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DESIGN CRITERIA FOR THE HIGH- AND INTERMEDIATE-LEVEL LIQUID WASTE FACILITY

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ABSTRACT

Presented herein are the Design Criteria for the High- and Intermediate-Level Liquid Waste Facility to be constructed at ORNL.

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NOTICE

CONTENTS

1.0 INTRODUCTION

The purpose of this memo is to present sufficient data to initiate immediately the necessary Cost Estimate, Preliminary Proposal, and Title I Engineering for the "High- and Intermediate-Level Waste Facility."

The over-all modifications and additions to the ORNL aqueous waste system include:

1. The construction of two new 50,000-gallon water-cooled high-activity-level waste storage tanks and a 15,000-gallon per day evaporator for intermediate and high level waste;
2. The addition of a waste collection facility to serve all existing and proposed facilities in Melton Valley and tie-in of same to the Bethel Valley system;
3. The installation of a facility to guarantee that all low-level process waste is reduced in activity to levels recommended for discharge to populations in the vicinity of atomic energy installations.

This report covers the first of these items. A separate report for Item 2 has been issued as CF-61-5-24. Item 3 will be delayed about one year pending the construction and operation of test plants to further evaluate both the ion exchange and vermiculite absorption methods of process water cleanup.

A more complete summary of the studies leading up to criteria given in this memo, and on the drawings referred to herein, is presented in CF-61-5-22, "A study of Modifications for ORNL Liquid Waste System," by H. O. Weeren, J. O. Blomeke, and W. G. Stockdale.

Current plans are for the ORNL Engineering Department to submit the Preliminary Proposal to the Atomic Energy Commission on July 1 of this year. Upon approval of this "Proposal" the Engineering Department will proceed with Title II Engineering.

As in other projects the latest revisions of AEC Criteria, Southern Standard Building Code, ACl Standards, AISC Specifications and NFPA Exit Code applies.

2.0 GENERAL DESCRIPTION OF FACILITY

The proposed High- and Intermediate-Level Liquid Waste Facility will include two 50,000-gallon water-cooled stainless steel waste storage tanks for permanently storing high activity-level waste and a 15,000-gallon/day evaporator for routinely concentrating neutralized intermediate-level waste and occasionally concentrating high-level waste. The relationship between the facility and the total plant liquid waste system is shown on Dwg. C-34529. The shaded boxes represent this new facility.

The line of demarkation between intermediate- and high-level waste has been set at 10 curies/gallon, which corresponds to ~0.1 Btu/hr·gal. This value was chosen because it was thought to be the maximum activity which can be safely stored in the six existing 170,000-gallon concrete waste storage tanks. It has been calculated that these tanks, which are uncooled, can only dissipate about 17,000 Btu/hr through the surrounding earth from boiling solutions.

2.1 Brief Description of Process and Equipment

At the present time there are no facilities at ORNL for the permanent storage of high-level aqueous wastes (> 10 curies/gallon). Admittedly, small to moderate quantities of neutralized higher level wastes can be stored in the existing concrete tanks if they can be diluted by the present tank contents to < 10 curies/gallon. The proposed 50,000-gallon tanks will be capable of storing acid waste with activities up to 2800 curies/gallon which will generate about 32 Btu/hr·gal if produced from 6-months' cooled high-burnup uranium. This is based on the filling of the tank in 2-1/2 years and represents a daily average input of 55 gallons. A second tank is provided as a standby to receive the contents of the first tank in case of leakage. Each tank will have a cooling capacity of 400,000 Btu/hr; 320,000 Btu/hr capacity in the form of external cooling pipes and 80,000 Btu/hr capacity in internal coils. Both tanks will be served by a common reflux condenser with a capacity of 450,000 Btu/hr to provide cooling in the event of a cooling coil failure. The remainder of the off-gas system is shared in common with the evaporator and its auxiliaries.

The proposed 15,000-gallon/day intermediate-level evaporator will be capable of evaporating high-level wastes to an activity level of 2800 curies/gal (at 6 months' cooling), but will be used primarily for the volume reduction of supernatants from the present concrete intermediate-level waste tanks. These supernatants will no longer be routed to the seepage pits in Melton Valley. This stream has an average composition of 0.3 $\underline{M}$ $NaNO_3$--0.2 $\underline{M}$ NaOH and an average activity of 10 millicuries/gallon. The design is based on a 10:1 concentration factor for waste of this composition. The waste will be pumped and/or jetted batch-wise from existing waste facilities to a new evaporator feed tank. The evaporator will have a steam coil to serve as a foam breaker and an impingement baffle incorporated internally. The overhead from the evaporator will be filtered in a Yorkmesh filter similar to the unit described in BNL-121 and then will be condensed in a stainless steel condenser serviced by recirculated cooling water. The condensate, normally containing < 10 microcuries/gallon of activity, will be sent to the existing equalization basin. If it contains higher activity levels, it will be returned either to the evaporator for reprocessing or to W-5 for storage. Noncondensables will be scrubbed with caustic solution, heated, and then filtered before being dishcarged through a 6-in. VOG line connecting to the 3039 VOG system near Bldg. 3505. The VOG system is shown schematically on D-SK-81. The evaporator concentrates will be returned to the concrete tanks if ≤ 10 curies/gallon.

Material, heat, and activity balances for the system are shown in Dwg. E-34607. Engineering flowsheets are shown in D-34530, D-34549 through D-34552, and D-34621.

2.2 <u>Brief Description of Location and Structure</u>

The proposed facilities will be located in the excavation made for the abrogated 2527 building as shown on E-34618. The decision to use this site was based on its proximity to the present waste facilities and the savings which accrue by use of an existing excavation, much of which already has poured concrete foundation pads. Existing concrete elevations will be used as much as possible with a proposed layout shown on E-34525.

The facility will contain three process cells with the following inside dimensions:

Evaporator Cell - Cell I	14 x 26 x 20 ft deep
Condenser Cell - Cell II	14 x 8 x 12 ft deep
VOG Cell - Cell III	14 x 8 x 11-1/2 ft deep

These cells, the combination valve and pipe tunnel, and the ventilation filter pit constitute the primary containment zone. Containment criteria will conform to present plant standards for high-level beta-gamma containment. The valves necessary for alternate routing of waste streams is shown on C-34260. The ventilation exhaust filter pit will be external to the building since the secondary containment is part of the filter changing apparatus.

The secondary containment zone--all the building exclusive of the cells--consists of:

1. A change room and operating area, 16 x 55 x 14 ft high south of the building;
2. A crane bay, 18 ft high, over the removable roof slabs for cells I, II, and III serviced by a 20-ton gantry crane;
3. A sample gallery service area, 12 x 25 x 9, on the north side over a portion of the high-level cell.

The crane bay will have a telescoping truck door at the west end and will have tracks for the crane extending 20 ft outside the building. A finned water-to-air heat exchanger, LR-DWG-57135, will be located south of the building.

3.0 ARCHITECTURAL AND STRUCTURAL

3.1 Personnel Access and Containment Zones

Area	Personnel Access	Containment Zone
High-Level Tank Annulus	No normal access	Primary
Cell I	No normal access	Primary
Cell II, II, Pipe Tunnel	Very limited	Primary
Sample Room	Limited	Secondary
Crane Area	Limited	Secondary
Operating Area	Unlimited	Secondary
Change Room	Unlimited	Secondary

An emergency access hatch, covered by the Sample Room, is provided to each storage tank for entrance. Cell I will be entered only after extensive decontamination. Access to Cells I, II, and III is by means of removable roof plugs. These plugs should be sized so that the largest equipment item in each cell can be replaced.

Current thinking indicates the personnel in the facility at any one time will be:

Shift	Normal	Maximum
4-12	1	2
12-8	1	2
8-4	2	5
Total	4	Total 9

The change room will be divided into a locker section and a cleanup section. All normal access to the facility must pass through both sections. A personnel monitoring station will be located where one leaves the cleanup station to enter the locker section. In the locker section, lockers for 5 men, clean protective clothing bins, and a clean towel bin will be provided. Toilet facilities, showers, and soiled laundry bins will be in the cleanup section.

