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From: J. H. Arslanian

Project/Work Order Number

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200 AREA EFFLUENT BAT/AKART IMPLEMENTATION

ETF TRUCK LOAD-IN FACILITY

PROJECT W-291H

INTEGRITY ASSESSMENT REPORT

(System Construction and Tank Design)

Prepared By:

Karl F. Feigner

ICF Kaiser Hanford Company

Richland, Washington

For:

U. S. Department of Energy

Subcontract WHC-380393

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1.0 INTRODUCTION

1.1 General Comments

This Integrity Assessment Report (IAR) is prepared by ICF Kaiser Hanford Co. (ICFKH) for Westinghouse Hanford company (WHC), operations contractor and the Department of Energy (DOE), the system owner. The IAR is intended to demonstrate that construction has been completed in accordance with the provisions of WAC-173-303-640(3)(c) through WAC-173-303-640(3)(h). A design integrity assessment was previously performed, ref. [17], for the system excluding the waste storage tanks. Design calculations for the tanks were not available for review prior to the start of construction. The tanks were designed and built off-site by a tank vendor, which was required by the purchase specification, ref. [4], to design the tanks in accordance with the ASME Pressure Vessel Code, Section VIII. Project timing precluded the performance of a design assessment prior to installation. Therefore, the results of this assessment are also contained within this report.

1.2 System Description

The waste system components included in this assessment are the waste storage tanks, pumps, piping, and concrete structures required to construct a tanker truck load-in/load-out station. The station will store wastes that are generated in the UO_3 Plant, on a temporary basis, until the wastes can be transferred to the Effluent Treatment Facility (ETF) for treatment. Components included in the station are as follows:

(a) Two 304L stainless steel single wall waste storage tanks (TK-109 and TK-117). Nominal capacity of the tanks is 10,000 gallons each. They are located outdoors, above grade, set upon concrete foundations, and enclosed within a concrete spill containment structure. Electric heat tracing for freeze protection is included in the installation.

(b) The concrete containment pad provides secondary containment for the above grade piping, transfer pumps, and storage tanks. It also provides secondary containment for a tanker during off-loading/loading events. The floor of the structure is sloped to a collection sump so that potential spills can be promptly detected and removed. An electronic leak detection device is installed in the sump to signal the presence of moisture. The signal activates local/remote alarms and interlocks that prevent/stop waste transfer activities.

Concrete surfaces that may be exposed to waste are coated with a nonpermeable material to prevent diffusion of waste

liquids through the concrete into the surrounding soil column. Concrete joints were made using continuous PVC waterstop to prevent potential waste leakage through the joints. Because the water table is very deep, and the surrounding soil is primarily sand, water seepage into the sump in not likely.

(c) A waste transfer pipeline is installed below grade. The piping extends approximately 280 ln. ft. from the load-in/load-out station LERF basins to tank 60A-TK-1 Located at the EFT. The piping is a double containment design with electronic leak detection, and constructed from Fiberglass reinforced epoxy resin. Interlocks are installed to prevent or halt waste transfer operations in he event a piping leak is detected. Leak detection will also activate both local and remote alarms. Diameters of the carrier and encasement piping are 3 and 6 inches respectively.

(d) Inter-connecting piping is installed above grade, insulated, and heat traced to prevent freezing. This piping is entirely enclosed by the concrete spill containment pad.

1.3 Scope

This report applies to the facilities described above in paragraph 1.2. It is based on periodic inspections performed on a scheduled basis by qualified persons. Inspections were performed on the system described using applicable codes, standards, and properly maintained tools. In addition to the construction assessment, a design integrity assessment performed in accordance with WAC-173-303-640(3)(a) for the tanks described above in paragraph 1.2(a) is included.

1.4 Comments on Certification

Paragraph 3.0 contains a certificate attesting to the accuracy of the information presented in this report. The certificate is signed and sealed by an Independent Qualified Registered Professional Engineer (IQRPE) in accordance with WAC-173-303-810(13)(a).

2.0 CONSTRUCTION ASSESSMENT

The system described above in paragraph 1.2 is properly installed in accordance with the drawings, specifications, and applicable codes. This assessment is based upon inspections performed by qualified personnel during the construction phase of the project. The following paragraphs 2.1 through 2.10 discuss specific considerations for the construction assessment.

2.1 Weld Breaks

Personnel that joined sections of piping together were pre-qualified before performing the work. In process inspection was employed in accordance with ASME B31.3 to ensure properly bonded joints. The inspection process was supervised by a certified welding inspector, supplied by an independent contractor. In addition, hydrostatic pressure tests performed in accordance with the applicable piping code and project specifications, demonstrated that the piping was properly joined. Hydrostatic pressure tests were performed after each section of pipe was completed, but prior to burial (for underground piping) so that leaks could be visually detected.

2.2 Punctures

The piping hydrostatic pressure tests indicate that none exist.

2.3 Scrapes of Protective Coatings

Protective coatings were not used for corrosion protection, therefore this provision does not apply.

2.4 Cracks

Based on the inspections and hydrostatic pressure tests performed, cracks are not apparent.

2.5 Corrosion

Inspections performed during construction indicate that the system has not been damaged by corrosion.

2.6 Other Structural Damage

Based on inspections performed during construction, no structural damage is evident.

2.7 Backfill

Installation of this system required excavation and the use of backfill. Backfill was comprised of well graded soil materials that are native to the construction site. Soil compaction tests were performed in accordance with the applicable code to ensure proper placement. Placement methods were based on the applicable codes.

2.8 Tightness Test

Hydrostatic tests were performed on the piping after construction was completed (prior to burial for below grade sections). These tests indicate that the system is leak free. Hydrostatic test pressures were based on the ASME B31.3 Piping Code, and are as follows: (a) below grade waste transfer pipeline, 90 psig for the carrier pipe and the containment pipe was pneumatically tested at 66 psig; (b) above grade interconnecting piping sections, 150 psig. Design operating pressure for the below grade piping is 60 psig for the carrier pipe and 60 psig for the containment piping. The design operating pressure for the above grade piping is 100 psig. Test pressures were held for a minimum duration of 10 minutes.

A tightness test was also performed on the storage tanks. The tanks are designed to operate under atmospheric pressure, therefore the tanks were filled with water and observed for leaks. No external pressure was applied to the tanks.

2.9 Support System

Inspections were performed to determine whether the support systems for the piping and the tanks were installed in accordance with the plans and specifications. Based on these inspections, the support systems are properly installed.

2.10 Corrosion Protection System

Cathodic protection is not included in the system design, nor is it required. The buried piping is constructed from fiberglass reinforced epoxy materials that are inherently resistant to soil corrosion damage. The tanks and above grade piping is constructed of stainless steel and are not in contact with the soil.

3.0 STORAGE TANK DESIGN INTEGRITY ASSESSMENT

The tanks described in paragraph 1.2(a) above are adequately designed to prevent failure caused by corrosion or by structural loads imposed by the system's intended service. Refer to references [1] and [2] listed in Appendix I for a complete description of the system and intended service. Tank design fully complies with the requirements of WAC-173-303-640. These results are based on review of the applicable codes, standards, design, and construction documents. Design documents included the Functional Design Criteria ref. [1], calculations (listed in Appendix III), and drawings (listed in Appendix II). construction documents include the construction specifications, and inspection plans listed in Appendix I ref. [3]; [6], and [8]. the following paragraphs 3.1 through 3.9 discuss specific considerations for the design assessment.

3.1 Codes and Standards used as a basis for design are as follows:

"Pressure Vessel Code", ASME Section VIII, 1992.

"Pipe Flanges and Flanged Fittings", ASME B16.5, 1988.

"Heat-resisting Chromium and Chromium-nickel Stainless Steel Plate, Sheet, and Strip for Pressure vessels", ASTM A 240, 1992.

"Forged or Rolled Alloy-steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service", ASTM A182, 1992.

"Alloy-steel and Stainless Steel Bolting Materials for High Temperature Service, ASTM A193, 1992.

"Wrought Austenitic Stainless Steel Piping Fittings", ASTM A403, 1991.

Manual of Steel Construction Allowable Stress Design, 9th ed., AISC., 1989.

Standard Specifications for Highway Bridges, 13th Ed., AASHTO, 1983.

"Uniform Building Code", International Conference of Building Officials, 1991.

"Standard Terminology Relating to Soil, Rock, and Contained Fluids", ASTM D653, 1990.

"Road, Bridge, and Municipal Construction", WSDOT M41-10, 1994.

"Tolerances for Concrete construction and Materials", ACI 117, 1990.

"Structural Concrete for Buildings", ACI 301, 1991.

"Hot weather concreting", ACI 305R, 1991.

"Cold Weather concreting", ACI 306.1, 1990.

"Building Code Requirements for Reinforced concrete", 318, 1989 (Revised 1992).

ACI Detailing Manual, SP-66, 1988.

"Deformed and Plain Billet-Steel Bars for concrete Reinforcement", ASTM A615, 1992.

"Steel Wire, Carbon for General Use", ASTM A853, 1991.

"Concrete Aggregates", ASTM C33, 1992.

"Ready-mixed Concrete", ASTM C94, 1992.

"Portland Cement", ASTM C150, 1992.

"Air Entraining Admixtures for Concrete", ASTM C260, 1986.

"Packaged Dry, Hydraulic-cement Grout (Nonshrink)", ASTM C1107, 1991.

"Preformed Expansion Joint Filler for Concrete (Bituminous Type)", ASTM D994-71, 1982.

"Sealing Compound: Elastomeric Type Single Component (For Caulking, Sealing, and Glazing in Buildings and Other Structures)", Federal Specification TT-S-00230C AMD 2.

3.2 Waste Characterization

The waste characterization, included in Appendix IV (stream no. 5), was reviewed to evaluate the compatibility of the materials. Waste is primarily rain water collected from various basins located in the UO_3 Plant, or water discharged from miscellaneous equipment. However, the waste is considered hazardous because contaminate materials may be present. The aqueous mixed waste can contain trace quantities of inorganic salts, metals, and organic materials. The waste can also contain radionuclides that would classify it as low level radioactive waste. Typical rain water sources include outdoor sumps, yard drains, and pipe trenches within radiological control areas. Typical equipment water sources include HVAC, and air compressor condensate.

Based on the characterization, the wastes are not susceptible to ignition, or unstable. They do not react violently with water, or form an explosive mixture.

