Industrial Wastewater Treatment Facility Construction Permit Application

Tank Closure Cesium Removal System Installation

Savannah River Site
Aiken, SC 29808

www.srremediation.com

Transmittal Letter

Construction Permit Application

Location Map

Engineering Report

RECEIVED
SEP 19 2017
WATER FACILITIES
PERMITTING DIVISION

S. C. DEPT. OF HEALTH & ENVIRONMENTAL CONTROL
BUREAU OF WATER
WATER FACILITIES
FOR CONSTRUCTION
ANY PROVISIONS WHICH MAY
HE CONSTRUCTION PERMIT.)
PROVAL FOR OPERATION MUST
OM THIS OFFICE AFTER COM-
RUCTION.
-IW
DATE 10/31/17
DIRECTOR WATER FACILITIES PERMITTING DIVISION

Savannah River Remediation
AECOM | BECHTEL | CH2M | BWXT

SRR-ESH-2017-00064
RSM Track #: 10666

Mr. Barry S. Mullinax, Professional Engineer
South Carolina Department of Health and
Environmental Bureau of Water
South Carolina Department of Health and
Environmental Control
2600 Bull Street
Columbia, South Carolina 29201-1208

Dear Mr. Mullinax:

INDUSTRIAL WASTEWATER TREATMENT FACILITY CONSTRUCTION PERMIT APPLICATION FOR THE TANK CLOSURE CESIUM REMOVAL SYSTEM INSTALLATION

Savannah River Remediation (SRR) is planning to install Phase 1 of the Tank Closure Cesium Removal System within the H-Area High Level Radioactive Waste Tank Farm. The enclosed construction permit application package (three copies) is being submitted to the South Carolina Department of Health and Environmental Control for your review and approval. This package includes a construction permit application, location map, engineering report, and fee.

Your timely review and processing of the construction permit application package is requested.

If you have any questions, please contact Keith Liner of my staff at (803) 208-6466, or email keith.liner@srs.gov.

Sincerely,

Patricia M. Allen

Patricia M. Allen, Director
Environment, Safety, Health, Quality Assurance and Contractor Assurance
Savannah River Remediation LLC

kl/kl

Savannah River Site
Aiken, SC 29808

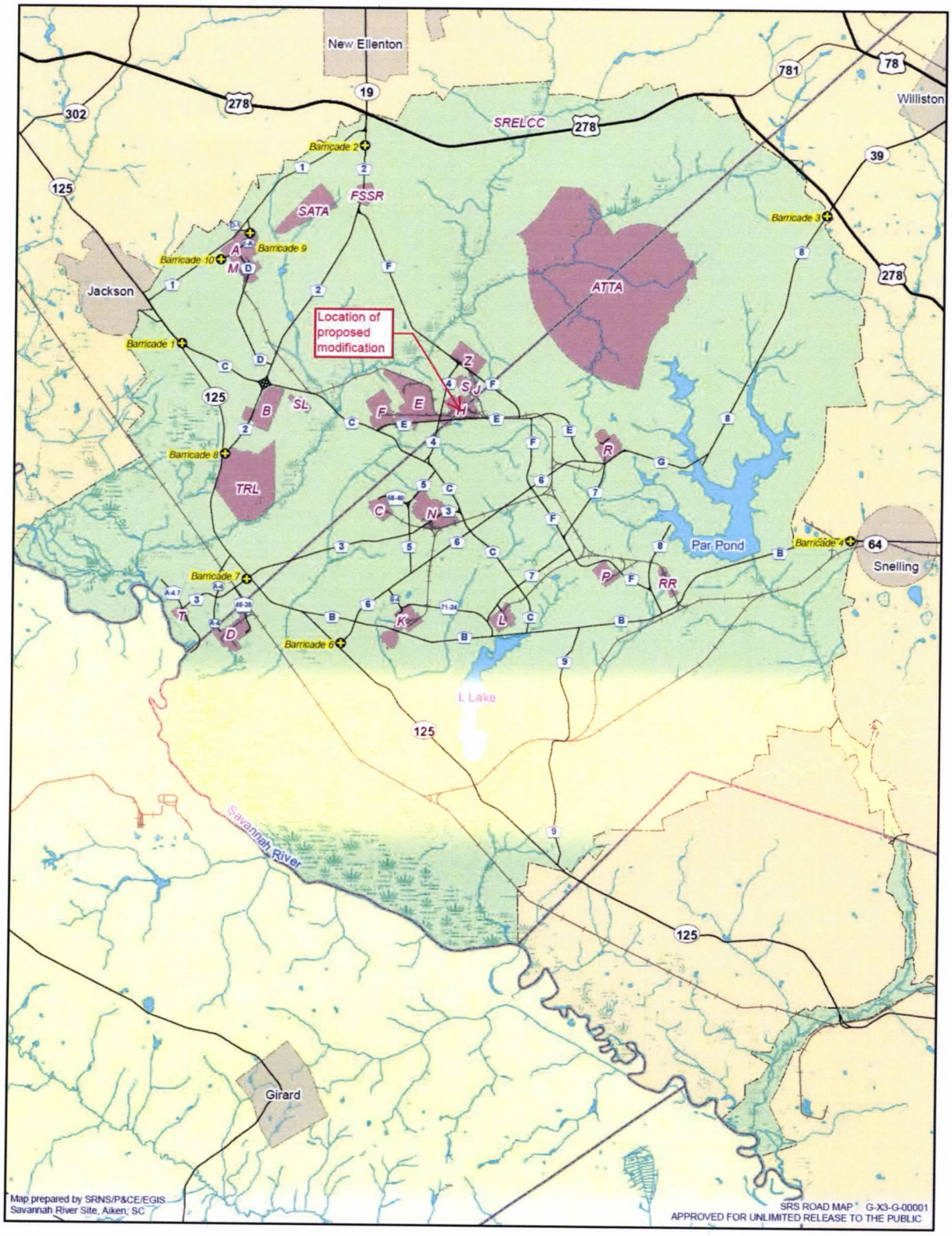
www.srremediation.com

Attachments:
1. *Construction Permit Application Water/Wastewater Facilities*, DHEC Form 1970, Tank Closure Cesium Removal System, Revision 0, June 2017
2. Location Map, Tank Closure Cesium Removal System, Revision 0, June 2017
3. *Engineering Report M-TRT-H-00101, South Carolina Department of Health and Environmental Control, Tank Closure Cesium Removal System Installation*, Revision 0, June 2017
4. Fee ($400.00) for *Construction Permit Application Water/Wastewater Facilities*, DHEC Form 1970, Tank Closure Cesium Removal System, Revision 0, June 2017

c:

M.D. Wilson, SCDHEC, Columbia, SC
C.D. Rippy, Columbia, SC
J.F. Litton, Columbia, SC
T.R. Fuss, Aiken, SC
J.L. Folk Jr., DOE, 704-S
J.M. Ridley, 704-S
P.C. Suggs, 704-S
J.L. Bentley, 704-S
D.J. Ferguson, 704-S
A.G. Hammett, 730-B
T.A. Foster, SRR, 766-H
D.B. Cook, 766-H
R.W. Blackmon, 766-H
S.P. Fairchild, 766-H
K.A. Hauer, 766-H
J.K. Fortenberry, 766-H
R.E. Edwards Jr., 766-H
J.R. Eschenberg Jr., 766-H
W.P. Mayson, 707-18E
J.E. Occhipinti, 704-56H
G.C. Arthur, 241-284H
M.T. Keefer, 766-H
D.C. Bumgarner, 704-56H
S.K. Smith, 766-H
O.D. Stevens, 766-H
D.P. Skiff, 766-H
T.F. England, 705-1C
S.A. Thomas, 705-1C
G.D. Barker, 766-H
C.L. Bergren, SRNS, 730-4B
A.J. Meyer, 730-4B
T.F. Kmetz, 730-4B
V.E. Millings III, 730-4B
Records Administration, 773-52A

Location Map



United States Department of Energy
Savannah River Site
Aiken, South Carolina
ENGINEERING REPORT
M-TRT-H-00101
Rev 0

South Carolina Department of Health and Environmental Control

Tank Closure Cesium Removal System Installation

Signed: MICHAEL B. WOOD S. C. Registration No. 22845

DISCLAIMER

APPROVAL SHEET

APPROVAL BY:

Originator	William E. Narrows PD&CS/ Design Services	7/20/17 Date
Reviewer (by Document Review)	Terry L. Allen PD&CS/ Design Services	7.20.17 Date
Reviewer	Keith R. Liner Environmental Compliance Authority	7/31/17 Date
Reviewer	Greg C. Arthur Closure Engineering Manager	7/31/17 Date
Verifier (by Document Review)	Michael B. Wood, PE Project Engineer PD&CS/ Design Services	7.26.17 Date
Project Manager	Mark T. Keefer TCCR Project Engineering Manager	7/31/17 Date

SUMMARY OF REVISIONS

Rev. No.	Reason for Change	Pages Affected	Issue Date
0	Initial Issue	N/A	

TABLE OF CONTENTS

LIST OF ACRONYMS

ASME	American Society of Mechanical Engineers
DSA	Documented Safety Analysis
DSS	Decontaminated Salt Solution
EPDM	Ethylene Propylene Diene Monomer
EPR	Ethylene-Propylene Rubber
ER	Engineering Report
HDB	H-Area Diversion Box
HEPA	High Efficiency Particulate Air
ISS	Interim Safe Storage
IW	Inhibited Water
SCDHEC	South Carolina Department of Health and Environmental Control
SRR	Savannah River Remediation
SRS	Savannah River Site
TCCR	Tank Closure Cesium Removal
TLV	Threshold Limit Value

1.0 ENGINEERING REPORT

This Engineering Report (ER) is being submitted pursuant to South Carolina Regulation 61-67, Standards for Wastewater Facility Construction to allow installation of a new Tank 10 Salt Dissolution & Cesium Removal Via the Tank Closure Cesium Removal (TCCR) process. This ER describes the location, industrial wastewater treatment process and configuration of the proposed new Tank Closure Cesium Removal system at Savannah River Site (SRS) at Tank 10.

Background Information
This Engineering Report describes a modification requiring a construction permit that is in addition to the H-Area Tank Farm facility's Industrial Wastewater Treatment permit (Construction Permit No. 17,424-IW) issued by South Carolina Department of Health and Environmental Control (SCDHEC). The function of the TCCR process is the removal of cesium from the High Level Tanks waste streams, and is in addition to the current process for cesium removal from the high level waste tank waste streams. The current cesium removal process at SRS is the Modular Caustic Side Solvent Extraction Unit. In the near future, this work will be performed by the Salt Waste Processing Facility.

2.0 LOCATION AND FACILITY LAYOUT

The initial deployment of TCCR is located within the H-Tank Farm Facility, in and around Tanks 9, 10, 11, and 12. The cluster of tanks is south of H-Area Diversion Box (HDB)-1 and north of HDB-2. The TCCR System main unit will be located a few feet north of HDB-1. The general SRS location of the modification is shown in Attachments 9.1 and 9.2.

Note that this submittal applies to phase 1 of the treatment of waste in Tank 10. The TCCR may be deployed at other locations within H-Tank Farm or F-Tank Farm. For each subsequent deployment of TCCR, a letter will be submitted to SCDHEC for review and approval. The updated information will identify:

- the tank to be treated
- the receipt tank
- revised or new plans and specifications
- a statement that TCCR complies with the current Documented Safety Analysis (DSA) or the revised DSA for the new deployment
- new calculations

If the information is acceptable, SCDHEC will issue a letter of approval for each subsequent TCCR deployment. Each tank treated by TCCR will be considered to be a separate phase for the TCCR construction permit.

3.0 PROJECT DESCRIPTION

Tank 10 is a salt tank that contains approximately 240,000 gallons of waste. Currently, Tank 10 and other tanks do not have a viable transfer path or an installed system via

which salt dissolution or cesium extraction can be performed. The bulk of the waste in these tanks must be removed and processed to continue progress towards final tank closure.

The scope of this modification is to install systems that will:

1. Dissolve the salt waste in the tank to be treated. (e.g., Tank 10)
2. Transfer the dissolved salt waste to the TCCR system to remove radioactive cesium-137.
3. Transfer processed waste (Decontaminated Salt Solution, DSS) to Receipt Tanks (e.g., Tank 11).
4. Transfer shielded cesium laden resin columns to Interim Safe Storage (ISS).
5. Provide a stack design to ensure mercury emissions are kept within allowable limits for personal protection during salt solution mixing.

Safety in design (to protect onsite and offsite personnel) is maintained through process safety management. The TCCR project safety basis will be integrated into the Tank Farm DSA (WSRC-SA-2002-00007) with specific safety requirements maintained in Technical Safety Requirements document (S-TSR-G-00001). These documents will be updated based on the application of the results of the Consolidated Hazard Analysis (U-CHA-H-00010 under development) process.

4.0 PROCESS DESCRIPTION

The TCCR system, an ion exchange process, will remove radioactive cesium-137 from aqueous high-level waste. See Attachment 9.3, TCCR System Interfaces.

This modification will:

a) Dissolve the salt waste in the Treatment Tank (Tank 10) through bulk Inhibited Water (IW) addition and mixing of the tank to promote salt dissolution. The salt solution is recirculated between the center riser and the three outer risers.

b) Transfer dissolved salt waste to the TCCR System that will remove radioactive cesium-137 and yield a Decontaminated Salt Solution (DSS) stream. Dissolved salt waste is filtered by the Pre-filter before it passes through the ion exchange columns. The pre-filter collects any particles to prevent fouling of the ion exchange columns. The Pre-filter will be back flushed to the Treatment Tank (Tank 10). The DSS passes through a Resin Trap after it passes through the ion exchange columns. The resin trap prevents resin particles from being transferred to the

Receipt Tank (Tank 11). The resin trap will be back flushed to the Treatment Tank (Tank 10).

c) Transfer DSS to a the Receipt Tank. (Tank 11)

d) The specific gravity of the salt waste stream will be monitored in the Treatment Tank (Tank 10). As the specific gravity rises, due to the removal of the dissolved salt solution, water is added in a batch like manner to maintain the specific gravity at appropriate values for TCCR operation. Maintaining control of specific gravity ensures the ionic concentrations are suitable for the ion exchange column operations.

e) The four ion exchange columns are sized to collect all of the Tank 10 Cesium by processing approximately 625,000 gallons of dissolved salt waste. The four ion exchange columns will be operated with a single column in line until the column has been fully loaded with cesium. The "full" column will then be isolated and the flow sent to the next column.

f) After processing of the Treatment Tank (Tank 10), the spent ion exchange columns will be dewatered (effluent will be directed to Treatment Tank), placed in the DOE approved ISS, and will remain there until such time the media is processed for final disposition.

5.0 MODIFICATION DESIGN

This modification will:

a) Dissolve the salt waste in the Treatment Tank through bulk IW addition and mixing, See Attachment 9.4, TCCR System Hose/Pipe Routing.

- IW is commonly used in the tank farm due to its corrosion inhibiting properties. IW has a chemical make-up of 0.01 M NaOH and 0.011 M $NaNO_2$. Since it is commonly used, there are piping systems distributing IW to various locations within the tank farms. The selected connection point to the IW system is at valve IW-V-84 on the existing Inhibited water header on Tank 11. The IW will run from that location to Tank 10 riser 3 (ASME B31.3 qualified).
- The selected tie in point has twice been used to transfer approximately 20,000 gallons of IW to Tank 10 during the early part of 2017. The flow rate of the transfers is estimated at greater than 125 GPM. At this flowrate, the required IW addition will take less than one day which supports the project schedule.
- A hose-in-hose waste transfer path providing secondary containment (both ASME B31.3 qualified) is routed between Tank 10 Pump located in the Center Riser of tank to be treated and distributed risers within the same tank to facilitate salt dissolution at a total flow rate of 100 GPM.

- Hoses are supported on web of wide flange I-beams to maintain proper slope. Lead blankets are utilized to provide shielding where required. (Note: this is typical for all hose applications)
- See Attachment 9.6 for Summary Equipment, Hose, and Piping Data.

b) Transfer the dissolved salt waste to the TCCR system to remove radioactive cesium-137, see Attachments 9.4 and 9.5.
- The salt solution feed to the TCCR System will 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

- A hose-in-hose waste transfer path providing secondary containment (both ASME B31.3 qualified) is routed between the Tank 10 Pump located in the Center Riser of the tank to be treated and the TCCR system consisting of a supply line at nominal flowrate of 5-10 GPM and a maximum flowrate of 10 GPM.
- A hose-in-hose waste transfer path providing secondary containment (both ASME B31.3 qualified) is routed between the TCCR system and Tank 10 for the TCCR flush system.
- See Attachment 9.6 for Summary Equipment, Hose, and Piping Data .
- The TCCR system will be operated typically with a single column processing the stream. When a column has been fully loaded with cesium (as determined by the total throughput, as well as, the integration of the differential of inlet vs outlet count rate), the column will be isolated and the flow sent to the next column.
- The four ion exchange columns are sized to collect all of the Tank 10 Cesium (approximately 100,000 Curies) by processing approximately 625,000 gallons of dissolved salt waste.

A. The capacity of an ion exchange column is driven by the concentration of cesium. Per the flow sheet and system plan, SRR will control the concentration, via a feed qualification program, to 25,000 curies per column. Actual capacity of the column can be greater than 25,000 curies if SRR allows the concentration of cesium to be greater than that assumed in the flow sheet. However, the credited feed qualification program, mentioned above, will be used to control cesium concentration and loading of the column.

- The TCCR System has a minimum cesium-137 decontamination factor of 1,000. Decontamination factor is the ratio between the feed stream cesium-137 concentration and the decontaminated salt solution stream cesium-137 concentration.

c) Transfer DSS to Receipt Tank, see Attachment 9.4.
   - A hose-in-hose waste transfer path providing secondary containment (both ASME B31.3 qualified) is routed between the TCCR system and Receipt Tank for the DSS transfer.

d) Cesium collected on ion exchange media will be placed in the DOE approved ISS (for up to 10 years) until the decision is made to allow it to go to an off-site repository or the material will be sluiced out of the column and sent to DWPF for vitrification. While in ISS:
   - The waste form (Cesium laden ion exchange media) will be characterized for disposal. Characterization data shall, at a minimum, include the following information relevant to the management of the waste:
     A. Physical and chemical characteristics;
     B. Volume, including the waste and any solidification media;
     C. Radionuclides or source information sufficient to describe the approximate radionuclide content of the waste; and
     D. Any other information that may be needed to demonstrate compliance with the requirements of the DOE/EM-0093, Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms.
   - The waste form will be housed within the ion exchange column with integral shielding for radiological protection.
   - The waste form will be de-watered or in a non-liquid form. For example, resins will be flushed and drained of any free liquid before removal from TCCR module. The water will be drained to the Treatment Tank (Tank 10)
   - The columns will be transported to ISS in a horizontal position.
   - The columns will be stored at ISS in a vertical position.
   - SRR will retain these materials in ISS until such time it is processed for final disposition. ISS will be located away from the TCCR system within the H-Area Tank Farm Facility in a remote area north of the Far East Pump House and associated cooling towers. The ISS will be approximately ¼ mile from the TCCR module (straight line distance).

- The equipment and methods used for storing resin while in ISS is designed to maintain a radiological dose rate less than 5 mR/hour at 30 cm with the exception of the opening at the top of column. This opening will emit rates in excess of 5 mrem/hr @ 30cm. Access to this opening area will be administratively controlled.

e) Treatment Tank ventilation stacks will be extended. See Air Emissions (Section 7.0) for details.

f) The TCCR system structure has a once-through confinement ventilation system where air is drawn through pre-filters, the confinement space, and then through exhaust filters by a fan which discharges to the atmosphere. Air inlets are HEPA filtered. Air exhaust is HEPA filtered. Approximately 200 standard cubic feet per minute provides the desired differential pressure (-0.1 to –0.3 inches water gauge) to prevent the release of contamination to the atmosphere.

g) TCCR module provides secondary containment. Secondary containment is sized to contain 100 percent of the capacity of the largest tank within its boundary. The secondary containment has a conductivity probe detecting the presence of a leak. The control system Isolates all incoming streams if a leak is detected.

6.0 OPERATIONS / MAINTENANCE

Trained Operations personnel will operate the equipment per approved procedures. Normal Operations will not require "hands on" with the equipment within the TCCR module.

Trained Maintenance and Electrical & Instrumentation Mechanics will perform required maintenance. Before any hands on maintenance, the TCCR system will be flushed. Any remaining radioactive material in the ion exchange columns will be sufficiently shielded to allow for hands on maintenance.