The operating area will contain the instrument penal. Greater than 90% of all normal operations will be controlled from this area. The instrument details presented on the engineering flowsheets will be used by the Instrument Department to obtain, first, the necessary data for the cost estimate and then for detail design such as the panelboard layout. The instrument estimate will not include the piping runs from the panel to individual equipment items. Certain critical readings will be telemetered to a central monitoring station to be built north of Building 3026. The cost estimate should include this telemetering cost item as a separate unit until a firm decision on how this operation is to be charged. The points telemetered are listed, using engineering flowsheet nomenclature, in the Appendix.

The Crane Area and the Sampling Room over the High-Level Storage Cell will be limited access areas. These areas will contain the equipment which could conceivably allow some activity to breech the cells, i.e., samplers and piping tie-ins to the cells. Cold equipment may also be located in these areas, i.e., the two cold makeup tanks M1 and M3 and service headers. A possible sampling method is shown on D-34276. This concept is a modification of the Thorex sampling system. The transfer station indicated is a necessary addition since shielded carriers will have to convey the samples to the Analytical Laboratory.

3.2 Structural Requirements

The cell block structure shown on E-34525 provides the radiation shielding necessary to insure safe working conditions in the secondary containment zone. The shielding calculations are shown in the Appendix of CF-61-5-22. The wall thicknesses indicated on the drawing are for normal concrete.

This structure should be capable of withstanding 900 lbs/sq ft of shock pressure. The removable roof plugs will be supported by the cell structure.

The floor loading for the various areas in the secondary containment zone pose no problem. Cart movement of a 2500-lb security file is the most severe usage for the change room, operating area, and sample room. The floor loading of the crane area is set by the cell block structure requirements plus the gantry crane.

The potential of an area to become contaminated should be reflected in the design of the various surfaces encountered in the building. Every effort shall be made to minimize all forms of cracks and crevices and porous surfaces. Each individual area shall be designed as air-tight as possible to confine contamination in the event of an accident. The interior surface finish requirements for floors, wainscoat, wall and ceiling are presented in the table below:

Area	Floor	Wainscoat[a]	Wall & Ceiling
Cell I	1/8" stainless steel	1/16" stainless steel	E
Cell II	1/8" stainless steel	1/16" stainless steel	E
Cell III	1/8" stainless steel	1/16" stainless steel	E
Sample Room	VT	-	V
Crane Area	EF	-	V
Operating Area	VT	-	V
Change Room	QT	GT[a]	L
Hi-Level Storage Tanks, External Surface Outer Tank			B

[a]Up 4', 6", 6", and 5'-6" for Cells I, II, III, and Change Room, respectively.

SS - stainless steel liner installed with liquid penetrant inspection of all exposed weld surface.

E - Epoxy coating (without Fiberglas reinforcement) Amercoat 74S, or equal.

EF - Fiberglas reinforced epoxy coating, Amercoat 74S, or equal.

V - Vinyl coating Amercoat 33HB (with 86 Primer), or equal.

VT - Vinyl asbestos tile.

QT - Quarry tile.

GT - Structural glazed tile.

L - Decorative paint.

B - Koppers Bitumastic

4.0 VENTILATION SYSTEM

All ventilation air flows are from cold to potentially warm to hot areas as shown on D-SK-81. The vessel off-gas, VOG, also shown on D-SK-81, system is regulated so as to maintain at least 1-1/2 in. of water negative pressure in the process vessels. The ventilation system is regulated to maintain about 1 in. of water negative pressure in the cells and less in the secondary containment zone.

Fresh air intakes shall be equipped with automatic closing dampers, filters, and heating coils. The air conditioning for the operating area shall also be equipped with cooling coils. All components shall be designed for the following extremes for intake air:

Summer, 95° FDB, 77° FWB

Winter, 0°F

The operating area is to be maintained at 76°FDB ± 2°F and 50% ± 5% relative humidity in the cooling season and a maximum of 55% the remainder of the year. The remainder of the secondary containment zone should be maintained at about 60°F in the wintertime.

Cell air intakes located in the crane area shall be equipped with a manual adjusting and shut-off damper (for filter change purposes), a backflow preventer, and a roughing filter. The duct shall have sufficient change of direction while passing through the concrete shield to minimize radiation beaming.

Cell air shall be exhausted via a duct originating near the floor and rising through the wall to the horizontal exhaust duct shown on E-34525. The riser inside of each cell should be constructed of 18-8 stainless steel. The horizontal duct should be sized for 8000 cfm total flow. The individual ducts should be sized so the cell will essentially be at the horizontal duct pressure at the flows shown on D-SK-81 and the riser for Cell I at 8000 cfm, Cells II and III at 4000 cfm to have about 1 in. pressure drop.

The pressure controls for the complete system shall be such that all closed cells will be at 1 in. water negative pressure and the secondary containment zone at 0.05 to 0.15 in. water negative pressure. In addition, the controls will be integrated into the building scram system in such a way that the secondary containment areas can be increased to a value of 0.3 in. when the scram system is actuated.

The engineering flowsheets indicate pneumatically transmitted recording systems to record Cells I, II, and III negative pressure. In addition, similar instrumentation shall be provided for the Crane Area and the Operating Area.

A filter pit for the ventilation exhaust shall be located outside the building near the southeast corner. The pit shall be designed to provide two parallel filter banks. Each bank shall have both roughing and absolute filters.

The VOG and CV exhaust lines are shown connecting to existing lines to the 3039 stack on Dwg. E-34618.

5.0 EQUIPMENT

5.1 Major Process Equipment

The major process equipment items are:

A1 - evaporator feed tank and high-level waste diversion tank

A2 - evaporator, normally for neutralized intermediate-level waste, but also capable of concentrating acidic high-level wastes

A3 - vapor filter to obtain the maximum decontamination factor (D.F.) from evaporator overhead to condensate. This unit is patterned on Brookhaven National Laboratory data partially covered by BNL-121.

A4 - condenser for vapor from A3.

A5 - condensate monitoring, surge, and diversion tank.

B1 - emergency condenser for high-level waste storage tank off-gas.

C1 & C2 - high-level waste storage tanks.

These items are located as follows:

Cell I - A1 and A2

Cell II - A3, A4, and A5

Cell III - B1

Buried - C1 and C2, each inside a stainless steel clad mild steel tank.

Each of these items will be fabricated from 304L stainless steel. The fabrication quality, with particular attention to welding and testing, will be equivalent to that illustrated by Specification CT 1.1, "Specification for Welded Type 304L Process Equipment," which is included in the Appendix. The Engineering and Mechanical Division Specification PS-13 might also be considered a quality guide.

Information on the individual equipment items is presented:

Engineering Flowsheets

Unnumbered sketches in Appendix

C-34280, C-34619, LR-57118

Equipment Item	Engineering Flowsheet	Appendix Sketch	Other
A1	D-34530	Yes	External coil shown on Appendix Sketch attached as shown on LR-57118
A2	D-34549	Yes	Internal impingement baffle shown on C-34619, conductivity probes on C-34280
A3	D-34550	Yes	BNL-121, "Semi-works Vapor Filtration"
A4	D-34550	Yes	
A5	D-34550	Yes	
B1	D-34552	Yes	
C1 & C2	D-34551	Yes	Sparger shown on C-34619, external coils on LR-57118

5.2 VOG Equipment

Scrubbing of vessel off-gas, VOG, is still under study by the Operations Division. Their studies could conceivably add to the caustic scrubber shown on D-34552. The items shown on D-34552 are:

B2 - Caustic scrubber for removing of nitrates when acidic wastes are evaporated. Present plant practice is to run caustic scrubbers continuously.

B3 - Caustic surge tank calls for a horizontal 304L stainless steel tank to minimize required headroom.

B4 - Chempump Model 3/4S.

5.3 Other Equipment

M1 and M3 - 55-gallon stainless steel tanks equipped with agitators for makeup or surge use in crane areas.