3.3 Potential for Corrosion Failure

The tanks are constructed from 304L stainless steel. 304L stainless steel is resistant to the compounds listed in the waste characterization (Appendix IV), therefore,the potential for failure caused by internal corrosion is very low. The potential for failure caused by soil induced corrosion does not exist. The tanks are not in contact with soil. They are installed upon concrete foundations, and the tank bottoms are elevated so that only the tank skirt is in contact with the foundation.

3.4 Effects of Vehicular Traffic

The tanks are situated within the confines of the containment basis in such a manner that the risk of inadvertent contact between vehicles and the tanks is minimized.

3.5 Foundation Loading

Calculations were performed to determine the suitability of the tank footings. These calculations demonstrate that footings and supports are properly designed.

3.6 Effects of Frost Heave

The tanks are protected from the effects of frost heave. The tanks are located above ground on concrete foundations. Edges of the foundations extent to depths greater than 30 inches, which is the accepted limit for the frost zone. In addition the tanks are insulated and heat traced.

3.7 Pressure Effects

Design stress calculations were performed for the tanks. These calculations demonstrate that the tanks are properly designed. Calculations were based on the hydrostatic head generated by a completely full tank.

Hydrostatic pressure tests will be applied after construction is complete to verify the integrity of the tanks. The tests will be performed in accordance with ASME B31.3 requirements.

3.8 Thermal Effects

Does not apply.

3.9 Seismic Effects

The tanks are designed in accordance with UBC-1991 to withstand seismic zone 2B events.

4.0 Certificate

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

KARL F. FEIGNER
STATE OF WASHINGTON
19055
REGISTERED
PROFESSIONAL ENGINEER

EXPIRES: March 19, 1996

Appendix I
(References)

References

for

Project W-291H

200 Area Effluent BAT/AKART Implementation

ETF

Truck Load-in Facility

[1] Functional Design Criteria for "Project W-291H, 200 Areas Effluent BAT/AKART Implementation", WHC-SD-W291H-FDC-001, Rev. 1, 12/93.

[2] Conceptual Design Report "200 Area Effluent BAT/AKART Implementation", WHC-SD-W291-CDR-001 Rev. 0, 2/93.

[3] Construction Specification for "200 Areas Effluent BAT/AKART Implementation ETF Truck Load-in Facility", W-291H-C2 Rev. 0, 4/14/94.

[4] Procurement Specification for "Atmospheric Tanks", W-291H-P3 Rev. 0, 2/16/94.

[5] Acceptance Inspection Plan for "Project W-291 200 Area's Effluent BAT/AKART Implementation ETF Truck Load-in Facility", IP-W-291-C2-1, 5/6/94.

[6] Packard, R. D.,"Slab Thickness Design for Industrial Concrete Floors on Grade", Portland Cement Association,, 1976.

[7] Bowles, J. E., Foundation Analysis and Design, 4th Ed., 1988.

[8] Nilson and Winter, Design of Concrete Structures, 10th Ed., 1986.

[9] Ringo and Anderson, "Designing Floor Slabs on Grade", 1992.

[10] Merritt, Standard Handbook for Civil Engineers, 3rd Ed., 1983.

[11] "Report of Geotechnical Investigation/Consulting Services Effluent Treatment Facility Hanford Reservation, Washington", for KEH by Dames and Moore Co., Job No. 10805-699-016, Mar 24, 1993.

[12] Tarzaghi K. and Beck, R. A. , Soils Mechanics in Engineering Practice, 1968.

[13] "Climatological Summary for the Hanford Area", Pacific Northwest Laboratory 4622, June 1983.

[14] "Standard Arch-Civil Design Criteria", SDC 4.1 Rev. 11.

[15] Blogett, O. W., "Design of Welded Structures", 8th Printing, 1975.

[16] DOE Order 6430.1A.

[17] "Integrity Assessment Report for 200 Areas' BAT/AKART Implementation, ETF Load-in Facility, Project W-291H", ICKFH Transmittal TR-W-291H-AI-45, 1/26/95.

Appendix II
(Drawing List)

Drawing List

for

Project W-291H

200 Area Effluent BAT/AKART Implementation

ETF

Truck Load-in Facility

H-2-817968	ETF Truck Load-in Facility Site Plan
H-2-817969	Civil ETF Truck Load-in Facility Site Plan, Sheet 1 of 5
H-2-817969	Civil ETF Truck Load-in Facility Plan and Profiles, Sheet 2 of 5
H-2-817969	Civil ETF Truck Load-in Facility Enlarged Plan, Sheet 3 of 5,
H-2-817969	Civil ETF Truck Load-in Facility Miscellaneous Details, Sheet 4 of 5
H-2-817969	Civil ETF Truck Load-in Facility Miscellaneous Details, Sheet 5 of 5
H-2-817970	Structural ETF Truck Load-in Facility Plan & Sections, Sheet 1 of 2
H-2-817970	Structural ETF Truck Load-in Sections & Details, Sheet 2 of 2
H-2-817971	Structural ETF Truck Load-in Steel Plan & Sections, Sheet 1 of 2
H-2-817971	Structural ETF Truck Load-in Steel Details, Sheet 2 of 2
H-2-817972	Structural ETF Truck Load-in Sections & Details
H-2-817973	Structural ETF Truck Load-in Misc Sections and Details

Appendix III
(Calculations List)

Calculations List

for

Project W-291H

200 Area Effluent BAT/AKART Implementation

ETF

Truck Load-in Facility

(1) "Load-in/Load-out Pad Structural Design", W-291-C-03, 11/11/93.

(2) "Depth of Catch Basin for Load-in/Load-out Station", W-291-C-04, 11/24/93.

(3) "Structural Analysis for Load-in/Load-out Catch Basin", W-291-C-05, 12/27/93.

(4) "Design Calculations for Tank TK-109 and TK-117, TMF Serial Nos. 18769-01 and 18769-02, Purchase Order No. 76036" Thompson Metal Fab Inc., 9/28/94.

Appendix IV

(Waste Characterization - Only Stream No. 5 Applies)

EFFLUENT CHARACTERIZATION DATA - DB 1

DB 1

Stream No.		Unit	1	2	3	4	5	6
Stream			Purex Plant	Purex Plant	242	242	Design Base	Liquid Waste
			PDD	ASD	Evaporator PC	Evaporator LCRF	Liquid Waste DB 1	Before Adjustment
Flowrate	Max./Min.	gpm					150/	
	Average	gpm	75	0	75	0	150	170
Density		lb/ft3						
pH	90%CI	-	2.20	9.66	11.30	11.30		
	Design	-	2.20	9.66	11.30	11.30		
Temperature	90%CI (High Side)	F	173	101	87	140	130	
	(Low Side)	F	113	86	71	71		
	Design	F					< 140	< 140
Pressure		psig						-
Beta		Ci/m3	1.9E-04	4.7E-04	4.6E-06	4.6E-06	2.5E-04	2.2E-04
Alpha		Ci/m3	2.2E-04	2.0E-06	3.5E-07	3.5E-07	1.1E-04	1.0E-04
H - 3		Ci/m3	6.0E-02	4.3E-03	6.3E-03	6.3E-03	3.7E-02	3.7E-02
Sr- 90		Ci/m3	0.5E-07	1.9E-05	7.6E-06	7.6E-06	4.2E-06	3.0E-06
Y - 90		Ci/m3	0.5E-07	1.9E-05	7.6E-06	7.6E-06	4.2E-06	3.0E-06
Ru-103		Ci/m3	2.7E-06	6.3E-05	1.0E-05	1.0E-05	1.0E-05	9.3E-06
Rh-103m		Ci/m3	2.7E-06	6.3E-05	1.0E-05	1.0E-05	1.0E-05	9.3E-06
Ru-106		Ci/m3	5.5E-05	2.0E-04	1.1E-05	1.1E-05	3.3E-05	3.0E-05
Rh-106		Ci/m3	5.5E-05	2.0E-04	1.1E-05	1.1E-05	3.3E-05	3.0E-05
Sn-113		Ci/m3	-	3.4E-05	7.7E-07	7.7E-07	3.9E-07	3.5E-07
In-113m		Ci/m3	-	3.4E-05	7.7E-07	7.7E-07	3.9E-07	3.5E-07
I -129		Ci/m3	7.0E-07	1.4E-07	-	-	3.9E-07	3.5E-07
Cs-134		Ci/m3	-	-	-	-	-	-
Cs-137		Ci/m3	0.0E-05	1.1E-05	5.4E-06	5.4E-06	4.7E-05	4.2E-05
Ba-137m		Ci/m3	0.0E-05	1.1E-05	5.4E-06	5.4E-06	4.7E-05	4.2E-05
Pm-147		Ci/m3	4.2E-06	3.7E-05	1.6E-06	1.6E-06	2.9E-06	2.6E-06
Eu-155		Ci/m3	-	-	-	-	-	-
Pu-241		Ci/m3	1.9E-04	5.6E-06	-	-	9.5E-05	8.6E-05
U (gross)		Ci/m3	6.4E-08	1.6E-07	3.3E-08	3.3E-08	4.9E-08	4.4E-08
Pu-238		Ci/m3	2.2E-06	-	-	-	1.1E-06	1.0E-06
Pu-239		Ci/m3	1.9E-05	9.3E-07	6.0E-13	6.0E-13	9.5E-06	8.6E-06
Am-241		Ci/m3	1.2E-05	2.1E-06	-	-	6.0E-06	5.4E-06
Total		Ci/m3	5.2E-04	8.6E-04	8.7E-05	8.7E-05	3.0E-04	2.8E-04
SS		ppm	10.0	10.0	10.0	10.0	10.0	9.1
Organic Compound	T-Butanol	ppm	0.000	-	30.000	30.000	15.017	10.237
	Acetone	ppm	0.004	-	1.000	1.000	0.542	0.520
	Benzyl Alcohol	ppm	-	-	0.014	0.014	0.007	0.026
	Chloroform	ppm	-	-	0.014	0.014	0.007	0.012
	Methylene Chloride	ppm	-	-	0.140	0.140	0.070	0.067
	MIBK	ppm	-	-	0.014	0.014	0.007	0.011
	Pyridine	ppm	-	-	0.550	0.550	0.275	0.237
	Tributyl Phosphate	ppm	107.000	-	4.100	4.100	55.550	49.905
	Others	ppm	145.210	-	1.730	1.730	73.476	69.796
	Total	ppm	252.330	-	37.570	37.570	144.950	130.920
H2O2		ppm	-	-	-	-	-	-
TDS		ppm	141.0	965.9	662.3	662.3	402.0	393.6
Na		ppm	26.200	0.456	4.5	4.5	12.3	12.4
K		ppm	0.994	-	6.5	6.5	3.7	3.4
Ca		ppm	0.050	0.007	2.0	2.0	1.4	1.3
NH4		ppm	0.062	962.471	511.3	511.3	255.7	241.4
Si		ppm	0.243	-	24.3	24.3	12.2	11.1
NO3		ppm	119.0	0.6	2.3	2.3	60.6	55.0
SO4		ppm	-	-	2.0	2.0	1.4	22.5
CO2/CO3 (as CO3)		ppm	-	-	104.3	104.3	52.2	46.3
Cl		ppm	-	2.3	1.2	1.2	0.6	0.6
F		ppm	1.2	-	1.0	1.0	1.1	1.0
PO4		ppm	-	-	1.3	1.3	0.7	0.6