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

The TCCR system may be placed in a standby condition between deployments while awaiting SCDHEC approval for a subsequent deployment. The TCCR standby condition will protect human health and the environment. Loaded resin columns will be placed in ISS. Transition between deployments will be coordinated with SCDHEC Regional Engineer for approval to operate and for approval for closure.

7.0 AIR EMISSIONS

Tank Emissions:

Mercury air emissions from Tanks has been evaluated (Documented in SRNL-STI-2016-00596) and are not expected to require South Carolina Bureau of Air Quality Permitting. SRR will maintain documentation demonstrating exemption from Bureau of Air Quality Permitting. This documentation will be maintained at SRS and will be made available upon request.

Mercury emissions are kept within allowable guidance for personnel protection during salt dissolution mixing.

The most conservative exposure guidelines are adhered to between the Occupational Safety and Health Agency (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH). The latter has the most conservative exposure limits for mercury. ACGIH Threshold Limit Values (TLVs) for mercury are separate for organic and inorganic forms:

- The threshold limit value, which is an 8 hour time weighted average, for elemental mercury exposure is 0.025 mg/m^3, and for aryl mercury compounds it is 0.010 mg/m^3.
- Aryl mercury compounds also have a short term exposure limit (15 minutes) of 0.030 mg/m^3. Ref: (ACGIH, Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices, 2017).

SRR ensures worker exposure remains below those limits through conservatively applying an administrative action level of 0.008 mg/m3 (effectively a 45 second average) to all airborne mercury forms (combined). Ref: SRR Procedure S12-IH.02.

Mercury emissions will be monitored, via direct reading instrumentation, at startup and periodically, as necessary, at the TCCR and waste tank discharge stacks to verify that the mercury generation rate does not exceed the concentrations anticipated in the modeled scenarios.

Ambient mercury will also be monitored in worker breathing zones and workspaces using direct reading instrumentation and adsorbent media (which is an integrated sample over a designated time period). For an example of the type of mercury monitoring to be performed, refer to OSHA ID-140, Mercury Vapor in Workplace Atmospheres.

TCCR Module Exhaust:

The confinement ventilation system exhaust will be filtered and will meet ASME-AG-1 and ASME-N509 requirements.

ISS Exhaust:

Gasses generated (water evaporation) and atmospheric breathing while ion exchange columns are in ISS will be vented through a HEPA filter.

8.0 CLOSURE

When the TCCR facility completes the treatment of the waste in Tank 10, a decision will be made whether to conduct treatment of an additional HLW tank (Phase 2) or to no longer use the TCCR facility. If the decision is to treat another tank, DOE/SRR will submit a letter to SCDHEC describing the standby configuration for TCCR while awaiting approval for Phase 2 for TCCR. The standby configuration will describe an acceptable non-operation configuration that no longer allows treatment of Tank 10 waste. The Regional Engineer shall perform an inspection of the standby configuration for TCCR. If the inspection results are satisfactory, TCCR shall remain in the standby configuration until SCDHEC approves Phase 2 for TCCR. Once the Phase 2 installation is completed, DOE/SRR will request that the Regional Engineer conduct an inspection of the Phase 2 installation. If the inspection results are satisfactory, the Regional Engineer will issue the Approval to Operate for Phase 2. The process described for Phase 2 will be used for subsequent phases for operation of the TCCR facility. Once the decision is made that the TCCR unit will no longer be used, it will be operationally closed in accordance with a SCDHEC and DOE approved closure plan.

9.0 ATTACHMENTS

9.1 General Site Location Map

9.2 Location of Proposed Modification in H-Tank Farm

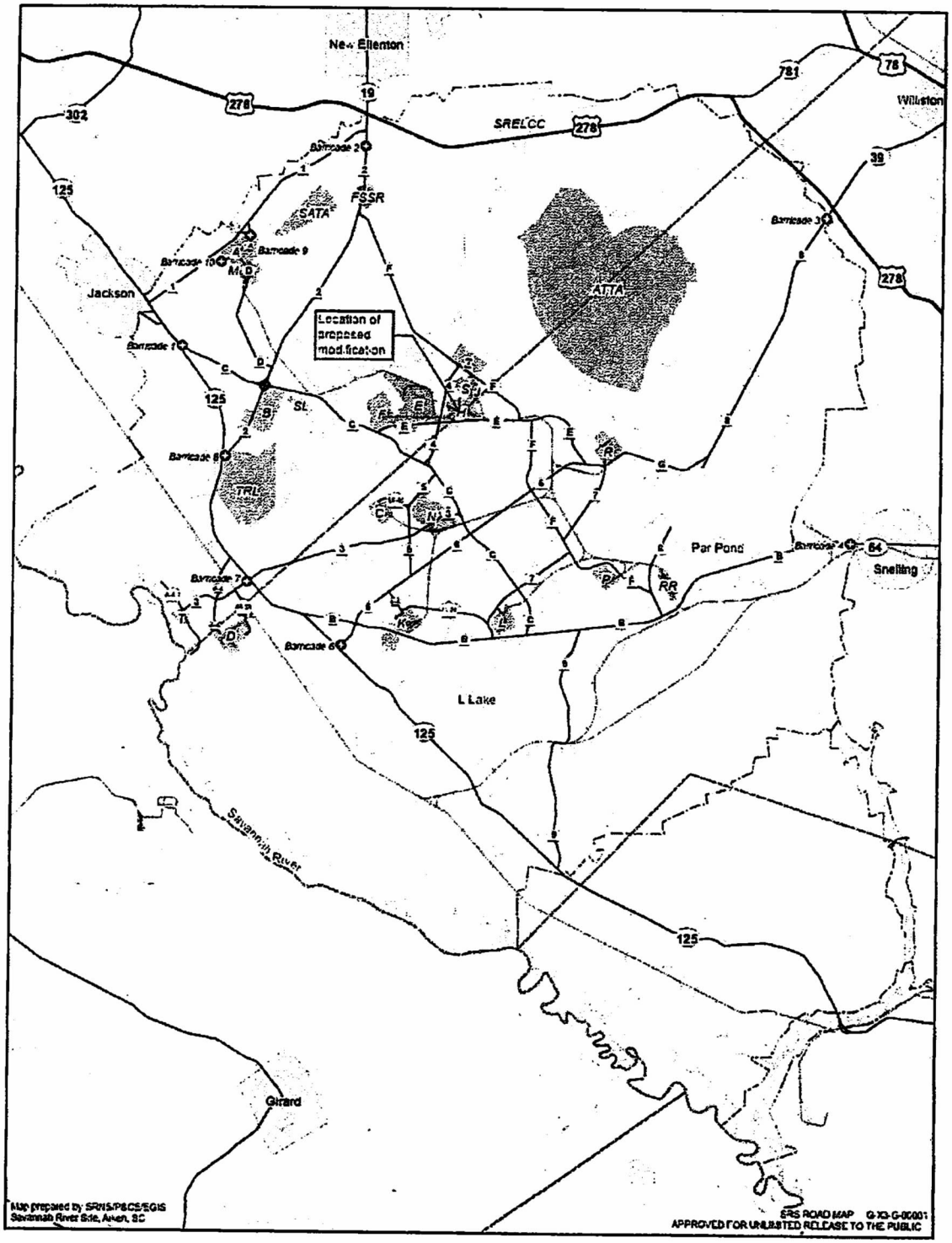
9.3 TCCR system Interfaces

9.4 TCCR system Hose/Pipe Routing

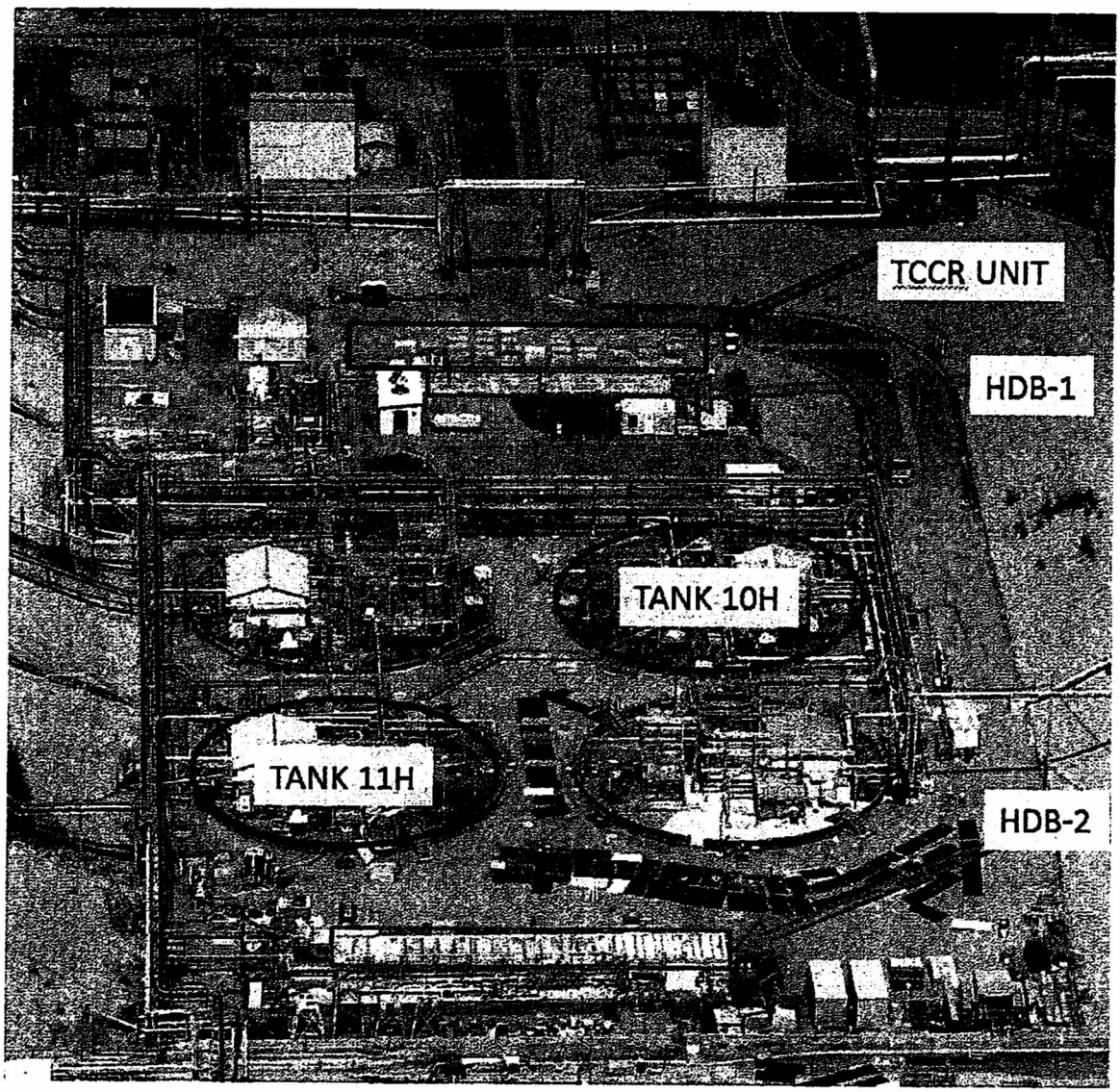
9.5 TCCR Module Configuration (Plan, Elevation, and Isometric Views)

9.6 Summary Equipment, Hose, and Piping Data

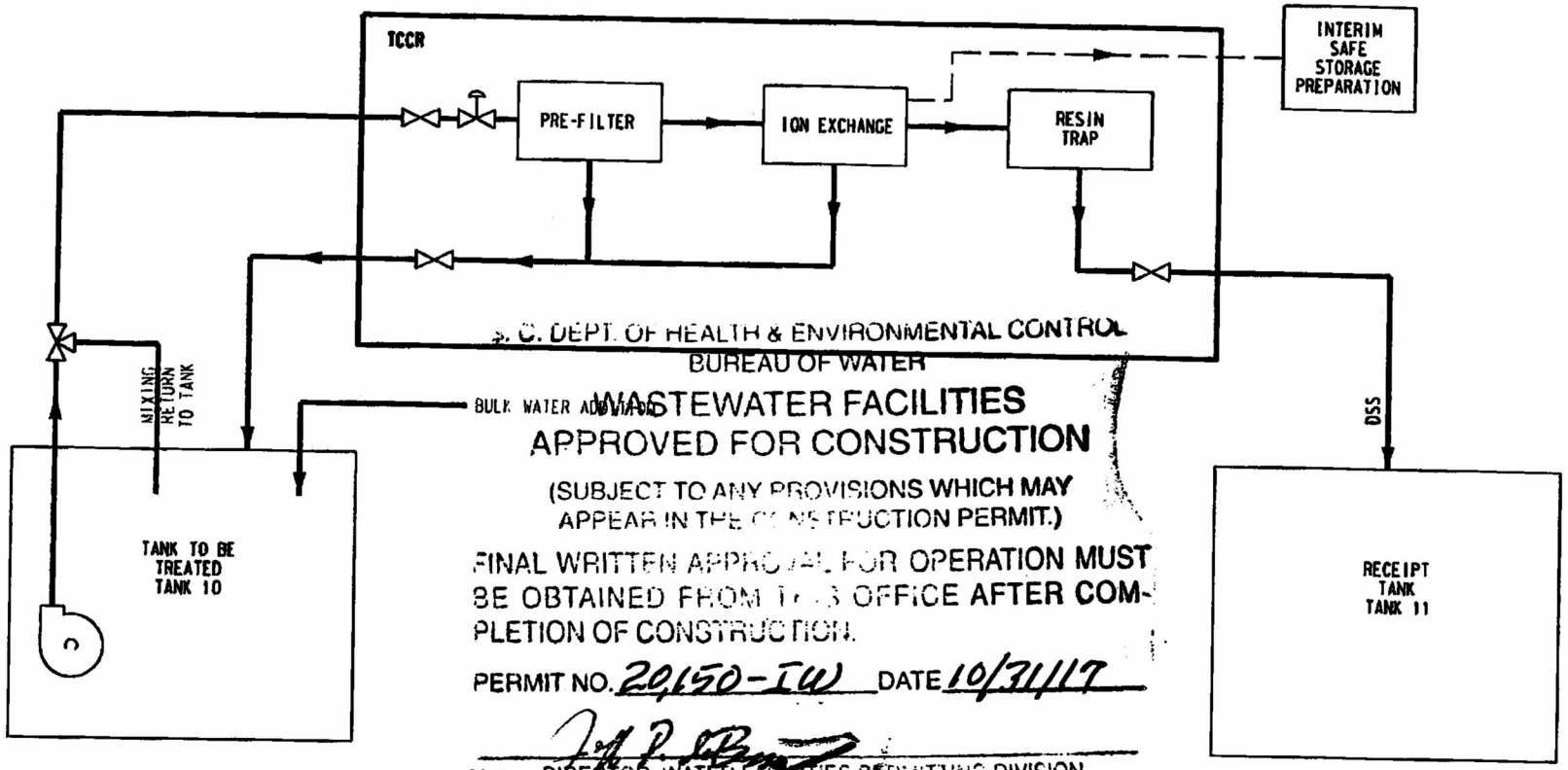
Attachment 9.1 General Site Location Map



Attachment 9.2 Location of Proposed Modification in H-Tank Farm



Attachment 9.3 TCCR System Interfaces



S. C. DEPT. OF HEALTH & ENVIRONMENTAL CONTROL
BUREAU OF WATER
WASTEWATER FACILITIES
APPROVED FOR CONSTRUCTION
(SUBJECT TO ANY PROVISIONS WHICH MAY APPEAR IN THE CONSTRUCTION PERMIT.)
FINAL WRITTEN APPROVAL FOR OPERATION MUST BE OBTAINED FROM THIS OFFICE AFTER COMPLETION OF CONSTRUCTION.
PERMIT NO. 20,150-IW DATE 10/31/17
DIRECTOR, WATER FACILITIES PERMITTING DIVISION

Note: Ion exchange columns will be transferred to ISS for future disposition

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SAVANNAH RIVER REMEDIATION, LLC
No. 3997
CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 22845
MICHAEL BRYAN WOOD
7.26.17

SOUTH CAROLINA
SAVANNAH RIVER REMEDIATION, LLC
No. 3997
CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA
PROFESSIONAL ENGINEER
No. 22845
MICHAEL BRYAN WOODWARD
7.26.17

Attachment 9.4 TCCR System Hose/Pipe Routing

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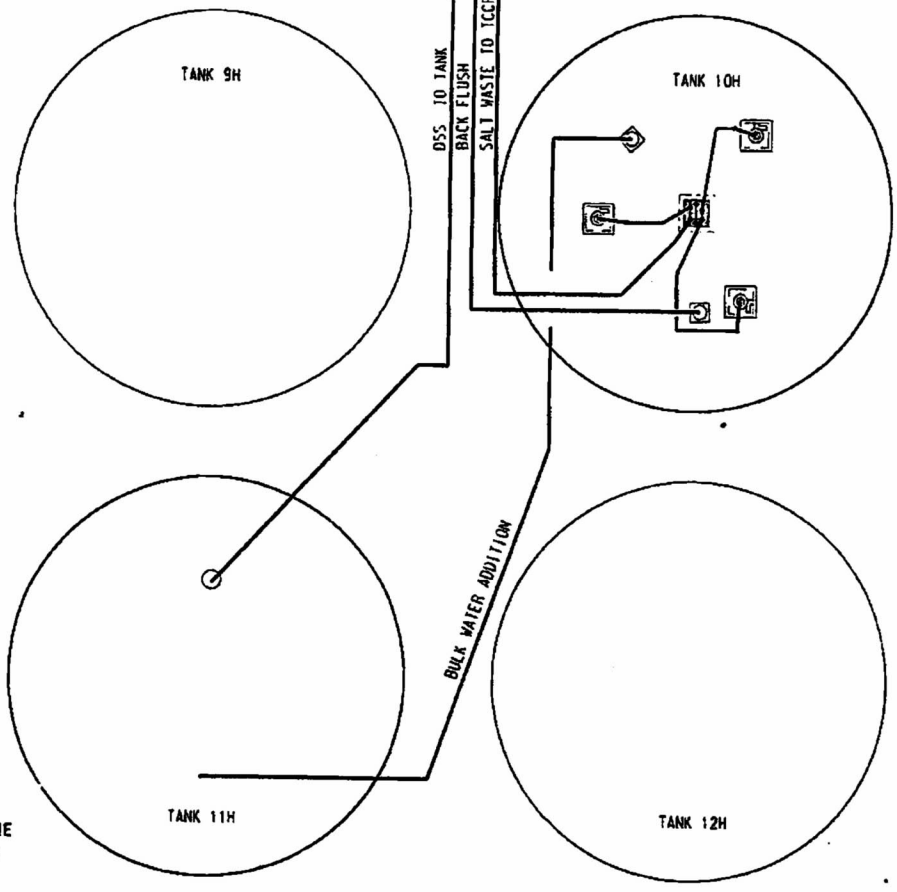
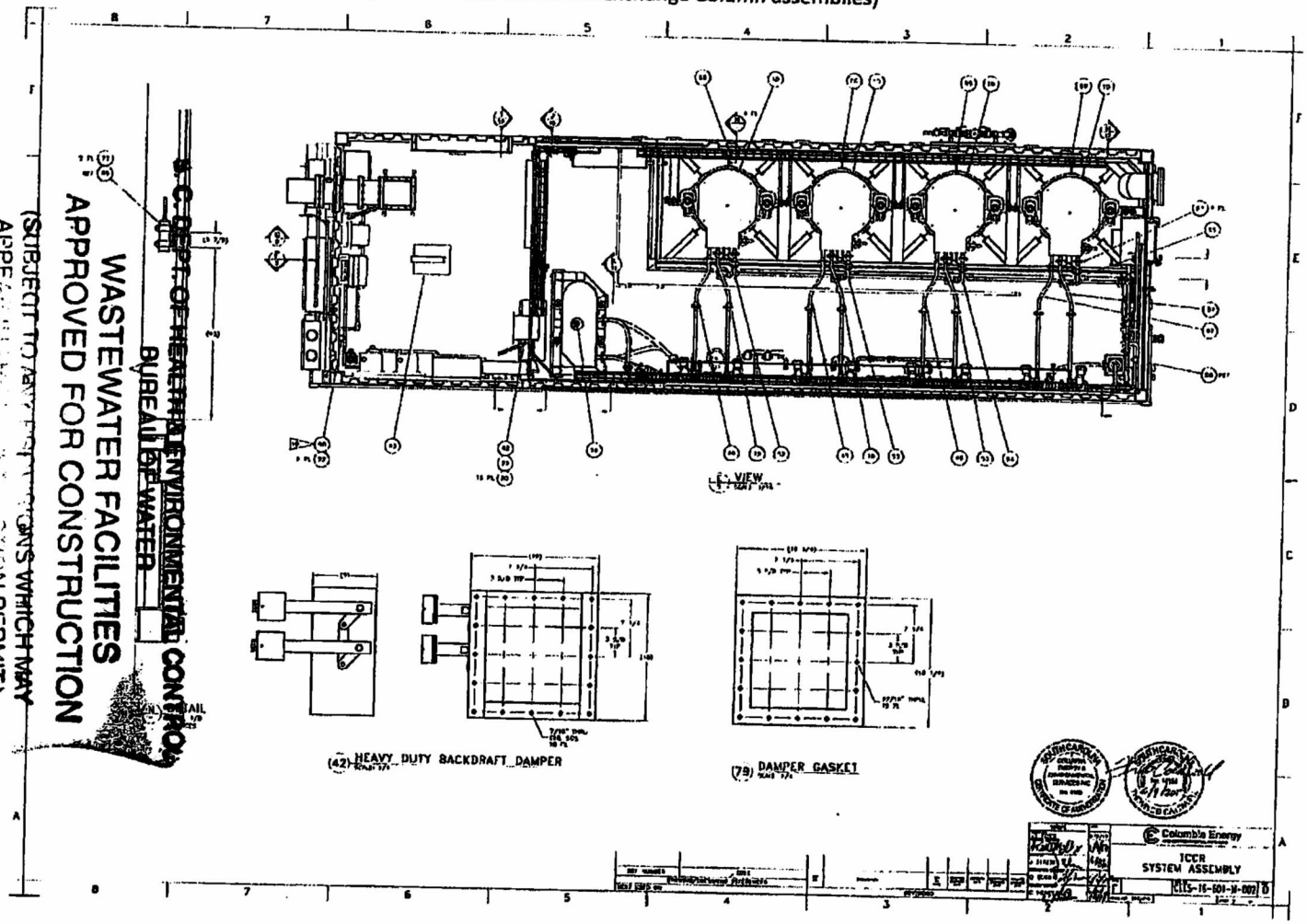
TCCR BUREAU OF WATER
WASTEWATER FACILITIES
APPROVED FOR CONSTRUCTION
(SUBJECT TO ANY PROVISIONS WHICH MAY APPEAR IN THE CONSTRUCTION PERMIT.)
FINAL WRITTEN APPROVAL FOR OPERATION MUST BE OBTAINED FROM THIS OFFICE AFTER COMPLETION OF CONSTRUCTION.
PERMIT NO. 20150-IW DATE 10/31/17
DIRECTOR WATER FACILITIES ... DIVISION