Cooling water recycle - see LR-57135

Waste water monitor will be based on the latest information from the Instrument and Controls Division. The unit now in use was designed by R. K. Abele and F. E. Gillespie and is capable of a full-scale reading of approximately 100 cts/min/ml of beta or gamma depending considerably on the energy of the radiation. The use of ultrasonic energy for removing activity from the Geiger tube and the monitoring cell walls is illustrated on LR-51256. The pump shown to circulate waste water through this monitor is a Viking two-stage gear pump. A proportional sampler is activated by flow recorder-controller in the unit.

A sampling concept is shown on D-34276. This system is a modification of the Thorex system to allow for the local conditions; particularly, the necessity for shipping samples to the analytical laboratory in a shielded carrier.

6.0 PIPING

6.1 General

Process piping and the service headers tying into the process are shown on engineering flowsheets No. 1 through No. 5 - Dwgs. D-34530, D-34549, D-34550, D-34551, and D-34552. In addition to the service headers shown on these drawings, the following systems are required:

Fire Protection System

Hot and Cold Potable Water

Low Pressure Steam for Ventilation Air Heating

Sanitary Sewer (Change Room)

The instrument air header for all the instruments indicated in the engineering flowsheet will take its supply from the indicated building air header as specified by the Instrument Division.

Attention must be given in the design of pipe runs to sealing against air leakage where the piping system penetrates from one portion of the building to any other. In addition, sleeves from the Crane Area to the cells must consider radiation as illustrated in the Appendix. These sleeves are cast into the concrete during construction and twenty per cent (20%) excess for each size should be provided up to six of one size for one cell.

In general, all building service supply mains, pressure reducing stations, flow measuring devices, and other associated equipment will be located in the Crane Area either north or south of the gantry crane tracks.

6.2 Process Piping

The engineering flowsheets specify all process piping. On these sheets and the attached piping list, the line numbering system illustrated and explained below has been used.

A1 02 A 2

- 2 — 2 inch
- A — specification
- 02 — process line:
  - 01 to 19 - process
  - 20 to 39 - service
  - 40 to 59 - pneumatic instrument
  - 60 to 69 - electronic or electrical
- A1 — point of origin

Specification:

A. All welded 304L stainless steel pipe, example of detail specification, included in Appendix;

B. For electronic and/or electrical runs such as stainless sheathed thermocouples and stainless-in-cell conduit. Junction boxes are located outside of cells.

C. For pneumatic instrument lines using tubing, tubing connectors and tube-to-pipe adaptors. The sleeve into the cell and all runs inside the cell are stainless. Plastic tubing may be used in the secondary containment areas.

Piping in the secondary containment zone follow standard industrial practice with special air-sealing attention where the pipe passes through walls separating areas.

6.3 Miscellaneous

6.3.1 Safety Showers with Combination Eye Wash. Three such units are required: one in Sampling area, one in Crane Area, and one in the Operating Area.

6.3.2 Drinking Fountain. One located within the Operating Area should suffice.

6.3.3 Hose Bibs. Three 1-in. size are required for cleanup operations: two in the Crane Area and one in the Sampling Area.

6.3.4 Fire Protection. All interior spaces in the building, except the cell interiors, shall be served by fire protection facilities as follows:

(a) A wet type sprinkler system conforming to the latest standards of NFPA No. 13 and shall include a monitor with connections to the existing ORNL fire alarm system.

(b) A system of standpipes and hose cabinets located throughout the building so as to serve single level floor areas and not to exceed 95 ft from the nearest cabinet. All standpipes and hose cabinets shall conform to standards NBFU Pamphlet No. 14 and ORNL Dwg. C-20788.

(c) Auxiliary fire alarm boxes shall be installed adjacent to each hose cabinet along with the required alarm equipment for the wet type system.

(d) A Siamese type Fire Department connection shall tie into the standpipe and sprinkler systems above ground level where the main enters the building. This location must be accessible to the Fire Department. A valve with post indicator shall be installed at least 20 ft from the face of the building. No connections other than fire protection purposes shall be permitted downstream from this valve. All outside water supply shall conform to Factory Material Engineering Division Specifications.

(e) Potable water from the existing ORNL plant distribution system shall supply the fire protection system.

6.3.5 Underground Lines. Drawing E-34618 shows possible runs of all underground lines called for by the Engineering Flowsheet and the runs illustrated are not necessarily the best course for any particular line. This drawing supersedes the information in F. E. Harrington's April 6, 1961, letter to J. A. Murray, Jr. In laying out these lines, the ORNL Atlas and the drawings listed below are good references. The connections to bring high-level waste from 3019 and 3517 are shown from W19 and S324, respectively. The line from 3019 to W19 is shown on:

D-32204 - Plot Plan
D-32205 - Profile
D-32206 - Sections & Elevations
D-32210 - Junction Box 1
D-32211 - Junction Box 2
D-32214 - Junction Box 3

The thinking is W19 will be the 3019 monitoring tank. At this point the waste must be monitored and its disposition to the high-level evaporation and storage or 3517 feed decided. No firm decision that this plan will be used has been reached. For the Cost Estimate, the length of run and the necessary tie-ins should be equivalent to any plan finally adopted. S324 is the 3517 waste disposal tank. Present plans are for the current discharge to W5 to be valved so that waste may be routed to W5 or to the high-level storage. The two lines carrying feed to the evaporator from W5 and concentrate to the concrete storage tanks are shown on D-34620. Drawing D-19809, "Alterations to the Tank Farm Transfer Lines," shows the present Moyno pump and valve pit one of these lines must tie into. Schematic Drawing C-34620 shows the valve arrangement required at this facility.

7.0 ELECTRICAL

7.1 General

The main distribution and load center for the building electrical system shall be located in the operating area.

All in-cell electrical systems shall be of vapor-tight construction. Normal construction will be used for the remainder of the plant.

No wireways, distribution or breaker panels are to be located within any cell. The necessary wall or other surface penetrations both here and between secondary containment zones will consider the need for containment air seals and possible contamination cleanup.

7.2 Lighting and Wall Receptacle Requirements

Lights shall be installed to provide the 50 and 30 ft candles at working elevations in the Operating Area and the remainder of the plant, respectively. Duplex wall receptacles, 15 amp, shall be provided as follows:

Area	220 v	110 v
Change Room	-	3
Operating Area	1	3
Sample Area	1	2
Crane Area	4	8

The Engineering Department will determine if regulated constant 110 v wall receptacles are required for hand and foot counter, air monitors (CAM's), and monitrons.

7.3 Welding Receptacles

One 60 amp, 440 v, weatherproof receptacle shall be located in each of the following locations: (a) Operating Area, (b) Sample Area, (c) east end Crane Area, and (d) west end Crane Area.

7.4 Special System

(a) Fire Alarm System. The fire alarm system shall be master-auxiliary Gamewell type with master at main entrance. Annunciator and dualarm cabinet are used. Master box is to be Gamewell No. 9000 surface or No. 9103 flush, three-fold, non-interfacing for 48-volt supply. Code wheel will be supplied by ORNL. Auxiliary boxes are to be Gamewell No. 9114 surface or No. 9114B flush. Annunciator is to be as per attached Dwg. D-26450 manufactured by Gamewell. Duralarm evacuation horns give complete coverage of personnel areas. The entire installation is to be in accordance with NFBU requirements.

(b) Intercom System. A radially designed conduit system shall be furnished connecting the areas listed below. It shall be a master-call type.

Change Room
Operating Area
Crane Area
Sampling Area

(c) Telephone System. A conduit system (with pull wires installed) for the Bell Telephone System shall be designed with outlets within the Operating Area.

(d) Evacuation System. A conduit system with radial speaker distribution is to be designed for the evacuation P.A. system (installed and maintained by Bell Telephone). This system shall be tied into the building emergency scram system. When the emergency scram button is actuated, the evacuation of all building personnel and the ventilation changes outlined in Sect. 4.1 shall occur simultaneously.

(e) Emergency Lighting. Emergency lighting shall be designed for safe shutdown and evacuation utilizing self-contained, portable, self-charging and automatic initiation battery-powered lamps.