EFFLUENT CHARACTERIZATION DATA - DB 2

PB2

Stream No.		Unit	1	2	3	4	5	6
Stream			Purex Plant	Purex Plant	242 Evaporator	242 Evaporator	Design Base Liquid Waste	Liquid Waste Before Adjustment
			PDD	ASD	PC	LCRF	DB 2	
Flowrate	Max./Min.	gpm					150/	
	Average	gpm	0	75	75	0	150	170
Density		lb/ft3						
pH	90%CI	-	2.20	9.66	11.30	11.30		
	Design	-	2.20	9.66	11.30	11.30		
Temperature	90%CI (High Side)	F	173	101	87	140	94	
	(Low Side)	F	113	86	71	71		
	Design	F					< 140	< 140
Pressure		psig						-
Beta		Ci/m3	1.9E-04	1.9E-04	4.6E-06	4.6E-06	2.5E-04	2.2E-04
Alpha		Ci/m3	2.2E-04	2.0E-06	3.5E-07	3.5E-07	1.2E-06	1.1E-06
H - 3		Ci/m3	6.0E-02	4.5E-03	6.5E-03	6.3E-03	5.3E-03	5.3E-03
Sr- 90		Ci/m3	0.5E-07	1.9E-05	7.6E-06	7.6E-06	1.3E-05	1.2E-05
Y - 90		Ci/m3	0.5E-07	1.9E-05	7.6E-06	7.6E-06	1.3E-05	1.2E-05
Ru-103		Ci/m3	2.7E-06	6.3E-05	1.0E-05	1.0E-05	4.0E-05	3.6E-05
Rh-103m		Ci/m3	2.7E-06	6.3E-05	1.0E-05	1.0E-05	4.0E-05	3.6E-05
Ru-106		Ci/m3	5.5E-05	2.0E-04	1.1E-05	1.1E-05	1.5E-04	1.3E-04
Rh-106		Ci/m3	5.5E-05	2.0E-04	1.1E-05	1.1E-05	1.5E-04	1.3E-04
Sn-113		Ci/m3	-	3.4E-05	7.7E-07	7.7E-07	1.7E-05	1.6E-05
In-113m		Ci/m3	-	3.4E-05	7.7E-07	7.7E-07	1.7E-05	1.6E-05
I -129		Ci/m3	7.0E-07	1.4E-07	-	-	7.0E-08	6.3E-08
Cs-134		Ci/m3	-	-	-	-	-	-
Cs-137		Ci/m3	8.0E-05	1.1E-05	5.4E-06	5.4E-06	8.2E-06	7.3E-06
Ba-137m		Ci/m3	8.0E-05	1.1E-05	5.4E-06	5.4E-06	8.2E-06	7.3E-06
Pm-147		Ci/m3	4.2E-06	3.7E-05	1.6E-06	1.6E-06	1.9E-05	1.7E-05
Eu-155		Ci/m3	-	-	-	-	-	-
Pu-241		Ci/m3	1.9E-04	5.6E-06	-	-	2.0E-06	2.5E-06
U (gross)		Ci/m3	6.4E-08	1.6E-07	3.3E-08	3.3E-08	9.7E-08	8.6E-08
Pu-238		Ci/m3	2.2E-06	-	-	-	-	-
Pu-239		Ci/m3	1.9E-05	9.3E-07	6.0E-13	6.0E-13	4.7E-07	4.2E-07
Am-241		Ci/m3	1.2E-05	2.1E-06	-	-	1.1E-06	9.4E-07
Total		Ci/m3	5.2E-04	8.6E-04	8.7E-05	8.7E-05	4.7E-04	4.2E-04
SS		ppm	10.0	10.0	10.0	10.0	10.0	8.9
Organic Compound	1-Butanol	ppm	8.033	-	30.000	30.000	15.000	10.215
	Acetone	ppm	0.004	-	1.000	1.000	0.500	0.490
	Benzyl Alcohol	ppm	-	-	0.014	0.014	0.007	0.026
	Chloroform	ppm	-	-	0.014	0.014	0.007	0.012
	Methylene Chloride	ppm	-	-	0.140	0.140	0.070	0.067
	MIBK	ppm	-	-	0.014	0.014	0.007	0.011
	Pyridine	ppm	-	-	0.550	0.550	0.275	0.256
	Tributyl Phosphate	ppm	107.000	-	4.100	4.100	2.050	2.007
	Others	ppm	145.213	-	1.730	1.730	0.869	5.774
	Total	ppm	252.330	-	37.570	37.570	18.785	27.659
H2O2		ppm	-	-	-	-	-	-
TDS		ppm	141.0	965.9	662.3	662.3	814.1	700.1
Na		ppm	20.200	0.456	4.5	4.5	2.5	3.0
K		ppm	0.994	-	6.5	6.5	3.2	2.9
Ca		ppm	0.050	0.007	2.0	2.0	1.4	1.3
NH4		ppm	0.062	962.471	511.3	511.3	736.9	605.3
Si		ppm	0.243	-	24.3	24.3	12.1	10.0
NO3		ppm	119.0	0.6	2.3	2.3	1.5	1.3
SO4		ppm	-	-	2.0	2.0	1.4	34.7
CO2/CO3 (as CO3)		ppm	-	-	104.3	104.3	52.2	46.0
Cl		ppm	-	2.3	1.2	1.2	1.7	1.6
F		ppm	1.2	-	1.0	1.0	0.5	0.5
PO4		ppm	-	-	1.3	1.3	0.7	0.6

EFFLUENT CHARACTERIZATION DATA - DB 3

DB 3

Stream No.		Unit	1	2	3	4	5	6
Stream			Purex Plant	Purex Plant	242	242	Design Base	Liquid Waste
			PDD	ASD	Evaporator PC	Evaporator LCRF	Liquid Waste DB 3	Before Adjustment
Flowrate	Max./Min.	gpm					1507	
	Average	gpm	0	0	75	75	150	170
Density		lb/ft3						
	Design	-	2.20	9.66	11.30	11.30		
	(Low Side)	F	113	06	71	71		
	Design	F					< 140	< 140
Pressure		psig						-
Beta		Ci/m3	4.9E-04	4.2E-04	4.6E-06	4.6E-06	4.6E-06	4.1E-06
Alpha		Ci/m3	2.2E-04	2.0E-06	3.5E-07	3.5E-07	3.5E-07	3.1E-07
H - 3		Ci/m3	6.0E-02	4.3E-03	6.3E-03	6.3E-03	6.3E-03	6.3E-03
Sr- 90		Ci/m3	0.5E-07	1.9E-05	7.6E-06	7.6E-06	7.6E-06	6.0E-06
Y - 90		Ci/m3	0.5E-07	1.9E-05	7.6E-06	7.6E-06	7.6E-06	6.0E-06
Ru-103		Ci/m3	2.7E-06	6.3E-05	1.0E-05	1.0E-05	1.0E-05	1.6E-05
Rh-103m		Ci/m3	2.7E-06	6.3E-05	1.0E-05	1.0E-05	1.0E-05	1.6E-05
Ru-106		Ci/m3	3.5E-05	2.0E-04	1.1E-05	1.1E-05	1.1E-05	1.0E-05
Rh-106		Ci/m3	3.5E-05	2.0E-04	1.1E-05	1.1E-05	1.1E-05	1.0E-05
Sn-113		Ci/m3	-	3.4E-05	7.7E-07	7.7E-07	7.7E-07	6.9E-07
In-113m		Ci/m3	-	3.4E-05	7.7E-07	7.7E-07	7.7E-07	6.9E-07
I -129		Ci/m3	7.0E-07	1.4E-07	-	-	-	-
Cs-134		Ci/m3	-	-	-	-	-	-
Cs-137		Ci/m3	0.0E-05	1.1E-05	5.4E-06	5.4E-06	5.4E-06	4.9E-06
Ba-137m		Ci/m3	0.0E-05	1.1E-05	5.4E-06	5.4E-06	5.4E-06	4.9E-06
Pm-147		Ci/m3	4.3E-06	3.7E-05	1.6E-06	1.6E-06	1.6E-06	1.4E-06
Eu-155		Ci/m3	-	-	-	-	-	-
Pu-241		Ci/m3	1.3E-04	5.6E-06	-	-	-	-
U (gross)		Ci/m3	3.3E-08	1.2E-07	3.3E-08	3.3E-08	3.3E-08	3.0E-08
Pu-238		Ci/m3	2.2E-06	-	-	-	-	-
Pu-239		Ci/m3	1.9E-05	9.3E-07	6.0E-13	6.0E-13	6.0E-13	6.1E-13
Am-241		Ci/m3	1.2E-05	2.1E-06	-	-	-	-
Total		Ci/m3	5.2E-04	0.2E-04	0.7E-05	0.7E-05	0.7E-05	7.0E-05
SS		ppm	10.0	10.0	10.0	10.0	10.0	5.0
Organic Compound	1-Butanol	ppm	0.033	-	30.000	30.000	30.000	31.445
	Acetone	ppm	0.014	-	1.000	1.000	1.000	0.931
	Benzyl Alcohol	ppm	-	-	0.014	0.014	0.014	0.032
	Chloroform	ppm	-	-	0.014	0.014	0.014	0.010
	Methylene Chloride	ppm	-	-	0.140	0.140	0.140	0.128
	MIBK	ppm	-	-	0.014	0.014	0.014	0.017
	Pyridine	ppm	-	-	0.550	0.550	0.550	0.499
	Tributyl Phosphate	ppm	107.000	-	4.100	4.100	4.100	4.615
	Others	ppm	145.213	-	1.730	1.730	1.730	6.539
	Total	ppm	252.330	-	37.570	37.570	37.570	44.230
H2O2		ppm	-	-	-	-	-	-
TDS		ppm	141.0	965.9	662.3	662.3	662.3	210.1
Na		ppm	20.200	0.456	4.5	4.5	4.5	4.0
K		ppm	0.994	-	6.5	6.5	6.5	5.0
Ca		ppm	0.050	0.007	2.0	2.0	2.0	2.5
NH4		ppm	0.062	962.471	511.3	511.3	511.3	477.0
Si		ppm	0.243	-	24.3	24.3	24.3	21.0
NO3		ppm	119.0	0.6	2.3	2.3	2.3	2.1
SO4		ppm	-	-	2.0	2.0	2.0	30.4
CO2/CO3 (as CO3)		ppm	-	-	104.3	104.3	104.3	92.1
Cl		ppm	-	2.3	1.2	1.2	1.2	1.1
F		ppm	1.2	-	1.0	1.0	1.0	0.9
PO4		ppm	-	-	1.3	1.3	1.3	1.2