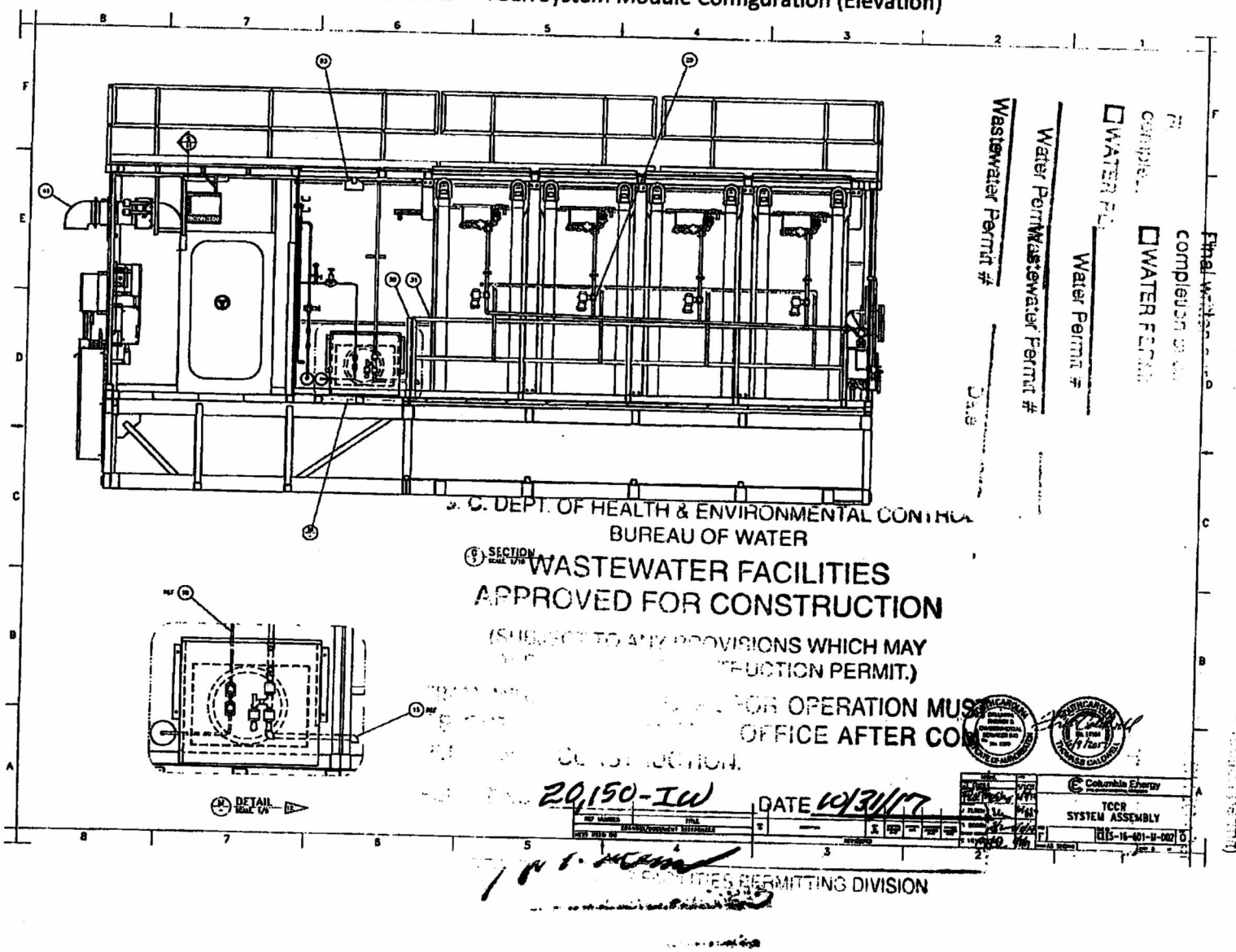
NOTE: INHIBITED WATER FOR BULK WATER ADDITION ORIGINATES AT THE INHIBITED WATER HEADER LOCATED ABOVE TANK 11.

Attachment 9.5 TCCR System Module Configuration (Plan)

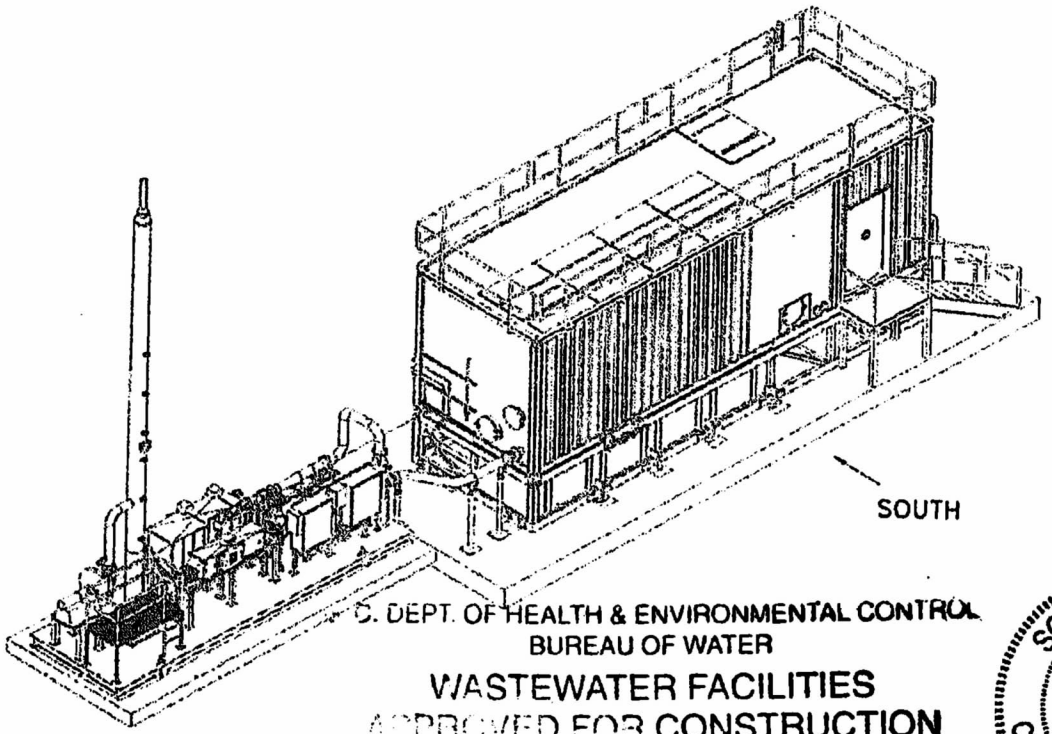
(Item 10 denotes the Ion Exchange Column assemblies)



Attachment 9.5 TCCR System Module Configuration (Elevation)



Attachment 9.5 TCCR System Module Configuration (Isometric)



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...ERATION MUST
...CE AFTER COM-

20,150-IW DATE 10/31/17

...WATER POLLUTION CONTROL DIVISION

SOUTH CAROLINA
COLUMBIA
ENERGY &
ENVIRONMENTAL
SERVICES INC
No. 4399
CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 32165
ERIC ALAN ANDERSON
6-29-17

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Description	Type Size Capacity	Specification
Process Hoses hose-in-hose	Hose will be EPDM (ethylene propylene diene monomer), EPR (Ethylene-Propylene Rubber) Hose will have helical wire reinforcement and a fabric reinforced cover. Hoses will be supported to maintain slope and will be shielded with lead blankets.	Designed to *Hose Handbook (RMA IP-2)* Qualified for: - Service in accordance with the requirements of ASME B31.3 Chapter VII. - As unlisted components in accordance with ASME B31.3, paragraph 304.7.2 Tested per ASME B31.3 paragraph A304.7.2 (b). (Including end fittings.)
Process Piping	Piping will be schedule 40 seamless pipe	Designed and tested in accordance with ASME B31.3 for normal fluid service. Type 304L stainless steel ASTM A312.
Automatic Valve Data	Fisher Vee-Ball V150	See Page 24 for Summary information
Manual valve data	Worcester Controls Series 59 Full Port Ball Valve	See Page 41 for Summary information
Tank 10H pump	100 gpm for dissolution 5 to 10 gpm to TCCR system 25 gpm filter backflush Summary Hydraulic Calculation	Manufacturer: Tsurumi Pump Model: LH311W-60 See Pages 45 for Summary Pump Data Sheet See Pages 46 to 66 Summary Hydraulic Calculation

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7.26.17

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Pre-filter	The filter housings are 8" diameter pipe with a height of approximately 24". The filter media is a 10 micron absolute sintered metal (stainless steel) mesh.	Qualified as a ASME B31.3 piping component.
Ion Exchange Column	Approximately 10 ft tall, 20 Inches diameter	ASME B&PVC Section VIII Div 1 Lethal Service ASTM A240, Grade 304L
Resin Trap	The resin trap housing is a 6" diameter stainless steel pipe approximately 19.5 inches long. The screen is an 80 micron absolute stainless steel wedge wire screen.	Qualified as a ASME B31.3 piping component.

Note: All system components and features have full supporting Calculations, Drawings, Specifications, and Datasheets, etc. The documentation is stored at SRS and copies of these documents are retrievable upon request.

A few prominent examples are:

- Pressure vessels and piping systems have required ASME code compliance calculations.
- Structural Integrity calculations.
- Pump, column, piping, and equipment sizing calculations.
- Foundation design calculations.

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Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Automatic Valve Data (Typical)

Vee-Ball Valves
D101363X012

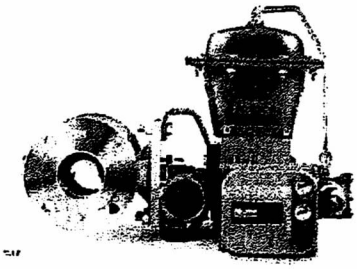
Product Bulletin
51.3:Vee-Ball
March 2016

Fisher™ Vee-Ball™ V150, V200, and V300 Rotary Control Valves

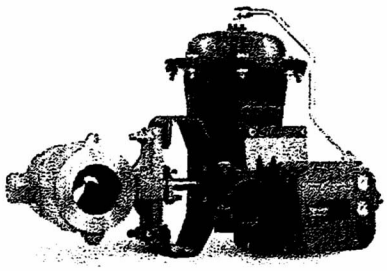
This bulletin covers the DN 25 through 600 (NPS 1 through 24) V150, V200 and V300 Vee-Ball control valves. The Vee-Ball valve combines globe valve ruggedness with the efficiency of a rotary valve. The Vee-Ball valve is a segmented ball valve which features a contoured segmented V-Notch ball. A shearing action between the V-notch ball and the ball seal (figure 1) promotes smooth, nonclogging operation. The unrestricted straight-through flow design provides high capacity for gas, steam, liquids, and fibrous slurries.

V150, V200, and V300 valves mate with a variety of ASME raised face flanges, as well as with EN flanges (see Specifications).

To meet specific application requirements, a variety of metal and soft ball seal materials are available. A splined drive shaft combines with a variety of power operated and manual actuators to provide reliable, high-performance throttling or on-off operation for many different applications in the process industries.



V150



V200

Typical Vee-Ball Valves with Fisher 2052 Actuators and FIELDVUE™ DVC6200 Digital Valve Controllers

Features

- Trim Versatility—Trim components are interchangeable between V150, V200, and V300 valves. This feature allows you to reduce your spare parts inventory and maintenance procedures. The seal assembly can be changed without removing the actuator or without removing the ball from the valve body.
- Easy Installation—Flanged body design of the V150 and V300 eliminates exposed line flange bolting, reduces alignment and installation time, and promotes secure valve installations and piping integrity. The V200 is available with flanges in NPS 2 through 8.

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Product Bulletin
51.3:Vee-Ball
March 2016

Vee-Ball Valves
D101363X012

Specifications

Valve Sizes

See table 1

Valve End Connection Styles

V150: Flanged valves that mate with CL150 raised-face flanges and EN 1092-1 Type B raised-face and Type F Recess

V200: Flangeless (all sizes) and flanged valves that mate with CL600 raised-face flanges (NPS 2-8)

V300: Flanged valves that mate with CL300 raised-face flanges and EN 1092-1 Type B raised-face and Type F Recess

Maximum Inlet Pressures(1)

V150 or V300 WCC (or 1.0619 Steel), CF3M (or 1.4409 SST), CG8M, LCC, M35-2, CK3McuN, CD3MN, and CD3MWCuN Valves: Consistent with CL150 for V150 or CL300 for V300 pressure-temperature ratings per ASME B16.34 or with PN pressure-temperature ratings shown in table 1. Note: CF3M is the standard material offering in Europe and Asia-Pacific. 1.0619 Steel and 1.4409 SST are also standard material offerings in Europe.

V200 WCC, CG8M, and LCC Valves: Consistent with applicable pressure-temperature ratings in table 1 per ASME B16.34.

CW2M: Consistent with applicable pressure-temperature ratings shown in table 6. Do not exceed the material temperature capabilities shown below or the pressure drop limitations.

Maximum Shutoff Pressure/Temperature Ratings(1)

Composition (Fisher TCM Plus or TCM Ultra), Flat Metal (NPS 3 through 12 valves only), HD and High Temperature HD Metal Ball Seals and Flow Ring: See table 8.

Shutoff Classification(1)

Fisher TCM Plus or Ultra Ball Seal (Forward Flow): Class VI per ANSI/FCI 70-2 and per IEC 60534-4.
Flat Metal Ball Seal for NPS 3 through 12 only (Forward Flow): Class IV per ANSI/FCI 70-2 and per IEC 60534-4

HD (Heavy Duty) Ball Seal (Bidirectional Flow): 0.01% of valve capacity; Class IV per ANSI/FCI 70-2 and IEC 60534-4; Maximum allowable pressure drop in reverse flow is 6.9 bar (100 psi).

High Temperature HD (Heavy Duty) Ball Seal (Bidirectional Flow): Class III per ANSI/FCI 70-2 and IEC 60534-4
Flow Ring Construction (Bidirectional Flow): 5% of valve capacity at full travel

Micro-Notch Ball with HD Seal: 4 SCFH (Leakage rate equivalent to Class IV for standard ball. This is based on the capacity of a standard ball.)

Construction Materials

See tables 4 and 5

Used for this design

Temperature Capabilities(1,2)

Composition Seals
Fisher TCM Plus: -46 to 232°C (-50 to 450°F)
Fisher TCM Ultra: -46 to 260°C (-50 to 500°F)
HD Metal Seals: -46 to 288°C (-50 to 550°F)
High Temperature HD Metal Seal: 288 to 427°C (550 to 800°F). Contact your Emerson Process Management sales office if higher temperatures are required.
Ceramic Micro-Notch Ball: -46 to 93°C (-50 to 200°F)(4)
Flow Ring or Flat Metal Seal : -198 to 425°C (-325 to 800°F)
PEEK/PTFE Bearings: -198 to 260°C (-325 to 500°F)

Packing Constructions

PTFE V-ring: -46 to 232°C (-50 to 450°F)
Graphite: -198 to 538°C (-325 to 1000°F)
ENVIRO-SEAL™ Single PTFE V-ring: -46 to 232°C (-50 to 450°F) (for 100 ppm service requirements)
ENVIRO-SEAL Graphite: -7 to 316°C (20 to 600°F) (for 100 ppm service requirements). This packing arrangement can be used to 371°C (700°F) for non-environmental service.

Flow Characteristic

Modified equal percentage

Dimensions

See figures 7, 8, and 10 for dimensions

Optional Face-to-Face Dimensions

■ ASME B16.10 short face-to-face dimensions are available as an option for NPS 1 through 12 valves. Note that ASME B16.10 short dimensions are actually longer than ISA S75.08.02. See figure 11 for dimensions.

(continued)

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Vee-Ball Valves
D101363X012

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March 2016

Specifications (continued)

Standard Flow Direction

Forward (into the convex face of the V-notch ball)

Flow Coefficients, Flow Coefficient Ratio[3], and Noise Levels

See Fisher Catalog 12

Maximum Ball Rotation

90 degrees

Actuator Mounting

Standard valve construction is for right-hand mounting, as viewed from upstream end of valve. Left-hand (optional) mounting is available upon request[5]

Valve/Actuator Action

With diaphragm or piston rotary actuator, the valve is field-reversible between PDTC or PDTO:

■ push-down-to-close (extending actuator rod closes valve) and ■ push-down-to-open (extending actuator rod opens valve)

Approximate Weight

See table 2

Options

■ Pipe plug at end of follower shaft for all sizes, ■ Line flange bolting, ■ Materials that are compatible with sour service, ■ Alloy construction materials, ■ ENVIRO-SEAL packing system: See figure 6 and Bulletin 59.3:041, ENVIRO-SEAL Packing Systems for Rotary Valves (D101638X012) for more information, ■ Micro-Notch construction for NPS 1 valves (see Micro-Notch Construction section), ■ Alloy trim material, ■ Chrome Carbide coated internals (NPS 2 through 12), ■ Rotary attenuator to reduce aerodynamic noise and cavitation effects, ■ Double D, Square, and Keyed shaft options

1. The pressure/temperature limits in this bulletin, and any applicable code or standard limitation, should not be exceeded
2. Additional limits are shown in tables 6, 7 and 8.
3. Ratio of maximum flow coefficient to minimum stable flow coefficient (can also be called rangeability).
4. For the CC8M and alloy 6 Micro-Notch constructions, pressure and temperature capabilities are the same as for standard constructions
5. The left-hand mount is not available for Micro-Notch constructions, as it will cause the ball to rotate to the bottom of the valve body

Table of Contents

Features (continued)

- **Application Versatility**—The valves are available with ISA S75.08.02 and IEC 534-3-2 face-to-face dimensions as a standard construction, and optional ASME B16.10 short face-to-face dimensions. IEC 534.3.2 face-to-face dimensions are equivalent to S75.08.02 face-to-face dimensions.