(f) Electrical Power. All known power users are:

30 hp fan and pumps - recirculating water system
Chempump - VOG scrubber liquor

Viking pumps - monitoring process water

Two agitators - makeup tanks

Drive for gantry crane

Capacity for about 20% increase should be provided.

8.0 INSTRUMENTATION

The Instruments and Controls Division is responsible for the detail engineering, including cost estimates for all instruments needed for this project. Part of this phase is discussed in Sect. 3.1 discussion of the operating area.

The engineering flowsheets are a guide to the bulk of the required instruments. The nomenclature and symbols used follow I&C Standards. In addition to the items shown on these flowsheets, the following should be included:

(a) Pneumatic flow recorders for continuously monitoring the total flow of major building services including VOG and cell ventilation exhaust.

(b) Emergency scram system designed for manual, as well as automatic, actuation upon loss of negative pressure within the cell exhaust duct. The evaporator steam will be shut off when this signal is actuated.

(c) Two personnel and background monitors (one a H&F unit).

(d) Four area beta-gamma monitors.

(e) One personnel alpha monitor.

(f) Two beta-gamma CAM's.

(g) A process waste monitor in the process waste system just below where this facility discharges into present waste system. This instrument will be the unit now being developed under D. J. Knowles. A flow recorder and proportional sampler is an integral part of the "package."

(h) A list of points to be telemetered to the new plant monitoring center is included in the Appendix.

(j) ORNL-1513 sums up earlier experience with foam indication for waste evaporators.

APPENDIX A

Evaporator Feed Tank (A-1)

Capacity	6500 gallons
Size	10 ft dia x 10 ft high
Material	304L stainless steel
Cooling Coil	240 ft of 1-1/2 in. pipe, external to tank

Purpose - The evaporator feed tank will be used as a feed tank for the evaporator and as a hold tank for sampling and adjusting high-level wastes prior to transfer to the waste tanks.

A coil will be welded to the outside of the feed tank so that the temperature of the waste solution in the tank can be kept suitably low and so the tank can be heated for decontamination. With the coils welded to the outside of the tank a leak in a coil will not provide a path for the escape of waste solution outside the cell; hence, no secondary cooling system will be needed. 280,000 Btu/hr is the probable maximum heat load that will have to be removed from the tank.

Evaporator (A-2)

Size	10 ft dia, 12 ft high
Feed Rate	600 gal/hr
Boil-up Rate	4500 lb/hr
Heat Load	4.8×10^6 Btu/hr
Material	304L stainless steel
Coil	6 permanent coils totaling 550 ft^2 of heat transfer area

Purpose - The evaporator will be used primarily to concentrate the intermediate-level alkaline waste solution from the concrete waste tanks. At some future date it may be used to concentrate acidic high-level waste solutions. Operation will be semi-batch, with a periodic discharge of the evaporator bottoms when the bottoms concentration reaches the maximum feasible value - probably at a 12 to 1 concentration factor.

De-entrainer

Size	3 ft dia, 17 in. high
Passage width	5/16 in.

Pressure drop (at 600 gph feed) - 10 in. of water

Smallest particle completely removed - 4.2 microns

Purpose - The de-entrainer will remove the large particles of entrained liquid from the vapor produced in the evaporator. The design of the de-entrainer is developed at Savannah River on high-velocity impingement caps. The de-entrainer will be built as an integral part of the evaporator.

Entrainment Filter (A-3)

Size	4 ft 6 in. dia, 4 ft high
Bed material	Stainless steel Yorkmesh, 0.0045 in. wire dia

Purpose - The filter will remove the micron and submicron sized entrained liquid droplets from the vapor stream. The filter will be mounted outside the evaporator cubicle and will consist of a thick bed of Yorkmesh made from small diameter wire. It will be similar to the filter used by BNL on their low-level waste evaporator. From results obtained with the BNL filter, a filter decontamination factor of approximately 1000 is expected. Heat losses from the filter assembly should be great enough to condense a small fraction (1 to 2%) of the vapor flowing through it, thereby providing a continuous washdown of the mesh and preventing any buildup of solids. The filter assembly will be designed for easy replacement of the mesh. The expected pressure drop is 15 in. of water.

Evaporator Condenser (A-4)

Size	2 ft dia, 7 ft long
Duty	4.5×10^6 Btu/hr
Area	600 sq ft
Cooling water required	360 gal/min at 130°F

Purpose - The condenser will condense the vapor from the evaporator.

Condensate Catch Tank (A-5)

Size	3 ft dia, 3 ft high
Volume	150 gal

Purpose - Condensate from the condenser will be collected in the catch tank and from there will normally drain to the process water drain. A monitor will measure the activity of the condensate and, if this activity exceeds a pre-set value (10^{-5} curies/gal) will actuate an alarm and close a valve in the process water drain line. The catch tank will then be drained back to the evaporator until the upset that caused the high condensate activity level has been corrected.

When high-level waste is being evaporated the condensate will contain too much activity to be discharged to the process water drain even under the best of conditions (a D.F. of 10^7). In this case the condensate will be jetted to the concrete waste tanks.

<u>Make-up Tank (M-1, M-3)</u>

Volume	55 gallons
Number Required	2

Purpose - The addition of small quantities of reagents that may be required will be done through the make-up tanks. Tank M-1 will serve the evaporator and feed tank and M-3 will serve the scrub liquor surge tank.

<u>High-Level Waste Storage Tank (C-1, C-2)</u>

Volume	50,000 gallons
Size	10 ft dia, 85 ft long
Expected heat load	116,000 Btu/hr
Maximum heat load	400,000 Btu/hr
Cooling system	External Coil, 1900 ft of 1-1/2 in. pipe Internal Coil, 700 ft of 1-1/2 in. pipe

Purpose - The waste tanks will be used for storage of high-level acidic waste solutions. One of the tanks will serve as a spare if leakage should occur in the first tank. Each tank will be contained in a slightly larger tank (11 ft dia by 86 ft long) fabricated of stainless-steel-clad mild steel and buried under 9 ft of earth. The outer surface of the outer tank shall be coated with Koppers Bitumastic.

Each tank will be cooled by two sets of cooling coils, one inside and one outside the tank. The cooling coils inside the tank are intended for emergency use only and will not be connected to a cooling water supply or drain. The ends of the coil will be brought outside the tank and above ground and capped off. The internal coil will be a staggered arrangement of 1-1/2 in. pipes running the length of the waste tank at about 1 ft off the bottom. Adjacent lengths of the coil should be spaced 1 ft apart horizontally and 6 in. vertically. Seven runs of pipe will be required for a total length of 700 ft.

The cooling coils outside the tank will consist of lengths of 1-1/2 in. pipe welded horizontally along the outside of the tank. There should be nine lengths of pipe spaced 1 ft apart on the bottom and lower sides of the tank and five lengths of pipe spaced 18 ft apart on each upper side. The bottom lengths are to be piped so that cooling water flows through three coils in parallel, each coil consisting of three lengths of pipe. On the upper sides the flow will be through five lengths in series.

Ten spargers will be installed in each waste tank. The spargers will be designed for an air flow of up to 10 cfm each. The air lines supplying the spargers will be brought out through the tank and capped off except for the lines supplying the spargers at each end of each waste tank.

Emergency Condenser (B-1)

Size	18 in. dia, 7 ft long
Duty	4.5×10^5 Btu/hr
Area	70 sq ft

Purpose - The emergency condenser will be used to condense any vapor generated in a waste tank should a failure of the cooling system occur. Since the condenser is intended for emergency use only, it will not normally be operated.

Scrubber (B-2)

Size	15 in. dia, 7 ft high
Vapor Flow	150 cfm
Liquid Flow	11 gal/min

Purpose - The vessel off-gas from both the waste tanks and the evaporator system will be scrubbed with a 5% caustic solution before being filtered and discharged to the laboratory off-gas system. A six foot height of wetted packing and a 1 foot height of dry packing for de-entrainment will be provided.