VENDOR INFORMATION

VI No.	Equipment Title	Organization Code
22657, SUPP 7	ATMOSPHERIC TANKS	K-4200
Property No.	**Vendor/Manufacturer**	**Project No./Work Order No.**
	THOMPSON METAL FAB INC.	W-291H/P03/6

Date	Equipment No.	Bldg. No.	P.O. Number
03/22/95		200 GENERAL	76036

Copies	Distribution	Address	Copies	Distribution	Address	Copies	Distribution	Address
3	A MCCABE	T3-28	1	Tech Ref Lib	S1-08	1	VI Files	L6-76
0	SDC/TCPC	E6-02	1	EA MCNAMAR	S6-71			

Item No.	Data Title Sheet 200-282	Sheet No.
1.	DESIGN CALCULATIONS TMF JOB NO. 18769 (2) TANKS TANK TK-109 & TANK TK-117 TMF SERIAL NOS. 18769-01 & 18769-02	
	A. PRESSURE SUMMARY	
	B. NOZZLE SUMMARY	
	C. NOZZLE SCHEDULE	
	D. THICKNESS SUMMARY	
	E. TOP HEAD	
	F. SHELL	
	G. BOTT. HEAD	
	H. SUPORT SKIRT	
	I. BASE RING	

VENDOR INFORMATION

Item No.	Data Title	Sheet No.
	J. WIND CALCULATIONS	
	K. SEISMIC CALCULATIONS	
	L. 4" LEVEL	
	M. 3" OVERFLOW	
	N. 3" INLET	
	O. F 24" MW	
	P. J 24" MW	
	Q. E 4" DRAIN	
	R. 24" MW FLG.	
	S. 24" MW COVER	
	T. NOZZLE LOADING	
2.	DESIGN CALCULATIONS TMF JOB NO. 18769 NEW CATCH TANK TAG. NO D-XX-E-11-015 RMF SERIAL NOS. 18769-04	
	A. PRESSURE SUMMARY	
	B. NOZZLE SUMMARY	
	C. NOZZLE SCHEDULE	
	D. THICKNESS SUMMARY	
	E. LEFT HEAD	
	F. SHELL	
	G. RIGHT HEAD	
	H. SADDLE SUPPORT	
	I. 4" INLET	
	J. B 30" MW	

VENDOR INFORMATION

Item No.	Data Title	Sheet No.
	K. 4" LEVEL	
	L. 3" INLET	
	M. 3" INLET	
	N. 3/4" SAMPLE	
	O. 30: MW FLANGE	
	P. 30" MW COVER	
	Q. 3" INLET	
	R. NOZZLE LOADING	
3.	DESIGN CALCULATIONS TMF JOB NO. 18769 HEAD END TANK TAG NO. D-XX-E-01-006 TMF SERIAL NOS. 18769-03	
	A. PRESSURE SUMMARY	
	B. NOZZLE SUMMARY	
	C. NOZZLE SCHEDULE	
	D. THICKNESS SUMMARY	
	E. LEFT HEAD	
	F. SHELL	
	G. RIGHT HEAD	
	H. SADDLES	
	I. 6" INLET	
	J. 3" PUMP OUT	
	K. 4" LEVEL	
	L. 2" RECIRC.	
	M. 4" VENT	

VENDOR INFORMATION

Item No.	Data Title	Sheet No.
	N. NOZZLE LOADING	

Approved:	For Design	For Contractor
	SDC/OPAL BANG	WHC

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DESIGN CALCULATIONS

VI. 22657 Sup 7
SHT. 200-239
Bldg. 2006

TMF JOB NO. 18769

LARRY F. PARRISH
STATE OF WASHINGTON
11086
REGISTERED
Professional Engineer

Larry F. Parrish
Sept. 28, 1994
Exp. 3/12/95, #11086

EQUIPMENT:

(2) TANKS

TANK TK-109 & TANK TK-117

TMF SERIAL NOS. 18769-01 & 18769-02

PURCHASE ORDER NO. 76036

BY:

THOMPSON METAL FAB INC.
3000 SE HIDDEN WAY
VANCOUVER, WA 98661

CUSTOMER:

KAISER ENGINEERS
P.O. BOX 888
RICHLAND, WA 99352

NOZZLES AND MANWAYS DO NOT REQUIRE ADDITIONAL REINFORCEMENT TO MEET THE SPECIFIED PRESSURE AND TEMPERATURE DESIGN CONDITIONS. ADDITIONAL, EXTERNAL, REINFORCEMENT HAS BEEN PROVIDED FOR THE NOZZLE CONNECTIONS TO MEET THE SPECIFIED NOZZLE LOADING CRITERIA. SEE TABLE ATTACHED.

"P.E." STAMP APPLIES TO; PAGES 1 THRU 37, 38 & 39.

L. Parrish
SEPTEMBER 27, 1994

Pressure Summary

Pressure summary for pressure chamber 1

Identifier	P design (psi)	T design (deg F)	MAWP (psi)	MAP (psi)	Pe external (psi)	UG-99 Ratio
TOP HEAD	0.0	140.0	20.3	31.2	2.0	1.005
SHELL	0.0	140.0	31.1	43.6	0.5	1.005
BOTT. HEAD	0.0	140.0	14.6	25.4	2.0	1.005
Wind Calculations			14.6		0.5	
Seismic Calculation			14.6		0.5	
B 4" LEVEL	0.0	140.0	0.0	0.0	0.5	1.005
C 3" OVERFLOW	0.0	140.0	0.0	0.0	0.5	1.005
D 3" INLET	0.0	140.0	0.0	0.0	0.5	1.005
F F 24" MW	0.0	140.0	0.0	0.0	0.5	1.005
J J 24" MW	0.0	140.0	0.0	0.0	0.5	1.005
E E 4" DRAIN	0.0	140.0	0.0	0.0	0.5	1.005
24" MW FLG.	0.0	140.0	235.4	257.7		1.005
24" MW COVER	0.0	140.0	54.6	63.5		1.005

Vessel MAWP hot & corroded is 0 psi @ 140 degrees F.

Vessel MAP new & cold is 0 psi @ 75 degrees F.

Vessel allowable external pressure is 0.5 psi @ 140 degrees F.

Hydrotest pressure calculation based on P

= 1.5*P*1.005 = 0 psi

Vessel hydrotest pressure is 0 psi.

Note: vessel MAWP rating not valid unless hydrotest pressure based on MAWP.

Note: vessel MAP rating not valid unless hydrotest pressure based on MAP.

Nozzle Summary

Nozzle mark	OD (in)	tn (in)	Req tn (in)	A1?	A2?	Nom t (in)	Req t (in)	User t (in)	Corr (in)	Aa/Ar (%)
B	4.50	0.3370	0.1428	y	y	0.2500	0.1244	0.2500	0.0625	1429.0
C	3.50	0.3000	0.1428	y	y	0.2500	0.1543	0.2500	0.0625	exempt
D	3.50	0.3000	0.1428	y	y	0.2500	0.1244	0.2500	0.0625	1746.9
F	24.00	0.2500	0.0735	y	y	0.2500	0.1244	0.2500	0.0625	443.3
J	24.00	0.2500	0.0687	y	y	0.2500	0.1543	0.2500	0.0625	236.7
E	4.50	0.3370	0.1428	y	y	0.2500	0.1244	0.2500	0.0625	1347.9

tn - nozzle thickness
Req tn - nozzle thickness required per UG-45/16
Nom t - vessel wall thickness
Req t - required vessel wall thickness due to pressure + corrosion
User t - local vessel wall thickness (near opening)
Aa - area available per UG-37, governing condition
Ar - area required per UG-37, governing condition
Corr - corrosion allowance on nozzle id.