- **Long Service Life**—The solid HD ball seal (figures 1 and 2) construction provides long service life in demanding applications. The constant wiping action of the seal across the ball's sealing surface prevents scale and sludge buildup, and provides excellent service on steam, gases, slurries, and various liquid applications.

- **Smooth Valve Operation**—Precision machined parts and pressure balanced seal designs allow smooth, precise movement of the ball.

- **Excellent Flow Control**—Precise contouring of the Vee-Ball provides a modified equal percentage flow characteristic. For very precise control of low flow rates, the Micro-Notch option is available on the NPS 1 valve. See the Micro-Notch Construction section of this bulletin for more information.

- **Sour Service Capability**—Materials are available for applications involving sour liquids and gases. These constructions comply with NACE MR0175-2002, MR0175-2003, MR0103, and MR0175/ISO 15156.

- **Quick and Easy Maintenance**—Ball seal inspection and replacement is done at the valve body inlet without removing the actuator or disassembling the valve. Valve maintenance requires no special tools.

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Product Bulletin
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March 2016

Vee-Ball Valves
D101363X012

- **Structural Integrity**—One-piece valve body improves structural integrity of the pressure boundary by eliminating leak paths that could be caused by the gaskets in two-piece, bolted valve designs.
- **Exceptional Environmental Capabilities**—The optional ENVIRO-SEAL packing systems are designed with very smooth shaft surfaces and live loading to provide exceptional sealing. The seal of the ENVIRO-SEAL system can restrict emissions to less than the EPA (Environmental Protection Agency) limit of 100 ppm (parts per million).

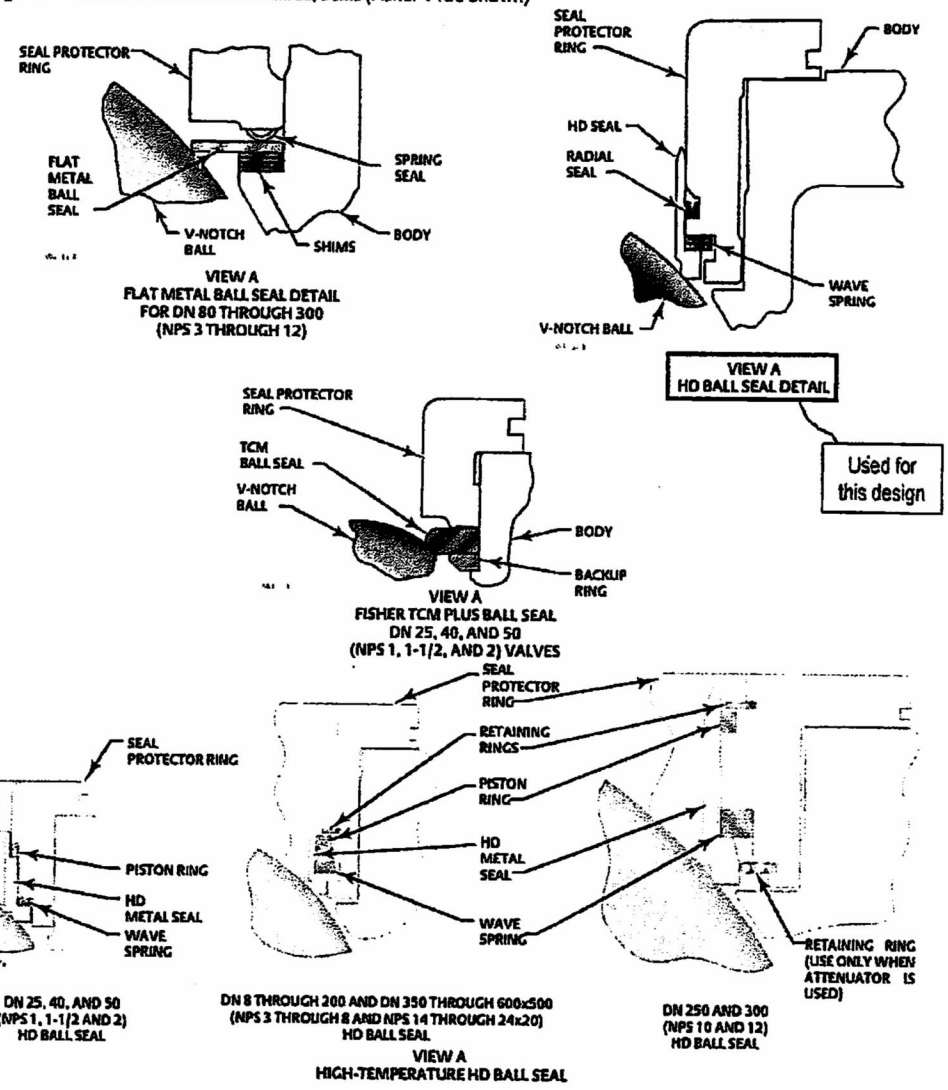
Table 1. Valve Body Materials, End Connections, and Ratings

VALVE DESIGN	VALVE BODY MATERIAL	SIZE	RATINGS
		NPS / DN	ASME / PN
Used for this design	WCC	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20, 24x20[5]	CL150
	WCC / 1.0619[1]	DN 80, 100, 150	PN 10-16
		DN 200, 250, 300	PN 10 or PN 16
	LCC	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	CL150
		DN 80, 100, 150	PN 10-16
		DN 200, 250, 300	PN 10 or PN 16
V150	CF3M[2]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	CL150
	CF3M/1.4409[1]	DN 80, 100, 150	PN 10-16
		DN 200, 250, 300	PN 10 or PN 16
	CG8M	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20, 24x20[5]	CL150
	CW2M	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	M35-2	NPS 1, 1-1/2, 2, 3, 4, 6, 8	
	CD3MN[3]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	CD3MWCuN[3]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	CK3MCuN	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
V200[4]	WCC, LCC, CG8M, or CF3M[2]	NPS 1, 1-1/2, 2	CL150/300/600 flangeless
		NPS 3, 4	CL150 and CL300/600 flangeless
		NPS 6, 8	CL150/300 and CL600 flangeless
		NPS 10	CL150 flangeless
	WCC, LCC, or CG8M	NPS 2, 3, 4, 6, 8	CL600
	CW2M, M35-2, or CK3MCuN	NPS 1, 1-1/2, 2, 3, 4, 6, 8	CL150/300/600 flangeless
	CK3MCuN	NPS 10	CL150 flangeless
V300	WCC	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20	CL300
	WCC / 1.0619[1]	DN 25, 40, 50	PN 10-40
		DN 80, 100, 150	PN 25-40
		DN 200, 250, 300	PN 25 or PN 40
	LCC	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	CL300
		DN 25, 40, 50	PN 10-40
		DN 80, 100, 150	PN 25-40
		DN 200, 250, 300	PN 25 or PN 40
	CF3M[2]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	CL300
	CF3M/1.4409[1]	DN 25, 40, 50	PN 10-40
		DN 80, 100, 150	PN 25-40
		DN 200, 250, 300	PN 25 or PN 40
	CG8M	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20	CL300
	CW2M	NPS 1, 1-1/2, 2, 3, 4, 6, 8	
	M35-2	NPS 1, 1-1/2, 2, 3, 4, 6, 8	
	CD3MN[3]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	CD3MWCuN[3]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	CK3MCuN	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	

1. WCC and F4 Std 1.0619 are dual certified. CF3M and FN SST 1.4409 are dual certified
2. CF3M is a standard offering on Europe and Asia Pacific
3. NORSOK compliant materials available upon request.
4. Flangeless V200 assemblies must with raised-face flanges.
5. Valve body mates with NPS 24 ASME CL150 flanges. Internal based on NPS 20 valve design.

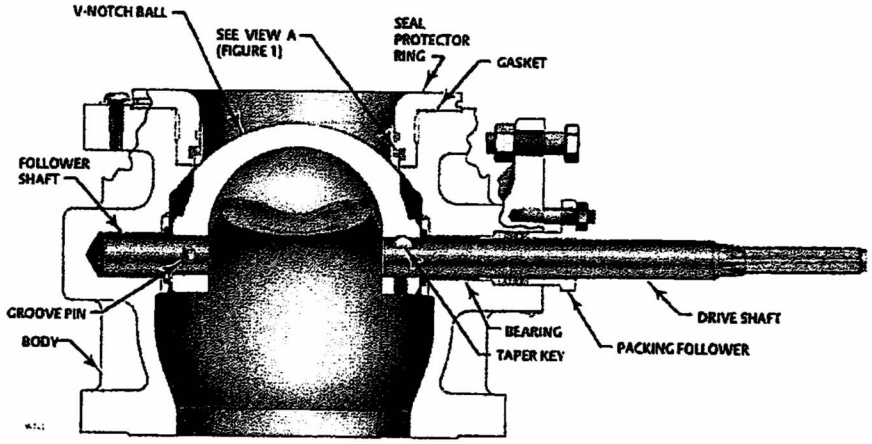
Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Figure 1. Vee-Ball Construction Features, Seals (Fisher V150 Shown)

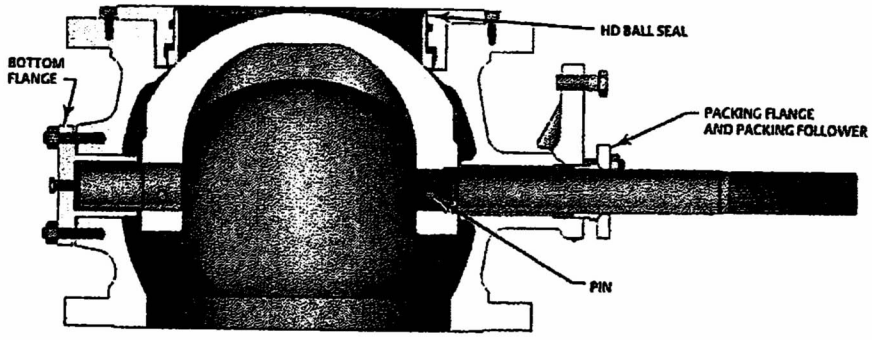


Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Figure 2. Vee-Ball Construction Features (Fisher V150 Shown)



DN 80 THROUGH 300
(NPS 3 THROUGH 12) VALVES
(HD BALL SEAL SHOWN)



DN 350, 400, 500 and 600x500
(NPS 14, 16, 20, and 24x20) VALVES
(HD BALL SEAL)

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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Table 2. Valve Weights, Approximate

Used for this design

VALVE SIZE		V150		V200		V300	
DN	NPS	kg	lbs	kg	lbs	kg	lbs
25	1	5.6	13	4.5	10	8	17
40	1-1/2	8.2	19	6.4	14	12	27
50	2	9.1	21	10	23	17	38
80	3	13	43	15	34	28	61
100	4	26	57	22	48	37	81
150	6	42	93	36	80	60	133
200	8	72	158	67	136	103	226
250	10	107	235	114	252	200	440
300	12	157	347	---	---	293	645
350	14	247	545	---	---	374	825
400	16	333	735	---	---	510	1125
500	20	524	1155	---	---	755	1661
600x500	24x20	757	1666	---	---	---	---

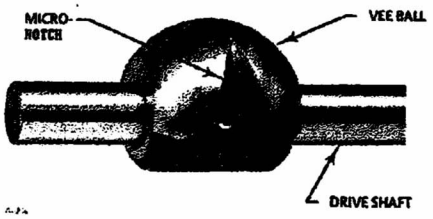
Series B

NPS 3 through 12 have been changed to reduce parts and to improve control performance. The V-notch Ball now resembles the NPS 14 through 24x20 V-notch Ball. The pressed-in bushings have been eliminated, as well as the thrust washer.

Micro-Notch Construction

For very precise control of low flow rates, the Micro-Notch construction (see figure 3) is available on DN 25 (NPS 1) valves. Three Micro-Notch ball materials are available: chrome-plated CG8M (317 stainless steel), solid alloy 6, and solid VTC ceramic. A VTC ceramic HD seal is standard with the VTC ceramic ball. For the CG8M and alloy 6 constructions, pressure and temperature capabilities are the same as for standard constructions. For the ceramic construction, maximum temperature is 93°C (200°F).

Figure 3. Typical Micro-Notch Ball and Shaft



For further information, please refer to the Fisher Vee-Ball V150, V200 and V300 Rotary Control Valves NPS 1 through 12 instruction manual (D101554X012).

In addition to the standard Micro-Notch offering, options are available in both low (Micro-Scratch) and high (Macro-Notch) flow construction. Contact your Emerson Process Management sales office for more information.

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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Severe Service Attenuator

Fisher Vee-Ball series valves (V150, V200, and V300), with the severe service attenuator, combine the efficiency of a rotary valve with the energy absorbing capability of a special trim to provide improved performance for demanding applications. The Fisher attenuator design can be utilized in both liquid and gas service to reduce cavitation and noise effects that cause pipeline vibration. See table 3 for a competitive comparison.

The attenuator will not change the NACE compliance of the Vee-Ball valve. When a rotary noise attenuator is installed in a Vee-Ball valve, the V-Notch is no longer a point of high-velocity erosion. As a result, the CoCr-A V-Notch option is not required when a rotary attenuator is used. The rotary attenuator and CoCr-A V-Notch options are not available together.

Features

- Trim Versatility — Trim components are interchangeable for Fisher V150, V200, and V300 valves. This feature allows you to reduce your spare parts inventory and maintenance procedures.
- Attenuator-Ball Fabrication — The ball-attenuator construction provides structural integrity because of its rugged fabrication weld.
- Attenuator Performance — Up to -10 dBA acoustical attenuation, and a K_c = 1.0 for hydrodynamics are achievable depending on service conditions.

Attenuator Ball Material

Standard attenuator ball material is CG8M, M35-1, CW2M, or CK3McuN.

Standard Flow Direction

Forward flow direction is into the convex face of the V-notch ball. The valve with the attenuator must be placed in the forward flow direction for the attenuator to be effective.

Actuator Mounting

Right-hand or left-hand as viewed from the upstream end of the valve. Counter-clockwise to close for both mounting styles.

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Figure 4. Fisher Vee-Ball Series Noise Attenuator Ball

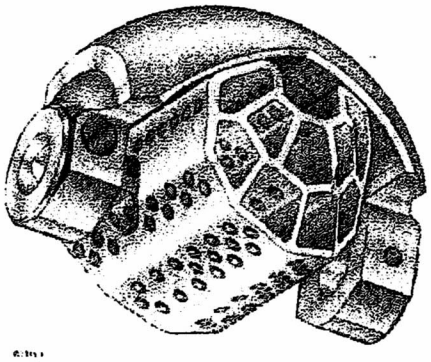

Figure 5. Fisher Vee-Ball Series Rotary Attenuator Construction

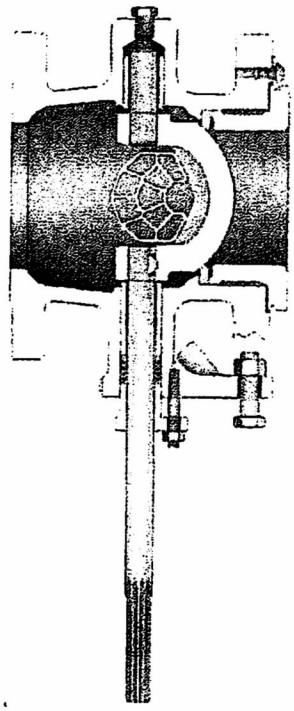

Table 3. Segmented Ball Benefits Analysis Comparison

Benefits	Typical Competitive Device	Fisher Vee-Ball Attenuator
Predictable Performance	No	Yes
10 dBA Aerodynamic Noise Attenuation	No	Yes
Superior Attenuation Effect at Critical Opening Position	No	Yes
Maximum Pressure Drop Capability	No	Yes
Heavy Duty, Integrally Welded Attenuator/Ball Assembly	No	Yes
Valve Splined Shaft Connects to Clamped Actuator Lever to Minimize Lost Motion	No	Yes
Superior Soft Seats for Tight Shutoff	No	Yes
Moderate Kc Improvement vs Unattenuated Device	Yes	Yes
Trunnion Mounted Ball for Superior Wear Resistance	Yes	Yes
Heavy Duty Metal Seats for Demanding Applications	Yes	Yes

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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Used for this design

Table 4. Materials of Construction for DN 25 through 300 (NPS 1 through 12) Valves

PART		MATERIAL
Valve Body and Seal Protector Ring or Flow Ring		WCC steel (EN 1.0619), CG8M (317 SST), CF3M[1] (316L SST EN 1.4409 or optional EN 1.4581), CD3MN, CD3MWCuN, CW2M (CW2M valve available with Fisher TCM Plus seal only), M35-2 or CK3MCuN
Backup Ring [DN 25, 40, and 50 (NPS 1, 1-1/2, and 2) only]		CG8M, CF3M[1], or CW2M
Segmented V-Notch Ball		CG8M, CF3M, CW2M, chromium-plated CF3M, chromium-plated CG8M, chromium-plated CG8M with alloy 6 notch, chromium-plated CF3M with alloy 6 notch, chromium-plated CD3MN, chromium-plated CD3MWCuN, M35-1, or CK3MCuN
Seal	Fisher TCM	Fisher TCM Plus and Fisher TCM Ultra
	Flat Metal Seal, Shims, and Spring Seal[7]	Spring Tempered S31600 (316 stainless steel) or Spring Tempered S30200 (302 stainless steel) for NPS 12 valves only
	HD (Heavy-Duty) Ball Seal	CF10SMnN[3], CD7MCuN[3] (alloy 255 duplex stainless steel) or R30006 (Alloy 6)
	High Temperature HD Seal	R30006 (Alloy 6)
Wave Spring (use with HD seal)		N07750
HD Seal Radial Seal		Graphite-reinforced PTFE
High Temp HD Seal Piston Ring		Graphite-PMS 17F39
Bearings		PEEK[4]/Carbon-filled PTFE liner, S31603 Nitride, R30006 (alloy 6), Silver-plated R30006, N10276 with carbon-filled PTFE liner, or N10276 with glass-filled PTFE liner
Seal Retainer Gasket		Laminated graphite
Packing		PTFE V-ring with one carbon-filled PTFE ring[2], PTFE V-ring, graphite ribbon, ENVIRO-SEAL PTFE, or ENVIRO-SEAL graphite
Shafts		S20910, S17400 (17-4PH stainless steel), N10276, N05500, S31254[5], or S32760[5]
Groove Pin		S31600 or N10276
Taper Key		R30006[6], S20910, or N10276
Taper Pin [DN 25, 40, and 50 (NPS 1, 1-1/2, and 2) only]		S20910 or N10276
Pipe Plug (Optional)		S31600 N10276, or S31603 (316L stainless steel)
Seal Retainer Screws and Washers		Stainless steel
Packing Follower and Packing Box Ring		CF8M (316 stainless steel), N10276, S312254, or N10276 with separate S31600 packing box flange
Actuator Mounting Bolts and Nuts		Grade S steel or strain-hardened B8M stainless steel
Spacer and Bushing		S31700, N10276, or S31603
Packing Follower Bolting and Optional Line Bolting		SA-193-B7, SA-193-B7M, or strain-hardened SA-193-B8M
Attenuator[9]		CG8M, M35-1, CW2M, or CK3MCuN

1. CF3M is also available in all areas as a special order and is the standard material offered in Europe.
2. Recommended for lubricated and non-lubricated service and where corrosion properties similar to 304 stainless steel are acceptable.
3. Recommended for lubricated service and where corrosion properties equal to or better than 317 stainless steel are required.
4. PEEK is poly-ether-ether-ketone.
5. The carbon-filled PTFE ring is used for grounding.
6. Standard material offered in North America.
7. Offered for lubricated service only.
8. S31254 and S32760 shafts may cause the valve to be derated. Contact your Emerson Process Management sales office.
9. Attenuator material will match segmented V-Notch ball material.

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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Table 6. Maximum Allowable Inlet Pressure for CW2M Valves

TEMPERATURE	CW2M[1]					
	150[2]	300[2]	PN 10[2]	PN 16[2]	PN 25[2]	PN 40[2]
°C	Bar					
-46 to 38	20.0	51.7	10.0	16.0	25.0	40.0
50	19.5	51.7	9.9	15.9	24.8	39.6
100	17.7	51.5	9.4	15.1	23.6	37.8
150	15.8	50.3	9.4	15.1	23.6	37.8
200	13.8	48.3	9.1	14.6	22.9	36.6
232	12.7	47.0	9.1	14.6	22.9	36.6
°F	Psig					
-50 to 100	290	750	145	232	362	580
200	260	750	144	230	359	575
300	230	730	137	219	342	548
400	200	700	133	212	331	530
450	185	680	133	212	331	530

1. This material is not listed in EN 12516-1 or ASME B16.34. Also see the Installation section.
2. The designations PN or 150 and 300 are used only to indicate relative pressure-retaining capabilities and are not PN or ASME pressure-temperature rating class designations.