Scrub Liquor Surge Tank (B-3)

Size	2 ft 6 in. dia, 4 ft 6 in. long
Volume	165 gallons

Purpose - The scrub liquor surge tank holds the caustic scrub solution used in the scrubber. The solution is periodically jetted to the evaporator and replaced with fresh solution.

Closed Cycle Cooling Water System (Fig. 1)

Flow	360 gal/min
Duty	4.5×10^6 Btu/hr
Cooling Water Temperature	160°F In, 130°F Out

Purpose - The closed cycle cooling water system will provide cooling water for the evaporator condenser. It will consist of a 700-gallon stainless steel surge tank, two 350 gal/min stainless steel pumps (one to serve as a spare), and an air-cooled heat exchanger. The heat exchanger will be a standard industrial model approximately 12 ft by 13 ft by 10 ft high.

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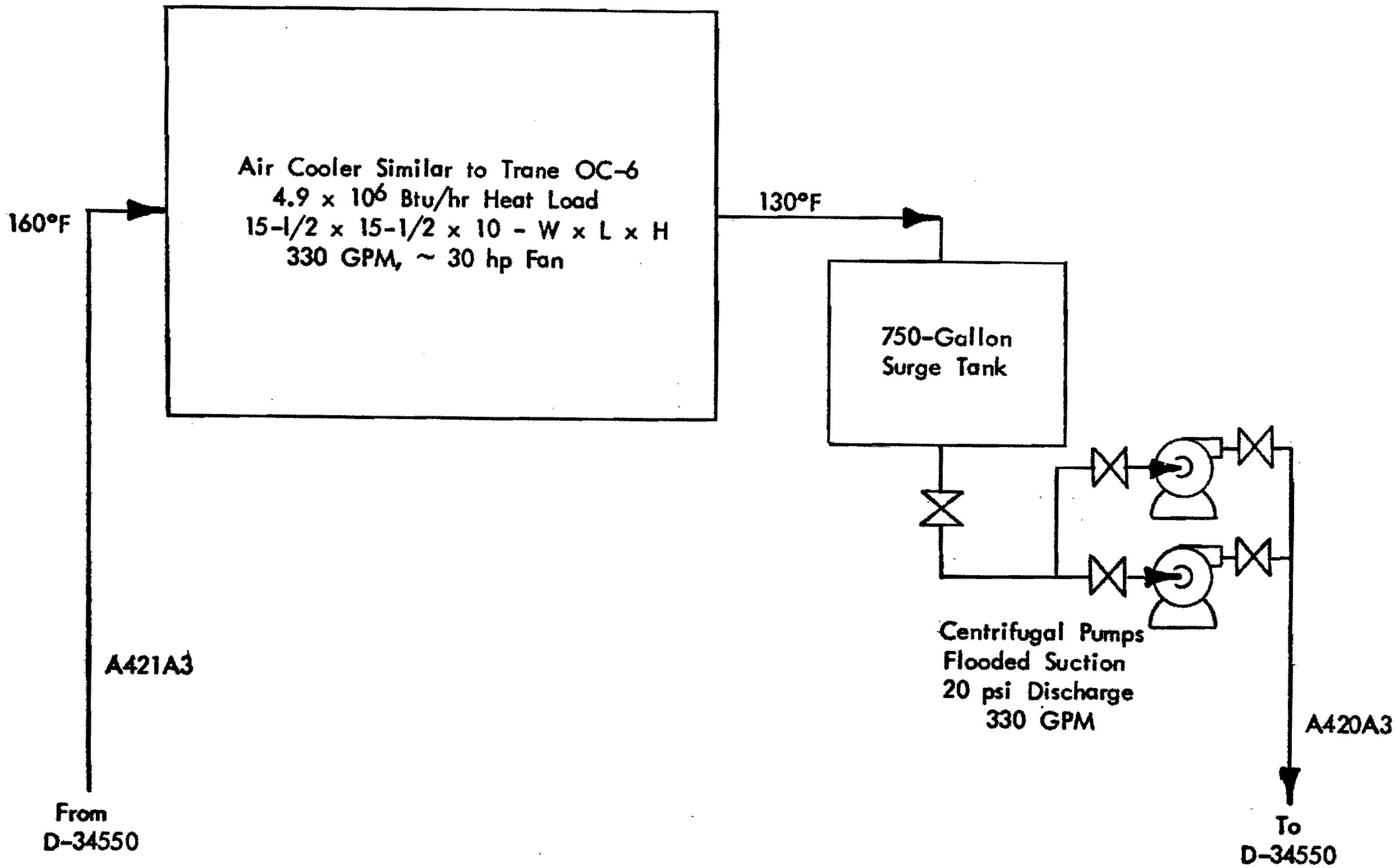


Fig. 1. High and Intermediate Level Waste Facility - Schematic Cooling Water Recycle.

ORNL-LR-Dwg. 58841
Unclassified

EVAPORATOR FEED TANK (A-1)

Operating volume . 5000 gal
Total volume . 6500 gal
Diameter . 10 ft
Height . 10 ft
Cooling system
Duty . negligible to 280,000 BTU/hr
Length of pipe . ~240 ft
Size of pipe . 1½" sch 40
Spacing . 18"

Nozzles

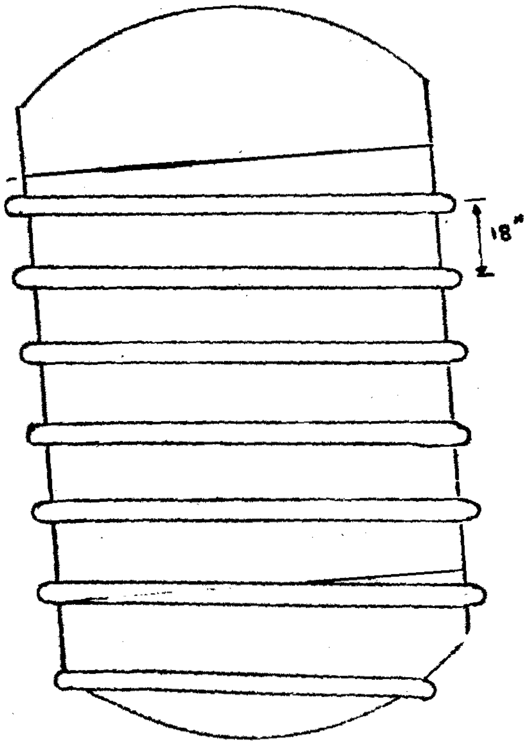
4	12"	solution inlets
4	12"	solution outlets
2	1"	evaporator feed
4	1¼"	steam supply to jets
2	¾"	steam supply to jets
1	½"	reagent addition
1	1½"	off-gas
1	3/4"	sparger
1	1/4"	sampler line

Material 304 L stainless steel

Jets

2	1"
4	2"