Nozzle Schedule

Nozzle mark	Service	Size	Materials Nozzle	Impact?	Norm?	Pad	Impact?	Norm?	Flange
B	4" level	4" Sch 80	312 TP304L SM	n	n	240 304L HIGH	n	n	A182F304L
C	3" overflow	3" Sch 80	312 TP304L SM	n	n	240 304L HIGH	n	n	A182F304L
D	3" inlet	3" Sch 80	312 TP304L SM	n	n	240 304L HIGH	n	n	A182F304L
F	24" mw	23.50 id x0.25	240 304L HIGH	n	n				
J	24" mw	23.50 id x0.25	240 304L HIGH	n	n				
E	4" drain	4" Sch 80	312 TP304L SM	n	n	240 304L HIGH	n	n	

Thickness Summary

Component Identifier	ID (in)	Nom t (in)	Req t (in)	Joint E	Load	Governing Status	Stress	Deflect (in)
Top head	143.50	0.2500	0.1869	1	external			
Shell	143.50	0.2500	0.1543	0.85	external			0.000
Bott. head	143.50	0.2500	0.1869	1	external			
Suport skirt	143.50	0.2500	0.0523	0.55	seismic	op/int	compres	0.000
24" mw cover	31.00	0.9680	0.9680	1	internal			

Nom t - vessel wall thickness
Req t - required vessel wall thickness due to governing loading
E - longitudinal seam joint efficiency

Load:
internal - circ stress due to internal pressure governs
external - external pressure governs
wind - combined long stress due to STATUS + wind governs
seismic - combined long stress due to STATUS + seismic governs

TOP HEAD

ASME Section VIII Division 1, 1992 Edition, A93 Addenda

Component: F&D head
Material specification: SA 240 304L HIGH

External design pressure: Pe= .5 psi @ 140 deg F

Static liquid head: Ps= 1.175 psi (S.G.= 1.05, Hs= 31 in)

Corrosion allowance: Inner C = 0.0625 Outer= 0 in

PWHT is not performed

Radiography: Category A joints - Full UW-11(a) type 1
Head to shell seam - Spot UW-11(a)(5)b

Estimated weight: new = 1563.2 corr = 1173 lb
capacity: new = 1295.96 corr = 1301.35 US ga

Operating liquid: 1302.08 US ga, weight: 11402.8 lb

OD = 144 crown L = 116 knuckle r = 8.64 t = .25 in (nom)

Straight flange = 1.5 forming allowance = .0625 in

Design thickness: (At 140 deg F) Appendix 1-4(d) Eq 4

M = .25*(3 + (L/r)^.5)
= .25*(3 + (116.0625/8.7025)^.5)
= 1.663

t = P*Lo*M/(2*S*E+P*(M-0.2)) + Corrosion+fa
= 1.175*116.25*1.663/(2*16620*1+1.175*(1.663-0.2)) + 0.0625+0.0625
= 0.1318 in

MAP: (New & at 75 deg F) Appendix 1-4(d) Eq 4

P = 2*S*E*t/(M*Lo - t*(M-0.2)) - Ps
= 2*16700*1*0.1875/(1.666*116.25 - 0.1875*(1.666-0.2)) - 1.175
= 31.20647 psi

MAWP: (Corroded & at 140 deg F) Appendix 1-4(d) Eq 4

P = 2*S*E*t/(M*Lo - t*(M-0.2)) - Ps
= 2*16620*1*0.125/(1.663*116.25 - 0.125*(1.663-0.2)) - 1.175
= 20.3378 psi

External Pressure: (Corroded & at 140 deg F) UG-33(e)

A = .125/(Ro/t)
= .125/(116.25/0.06192)
= 0.000067

From table HA-3: B = 944.4

Pa= B/(Ro/t)
= 944.4/(116.25/0.06192)
= .503 psi

Check the external pressure per UG-33(a)(1)

t = 1.67*Pa*Lo*M/(2*S*E + 1.67*Pa*(M-0.2))
= 1.67*0.503*116.25*1.663/(2*16620*1 + 1.67*0.503*(1.663-0.2))
= 0.004886 in

Design thickness for external pressure Pa = 0.503 psi:

= t + Corrosion + fa
= 0.06192 + 0.0625 + 0.0625

TOP HEAD

= 0.18692 in

Maximum Allowable External Pressure: (Corroded @ 140 deg F)

A = .125/(Ro/t)
= .125/(116.25/0.125)
= 0.000134

From table HA-3: B = 1905.8

Pa= B/(Ro/t)
= 1905.8/(116.25/0.125)
= 2.0492 psi

Check the Maximum External Pressure: UG-33(a)(1) & App. 1-4(d)

Pe= 2*S*E*t/((M*Lo - t*(M-0.2))*1.67)
= 2*16620*1*0.125/((1.663*116.25 - 0.125*(1.663-0.2))*1.67)
= 12.88191 psi

The maximum allowable external pressure is 2.0492 psi.

SHELL

ASME Section VIII Division 1, 1992 Edition, A93 Addenda

Component: Cylinder
Material specification: SA 240 304L HIGH

External design pressure: Pe= .5 psi @ 140 deg F

Static liquid head: Ps= 5.723 psi (S.G.= 1.05, Hs= 151 in)

Corrosion allowance: Inner C = 0.0625 Outer= 0 in

PWHT is not performed

Radiography: Category A joints - Spot UW-11(b) type 1
Category B joints - Spot UW-11(b) type 1

Estimated weight: new = 3929 corr = 2948 lb
capacity: new = 8401.611 corr = 8416.255 US ga

Operating liquid: 8416.25 US ga, weight: 73704.1 lb

OD = 144 length Lc= 120 t = 0.25 in (new)

Design thickness: (At 140 deg F) Appendix 1-1(a)

t = P*Ro/(S*E + 0.4*P) + Corrosion
= 5.723*72/(16620*0.85 + 0.4*5.723) + 0.0625
= 0.0917 in

MAP: (New & at 75 deg F) Appendix 1-1(a)

P = S*E*t/(Ro - 0.4*t) - Ps
= 16700*0.85*0.25/(72 - 0.4*0.25) - 5.723
= 43.63375 psi

MAWP: (Corroded & at 140 deg F) Appendix 1-1(a)

P = S*E*t/(Ro - 0.4*t) - Ps
= 16620*0.85*0.1875/(72 - 0.4*0.1875) - 5.723
= 31.10443 psi

External Pressure: (Corroded & at 140 deg F) UG-28

L/Do = 142.5986/144 =0.9903 Do/t = 144/0.09182 = 1568.286
From table G: A = 0.000042
From table HA-3: B = 588.4

Pa= 4*B/(3*Do/t)
= 4*588.4/(3*144/0.09182)
= .5002 psi

Design thickness for external pressure Pa = 0.5002 psi:

= t + Corrosion
= 0.09182 + 0.0625
= 0.15432 in

Maximum Allowable External Pressure: (Corroded @ 140 deg F)

L/Do = 142.5986/144 =0.9903 Do/t = 144/0.1875 = 768
From table G: A = 0.000064
From table HA-3: B = 901.6

Pa= 4*B/(3*Do/t)
= 4*901.6/(3*144/0.1875)
= 1.5653 psi

Vacuum + external loading check (Bergman, ASME paper 54-A-104)

SHELL

Calculate the compressive loading due to weight + bending:

```
Pv = W / (pi*Dm) + 48 * M / (pi*Dm^2)
   = 4556.797 / (pi*143.8125) + 48 * 115372.8 / (pi*143.8125^2)
   = 95.31761 lb/in

Alpha = Pv / (Pe * Do)
      = 95.31761 / (0.5 * 144) = 1.32386
```

From Fig. 1 of the Bergman paper # lobes @ collapse n = 6

```
m = 1.23 / (L / Do)^2
  = 1.23 / (142.5986 / 144)^2 = 1.2543

P'o= Pe*(n^2 - 1 + m + m * Alpha) / (n^2 - 1 + m)
   = 0.5*(6^2 - 1 + 1.2543 + 1.2543 * 1.32386) / (6^2 - 1 + 1.2543)
   = .522901 psi
```

As P'o < Pa (1.5653) interaction stresses are ok.

BOTT. HEAD

ASME Section VIII Division 1, 1992 Edition, A93 Addenda

Component: F&D head
Material specification: SA 240 304L HIGH

External design pressure: Pe= .5 psi @ 140 deg F

Static liquid head: Ps= 6.892 psi (S.G.= 1.05, Hs= 181.8378 in)

Corrosion allowance: Inner C = 0.0625 Outer= 0 in

PWHT is not performed

Radiography: Category A joints - Full UW-11(a) type 1
Head to shell seam - Spot UW-11(a)(5)b

Estimated weight: new = 1563.2 corr = 1173 lb
capacity: new = 1295.96 corr = 1301.35 US ga

Operating liquid: 1302.08 US ga, weight: 11402.8 lb

OD = 144 crown L = 116 knuckle r = 8.64 t = .25 in (nom)

Straight flange = 1.5 forming allowance = .0625 in

Design thickness: (At 140 deg F) Appendix 1-4(d) Eq 4

M = .25*(3 + (L/r)^.5)
= .25*(3 + (116.0625/8.7025)^.5)
= 1.663

t = P*Lo*M/(2*S*E+P*(M-0.2)) + Corrosion+fa
= 6.892*116.25*1.663/(2*16620*1+6.892*(1.663-0.2)) + 0.0625+0.0625
= 0.1651 in

MAP: (New & at 75 deg F) Appendix 1-4(d) Eq 4

P = 2*S*E*t/(M*Lo - t*(M-0.2)) - Ps
= 2*16700*1*0.1875/(1.666*116.25 - 0.1875*(1.666-0.2)) - 6.892
= 25.48947 psi

MAWP: (Corroded & at 140 deg F) Appendix 1-4(d) Eq 4

P = 2*S*E*t/(M*Lo - t*(M-0.2)) - Ps
= 2*16620*1*0.125/(1.663*116.25 - 0.125*(1.663-0.2)) - 6.892
= 14.62079 psi

External Pressure: (Corroded & at 140 deg F) UG-33(e)

A = .125/(Ro/t)
= .125/(116.25/0.06192)
= 0.000067

From table HA-3: B = 944.4

Pa= B/(Ro/t)
= 944.4/(116.25/0.06192)
= .503 psi

Check the external pressure per UG-33(a)(1)

t = 1.67*Pa*Lo*M/(2*S*E + 1.67*Pa*(M-0.2))
= 1.67*0.503*116.25*1.663/(2*16620*1 + 1.67*0.503*(1.663-0.2))
= 0.004886 in

Design thickness for external pressure Pa = 0.503 psi:

= t + Corrosion + fa
= 0.06192 + 0.0625 + 0.0625

BOTT. HEAD

= 0.18692 in

Maximum Allowable External Pressure: (Corroded @ 140 deg F)

A = .125/(Ro/t)
= .125/(116.25/0.125)
= 0.000134

From table HA-3: B = 1905.8

Pa= B/(Ro/t)
= 1905.8/(116.25/0.125)
= 2.0492 psi

Check the Maximum External Pressure: UG-33(a)(1) & App. 1-4(d)

Pe= 2*S*E*t/((M*Lo - t*(M-0.2))*1.67)
= 2*16620*1*0.125/((1.663*116.25 - 0.125*(1.663-0.2))*1.67)
= 12.88191 psi

The maximum allowable external pressure is 2.0492 psi.