Pressure Drops

Pressure drop limits of any given valve are based on valve body, and trim material limits. To find the appropriate pressure drop limitation, choose the desired valve size and temperature range. Then search table 7 for body limitations and table 8 for trim limitations. Information on limits for S31254, CW2M, M35-2, CD3MN, CD3MWCuN, and other alloy constructions can be obtained by contacting your Emerson Process Management sales office. The lowest number from the tables is the appropriate limit. The tables for both trim and body limits must be consulted.

Table 7. Maximum Allowable Shutoff Pressure Drops (Body Ratings) based on Carbon Steel and Stainless Steel Valve Body Types. (The tables for both trim and body limits must be consulted.)

TEMPERATURE RANGE	PRESSURE CLASS											
	WCC CL150	316L SST CL150	317 SST CL150	LCC CL150	WCC CL300	316L SST CL300	317 SST CL300	LCC CL300	WCC CL600	316L SST CL600	317 SST CL600	LCC CL600
°C	Bar											
-46 to -29	---	15.9	19.0	20	---	41.4	49.6	51.7	---	82.7	99.3	103
-29 to 38	20.0	15.9	19.0	20	51.7	41.4	49.6	51.7	103	82.7	99.3	103
93	17.9	13.4	16.2	17.9	51.7	34.8	42.7	51.7	103	70.0	85.5	103
149	15.9	12.1	14.8	15.9	50.3	31.4	38.6	50.3	100	62.7	77.2	100
204	13.8	11.0	13.4	13.8	48.6	28.6	35.5	48.6	97.2	56.9	70.6	97.2
232	12.8	10.7	12.8	12.8	47.2	27.9	34.5	47.2	94.5	54.8	68.6	94.5
260	11.7	10.0	11.7	11.7	45.9	26.2	33.1	45.9	91.7	52.7	65.8	91.7
316	10.7	9.9	10.7	10.7	43.8	25.5	32.1	43.8	87.6	51.0	64.1	87.6
343	9.65	9.7	9.65	9.65	41.7	23.8	31.0	41.7	83.4	49.6	62.4	83.4
371	8.62	8.6	7.58	---	40.7	23.8	30.7	---	81.0	48.3	60.0	---
399	6.55	6.6	6.55	---	34.8	23.1	29.3	---	69.6	46.2	58.9	---
427	5.52	5.5	5.52	---	28.3	22.8	29.0	---	56.9	45.5	58.3	---
°F	Psi											
50 to 20	--	230	275	290		600	720	750		1200	1440	1500
-20 to 100	290	230	275	290	750	600	720	750	1500	1200	1440	1500
200	260	195	235	260	750	505	620	750	1500	1015	1240	1500
300	230	175	215	230	730	455	560	730	1455	910	1120	1455
400	200	160	195	200	705	415	515	705	1410	825	1025	1410
450	185	155	185	185	685	405	500	685	1370	795	995	1370
500	170	145	170	170	665	380	480	665	1330	765	955	1330
550	155	143	155	155	635	370	465	635	1270	740	930	1270
600	140	140	140	140	605	360	450	605	1210	720	905	1210
650	125	125	125	125	590	350	445	590	1175	700	890	1175
700	110	110	110	---	570	345	430	---	1135	685	870	---
750	95	95	95		505	335	425	---	1010	670	855	
800	80	80	80	---	410	330	420	---	825	660	845	---

Used for this design

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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Table 8. Maximum Allowable Shutoff Pressure Drops based on Trim (Bearing and Seal).
(Note: Do not exceed the PN or ASME pressure/temperature rating of the valve or mating flanges.)

BEARING MATERIAL	BALL SEAL	TEMPERATURE RANGE, °C	VALVE SIZE, DN												
			25	40	50	80	100	150	200	250	300	350	400		500[4]
			Bar												
			Shaft Size, inches												
			1/2	5/8	5/8	3/4	3/4	1	1-1/4	1-1/4	1-1/2	1-3/4	2-1/8x2	2-1/8	2-1/2
PEEK/PTFE	Fisher TCM Plus or Ultra	-46 to 38	51.7	51.7	51.7	51.7	51.7	51.7	51.7	40.2	37.6	31.0	23.8	31.0	31.0
		93	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.6	31.0	23.8	31.0	31.0
		149	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	23.8	24.1	24.1
		204	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
		232	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.44	3.45	
	HD Seal[1]	-46 to 260	51.7	51.7	51.7	51.7	51.7	51.7	51.7	40.9	38.1	31.0	26.5	31.0	31.0
	Flat Metal[2]	-73 to 260	---	---	---	20.7	20.7	20.7	20.7	10.3	10.3	---	---	---	---
	Flow Ring	260	103.4	103.4	103.4	103.4	72.4	75.2	73.8	40.5	37.7	40.5	35.0	48.8	44.7
R30006	HD Seal[1]	-46 to 288	51.7	50.0	25.7	17.5	11.0	10.9	11.2	6.14	5.72	6.14	7.52	7.51	6.83
	High Temp HD Seal[1]	228 to 427	38.3[3]	37.5[3]	19.3[3]	13.2[3]	8.3[3]	8.2[3]	8.4[3]	4.6[3]	4.3[3]	4.62	5.65	5.65	5.10
	Flat Metal[2]	-73 to 427	---	---	---	17.0	10.1	10.2	10.6	5.86	5.52	---	---	---	---
	Flow Ring	427	74.5	49.6	26.8	18.8	10.9	11.2	11.1	6.07	5.65	6.07	7.31	7.30	6.69
R30006 Silver Plated	HD Seal[1]	-46 to 288	51.7	51.7	51.7	35.0	22.1	21.8	22.5	12.3	11.4	12.3	13.2	15.0	13.7
	High Temp HD Seal[1]	228 to 427	38.3[3]	38.3[3]	38.3[3]	26.3[3]	16.5[3]	16.3[3]	16.9[3]	9.2[3]	8.6[3]	9.16	11.2	11.2	10.2
	Flat Metal[2]	-73 to 427	---	---	---	20.7	20.1	20.7	20.7	10.3	10.3	---	---	---	---
	Flow Ring	427	103.4	103.4	53.5	37.6	21.8	22.5	22.2	12.1	11.3	12.1	14.6	14.6	13.4
S31603L Nitride	HD Seal[1]	-46 to 288	51.0	51.0	51.0	51.7	36.7	36.3	37.4	20.5	19.1	20.5	25.0	25.0	14.0
	High Temp HD Seal[1]	228 to 427	---	---	---	38.3[3]	27.6[3]	27.2[3]	28.1[3]	15.4[3]	14.3[3]	15.3	18.7	18.7	17.0
	Flat Metal[2]	-73 to 427	---	---	---	20.7	20.7	20.7	20.7	10.3	10.3	---	---	---	---
	Flow Ring	427	99.3	99.3	88.9	62.7	36.3	37.4	37.0	20.2	18.8	20.2	24.3	24.3	22.3

BEARING MATERIAL	BALL SEAL	TEMPERATURE RANGE, °F	VALVE SIZE, NPS												
			1	1-1/2	2	3	4	6	8	10	12	14	16		20[4]
			Psi												
			Shaft Size, inches												
			1/2	5/8	5/8	3/4	3/4	1	1-1/4	1-1/4	1-1/2	1-3/4	2-1/8x2	2-1/8	2-1/2
PEEK/PTFE	Fisher TCM Plus or Ultra	-50 to 100	750	750	750	750	750	750	750	583	545	450	345	450	450
		200	550	550	550	550	550	550	550	550	545	450	345	450	450
		300	350	350	350	350	350	350	350	350	350	350	345	350	350
		400	150	150	150	150	150	150	150	150	150	150	150	150	150
		450	50	50	50	50	50	50	50	50	50	50	50	50	50
	HD Seal[1]	-50 to 500	750	750	750	750	750	750	750	593	553	450	384	450	450
	Flat Metal[2]	-100 to 500	---	---	---	300	300	300	300	130	150	---	---	---	---
	Flow Ring	500	1500	1500	1500	1500	1050	1090	1070	587	542	587	508	708	648
R30006	HD Seal[1]	-50 to 550	750	725	373	254	160	158	163	89	83	89	109	109	99
	High Temp HD Seal[1]	550 to 800	555[3]	544[3]	280[3]	191[3]	120[3]	119[3]	122[3]	67[3]	62[3]	67	82	82	74
	Flat Metal[2]	-100 to 800	---	---	---	246	146	155	154	85	80	---	---	---	---
	Flow Ring	800	1080	720	388	273	158	163	161	88	82	88	105	106	97
R30006 Silver Plated	HD Seal[1]	50 to 550	750	750	750	508	320	316	326	178	166	178	192	218	198
	High Temp HD Seal[1]	550 to 800	555[3]	555[3]	555[3]	381[3]	240[3]	237[3]	245[3]	134[3]	125[3]	133	163	163	148
	Flat Metal[2]	-100 to 800	---	---	---	300	292	300	300	150	150	---	---	---	---
	Flow Ring	800	1500	1500	776	548	316	326	322	176	164	176	212	212	194
S31603L Nitride	HD Seal[1]	-50 to 550	740	740	740	730	533	527	543	297	277	297	363	363	203
	High Temp HD Seal[1]	550 to 800	---	---	---	555[3]	400[3]	395[3]	407[3]	223[3]	208[3]	222	272	272	247
	Flat Metal[2]	-100 to 800	---	---	---	300	300	300	300	150	150	---	---	---	---
	Flow Ring	800	1440	1440	1298	910	527	543	537	293	273	293	353	353	323

1. Pressure drops shown for HD seals are for forward flow only. For reverse flow with HD seal, limit pressure drop to 6.9 bar (100 psig).
2. Lubricated service only.
3. Consult your Emerson Process Management sales office if higher pressure drops are required.
4. This column is also appropriate for the DN 650 to 900 (NPS 24 to 36).

Used for this design

Used for this design

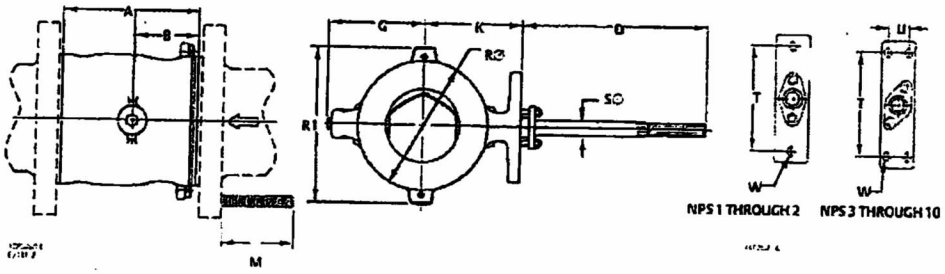
Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Table 10. Fisher V200 Flangeless Dimensions

VALVE SIZE, NPS	V200 DIMENSIONS (ISA S75.08.02)														ASME B16.5 RF FLANGES	APPROX. WEIGHT
	A	B	D	G	K	M CL150	M CL300	M CL600	R	R1	S	T	U	W		
	mm															kg
1	102	56	188	81	95	176	202	202	51	102	12.7	117		14.2	CL150, 300, and 600	4.3
1-1/2	114	62		89	121	189	224	224	73	119	15.7 and 15.7 x 12.7					6.4
2	124	67		105	127	211	236	236	92	137	15.7 and 15.7 x 12.7					10
3	165	79	214	117	130	254	279	286	127	157	19.1	152	32	14.2		15
4	194	101		133	141	286	305	343	157	197	19.1					22
6	229	109		159	164[1]	343	362	413	216	250	25.4					27
8	243	124	203	195	232	343	387	426	270	314	31.8	235	46	17.5		62
10	297	147		222	260	419	---	---	324	368					CL150	114
	inch															lbs
1	4.00	2.21	7.38	3.19	3.75	6.94	7.94	7.94	2	4.00	1/2	4.62	---	0.56	CL150, 300, and 600	10
1-1/2	4.50	2.46		3.50	4.75	7.44	8.81	8.81	2.88	4.68	5/8 and 5/8 x 1/2					14
2	4.88	2.63		4.19	5.00	8.31	9.31	9.31	3.63	5.38	5/8 and 5/8 x 1/2					23
3	6.50	3.10	8.44	4.62	5.12	10.00	11.00	11.25	5.00	6.56	3/4	6.00	1.25	0.56		34
4	7.62	3.99		5.25	5.56	11.25	12.00	13.50	6.19	7.76	3/4					48
6	9.00	4.29		6.25	6.44[1]	13.50	14.25	16.25	8.50	10.24	1					60
8	9.56	4.88	8.19	7.69	9.12	13.50	15.25	16.75	10.63	12.38	1 1/4	9.25	1.81	0.69		136
10	11.69	5.77		8.75	10.25	16.50	---	---	12.75	14.50					CL150	252

1. 179 mm (7.06 inches) for NPS 6, CL600 valves only.

Figure 8. Fisher V200 Dimensions (also see table 10)

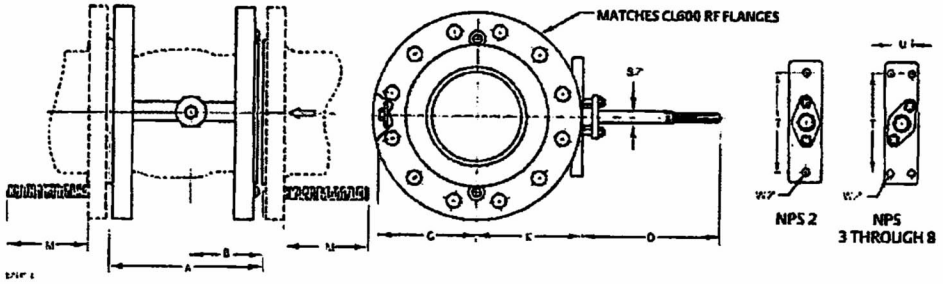


Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Table 11. Fisher V200 Flanged CL600 Dimensions

VALVE SIZE	DIMENSIONS (ANSI/ISA 75.08.02)												APPROXIMATE WEIGHT
	A	B	D	G	K	M (Qty)	Bolt Size	Flange Hole Thread, Inch	E Diameter	T	U	W	
DN	mm												kg
50	124	67	188	106	127	121 (16)	5/8-11 UNC	5/8-11 UNC	16	117	---	14.2	17
80	165	79	214	117	130	140 (16)	3/4-10 UNC	3/4-10 UNC	19	152	32		28
100	194	101	214	133	141	165 (16)	7/8 9 UNC	---	19	152	32	14.2	48
150	229	109	214	159	164	197 (24)	1-8 UNC	1-8 UNC	25	152	32	14.2	93
200	243	124	205	195	232	216 (24)	1-1/8-8 UNC	1-1/8-8 UNC	32	235	46	17.5	160
NPS	Inch												lbs
2	4.88	2.63	7.38	4.19	5.00	4.75 (16)	5/8 11 UNC	5/8-11 UNC	5/8	4.62		0.56	38
3	6.50	3.10	8.44	4.62	5.12	5.50 (16)	3/4-10 UNC	3/4-10 UNC	3/4	6.00	1.25		61
4	7.62	3.99	8.44	5.25	5.56	6.50 (16)	7/8-9 UNC	--	3/4	6.00	1.25	0.56	105
6	9.00	4.29	8.44	6.25	6.44	7.75 (24)	1-8 UNC	1-8 UNC	1	6.00	1.25	0.56	205
8	9.55	4.88	8.19	7.69	9.12	8.50 (24)	1-1/8-8 UNC	1-1/8-8 UNC	1-1/4	9.25	1.81	0.69	352

Figure 9. Fisher V200 CL600 Flanged Dimensions (also see table 11)



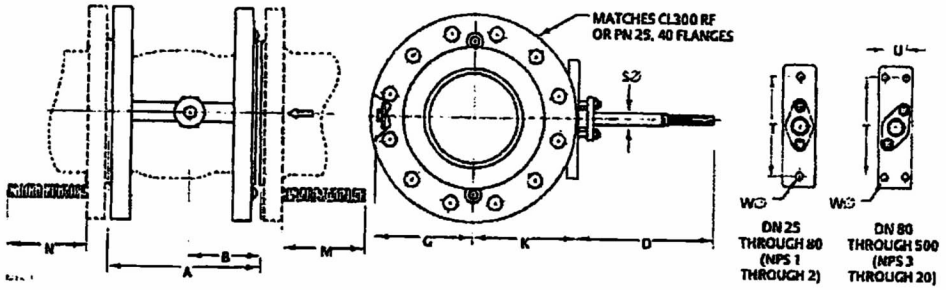
Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Table 12. Fisher V300 Dimensions

VALVE SIZE,	V300 DIMENSIONS (ISA S75.08.02)											APPROXIMATE WEIGHT
	A	B	D	G	K	M[3,4]	N[3]	S Diameter	T	U	W	
DN[1]	mm											kg
25	102	56	188	81	95	100	94	13	117	---	14.2	8
40	114	62		89	121	114	108	16 and 16 X 13				12
50	124	67		106	127	106	100	16 and 16 X 13				17
80	165	79	214	117	130	133	121	19	152	32		28
100	194	101		133	141	140	127	19				37
150	229	109		159	164	152	140	25				60
200	243	124	308	195	232	165	152	32	235	46	17.5	103
250	297	147		222	260	186	173	32				200
300	338	174		268	303	198	186	38				293
350[2]	381	206	356	295	343	152	133	44.5	273	50.8	19.1	375
400[2]	406	229		330	365	152	133	54.0	273	50.8	19.1	511
500	508	235		406	457	224	203	63.5	337	76.2	22.4	755
NPS	inch											lbs
1	4.00	2.21	7.38	3.19	3.75	3.94	3.69	1/2	4.62	---	0.56	17
1-1/2	4.50	2.46		3.50	4.75	4.50	4.25	5/8 and 5/8 X 1/2				27
2	4.88	2.63		4.19	5.00	4.19	3.94	5/8 and 5/8 X 1/2				38
3	6.50	3.10	8.44	4.62	5.12	5.25	4.75	3/4	6.00	1.25		61
4	7.62	3.99		5.25	5.56	5.50	5.00	3/4				81
6	9.00	4.29		6.25	6.44	6.00	5.50	1				133
8	9.56	4.86	8.19	7.69	9.12	6.50	6.00	1-1/4	9.25	1.81	0.69	226
10	11.69	5.77		8.75	10.25	7.31	6.81	1-1/4				440
12	13.31	6.87		10.56	11.94	7.81	7.31	1-1/2				645
14[4]	15.00	8.12	14.00	11.62	13.50	7.75	7.00	1-3/4	10.75	2.00	0.75	825
16[2]	16.00	9.00	14.00	13.31	14.38	8.25	7.50	2-1/8	10.75	2.00	0.75	1125
20	20.00	9.25	14.00	16.00	18.00	8.81	8.00	2-1/2	13.25	3.00	0.88	1661

1. DN25, 40, 50, 80, and 100 are the only sizes offered in V300 for Foreign.
2. DN 350 and 400 (NPS 14 and 16) valves are available in ASME B16.10 short, only. See dimension A for ASME B16.10 short shown in figure 11.
3. Clearance necessary to remove flange bolts.
4. DN 25 and NPS 1 constructions have threaded inlet flange holes.

Figure 10. Fisher V300 Dimensions (also see table 12)



Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Table 13. Fisher V150 Optional Dimensions

V150 OPTIONAL DIMENSIONS FOR NPS 1 THROUGH 12 (ASME B16.10 SHORT)							
VALVE SIZE		A		M(1)		N	
DN	NPS	mm	Inches	mm	Inches	mm	Inches
25	1	127	5.00	103	4.06	71	2.81
40	1-1/2	165	6.50	135	5.31	78	3.06
50	2	178	7.00	155	6.11	92	3.61
80	3	203	8.00	142	5.61	98	3.86
100	4	229	9.00	155	6.11	98	3.86
150	6	267	10.50	163	6.40	112	4.40
200	8	292	11.50	182	7.15	124	4.90
250	10	330	13.00	176	6.94	132	5.19
300	12	356	14.00	170	6.69	132	5.19

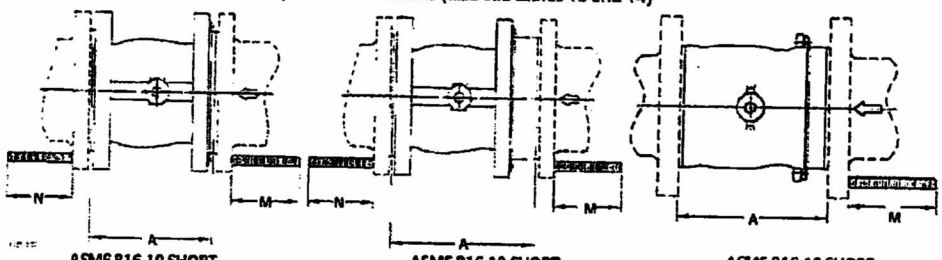
1. NPS 1 constructions have threaded inlet flange holes.