Instruments
Liquid level, density
Temperature



ORNL-LR-Dwg. 53842
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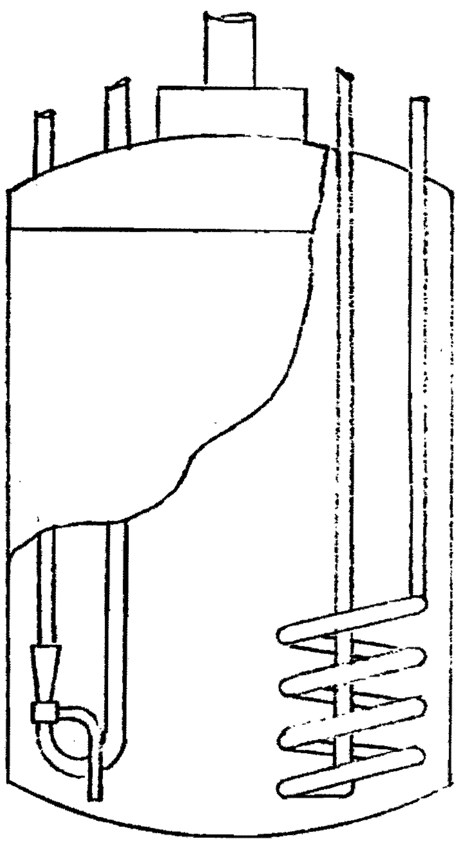
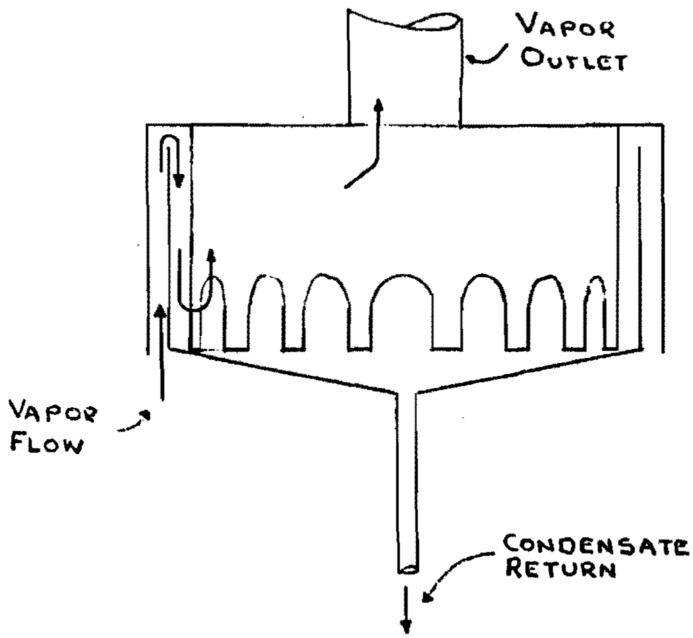


EVAPORATOR A-2

Diameter	-	10 ft
Height	-	12 ft
Operating volume	-	2200 GAL
Boil-up rate	-	4500 #/hr
Heat load	-	4.8×10^6 BTU/hr
Coil area	-	550 ft^2
Jets	-	2 2" submerged
		2 1½" submerged
Instruments	-	Liquid level, density
		Temperature
		Foam indication
Nozzles	-	Inlet and outlet to steam coil as needed
		10" vapor outlet
		2 2" solution inlets
		3 1" solution inlets
		2 2" jet outlets
		2 1½" jet outlets
		2 1¼" steam to jets
		2 1" steam to jets
		1 1" condensate return
		1 ¾" sparger
		2 ⅜" sampler line
		1 ⅜" sampler return
Corrosion Allowance	-	⅛"
Material	-	304 L stainless steel
D.F.	-	10^4

ORNL-LR-Dwg. 58843
Unclassified



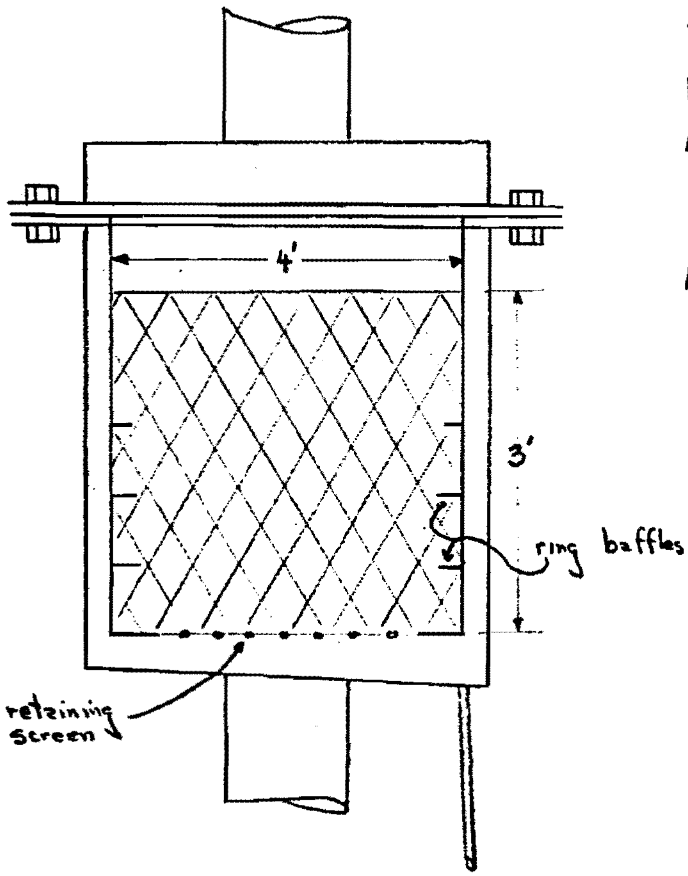
ENTRAINMENT SEPARATOR FOR EVAPORATOR

OVERALL DIAMETER	· 3 FT
HEIGHT	· 17 INCHES
PASSAGE WIDTH	· 5/16 INCH
ΔP AT 300 GPH EVAPORATOR FEED	· 2.5 INCHES WATER
SMALLEST PARTICLE COMPLETELY REMOVED	· 6 MICRONS
ΔP AT 600 GPH EVAPORATOR FEED	· 10 INCHES WATER
SMALLEST PARTICLE COMPLETELY REMOVED	· 4.2 MICRONS
MATERIAL	· 304 L STAINLESS STEEL

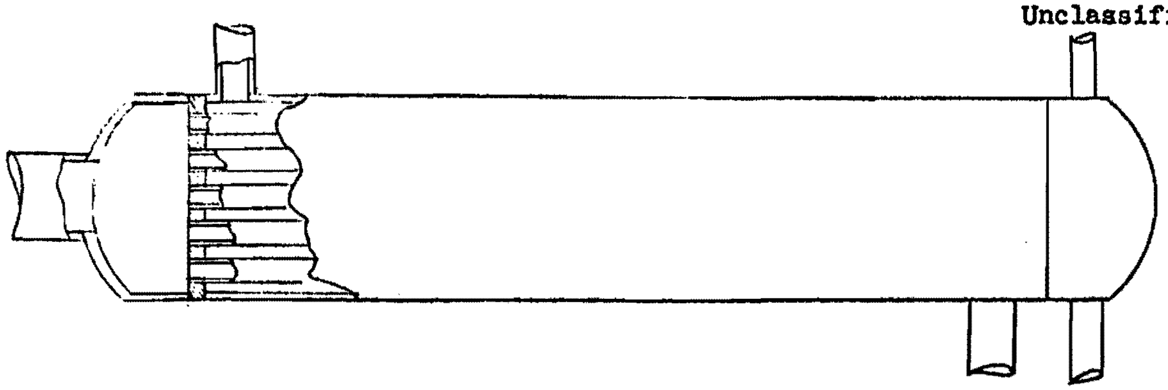
ORNL-LR-Dwg. 58844
Unclassified

FILTER FOR EVAPORATOR VAPOR (A-3)

Overall Diameter	-	4' 6"
Overall Height	-	4'
Bed Diameter	-	4'
Bed Height	-	3'
Bed Material	-	Stainless steel Yorkmesh (0.0045" wire)
Nozzles	-	10" vapor inlet (bottom)
		10" vapor exit (top)
		1" drain (bottom)
Material of Construction	-	304L stainless steel



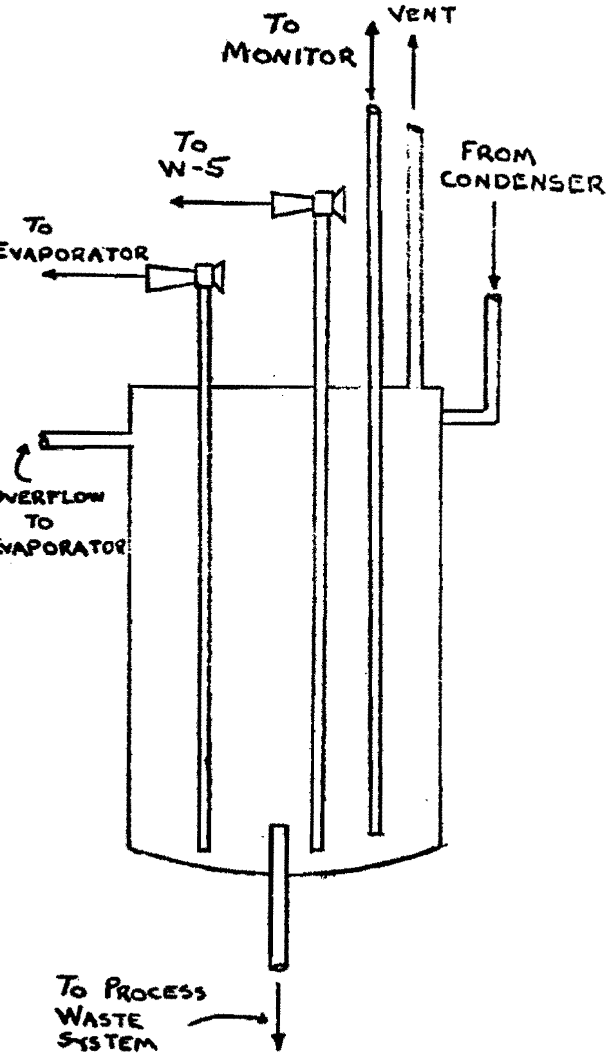
ORNL-LR-Dwg. 58845
Unclassified



EVAPORATOR CONDENSER (A-4)