SUPORT SKIRT

Material:	SA 240 304L HIGH
Left end outer diameter:	144 in
Right end outer diameter:	144 in
Overall length:	48 in
Corrosion inside:	0 in
Corrosion outside:	0 in
Weld joint efficiency top:	E = 0.55
Weld joint efficiency bottom:	Eb = 0.55
Nominal thickness:	0.25 in
Estimated skirt weight, new:	1571.6 lb
Estimated skirt weight, corroded:	1571.6 lb

Skirt Allowable Stresses, Corroded

Allowable tensile stress St = 16620*1.2 = 19944 psi

Factor A = 0.125/(72/0.25) = 4.340278E-04
From table HA-3: B = 6146.2
Allowable buckling stress Sb = 6146.2*1.2 = 7375.44 psi

Allowable compression Sc =lesser of St, Sb = 7375.44 psi

Skirt required thickness, tensile stress at base

Governing loading is seismic in the empty condition

```
t = -W/(pi*D*St*E) + 48*M/(pi*D^2*St*E)
  = -7845.5/(pi*143.75*19944*0.55) + 48*14441.86/(pi*143.75^2*19944*0.55)
  = 0.0006 in  [compressive stress]
```

Skirt required thickness, tensile stress at top

```
t = -W/(pi*D*St*E) + 48*M/(pi*D^2*St*E)
  = -6273.9/(pi*143.75*19944*0.55) + 48*7747.144/(pi*143.75^2*19944*0.55)
  = 0.0007 in  [compressive stress]
```

Skirt required thickness, compressive stress at base

Governing loading is seismic in the operating condition

```
t = W/(pi*D*Sc) + 48*M/(pi*D^2*Sc)
  = 104355.2/(pi*143.75*7375.44) + 48*209351.4/(pi*143.75^2*7375.44)
  = 0.0523 in
```

Skirt required thickness, compressive stress at top

```
t = W/(pi*D*Sc) + 48*M/(pi*D^2*Sc)
  = 102783.6/(pi*143.75*7375.44) + 48*115372.8/(pi*143.75^2*7375.44)
  = 0.0424 in
```

Skirt required thickness, largest of the above + corrosion

= 0.0523 in

The skirt thickness is adequate.

BASE RING

Base configuration:	Single Base Plate
Foundation allowable stress:	Sc= 1350 psi
Concrete ult. 28 day strength:	fc'= 3000 psi
Anchor bolt material:	A193 B8
Anchor bolt allowable stress:	Sb= 18800 psi
Bolt circle:	BC= 148 in
Anchor bolt corrosion allowance:	0 in
Anchor bolt clearance:	0.0625 in
Base plate material:	A 240 304L
Base plate allowable stress:	Sp= 19992 psi
Base plate inner diameter:	Di= 141 in
Base plate outer diameter:	Do= 151 in
Base plate thickness:	tb= 0.5 in
Gusset separation:	w = 3.5 in
Gusset height:	h = 3.5 in
Gusset thickness:	tg= 0.5 in
Estimated base ring weight:	Wr= 332.5 lb
Initial bolt preload:	0 % (0 psi)
Number of bolts:	N = 8
Bolt size & type:	1 inch coarse threads
Diameter of anchor bolt holes:	db= 1.0625 in

Calculate the load per anchor bolt

Governing vessel weight:	W = 7845.5 lb
Governing overturning moment:	M = 14441.86 lb-ft
Bolt root area (corroded):	Ab= 0.5509999 in^2

```
P = -W / N + 48 * M / (N*BC)
  = -7845.5 / 8 + 48 * 14441.86 / (8*148)
  =-395.2069 lb
```

The anchor bolts are satisfactory (no overturning moment)

Foundation bearing stress (Operating)

```
Ac= pi*(Do^2 - Di^2)/4 - N*pi*db^2/4
  = pi*(151^2 - 141^2)/4 - 8*pi*1.0625^2/4
  = 2286.27 in^2

Ic= pi*(Do^4 - Di^4)/64
  = pi*(151^4 - 141^4)/64
  = 6117832 in^4

fc= N*Ab*PreLoad/Ac + W/Ac + 6*M*Do/Ic
  = 8*0.5509999*0/2286.27 + 104355.2/2286.27 + 6*209351.4*151/6117832
  = 76.6475 psi
```

As fc <= Sc the base plate width is satisfactory.

Foundation bearing stress, hydro test condition

```
fc= N*Ab*PreLoad/Ac + W/Ac + 6*M*Do/Ic
  = 8*0.5509999*0/2286.27 + 101310.3/2286.27 + 6*3136.436*151/6117832
  = 44.77698 psi
```

As fc <= Sc the base plate width is satisfactory.

Check the base plate for foundation bearing load

```
tr= Sqr(3*fc*L^2 / Sp)
  = Sqr(3*76.6475*3.5^2 / 19992)
  = .3753614 in
```

The base plate thickness is satisfactory.

BASE RING

Check base plate for bolt load (Jawad & Farr eq. 12.13)

Bolt load F = Ab*fs = .5509999*0= 0 lb

```
tr= Sqr(3.91*F/(Sy*(2*b/w+w/(2*l) - db*(2/w+1/(2*l)))))
  = Sqr(3.91*0/(36000*(2*3.5/3.5+3.5/(2*2) - 1.0625*(2/3.5+1/(2*2)))))
  = 0 in
```

The base plate thickness is satisfactory.

Check skirt for gusset reaction (Jawad & Farr eq. 12.14)

```
Sr= 1.5*F*b/(pi*tsk^2*h)
  = 1.5*0*3.5/(pi*0.25^2*3.5)
  = 0 psi
```

The skirt thickness is satisfactory.

Wind Calculations

Method of wind analysis:	UBC 91
Elevation of base above grade:	0 ft
Increase effective outer diameter:	2 ft
Wind force coefficient Cq:	0.7
Structural damping coefficient:	0.01
Basic wind speed:	70 mph
Importance factor, I:	1
Exposure category:	B

Period of vibration calculation

The fundamental period of vibration is calculated using the Rayleigh method of approximation by the numerical integration of the following formulae:

T = 2*Pi*Sqr[Sum W*y^2 / g(Sum W*y)]

T(operating)	= .02 seconds
T(empty)	= .01 seconds
T(test)	= .02 seconds

Wind Calculations

Combined stresses due to Wind + External pressure, Corroded

Elevation above base (in.)	Type	Minimum thickness corroded (in.)	Circ joint eff. E	Required thickness (in.)	Overhead weight (lbs)	Bending moment (lb-ft)
48.00	cyl	0.1875	0.85	0.0056	4556.7	5283.6
0.00	skirt	0.2500	0.55	0.0322	104355.2	9493.8

Table Continues

Maximum tensile stress/E (psi)	Allowable tensile stress (psi)	Maximum compress stress E=1 (psi)	Allowable compressive stress (psi)	Vacuum (psi)
-151.3c	16620.0*1.2	170.2	4683.0*1.2	0.5
-1626.8c	16620.0*1.2	952.3	6146.2*1.2	

Wind Calculations

Combined stresses due to Wind + Internal pressure, Operating & Co

Elevation above base (in.)	Type	Minimum thickness corroded (in.)	Circ joint eff. E	Required thickness (in.)	Overhead weight (lbs)	Bending moment (lb-ft)
48.00	cyl	0.1875	0.85	0.0305	4556.7	5283.6
0.00	skirt	0.2500	0.55	0.0322	104355.2	9493.8

Table Continues

Maximum tensile stress/E (psi)	Allowable tensile stress (psi)	Maximum compress stress E=1 (psi)	Allowable compressive stress (psi)	Pressure (psi)
3251.7	16620.0*1.2	74.6	4683.0*1.2	14.6
-1626.8c	16620.0*1.2	952.3	6146.2*1.2	

Wind Calculations

Wind deflection report, operating & corroded

Elevation start above base (in.)	Elastic Modulus psi x10^6	Inertia (I, ft^4)	Platform wind shear (lbs)	Total wind & other shear (lbs)	Bending (platform & other) (lb-ft)	Deflection section top (in.)
48.00	27.9	10.561	0.0	899.4	0.0	0.0001
0.00	27.9	14.063	0.0	1205.6	0.0	0.0000

Wind Calculations

Combined stresses due to Wind, Corroded Empty Condition

Elevation above base (in.)	Type	Minimum thickness corroded (in.)	Circ joint eff. E	Required thickness (in.)	Overhead weight (lbs)	Bending moment (lb-ft)
48.00	cyl	0.1875	0.85	0.0024	4556.8	5283.6
0.00	skirt	0.2500	0.55	0.0033	7845.5	9493.8

Table Continues

Maximum tensile stress/E (psi)	Allowable tensile stress (psi)	Maximum compress stress E=1 (psi)	Allowable compressive stress (psi)	Pressure (psi)
-38.7c	16700.0*1.2	74.6	4740.6*1.2	0.0
-72.6c	16620.0*1.2	97.5	6146.2*1.2	

Wind Calculations

Wind deflection report, empty & corroded

Elevation start above base (in.)	Elastic Modulus psi x10^6	Inertia (I, ft^4)	Platform wind shear (lbs)	Total wind & other shear (lbs)	Bending (platform & other) (lb-ft)	Deflection section top (in.)
48.00	28.1	10.561	0.0	899.4	0.0	0.0001
0.00	28.1	14.063	0.0	1205.6	0.0	0.0000

Wind Calculations

Combined stresses due to Wind + Hydrotest pressure, Corroded

Elevation above base (in.)	Type	Minimum thickness corroded (in.)	Circ joint eff. E	Required thickness (in.)	Overhead weight (lbs)	Bending moment (lb-ft)
48.00	cyl	0.1875	0.85		4556.7	1745.5
0.00	skirt	0.2500	0.55	0.0301	99535.2	3136.4

Table Continues

Maximum tensile stress/E (psi)	Allowable tensile stress (psi)	Maximum compress stress E=1 (psi)	Allowable compressive stress (psi)	Hydro Pressure (psi)
-55.1c	16700.0*1.5	60.6	4740.6*1.5	0.0
-1568.2c	16620.0*1.2	890.8	6146.2*1.2	

Wind Calculations

Combined stresses due to Wind + Hydrotest pressure, New

Elevation above base (in.)	Type	Minimum thickness (in.)	Circ joint eff. E	Required thickness (in.)	Overhead weight (lbs)	Bending moment (lb-ft)
48.00	cyl	0.2500	0.85		5928.0	1745.5
0.00	skirt	0.2500	0.55	0.0307	101310.3	3136.4

Table Continues

Maximum tensile stress/E (psi)	Allowable tensile stress (psi)	Maximum compress stress E=1 (psi)	Allowable compressive stress (psi)	Hydro Pressure (psi)
-55.6c	16700.0*1.5	57.6	6345.2*1.5	0.0
-1596.8c	16620.0*1.2	906.6	6146.2*1.2	