Table 14. Fisher V200 Optional Dimensions

V200 OPTIONAL DIMENSIONS (ASME B16.10 SHORT)(1,2)		
VALVE SIZE, NPS	A	M
	mm	
1	127	202
1-1/2	165	240
2	178	268
3	203	286
4	229	321
6	267	381
8	292	394
10	330	451
	Inch	
1	5.00	7.94
1-1/2	6.50	9.44
2	7.00	10.56
3	8.00	11.25
4	9.00	12.62
6	10.50	15.00
8	11.50	15.50
10	13.00	17.75

1. Available for CL150 valves only.
2. ASME B16.10 short dimensions are actually longer than ISA S75.08.02 dimensions.

Figure 11. Fisher V150 and V200 Optional Dimensions (also see tables 13 and 14)



ASME B16.10 SHORT NPS 14 AND 16 V150 | ASME B16.10 SHORT NPS 1 THROUGH 12 V150 | ASME B16.10 SHORT V200

Notes:
- NPS 1 through 12 valves are available with either ISA S75.08.02 face-to-face dimensions or ASME B16.10 short face-to-face dimensions. NPS 1 through 12 valves will be supplied in ISA S75.08.02 unless you specify otherwise. Note that ASME B16.10 short dimensions are actually longer than ISA S75.08.02.
- NPS 14 and 16 valves are available only with ASME B16.10 short face-to-face dimensions.
- NPS 20 valves are available only with a 508 mm (20-inch) face-to-face dimension.
- M and N dimensions shown for V150 are clearance necessary to remove flange bolts.

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Product Bulletin
51.3:Vee-Ball
March 2016

Vee-Ball Valves
D101363X012

Emerson Process Management
Marshalltown, Iowa 50158 USA
Sorocaba, 18087 Brazil
Cernay, 68700 France
Dubai, United Arab Emirates
Singapore 128461 Singapore

www.Fisher.com

EMERSON
Process Management

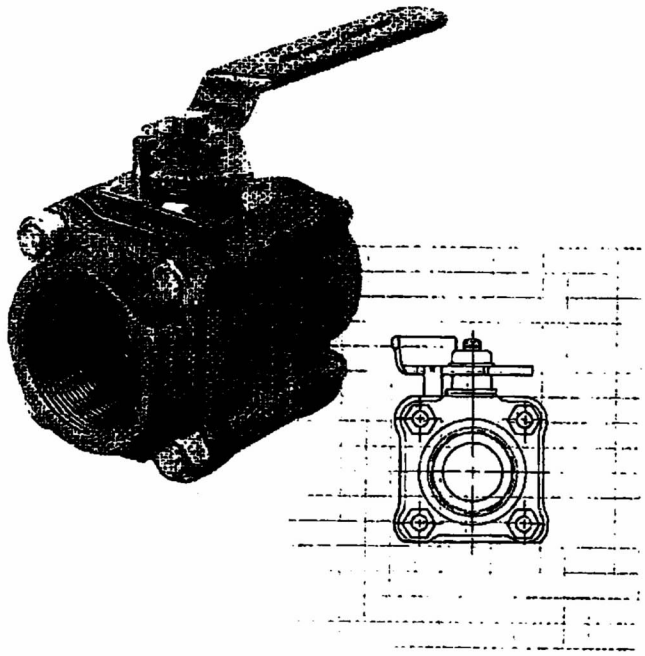
Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Manual Valve Data (Typical)

Worcester Controls PB 451-26

Series 59
Full Port Ball Valve

Full port valves offer maximum capacity, minimum restriction, optional fire-rated design



AN ISO 9001 REGISTERED COMPANY www.worcestercc.com

File Name: Worcester Full Port Ball Valve Series 59 (00)

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Series 59 Full Port Ball Valves

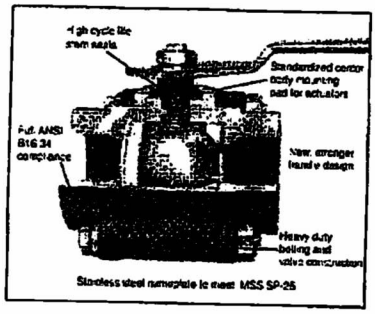
Manual and Automated Valves for processes requiring maximum flow area.

Full Port ball valves are recommended for processes requiring minimum restriction through piping, shut-off valves, and other equipment. For example pump inlet valves are often full port valves. Full port valves are also useful in systems handling slurries, viscous fluids and fluids with residues, and where the capacity to pig lines is desired.

¼" - 2" Series 59 valves are rated to ANSI Class 600. 3" and 4" valves are rated to ANSI Class 300.

Worcester offers a complete line of pneumatic and electric automation packages for on-off or throttling control including the Series 39 twin piston pneumatic actuator (brochure PB 302) and the Series 75 electric actuator (brochure PB 730).

Series 59 full port valves are available in a fire-rated configuration AFS9 in sizes ½", ¾", 1", 1½", and 2". Refer to brochure PB FZ. Flanged ANSI Class 150 and 300 full port valves are available in sizes ½"-10". Refer to brochures PB 82/83 and PB 600



Used for this design

SPECIFICATIONS

Sizes: ¼", ⅜", ½", ¾", 1", 1¼", 1½", 2", 3", 4"

Style: 3-piece, 4-bolt (¼" - 2")
3 piece, 8-bolt (3" - 4")

Valve Pressure Rating*: ¼" - 2" Carbon Steel and S. S. Valves, ANSI Class 600
3" - 4" Carbon Steel and S. S. Valves, ANSI Class 300
¼" -1" Brass Valves, 1500 psi
1 ¼"-1 ½" Brass Valves, 1000 psi

Body: Carbon Steel, 316 Stainless Steel, Brass (valve sizes 1/4" - 1½")

Pipe Ends: Screw End, Socket Weld, Butt Weld, Tube End

Ball: Chrome Plated Brass, 316 Stainless Steel

Temp. Range: Depends on seat and seal choice; will operate from -20°F to +800°F

Seat/Seal Leakage: Standard valves, less than 1 X 10^{-6} cc He/Sec inboard and through (bubbletight is 1 X 10^{-4} cc He/Sec). With preparation, leakage will be less than 2 X 10^{-9} cc He/Sec. All valves 100% tested to bubbletight standards.

Flow: Bidirectional

*These are valve body pressure ratings. Seat selection may decrease the valve pressure rating. Example: A 1" carbon steel Series 59 valve has a rating of 1480 psi at 70°F. Selection of reinforced TFE seats operating at fluid temperature of 200°F limits allowable pressure in the valve to 1000 psi.

Design Specifications: ANSI B16.34 (¼" - 2", if ordered with Hydro Test)
ANSI B16.25 - Butt Weld Ends (Weld End Preparation)
ANSI B16.11
ANSI B1.20.1 - NPT Pipe Threads
MSS SP25 - Valve Marking
MSS SP72 - Socket Weld Ball Valves
NACE - MR0 1-75 Category 3

Ut. Listed: (¼" - 2")
Flammable liquid shut-off (YRBX)
Anhydrous ammonia shut-off (YQAR)
Compressed gas shut-off, including oxygen (YQNZ)
Trim and drain valves (VQGU)

Weld-in-Place Valves (V67): ¼" - 1½" Series 59 valves with "G" body seals and seats of reinforced TFE (R). Polyfill® (P), or High per RIF (X) may be welded to the pipeline in the assembled condition. (Must have V67 suffix in ordering code)

Optional S-7: (1/4" -1 ½") Complete S.S. trim: handle, nut, lock washer, retaining nut, belleville washers, body bolts, nuts, stop pin.

External Valve Trim: External components are available as an option on brass and carbon steel valves. They are standard on ¼" - 1½" stainless steel valves. For 2" - 4", they are available through custom products.
Certified Material Testing Reports (CMTR's) are available with B16.34.

FLOW COEFFICIENT

Flow coefficient and pressure loss through full port ball valves are the same as the pipe they are attached to

Valve Size	C_v	Equiv. Length of Sched. 40 pipe feet
¼", ⅜"	8	0.9
½"	26	1.4
¾"	71	1.6
1"	110	1.9

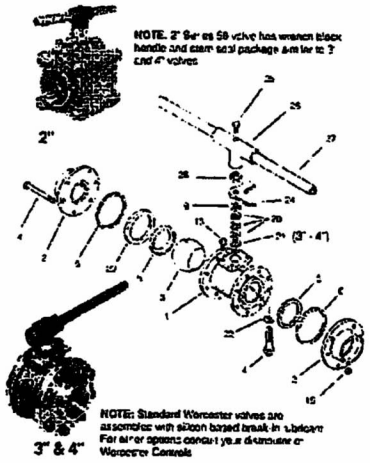
Valve Size	C_v	Equiv. Length of Sched. 40 pipe feet
1¼"	220	2.1
1½"	350	2.1
2"	600	2.1
3"	1330	3.0
4"	2420	2.7

VARIATIONS (V#)

V3	Upstream Relief Hole	V51	High Cycle Stem Build (2"-4")
V5	Hydrostatic Testing	V58	B16.34 Compliance
V6	Source Inspection	V59	Extended Oval Handle (1/4"-1 1/2")
V14	Handleless Valve (2" - 4")	V60	OSHA Lockout (1/4"-1 1/2")
V17	Grounding Thrust Bearing	V66	Cert. of Conf. - European orders
V20	Oxygen Service	V67	Weld-in-Place Valve (1/4"-1½")
V32	Oval Handle (1/4"-1½")	V72	Cert. of Conf. - European Pressure Equipment Directive Conformance
V33	Oxygen Service w/out Source Inspect		
V36	Certificate of Compliance		
V37	Certificate of Compliance & Hydro Testing		
V38	Assembly without Lubricant		
V46	Silicon Free Lubricant		
V48	Extended Lever Handle (1/4"-1½")		

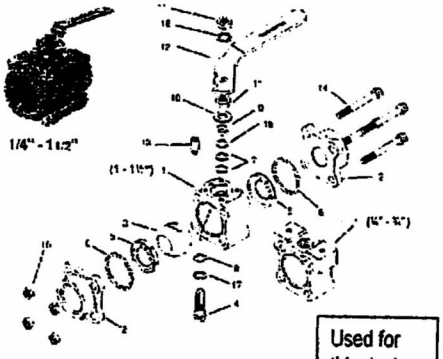
Attachment 9.6 - Summary Equipment, Hose, and Piping Data

PARTS IDENTIFICATION & MATERIAL SPECIFICATIONS



NOTE: 3" Series 59 valve has wrench block handle and stem seal package similar to 2" and 4" valves

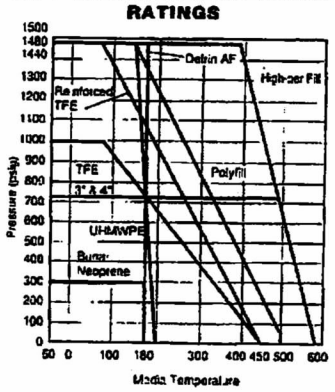
NOTE: Standard Worcester valves are assembled with silicon based grease lubricant. For other options consult your distributor or Worcester Controls.



Used for this design

No.	Part	Qty	Material
1	Body	1	C.S. 316 S.S. Brass
2	Pipe End	2	C.S. Brass 316 S.S. 316L for weld ends
3	Bolt	1	316 S.S. Chrome Plated Brass
4	Stem	1	316 S.S. Brass
5	Seat	2	TFE, Reinforced TFE Buna, Neoprene, Polyfill UHMWPE High-per FB, Delrin AF
6	Body seal	2	Buna, Viton, EPR, TFE, Neoprene TFE Coated 316 S.S. S" Gasket. Graphite Coated 316 S.S. "S" Gasket UHMWPE Graphite TFE (poly)
7	Stem Seal	2	Polyfill (UHMWPE with UHMWPE seals) Delrin AF with PEEK backup seals
8	Thrust bearing	1	Polyfill UHMWPE with UHMWPE seals PEEK for High-per FB seals Delrin AF seals
9	Stem Seal Retainer	1	316 S.S.
10	Belleville Washers	2	Carbon Steel Zinc Plated S.S.
11	Retaining Nut	2	Carbon Steel Zinc Plated S.S.
12	Handle Assembly	1	Carbon Steel Zinc Plated S.S. Vinyl Sleeve
13	Stop Pin (1" and up) (1/4" - 3/4")	1 2	316 S.S. or C.S. Zinc Plated 2" - 4" C.S. Black Oxide Coated
14	Body Bolts	4 8	C.S. ASTM A193 GR B7 S.S. ASTM A193 GR B8 3" - 4" C.S. Black Oxide Coated
15	Body Nuts	4 8	C.S. ASTM A194 GR 2H S.S. ASTM A194 GR B8 3" - 4" C.S. Black Oxide Coated
16	Lockwasher	1	Carbon Steel Zinc Plated S.S.
17	Thrust bearing*	1	PEEK (UHMWPE with UHMWPE seals) Delrin AF with PEEK backup seals
18	Seal Protector*	1	PEEK
19	Nameplate (not shown)	1	304 Stainless Steel
20	Stem Seal	3	S.S. 2", 3", 4" VALVES Glass Filled TFE
21	Centering Washer	1	C.S., 316 S.S. (2" & 4" only)
22	Thrust bearing	1	Glass Filled TFE
23	Seat Retainer	1	Carbon Steel or 316 S.S.
24	Stop	1	C.S. Black Oxide Coated
25	Hex Head Bolt	1	Carbon Steel
26	Wrench Block	1	Malleable Iron
27	Wrench Extension	1	Carbon Steel
28	Retaining Nut	1	Carbon Steel Zinc Plated or S.S.

SEAT PRESSURE/TEMPERATURE RATINGS



Body seals have a pressure/temperature rating 2" & 4" equals or exceeds the 3" size.
*Oxygen Service valves use Polyfill in place of PEEK

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Polyfill® is a registered trademark of Worcester Controls.
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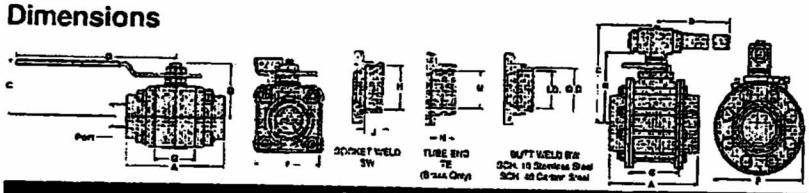
Attachment 9.6 - Summary Equipment, Hose, and Piping Data

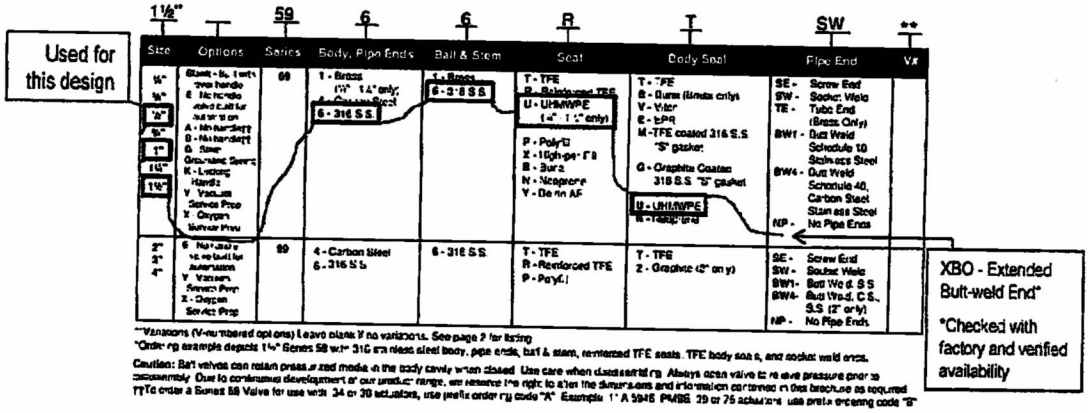
Dimensions



Valve Size	Socket Weld A	B	C	D	F	G	H	J	Tube End M	N	Butt Weld Sched. 10 O.D	I.D.	Butt Weld Sched. 40 O.D	I.D.	Port	Weight Lbs. (Kg.)
½"	2.64 (54.52)	1.55 (39.4)	1.76 (44.7)	5.53 (140.5)	1.75 (44.5)	.813 (20.7)	.565 (14.1)	.440 (11.2)	.376 (9.6)	.370 (9.40)	.550 (14.4)	.408 (10.3)	.550 (14.4)	.344 (8.7)	.440 (11.2)	1.10 (0.5)
½"	2.64 (54.52)	1.55 (39.4)	1.76 (44.7)	5.53 (140.5)	1.75 (44.5)	.813 (20.7)	.680 (17.5)	.440 (11.2)	.504 (12.8)	.449 (11.2)	.670 (17.0)	.547 (13.9)	.670 (17.0)	.516 (13.1)	.440 (11.2)	1.10 (0.5)
¾"	2.76 (70.1)	1.64 (41.7)	1.86 (47.24)	5.53 (140.5)	2.00 (50.8)	.968 (24.6)	.856 (21.7)	.440 (11.2)	.628 (15.0)	.560 (14.2)	.840 (21.3)	.672 (17.1)	.840 (21.3)	.625 (13.9)	.560 (14.2)	1.80 (0.82)
¾"	3.66 (92.96)	2.19 (55.6)	2.28 (57.91)	6.53 (165.9)	2.38 (60.5)	1.25 (31.8)	1.07 (27.1)	.560 (14.2)	.878 (22.3)	.810 (20.6)	1.05 (26.7)	.875 (22.2)	1.05 (26.7)	.812 (20.6)	0.81 (20.6)	3.10 (1.41)
1"	4.16 (105.7)	2.38 (60.5)	2.47 (62.74)	6.53 (165.9)	2.70 (68.6)	1.63 (41.3)	1.32 (33.8)	.720 (18.3)	1.13 (28.7)	.97 (24.6)	1.31 (33.3)	1.09 (27.8)	131 (33.3)	1.05 (26.6)	1.00 (25.4)	4.50 (2.05)
1½"	4.50 (114.3)	2.88 (73.2)	2.83 (71.88)	8.03 (204.0)	3.16 (80.5)	1.91 (48.4)	1.68 (42.5)	.720 (18.3)	1.38 (35.0)	1.03 (25.2)	1.66 (42.2)	1.44 (36.5)	1.66 (42.2)	1.38 (35.1)	1.25 (31.8)	6.20 (2.81)
1½"	4.94 (125.5)	3.06 (77.7)	3.02 (76.71)	8.03 (224.0)	3.56 (90.4)	2.22 (56.3)	1.92 (48.8)	.720 (18.3)	1.63 (41.4)	1.15 (29.2)	1.91 (48.5)	1.67 (42.5)	1.91 (48.5)	1.59 (40.5)	1.50 (38.1)	9.50 (4.31)
2"	5.88 (149.0)	4.56 (115.8)	5.58 (142.0)	8.82 (224.0)	4.57 (116.0)	2.85 (72.8)	2.41 (61.2)	.840 (21.34)	—	—	2.38 (60.5)	2.15 (54.5)	2.38 (60.5)	2.06 (52.3)	2.00 (50.8)	25.00 (11.3)
3"	7.54 (191.0)	6.31 (160.3)	7.84 (199.0)	22.00 (559.8)	8.13 (206.4)	4.28 (108.0)	3.54 (89.8)	1.31 (33.27)	—	—	3.50 (88.9)	3.28 (82.55)	3.50 (88.9)	3.07 (77.98)	3.25 (82.55)	50.20 (22.8)
4"	11.75 (298.0)	8.96 (227.9)	11.21 (284.0)	26.00 (660.0)	11.13 (282.6)	5.75 (146.0)	4.53 (115.1)	1.56 (39.62)	—	—	4.50 (114.3)	4.26 (108.2)	4.50 (114.3)	4.03 (102.4)	4.03 (102.4)	80.10 (36.4)

Dimensions are given for layout purposes only. For clearances, consult your Worcester distributor. Metric equivalents are converted from Standard English

How To Order*



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35 LOCKE DRIVE
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(508) 481-4830
(508) 481-4944 FAX