Duty	-	4.5×10^6 BTU/hr
Area	-	600 ft^2
Length	-	6 ft
Tube size	-	3/4"
Tube number	-	520
Pressure Drop (vapor side)	-	0.5 inches water
Cooling Water required	-	360 gal/min @ 130°F inlet
Nozzles	-	10" vapor inlet
		1½" condensate outlet
		2" vent
		3" cooling water inlet
		3" cooling water outlet
Material of Construction	-	304 L stainless steel

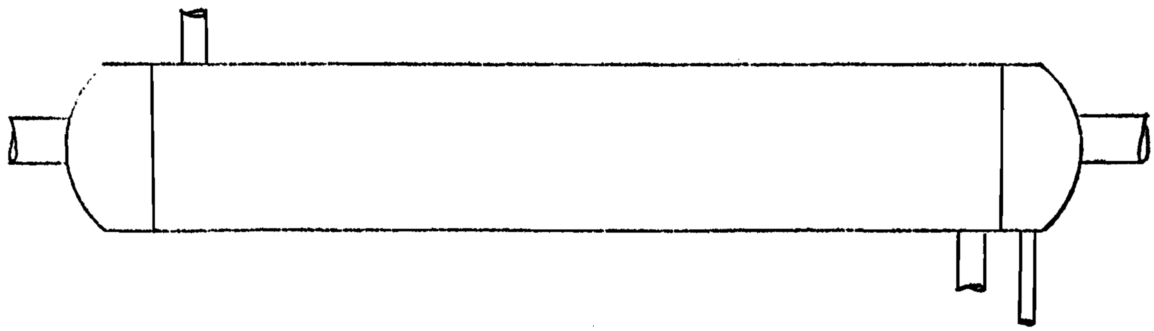
ORNL-LR-Dwg. 58846
Unclassified



CONDENSATE CATCH TANK (A-5)

DIAMETER	-	3 FT
HEIGHT	-	3 FT
VOLUME	-	150 GAL
NORMAL OPERATING VOLUME	-	10 GAL
JETS	-	2 3/4"
INSTRUMENTS	-	LEVEL INDICATION
		TEMPERATURE INDICATION
NOZZLES	-	1 1" BOTTOM OUTLET
		1 1½" BOTTOM OUTLET TO MONITOR
		1 1½" FEED FROM CONDENSER
		2 ¾" LINES TO JETS
		1 ¾" FROM SUMP JET
		1 ⅜" SAMPLE LINE
		1 ½" SPARGER
		1 1" VENT
		1 ½" RETURN FROM MONITOR
		1 1" OVERFLOW
MATERIAL	-	304 L STAINLESS STEEL

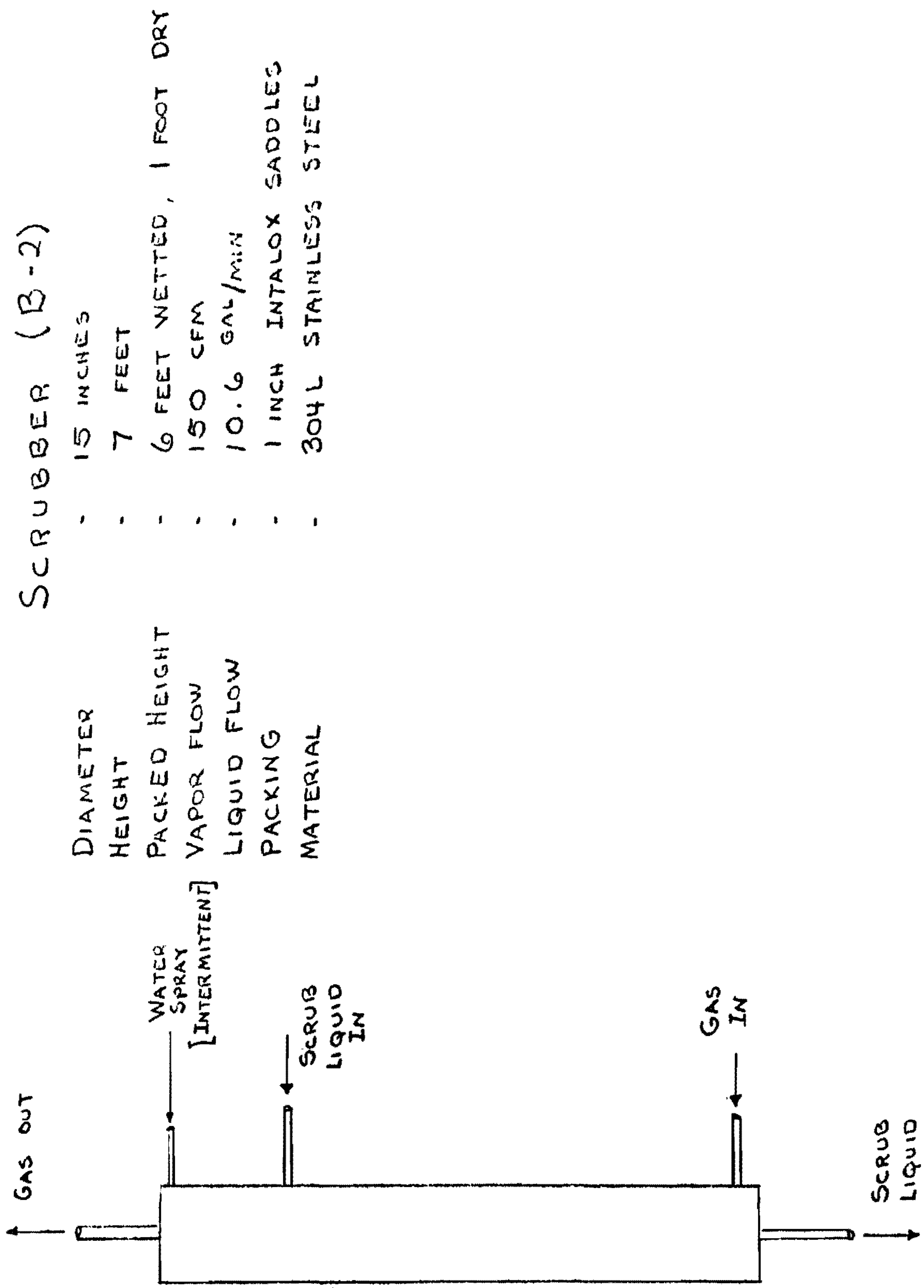
ORNL-LR-Dwg. 58847
Unclassified



EMERGENCY CONDENSER (B-1)

Duty	-	4.5×10^5 BTU/hr
Area	-	70 ft^2
Length	-	6 ft
Tube size	-	3/4"
Tube number	-	60
Cooling water required	-	30 gpm
Nozzles	-	3" vapor inlet
		1" condensate outlet
		1" vent
		1½" cooling water inlet
		1½" cooling water outlet
Material	-	304 L stainless steel