Seismic Calculations

Method of seismic analysis:	UBC 91
Seismic zone:	2B
Importance factor, I:	1.25
Soil profile:	S3
Site coefficient, S:	1.5
Coefficient Rw:	3

Period of vibration calculation

The fundamental period of vibration is calculated using the Rayleigh method of approximation by the numerical integration of the following formulae:

T = 2*Pi*Sqr[Sum W*y^2 / g(Sum W*y)]

T(operating) = .02 seconds
T(empty) = .01 seconds

Seismic Calculations

Combined stresses due to Earthquake + External pressure, Corroded

Elevation above base (in.)	Type	Minimum thickness corroded (in.)	Circ joint eff. E	Required thickness (in.)	Overhead weight (lbs)	Bending moment (lb-ft)
48.00	cyl	0.1875	0.85	0.0201	4556.7	115372.8
0.00	skirt	0.2500	0.55	0.0523	104355.2	209351.4

Table Continues

Maximum tensile stress/E (psi)	Allowable tensile stress (psi)	Maximum compress stress E=1 (psi)	Allowable compressive stress (psi)	Vacuum (psi)
358.9	16620.0*1.2	604.0	4683.0*1.2	0.5
-554.7c	16620.0*1.2	1543.4	6146.2*1.2	

Seismic Calculations

Combined stresses due to Earthquake + Internal pressure, Operating & Co

Elevation above base (in.)	Type	Minimum thickness corroded (in.)	Circ joint eff. E	Required thickness (in.)	Overhead weight (lbs)	Bending moment (lb-ft)
48.00	cyl	0.1875	0.85	0.0353	4556.7	115372.8
0.00	skirt	0.2500	0.55	0.0523	104355.2	209351.4

Table Continues

Maximum tensile stress/E (psi)	Allowable tensile stress (psi)	Maximum compress stress E=1 (psi)	Allowable compressive stress (psi)	Pressure (psi)
3762.0	16620.0*1.2	-2288.5t	4683.0*1.2	14.6
-554.7c	16620.0*1.2	1543.4	6146.2*1.2	

Seismic Calculations

Seismic shear report, operating & corroded

Elevation start above base (in.)	Elastic Modulus psi x10^6	Inertia (I, ft^4)	Seismic & other shear (lbs)	Bending (platform & other) (lb-ft)
48.00	27.9	10.561	23074.5	0.0
0.00	27.9	14.063	23914.7	0.0

Seismic Calculations

Combined stresses due to Earthquake, Corroded Empty Condition

Elevation above base (in.)	Type	Minimum thickness corroded (in.)	Circ joint eff. E	Required thickness (in.)	Overhead weight (lbs)	Bending moment (lb-ft)
48.00	cyl	0.1875	0.85	0.0027	4556.8	7747.1
0.00	skirt	0.2500	0.55	0.0038	7845.5	14441.8

Table Continues

Maximum tensile stress/E (psi)	Allowable tensile stress (psi)	Maximum compress stress E=1 (psi)	Allowable compressive stress (psi)	Pressure (psi)
-27.3c	16700.0*1.2	84.3	4740.6*1.2	0.0
-48.6c	16620.0*1.2	112.2	6146.2*1.2	

Seismic Calculations

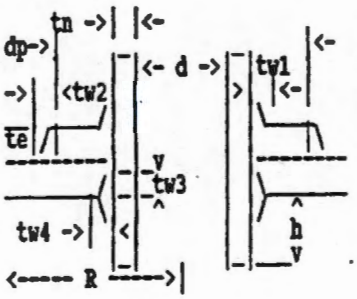
Seismic shear report, empty & corroded

Elevation start above base (in.)	Elastic Modulus psi x10^6	Inertia (I, ft^4)	Seismic & other shear (lbs)	Bending (platform & other) (lb-ft)
48.00	28.1	10.561	1549.4	0.0
0.00	28.1	14.063	1797.9	0.0

4" LEVEL

Opening B summary

Located on:	TOP HEAD
Flange description:	4 inch 150# WN A182F304L
ANSI B16.5 flange rating MAP:	230 psi
ANSI B16.5 flange rating MAWP:	216 psi
Nozzle description:	4 inch Sch 80
Nozzle material specification:	SA 312 TP304L SMLS HIGH
Pad material specification:	SA 240 304L HIGH
Nozzle orientation:	120 degrees
End of nozzle to datum line:	157 in
Nozzle calculated as hillside:	yes
Projection outside vessel Lpr:	8.479 in



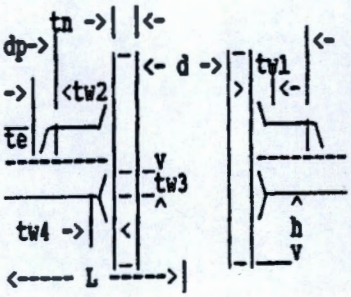
corrosion allow = .0625 in
noz thick new tn= .337 in
nozzle id. new d= 3.826 in
pad diameter dp = 12 in
pad thickness te= .25 in
fillet weld tw1 = .25 in
fillet weld tw2 = .25 in
groove weld tw3 = .25 in
fillet weld tw4 = .25 in

projection new h= .25 in
To head center R= 24 in

3" OVERFLOW

Opening C summary

Located on:	SHELL
Flange description:	3 inch 150# WN A182F304L
ANSI B16.5 flange rating MAP:	230 psi
ANSI B16.5 flange rating MAWP:	216 psi
Nozzle description:	3 inch Sch 80
Nozzle material specification:	SA 312 TP304L SMLS HIGH
Pad material specification:	SA 240 304L HIGH
Nozzle orientation:	210 degrees
End of nozzle to shell center:	80 in
Nozzle offset from center Lo:	0 in
Projection outside vessel Lpr:	8 in



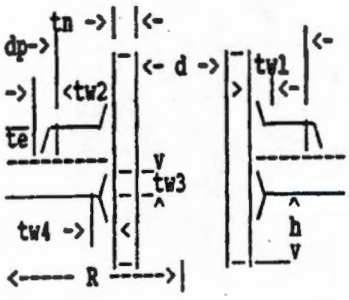
corrosion allow = .0625 in
noz thick new tn= .3 in
nozzle id. new d= 2.9 in
pad diameter dp = 9 in
pad thickness te= .375 in
fillet weld tw1 = .25 in
fillet weld tw2 = .3125 in
groove weld tw3 = .25 in
fillet weld tw4 = .25 in

projection new h= .25 in
To datum L= 114 in

3" INLET

Opening D summary

Located on:	TOP HEAD
Flange description:	3 inch 150# WN A182F304L
ANSI B16.5 flange rating MAP:	230 psi
ANSI B16.5 flange rating MAWP:	216 psi
Nozzle description:	3 inch Sch 80
Nozzle material specification:	SA 312 TP304L SMLS HIGH
Pad material specification:	SA 240 304L HIGH
Nozzle orientation:	120 degrees
End of nozzle to datum line:	143 in
Nozzle calculated as hillside:	yes
Projection outside vessel Lpr:	8.655 in



corrosion allow = .0625 in
noz thick new tn= .3 in
nozzle id. new d= 2.9 in
pad diameter dp = 12 in
pad thickness te= .375 in
fillet weld tw1 = .25 in
fillet weld tw2 = .375 in
groove weld tw3 = .25 in
fillet weld tw4 = .25 in

projection new h= .25 in
To head center R= 60 in

F 24" MW

Opening F summary

Located on:	TOP HEAD
Flange description:	Not installed
Nozzle material specification:	SA 240 304L HIGH
Nozzle orientation:	0 degrees
End of nozzle to datum line:	158 in
Nozzle calculated as hillside:	yes
Projection outside vessel Lpr:	17.347 in

```
  tn ->| |<-
       |-|<- d ->|-|
tw1->| |<|       | |
     |/| |  v    | |\
-----.-|-|--      | |-.-----
     \| |-|  tw3  | |/
------\|-|-|^      | |/^
tw2->| |<|        | |/ h
     |-|-|        |-|-↓
<---- R ---->|
```

corrosion allow = .0625 in
noz thick new tn= .25 in
nozzle id. new d= 23.5 in
fillet weld tw1 = .25 in
fillet weld tw2 = .25 in
groove weld tw3 = .25 in
projection new h= .25 in

To head center R= 48 in

J 24" NM

Opening J summary

Located on:	SHELL
Flange description:	Not installed
Nozzle material specification:	SA 240 304L HIGH
Nozzle orientation:	270 degrees
End of nozzle to shell center:	82 in
Nozzle offset from center Lo:	0 in
Projection outside vessel Lpr:	10 in

```
  tn ->| |<-
       |-|<- d ->|-|
tw1->| |<|  v    | |\
-----.-|-|--      | |-.-----
      \|-|-tw3    | |/
-------\|-|-^      | |/-------
tw2->| |<|        | |/ ^
       |-|        | |  h
       |-|        |-|  ↓
<---- L ---->|
```

corrosion allow = .0625 in
noz thick new tn= .25 in
nozzle id. new d= 23.5 in
fillet weld tw1 = .25 in
fillet weld tw2 = .25 in
groove weld tw3 = .25 in
projection new h= .25 in

To datum L= 16.5 in

E 4" DRAIN

Opening E summary

Located on:	BOTT. HEAD
Flange description:	Not installed
Nozzle description:	4 inch Sch 80
Nozzle material specification:	SA 312 TP304L SMLS HIGH
Pad material specification:	SA 240 304L HIGH
Nozzle orientation:	0 degrees
End of nozzle to datum line:	-36 in
Nozzle calculated as hillside:	no
Projection outside vessel Lpr:	4.975 in

```
    tn ->| |<-                          corrosion allow = .0625 in
dp->|                   |<-            noz thick new tn= .337 in
    |   |<tw2 |<- d ->|  |tw1          nozzle id. new d= 3.826 in
->| |   /     |       >|  |<-           pad diameter dp = 12 in
    |  /      |        |   \           pad thickness te= .25 in
te|/|         |        |    \          fillet weld tw1 = .25 in
---------     |-|-v    |     --------   fillet weld tw2 = .25 in
        /     |-|-tw3  |-|\             groove weld tw3 = .25 in
                  ^
<----- R ----->|                        To head center R= 0 in
```

24" MW FLG.