35 MID DONNISON ACRES
SCARBOROUGH, ONTARIO
M1B 4A5 CANADA
(416) 299-1871
(416) 299-8236 FAX

RUA TOCANTINS, 188 - VILA GOMTY
SÃO CAETANO DO SUL
SÃO PAULO CEP 09560-130
BRAZIL
(55-11) 4238-3500
(55-11) 4238-4757 FAX

Distributed by

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Tank 10H Pump Datasheet (Typical)

1	SERVICE	CONTINUOUS TRANSFER			
2	PLANT	SRS / TANK FARM AREA			
3	FUNCTIONAL CLASS (FOR SRS INFORMATION ONLY)	PS			
4	QUANTITY REQUIRED	Project Specific			
5	MANUFACTURER / MFR MODEL NO.	TSURUMI	LH311W-60		
6	LIQUID PUMPED	CAUSTIC WASTE SOLUTION (SUPERNATE/SLUDGE)			
7	VISCOSITY (CP)	1.0 to 3.1 CP			
8	TEMPERATURE (F): MAX./MIN/SPECIFIC GRAVITY	167	40	1.0 TO 1.5	
9	TOTAL DISCHARGE HEAD; RATING/ SHUT OFF HEAD (FEET)	270	* FT		
10	FLOW: RATING/MIN./MAX	* GPM	30 GPM	90 GPM	
11	NPSH OR SUBMERGENCE: AVAILABLE/REQ'D @	N/A	*		
12	LIQUID PH / WEIGHT % OF SOLIDS / PARTICLE SIZE	PH = 8 – 14	0 to 11 %	3/8" dia. solids max.	
13	RPM/ROTATION (VIEW FROM MOTOR FACING PUMP)	3465 nominal	*		
14	EFFICIENCY/BHP AT RATING/BHP MAX. @	*	*		
15	DISCHARGE: SIZE/RATING/FACING/POSITION	Manufacturer's standard. Two spare gaskets required.			
16	MATERIAL: CASE OR BOWL OR DIFFUSER	*			
17	(& SIZE) BARREL	*			
18	SHAFT: CASE OR BOWL/(DIA)	*	N/A		
19	SHAFT SLEEVE: BRG. /STUFF. BOX	*	*		
20	WEAR RING: CASE/IMPELLER	*	*		
21	IMPELLERS/LINES	*			
22	DRIVER: TYPE (MOTOR) (SOLID-HOLLOW SH.)/RPM/HP	SUBMERSIBLE MOTOR	3465 Nominal	15	
23	FURN. BY/WEIGHT/DWG. REF.	TSURUMI	*	*	
24	BEARING DESCRIPTION/MATERIAL	*	*		
25	MOTOR: VOLTS / PHASE / HERTZ	460V	3	60	
26	MOTOR: FULL LOAD CURRENT / TURN DOWN RATIO	*	*		
27	DRAWING NO.. OUTLINE/SECTIONAL/PERFORMANCE CURVE	*	*	*	
28	NET WEIGHT: PUMP/ MOTOR/ ASSEMBLY	* LBS			
29	INSPECTION: STD. /ASME III / ASME BPVC VIII	MFG STD	N/A	N/A	
30	HYDROSTATIC TEST:	Greater of 1.5 time shutoff head or 150 psig (+10%, -0%) (Con't on Sheet 3)			
31	PERFORMANCE TEST:	REQUIRED			
32					

* VENDOR TO CONFIRM OR SUPPLY DATA. IF BLOCK IS NOT APPLICABLE, VENDOR TO MARK 'N/A'

PROJECT	REV.	DATE	REVISION DESCRIPTION
N A	A		ISSUED FOR BID

APPROVALS MAINTAINED IN DCR / EDWS

PRPD	LEAD	CHKD	APRVD	APRVD	APRVD

BLDG NO: Various Tanks | DESIGN GROUP: MECH

CENTRIFUGAL PUMP DATA SHEET
TSURUMI PUMP MODEL LH311W-60

UNITED STATES DEPARTMENT OF ENERGY
Aiken, South Carolina

M D S G 0 0 0 8 9

DATA SHEET NUMBER: N/A | REV: A

SHEET OF 4

SOUTH CAROLINA SAVANNAH RIVER REMEDIATION, LLC No. 3997 CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 22845 MICHAEL BRYAN WOOD

7.26.17

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Summary Hydraulic Calculation

Document No.	Sheet No.
Attachment 9.6	1 of 17

Originator (Print / Sign and Date) Neil Carlson / 7/12/17

Checker (Print / Sign and Date) Charles Pritchard / 7/12/17

Lead (Print / Sign and Date) Chris Schilling / Chris Schilling 7-17-17

SOUTH CAROLINA
SAVANNAH RIVER REMEDIATION, LLC
No. 3997
CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA
PROFESSIONAL ENGINEER
No. 22845
MICHAEL BRYAN WOOD

7.26.17

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	2 of 17

1. **PURPOSE**
   1.1 Evaluate the hydraulic performance of Tank 10 transfer to the TCCR and recirculation to Tank 10. This document is a summary of SRS calculation M-CLC-H-03436, Rev. 0.

2. **OBJECTIVE**
   2.1. Determine that hydraulic performance of the pump (i.e. flow, speed, pressure, horsepower, and pressure excursions) meet project requirements.

3. **INPUTS & ASSUMPTIONS**
   3.1. Fluid Data
      3.1.1.Maximum temperature is 167 °F.
      3.1.2.Maximum Specific Gravity is 1.5.
      3.1.3.Maximum Viscosity is 3.1 cP.
      3.1.4.Design Pressure is 150 psig.
      3.1.5.Maximum TCCR flow is 10 gpm.
      3.1.6.Maximum TCCR pressure loss is 62.31 psid.
      3.1.7.Tank 10 recirculation flow is 90 gpm.
      3.1.8.Back flush flow of 10 gpm has a 6.41 psid TCCR pressure loss

   3.2. Elevations

3.2.1 Tank 10 Bottom Elevation	El. 244.39'
3.2.2 Tank 10 Fill Limit Elevation	El. 266.97'
3.2.3 Tank 10 Riser 7 Discharge Elev.	El. 266.40'
3.2.4 Low Point Elevation (Pump Discharge)	El. 246.0'
3.2.5 Tank 11 Riser 2 Discharge Elev.	El. 264.60'
3.2.6 Tank 10 Recirculation Discharge Elev.	El. 265.90'

   3.3. Flow Path
      The flow paths are shown below. The length of pipe, fitting numbers and components are shown in Appendix 7.2.

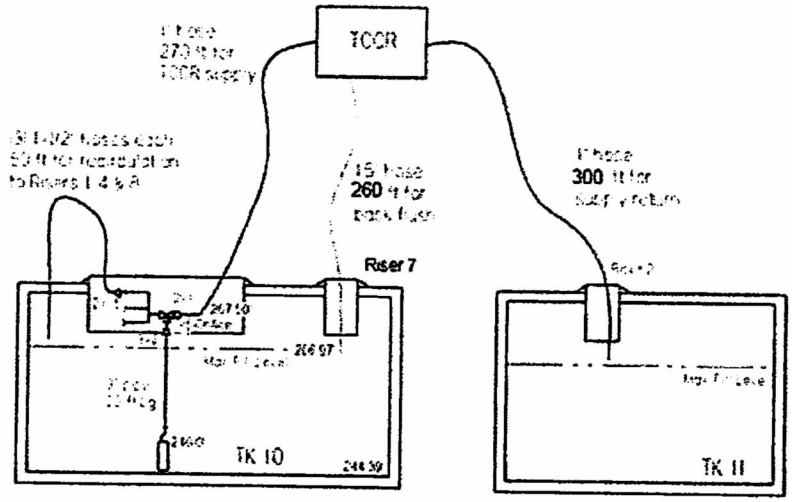

Figure 3.3.1

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	3 of 17

3.4. Pump Information
Tsurumi Pump LH311W-60, 2 stage, centrifugal, 15 hp motor (Appendix 7.1)

3.5. Assumptions
3.5.1. The pressure head terms are neglected for the purpose of this calculation. **Basis:** Supply and receiving tanks are maintained at a slight negative pressure (on the order of inches of water). Since the pressures are essentially equal the difference approximates zero. **Sensitivity:** Since the vacuums are small the impact on results is less than 1%.
3.5.2. The diameter of the recirculation orifice in Tank 10 is assumed to be 0.261 inch. **Basis:** This diameter was the result of informal sizing computations for the various operating scenarios and chosen to provide approximately 12 gpm recirculation when flow exists to the TCCR. **Sensitivity:** N/A

4 ANALYTICAL METHODS & COMPUTATIONS

4.1 Determine System Performance
There are three scenarios considered. One scenario is TCCR Supply from Tank 10 at 5 to 10 gpm with return to Tank 11 Riser 2. Another scenario is Tank 10 Dissolution at 90 gpm, total flow, to Risers 1, 4 and 8. The last scenario is TCCR Back Flush with flow to the TCCR in a 1" supply hose and returning to Tank 10 Riser 7 via a 1.5" hose.

4.1.1 Determine the Total Dynamic Head (TDH) using the following equations. Use Supernate (Salt Solution) with a Specific Gravity of 1.5 and viscosity of 3.1 cP to bound all fluid transfers (i.e., for maximum density and viscosity). An orifice just after the three-way valve will act as a continuous recirculation flow path so that the pump operating point is more to the right on the pump curve.

Per standard engineering practice, TDH = Static Head (h_s) + Friction Head (h_L) + Pressure Head + Velocity Head. Since the Pressure and Velocity Heads can be ignored, the equation remaining is:

$$TDH = h_L + h_s$$

a) Friction Head Loss (h_L)
For a straight length of pipe, the head loss is determined using the following equation:

$$h_L = f\frac{L}{D}\frac{v^2}{2g}$$

Where; f is the Moody Friction Factor (or total friction factor as defined in nomenclature).

For a fitting, the friction head loss is given as:

$$h_L = K\frac{v^2}{2g}$$

For more than one fitting, the *K*-values of each fitting are added together to produce the summation. Therefore, for a system with straight lengths of pipe and fittings (equivalent diameters), friction head loss is calculated together as:

$$h_L = \frac{1}{2g}\left(f\frac{Lv^2}{D} + \sum Kv^2\right)$$

b) Moody Friction Factor

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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Attachment 9.6	4 of 17

To solve for the Moody Friction Factor, the traditional Reynolds number is needed. The Reynolds number (Re) for a Newtonian Fluid is given by:

$$\mathrm{Re} = \frac{D v \rho}{\mu_e}$$

For Newtonian Fluids, the Moody Colebrook Correlation is used to determine the friction factor.

$$f = \left(-2 \log\left(\frac{\varepsilon}{3.7D} + \frac{2.51}{\mathrm{Re}\sqrt{f}} \right) \right)^{-2}$$

Note: The equation has been rearranged & simplified from the form shown in the text; nomenclature from the text has been replaced with nomenclature of this calculation).

ε is the Absolute Roughness of commercial steel and is in units of length (= 0.00015 ft).

For Newtonian Fluids, the turbulent friction factor (f_T) is constant for a given diameter. The turbulent friction factor for a 3" & 2" SCH 40 Pipes and the 1.5" & 1" hoses* are given below. The turbulent friction factor is used for calculation of fitting losses with Newtonian fluids.

$f_T = 0.017$	(for 3" pipe)
$f_T = 0.019$	(for 2" pipe)
$f_T = 0.02$	(for 1.5" hose*)
$f_T = 0.022$	(for 1.0" hose*)

*Hoses are modeled as rigid pipe.

c) Calculating K-Values of Fittings

For Newtonian Fluids, losses through the various pipe fitting are calculated using the resistance coefficients given below in Table 4.1.1. These flow coefficients are used in conjunction with the Pipe and Fittings Summary Table in Appendix 7.2 to determine head losses through the system for each scenario.

Table 4.1.1

Fitting Description	*K* - Value Equation
90° Elbow (r/d=1.5)	$K = 14 f_T$
45° Elbow (r/d=1.5)	$K = 0.17$
3-Way Valve (2")	$K = 35.71$
Tee (FTB) – welded	$K = 1.7$
2 x 1 Reducer (in 2" terms)	$K = 1.56$
3 x 2 Reducer (in 3" terms)	$K = 0.34$
2 x 1.5 Reducer (in 2" terms)	$K = 0.07$
Entrance (r/d=0)	$K = 0.50$
Exit	$K = 1.0$
Pre-filter	$K = 184$

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	5 of 17

4.1.2 System Operating Parameters

The results of the previous sections are compared to the specific performance requirements for this project.

Pump affinity rules are used to derive pump characteristic curves at varying speeds as follows:

$$\frac{Q_1}{Q_2}=\frac{N_1}{N_2};\quad \frac{H_1}{H_2}=\left(\frac{Q_1}{Q_2}\right)^2;\quad \frac{BHP_1}{BHP_2}=\left(\frac{Q_1}{Q_2}\right)^3$$

Where:

Q = Flow rate (gpm)
N = Impeller speed (rpm)
H = Pump head (ft.)
BHP=Brake Horse Power (hp)

Hydraulic pump power:

$$bhp = Q * H * \rho \div 247000 * \eta_p$$

(Formula from Crane Technical Paper No. 410, Eq. 5-8, Reprinted 11/12)

Where:

Q = Flow, gpm
H = head, feet of fluid
ρ = weight density of fluid, lb. / ft^3
η_p = pump efficiency

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	6 of 17

5 RESULTS

5.1 System Performance

5.1.1 TCCR Transfer with Salt Solution

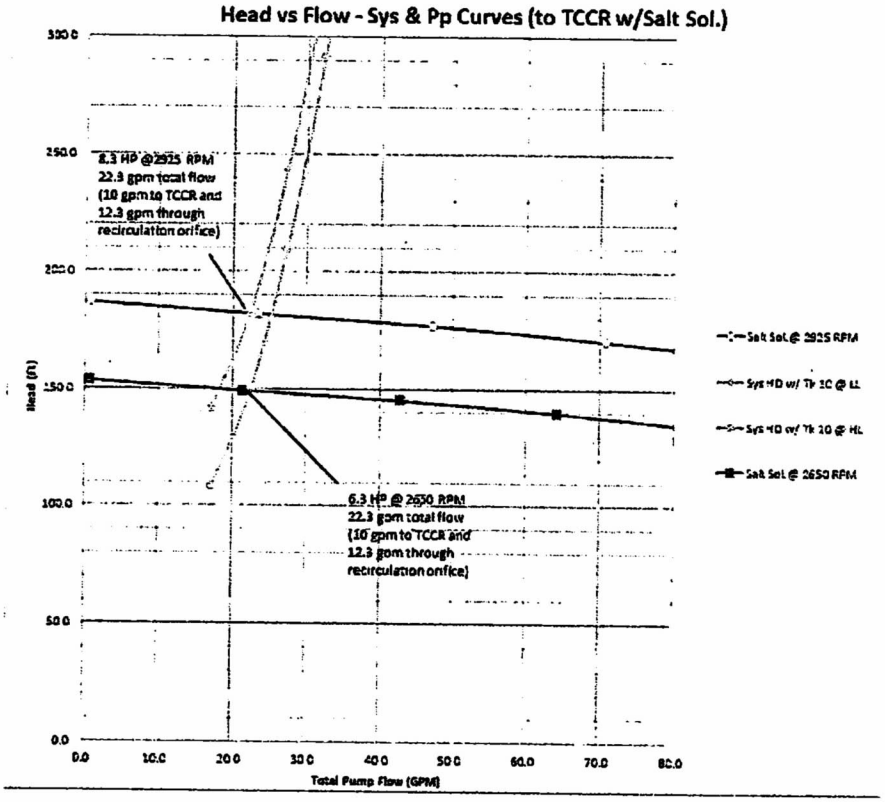


Figure 5.1.1-1

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	7 of 17

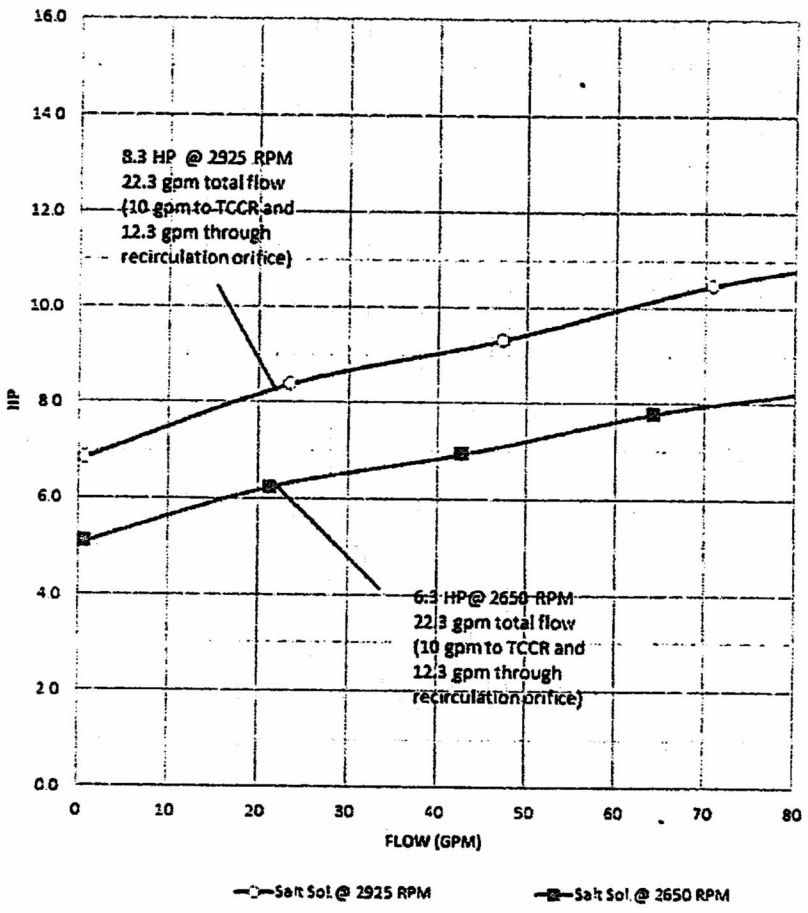


Figure 5.1.1-2

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	8 of 17

5.1.2 Dissolution with Salt Solution

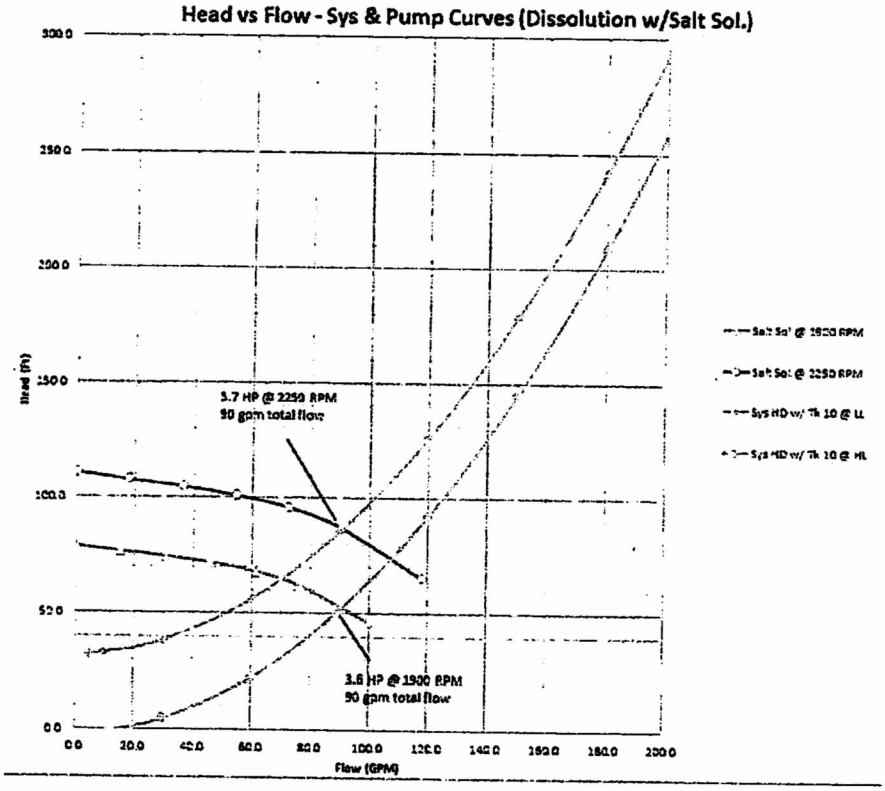


Figure 5.1.2-1

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	9 of 17

HP -vs- Flow (Dissolution w/Salt Sol.)

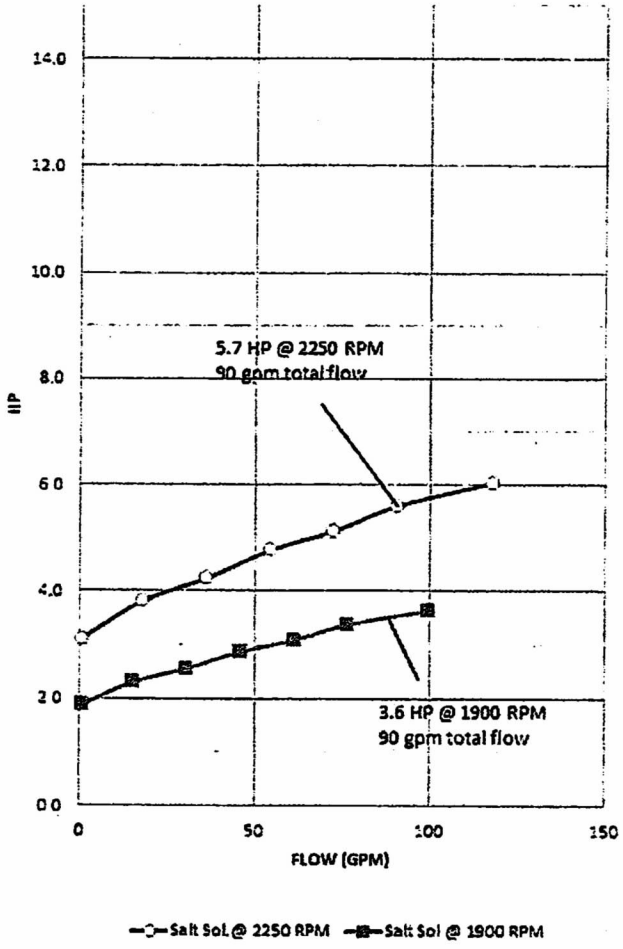


Figure 5.1.2-2

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	10 of 17

5.1.3 Back Flush with Salt Solution

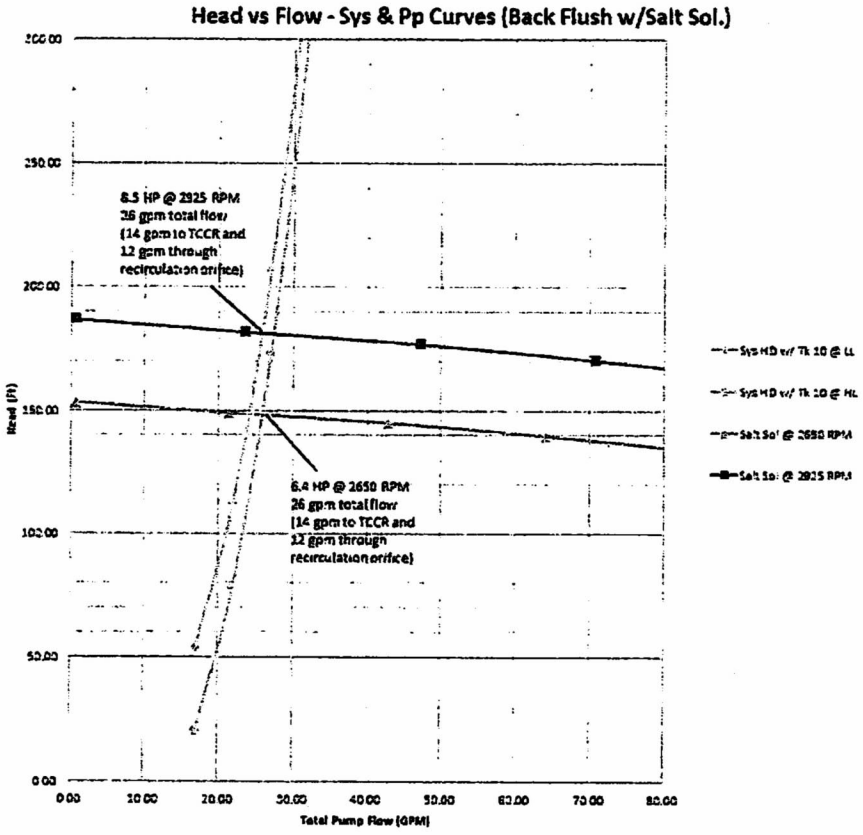


Figure 5.1.3-1

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	11 of 17

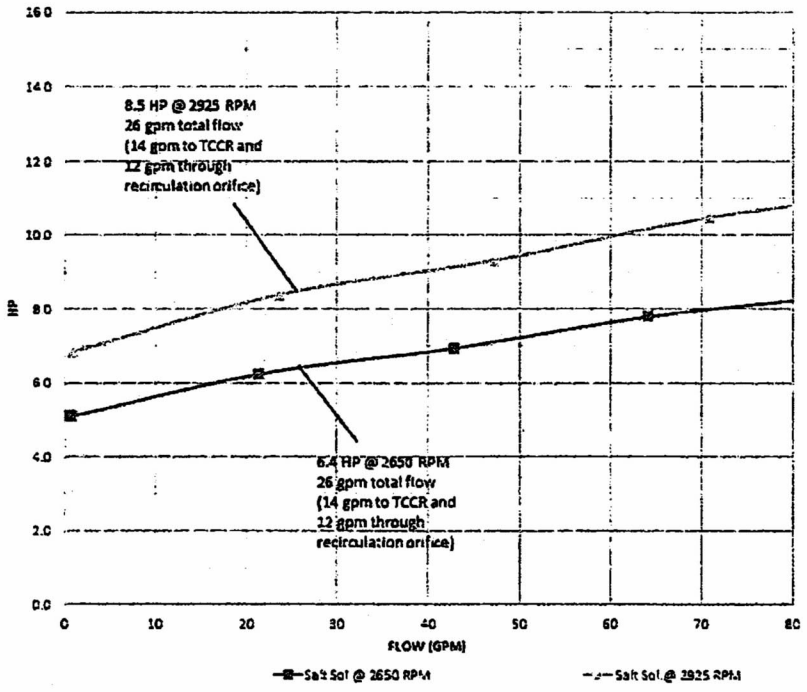


Figure 5.1.3-2

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	12 of 17

6 CONCLUSION

The transfer of waste from Tank 10 to the TCCR or recirculation back to Tank 10 can be performed with the Tsurumi LH311W-60 Pump powered by a 15 HP motor through a Variable Frequency Drive (VFD) with pump speed limited to 3075 rpm. This will achieve system flows of 5 to 10 gpm to the TCCR or 90 gpm dissolution flows rpm (see Table 6.1). Note that there is an orifice downstream of the three-way valve to the TCCR for recirculation during transfer to the TCCR. The motor is non-overloading.

Table 6.1

Tank 10	Evolution	Flow (gpm)	Fluid	Pump Speed (rpm)
Low Level	TCCR Transfer	10	Salt Solution	2925
High Level	TCCR Transfer	10	Salt Solution	2650
Low Level	Tank 10 Dissolution	90	Salt Solution	2250
High Level	Tank 10 Dissolution	90	Salt Solution	1900
Low Level	TCCR Back Flush	14	Salt Solution	2925
High Level	TCCR Back Flush	14	Salt Solution	2650

7. APPENDICES

7.1 Tsurumi Pump LH-W Series Information (3 pages)
7.2 Pipe and Fittings Summary Table (1 page)
7.3 Hose Information (1 page)

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

Document No.	Sheet No.
Attachment 9.6	13 of 17

Appendix 7.1 – Tsurumi Pump LH-W Series Information (pg 1 of 3)

TSURUMI PUMP

LH-W SERIES PERFORMANCE CURVE

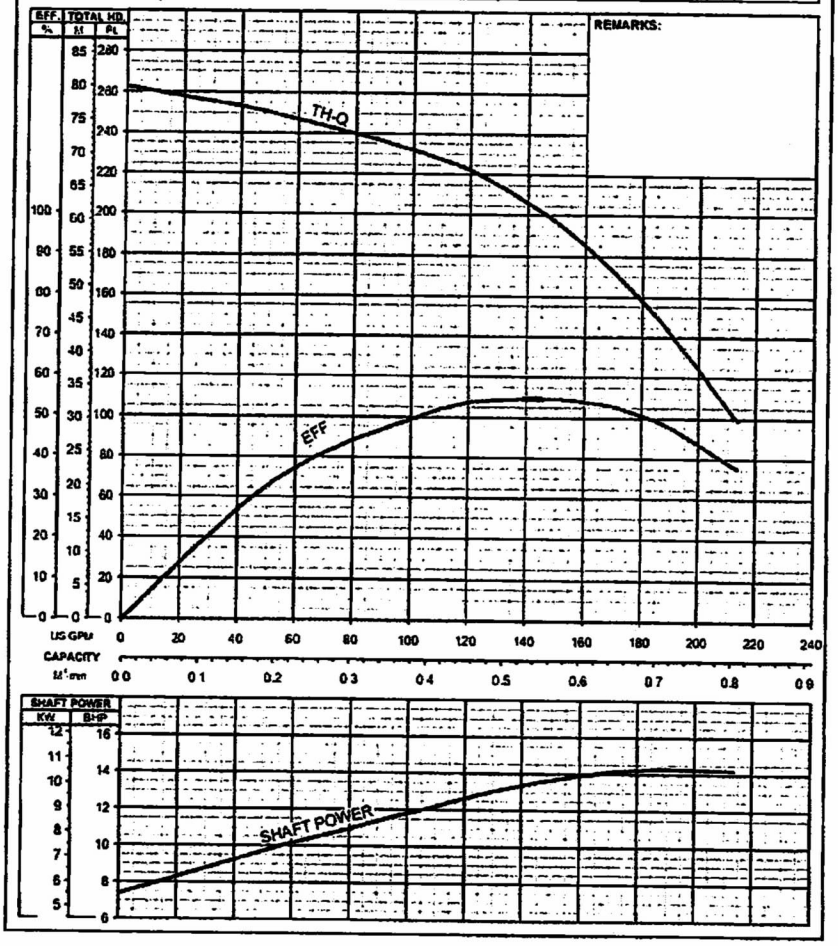
LH311W-60

MODEL	BORE	HP	KW	RPM	SOLIDS DIA	LIQUID	SG.	VISCOSITY	TEMP.
LH311W-60	3"x80mm	15	11	3465	0.334"/8.5mm	Water	1.0	1.81 CST	60°F

PUMP TYPE	PHASE	VOLTAGE	AMPERAGE	HZ	STARTING METHOD	INS. CLASS
High Head Dewatering Pump	3	208/230/460/575	43.0/37.0/18.5/14.8	60	Direct On Line	B

CURVE No.	DATE	PHASE	VOLTAGE	AMPERAGE	HZ	STARTING METHOD	INS. CLASS
-	-	-	-	-	-	-	-

REMARKS:



Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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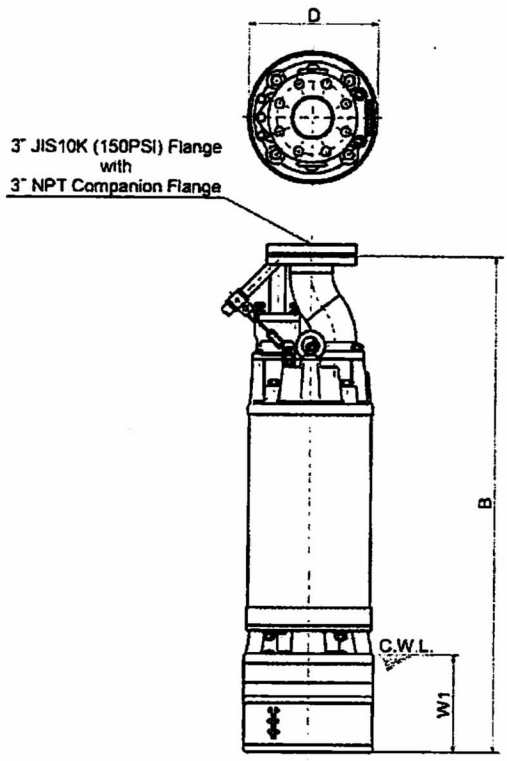
Attachment 9.6	14 of 17

Appendix 7.1 – Tsurumi Pump LH-W Series Information (pg 2 of 3)

TSURUMI PUMP | LH-W SERIES DIMENSIONS | LH311W-60



C.W.L. : Continuous running Water Level

DIMENSIONS:USCS (Inch)

Model	HP	NOM. SIZE	Pump & Motor B	Pump & Motor D	C.W.L. W1	Wt. (lbs.)
LH311W-60	15	3"	40 5/16	10 5/8	7 7/8	286

DIMENSIONS:METRIC (mm)

Model	kW	NOM. SIZE	Pump & Motor B	Pump & Motor D	C.W.L. W1	Wt. (kg)
LH311W-60	11	80	1024	270	200	130

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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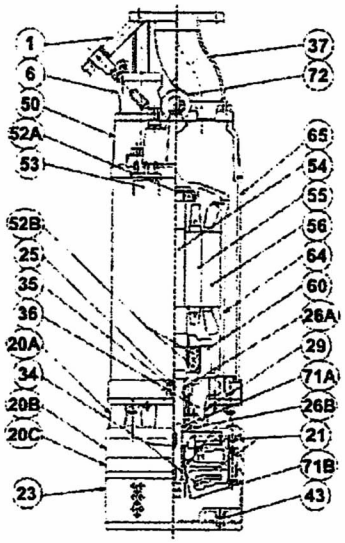
Appendix 7.1 – Tsurumi Pump LH-W Series Information (pg 3 of 3)

TSURUMI PUMP	LH-W SERIES SECTIONAL VIEW	LH311W-60



ITEMs	DESCRIPTION	MAIN MATERIAL / NOTE	ASTM, AISI CODE	RELATED DIN CODE	QTY
1	Power Cable	Chloroprene Sheath 4/WG8/4-50P			1
6	Shifting Ring	Cast Iron	A48 Class 35	1691/GG20	1
20A	Upper Pump Casing	Cast Iron	A48 Class 35	1691/GG20	1
20B	Lower Pump Casing	Cast Iron	A48 Class 35	1691/GG20	1
20C	Upper Pump Casing	Cast Iron	A48 Class 35	1691/GG20	1
20D	Lower Pump Casing	Cast Iron	A48 Class 35	1691/GG20	1
21	Impeller	High Chrome Cast Iron	A532 93Y Class III Type A	1695:1977	2
23	Suction Strainer	Steel	A283 Grade D	17100 RSt 46-2	1
25	Mechanical Seal	Silicon Carbide / HT-3540S			1
	Oil Lifter	ABS Resin			1
26	Labyrinth Ring	Stainless Steel	AISI 304	17440 X5 CrNi 18 9	2
29	Oil Casing	Cast Iron	A48 Class 35	1691/GG20	1
34	Suction Wear Plate	High Chrome Cast Iron	A532 93Z Class III Type A	1695 1977	2
35	Oil Pipe	Stainless Steel	AISI 304	17440 X5 CrNi 18-9	1
36	Lubricant	Turbine Oil ISO VG32 or SAE10W/20W			
37	Flanged Discharge Pipe	Carbon Steel Pipe + Steel + 3" JIS10K	A53 Type F + A283 Grade D	1615 STD + 17100 RSt 46-2	1
	Discharge Flange	Cast Iron / NPT 3"	A48 Class 35	1691/GG20	1
43	Cathodic Protection Plate	Zinc Anode			2
50	Motor Head Cover	Cast Iron	A48 Class 35	1691-GG20	1
52A	Upper Bearing	6630DZ/C3			1
52B	Lower Bearing	6730DADBC3			1 set
53	Motor Protector				1
54	Shaft	Stainless Steel	AISI 420	17440 X20 Cr 13	1
55	Rotor				1
56	Stator				1
60	Bearing Housing	Cast Iron	A48 Class 35	1691/GG20	1
64	Motor Housing	Cast Iron	A48 Class 35	1691/GG20	1
65	Cover Cover	Steel	A283 Grade D	17100 RSt 46-2	1
71A	Shaft Sleeve (Upper)	Stainless Steel	AISI 403	17440 X16 Cr 13	1
71B	Shaft Sleeve (Lower)	Stainless Steel	AISI 403	17440 X16 Cr 13	1
72	Lifting Lug Bolt	Stainless Steel	AISI 304	17440 X5 CrNi 18-9	2

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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Appendix 7.2 - Pipe and Fittings Summary Table (page 1 of 1)

	A	B	C	D	E	F	G	H	I	J	K	L	N	N	O	P	Q	R	S
1	Elevation Data (ft):																		
2	Tank 19 Tk Bottom Elev	244.39																	
3	Tank 19 Max Liq Level Elev.	266.67																	
4																			
5																			
6	Discharge Elev	267.50																	
7																			
8	Transfer Path Piping, Fittings & Components																		
9							90° ELL			45° ELL			TEE FTG						
10	Segment	Pipe 2-inch 40S	Pipe 3-inch 40S	Pipe* 1.5-inch 40S	Pipe* 1-inch 40S	2-inch 40S	1.5-inch 40S	1.0-inch 40S	2-inch 40S	1.5-inch 40S	1.0-inch 40S	2-inch 40S	1.5-inch 40S	1.0-inch 40S	45° ELL 3-inch 40S	2-inch 3-way Valve 40S	Reducer 2 x 1.5 Gradual	Reducer 2 x 1 Gradual	Reducer 3 x 2 Gradual
11	Tank 19 Transfer	10	20	0	570	4	0	0	0	0	0	0	0	0	2	1	0	1	1
12	Tank Dissolution	10	20	80	0	2	0	0	0	0	0	2	0	0	2	1	1	0	1
13	TCCR Backflush	10	20	0	322	4	0	0	0	0	0	0	0	0	2	1	0	1	1
14	(*1.5" and 1.0" hoses treated as Sch 40S pipe																		

Attachment 9.6 - Summary Equipment, Hose, and Piping Data

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Appendix 7.3 – Hose Information (page 1 of 1)

Continental

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Industrial Products
Conveyor Belt
Engineered Belt
Hose
Industrial Hose
Power Transmission Products
Elite Alternatives
Barkman Rubber Track
Transportation OE Products

Industrial Hose and Fittings

Viper™

Application:
For the transfer of a variety of industrial chemicals used today. (Refer to Chemical Resistance Guide for compatibility.) For use in pressure, gravity flow and/or suction service. Hose may be cleaned using open-end steam up to 50 psi or in a bath containing 10% Sodium Hydroxide (NaOH) up to 212°F (100°C).

Construction:

Tube: Beige Aphas(m)® Modified Cross-Linked Polyethylene (Modified XLPE)

Cover: Black Omegasyn™ abrasion-resistant EPDM with white spiral stripe

Reinforcement: Spiral-plied synthetic fabric with double wire helix

Temperature Range: -40°F to 250°F (-40°C to 121°C)

Packaging: 100' length coiled, polywrapped

Branding (Spiral): Continental ContiTech Viper Chemical Transfer Aphas(m)® 250 psi WP

Couplings: Fittings should be permanently attached for fluid temperatures above 125°F (52°C) and up to 250°F (121°C). Use Continental ContiTech Insta-Lock™ Cam & Groove Fittings with this product. For available Insta-Lock products, contact Customer Service.

Non-Stock/Sizes: For special production run minimum requirements, contact Customer Service.

Order Code: 546-345

ID		Nom. OD		Max. WP		Bend Radius		Vacuum HG		Weight	
in	mm	in	mm	psi	MPa	in.	mm	in	mm	lbs./ft.	kg/m
3/4	19.1	1.25	31.7	200	1.38	4	100	29	737	0.45	0.67
1	25.4	1.45	36.9	200	1.38	4	100	29	737	0.53	0.79
1-1/4	32.0	1.71	43.6	200	1.38	5	125	29	737	0.64	0.95
1-1/2	38.1	1.95	49.6	200	1.38	5	125	29	737	0.74	1.10
2	50.8	2.54	64.5	200	1.38	7	175	29	737	1.16	1.73
2-1/2	63.5	3.05	77.5	200	1.38	8	200	29	737	1.41	2.10
3	76.2	3.59	91.2	200	1.38	10	250	29	737	1.82	2.71
4	101.6	4.64	117.8	200	1.38	14	350	29	737	2.42	3.61

Note: Refer to the Continental ContiTech Chemical Resistance Chart for Specific chemical and temperature compatibility.

Viper chemical hose will handle fluids up to 250°F, however, the rating is contingent on the specific chemical conveyed. Contact Customer Service at 1-800-235-4632 for any chemical above the temperature stated in the Chemical Resistance Guide.