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Flange material: SA 240 304L HIGH

Bolt material: SA 193 B8 CL1

Internal design pressure: P = 0 psi @ 140 deg F
Flange MAWP: P = 235.413 psi @ 140 deg F

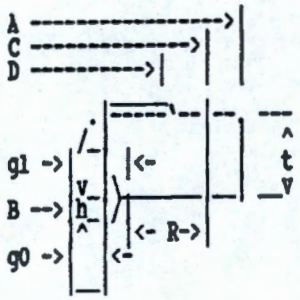
Static liquid head: Ps= 5.098 psi (S.G.= 1.05, Hs= 134.5049 in)

Corrosion allowance: Bore C = 0 Flange= 0.0625 in

PWHT is not performed

Estimated weight: new = 196.4 corr = 196.4 lb

Flange dimensions, new



flange OD, A = 31 in
flange ID, B = 23.5 in
gasket OD, D = 25 in
gasket ID, = 24.25 in
bolt circle, C = 26.75 in
hub thickness, g1= 0.625 in
hub thickness, g0= 0.25 in
fillet weld, h = 0.375 in
clearance, R = 1 in
thickness, t = 2.11 in
bolting, 24 - 0.875 in dia.

gasket factor m = 3
seating stress y = 10000 psi

Note: this flange is an optional type calculated as integral.

Gasket details from facing sketch 1(a) or (b), column II

Gasket width, N = 0.375 in

b0 = N/2 = 0.1875 in

Effective gasket seating width, b = b0 = 0.1875 in

G = (OD of contact face + Gasket ID) / 2 = 24.625 in

hG = (C - G)/2 = (26.75 - 24.625)/2 = 1.0625 in

hD = R + g1/2 = 1 + 0.625/2 = 1.3125 in

hT = (R + g1 + hG)/2
= (1 + 0.625 + 1.0625)/2
= 1.34375

Hp = 2*b*3.14*G*m*P
= 2*0.1875*3.14*24.625*3*5.098
= 443.4639

H = .785*G^2*P
= .785*24.625^2*5.098
= 2426.733

HD = 0.785*B^2*P
= 0.785*23.5^2*5.098
= 2210.066

HT = H - HD = 2426.733 - 2210.066 = 216.667

24" MW FLG.

HG = HP = 443.4639 lb

Wm1 = H + Hp = 2426.733 + 443.4639 = 2870.197

Wm2 = 3.14*b*G*y
= 3.14*0.1875*24.625*10000
= 144979.7

Required bolt area, Am = greater of Wm2/Sa or Wm1/Sb so

Am = Wm2/Sa = 144979.7/18800 = 7.711686 in^2

Total bolt area Ab = 10.056 in^2

W = (Am + Ab)*Sa/2
= (7.711686 + 10.056)*18800/2
= 167016.2

MD = HD*hD = 2210.066*1.3125 = 2900.711 lb-in

MT = HT*hT = 216.667*1.34375 = 291.1463 lb-in

MG = HG*hG = 443.4639*1.0625 = 471.1804 lb-in

Operating, Mo= MD + MT + MG = 2900.711 + 291.1463 + 471.1804 = 3663.038 lb-in

Seating, Mg= W*hG = 167016.2*1.0625 = 177454.7 lb-in

Hub and Flange Factors

h0 = Sqr(B*g0) = 2.42384 in

From FIG. 2-7.1, where K = A/B = 1.31915

T = 1.78919 Z = 3.702141 Y = 7.160606 U = 7.868781
h/h0 = 0.15471 g1/g0 = 2.5
F = 0.8980244 V = 0.3715914

e = F/h0 = 0.3704966

d = (U/V)*h0*g0^2
= (7.868781/0.3715914)*2.42384*0.25^2
= 3.207937

Stresses at operating conditions - App. 2-8

f = 4.567136

L = (t*e + 1)/T + t^3/d
= (2.0475*0.3704966 + 1)/1.78919 + 2.0475^3/3.207937
= 3.658651

SH = f*Mo/(L*g1^2*B)
= 4.567136*3663.038/(3.658651*0.625^2*23.5)
= 498.1229 psi

SR = (1.33*t*e + 1)*Mo/(L*t^2*B)
= (1.33*2.0475*0.3704966 + 1)*3663.038/(3.658651*2.0475^2*23.5)
= 20.41592 psi

ST = Y*Mo/(t^2*B) - Z*SR
= 7.160606*3663.038/(2.0475^2*23.5) - 3.702141*20.41592
= 190.6588 psi

Sfo = 16620 psi

ST <= Sfo
SH <= 1.5*Sfo = 24930 psi

24" NH FLG.

SR <= Sfo
.5(SH + SR) = 259.27 <= Sfo
.5(SH + ST) = 344.39 <= Sfo

Stresses at gasket seating - App. 2-8

SH = f*Mg/(L*g1^2*B)
= 4.567136*177454.7/(3.658651*0.625^2*23.5)
= 24131.41 psi

SR = (1.33*t*e + 1)*Mg/(L*t^2*B)
= (1.33*2.0475*0.3704966 + 1)*177454.7/(3.658651*2.0475^2*23.5)
= 989.043 psi

ST = Y*Mg/(t^2*B) - Z*SR
= 7.160606*177454.7/(2.0475^2*23.5) - 3.702141*989.043
= 9236.404 psi

Sfa = 16700 psi

ST <= Sfa
SH <= 1.5*Sfa = 25050 psi
SR <= Sfa
.5(SH + SR) = 12560.23 <= Sfa
.5(SH + ST) = 16683.91 <= Sfa

24" MW COVER

ASME Section VIII Division 1, 1992 Edition, A93 Addenda

Component: Bolted cover
Material specification: SA 240 304L HIGH

Static liquid head: Ps= 5.098 psi (S.G.= 1.05, Hs= 0 in)

Corrosion allowance: Inner C = 0.0625 Outer= 0 in

PWHT is not performed

Radiography: Category A joints - Seamless NO X-Ray

Estimated weight: new = 211.8721 corr = 198.2 lb

OD = 31 t = .968 in (new)

Design thickness: (At 140 deg F) UG-34 eq (2) Larger of

```
t = d*Sqr(C*P/(S*E) + 1.9*W*hg/(S*E*d^3)) + Corrosion
  = 24.625*Sqr(0.3*5.098/(16620*1) + 1.9*2870.197*1.0625/(16620*1*24.625^3))
                    + 0.0625
  = 0.327 in

t = d*Sqr(1.9*W*hg/(S*E*d^3)) + Corrosion
  = 24.625*Sqr(1.9*167016.2*1.0625/(16700*1*24.625^3)) + 0.0625
  = 0.968 in
```

MAP: (New & at 75 deg F)

```
W = .785*G^2*P + 2*b*3.14*G*m*P
  = .785*24.625^2*68.61119 + 2*0.1875*3.14*24.625*3*68.61119
  = 38628.41

P = (S*E/C)*((t/d)^2 - 1.9*W*hg/(S*E*d^3)) - Ps
  = (16700*1/0.3)*((0.968/24.625)^2 -
                    1.9*38628.41*1.0625/(16700*1*24.625^3)) - 5.098
  = 63.5132 psi
```

MAWP: (Corroded 140 deg F)

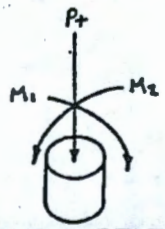
```
W = .785*G^2*P + 2*b*3.14*G*m*P
  = .785*24.625^2*59.7497 + 2*0.1875*3.14*24.625*3*59.7497
  = 33639.35

P = (S*E/C)*((t/d)^2 - 1.9*W*hg/(S*E*d^3)) - Ps
  = (16620*1/0.3)*((0.9055/24.625)^2 -
                    1.9*33639.35*1.0625/(16620*1*24.625^3)) - 5.098
  = 54.6517 psi
```

NOZZLE LOAD SUMMARY

JOB NO. 18769 VESSEL NO. TK-109 & TK-117

CUSTOMER KAISER ENGINEERS P.O.NO. 76036

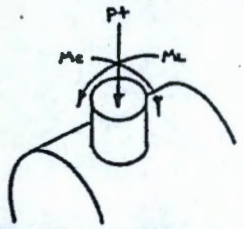
IGN LOADS: F = P = ± +500 lbs. M = 750 ft-lbs.



HEAD NOZZLE

ALLOWABLE LOADS

(Ref. WRC Bulletin 107)



SHELL NOZZLE

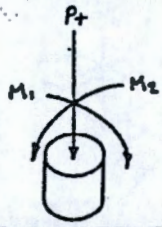
NOZZLE NO.	FORCES LBS.	MOMENTS FT - LBS.				REMARKS
		Mc	ML	M1	M2	
"C"	P+500	1479	1428			
3" OVERFLOW	P- 500	1440	1417			
	P+2558	774	750			
	P-2516	750	752			
"B"	P+500			974	974	
4" LEVEL	P-500			971	971	
	P+1166			750	750	
	P-1158			750	750	
"D"	P+ 500			981	981	
3" INLET	P- 500			963	963	
	P+1461			750	750	
	P-1386			750	750	
"G"	P+500			981	981	
3" SPARE	P- 500			963	963	
	P+1461			750	750	
	P-1386			750	750	
	P+					
	P-					

NOZZLE LOAD SUMMARY

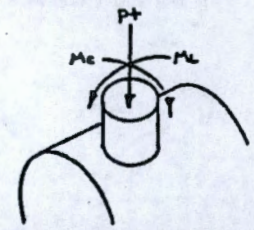
JOB NO. 18769 VESSEL NO. TK-109 & TK-117

CUSTOMER KAISER ENGINEERS P.O.NO. 76036

DESIGN LOADS: F = P = ± ±500 lbs. M = 750 ft-lbs



HEAD NOZZLE



SHELL NOZZLE

ALLOWABLE LOADS

(Ref. WRC Bulletin 107)

NOZZLE NO.	FORCES LBS.	MOMENTS FT - LBS.				REMARKS
		Mc	ML	M1	M2	
"H"	P+500			981	981	
3" SPARE	P- 500			963	963	
	P+1461			750	750	
	P- 1386			750	750	
"E"	P+500			1078	1078	
4" DRAIN	P-500			866	866	
	P+1458			750	750	
	P- 865			750	750	
	P+					
	P-					
	P+					
	P-					
	P+					
	P-					
	P+					
	P-					
	P+					
	P-					