ORNL-LR-Dwg. 58848
Unclassified



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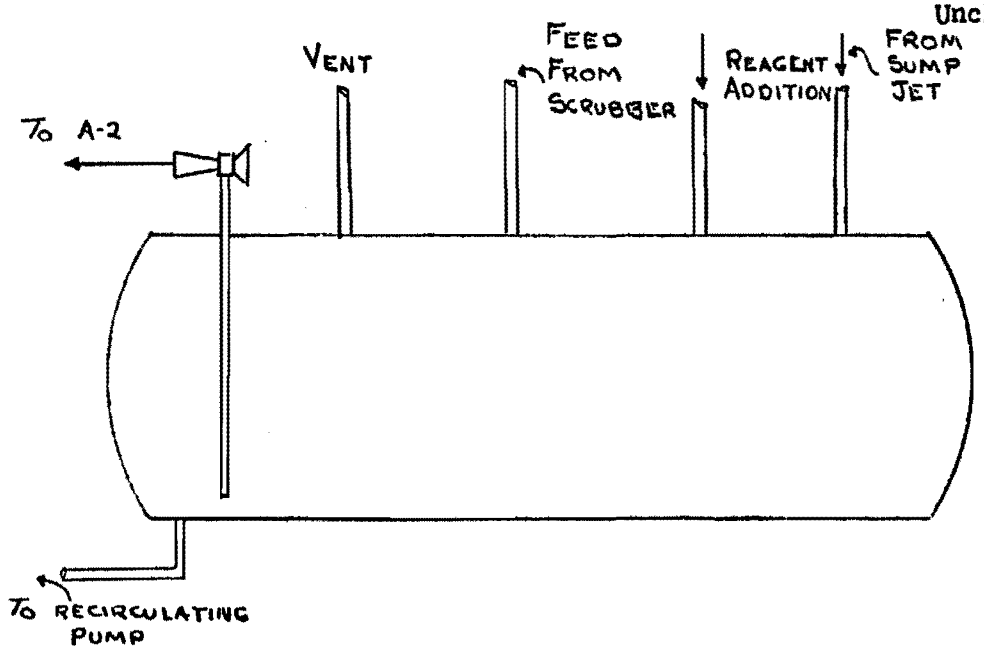
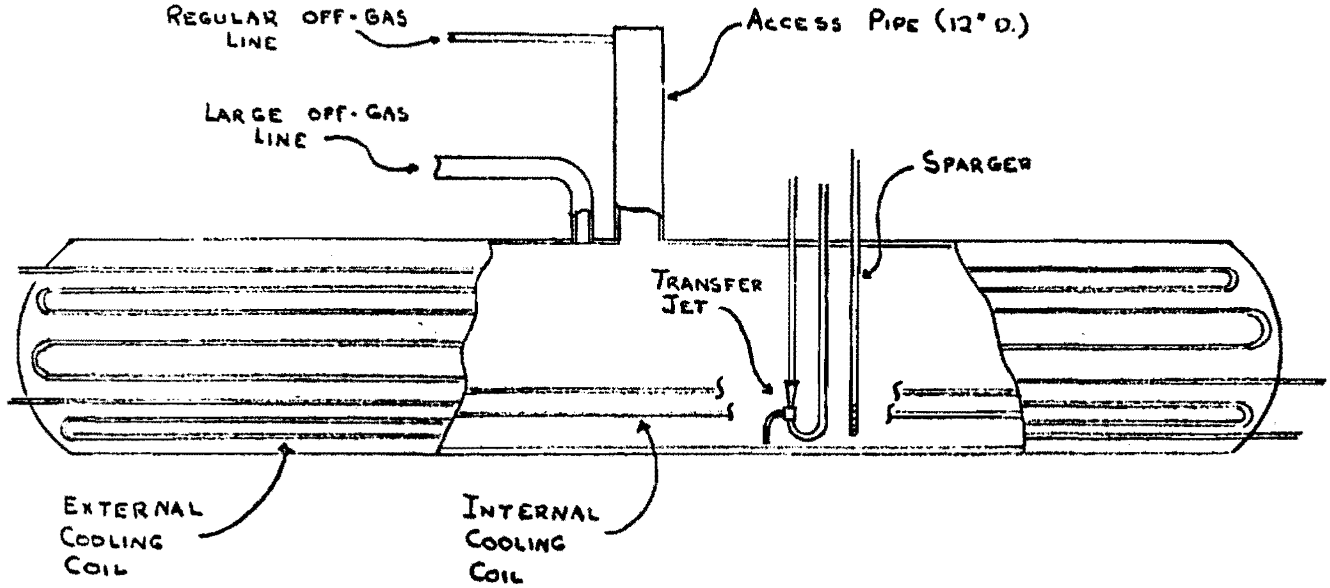


Scrub Liquor Surge Tank (B-3)

Diameter	-	2 ½ ft
Length	-	4 ½ ft
Total volume	-	165 gal
Operating volume	-	130 gal
Jet	-	1 ¾"
Instruments	-	Level Indication
		Density Indication
		Temperature Indication
Nozzles	-	1 ¾" Bottom discharge
		1 1" Vent
		1 1" Jet suction
		1 1" Feed from scrubber
		1 ⅜" Sampler line
		1 ½" Reagent addition
		1 ¾" From sump jet
Material	-	304 L stainless steel

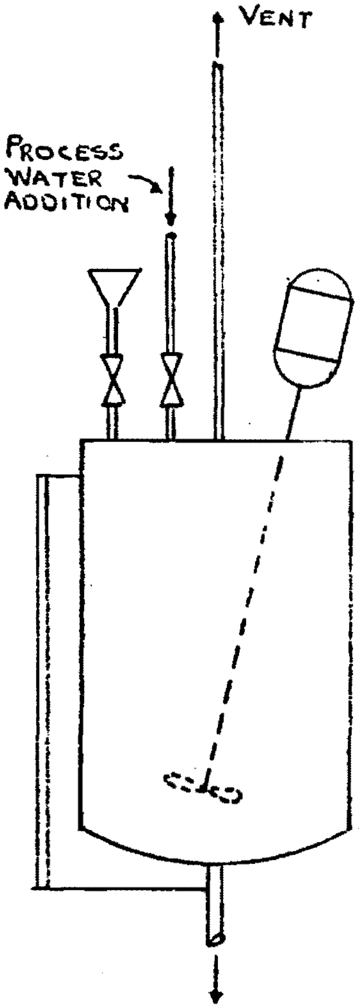
ORNL-LR-Dwg. 58850
Unclassified



HIGH LEVEL WASTE STORAGE TANK (C-1, C-2)

DIAMETER	-	10 FT
LENGTH	-	185 FT
TOTAL VOLUME	-	50,000 GAL
OPERATING VOLUME	-	40,000 GAL
EXPECTED HEAT LOAD	-	116,000 BTU/HR
MAXIMUM HEAT LOAD	-	400,000 BTU/HR
INTERNAL COIL	-	7 LENGTHS OF 1½" PIPE (~ 700 FT TOTAL)
EXTERNAL COIL	-	19 LENGTHS OF 1½" PIPE (~ 1900 FT TOTAL)
CORROSION ALLOWANCE	-	⅛"
NORMAL OFF-GAS FLOW	-	4 CFM
EMERGENCY OFF-GAS FLOW	-	85 CFM
NUMBER OF SPARGERS	-	9 (ALL BUT 2 ARE DISCONNECTED)
JETS	-	2 - 1½" SUBMERGED
INSTRUMENTATION	-	LEVEL, DENSITY, TEMPERATURE
NOZZLES	-	10 ¾" SPARGERS
		2 1" STEAM INLETS TO JETS
		2 1½" JET OUTLETS, ONE CAPPED
		1 1" FEED LINE (SPARE)
		1 2" FEED LINE FROM VALVE PIT
		1 1½" FEED LINE FROM OTHER TANK
		1 1" FEED LINE FROM SUMP
		1 2½" OFF-GAS LINE
		1 1½" FEED LINE FROM A-1
		2 ⅜" SAMPLING LINES
		2 1½" COOLING WATER LINES

ORNL-LR-Dwg. 58851
Unclassified



MAKE-UP TANK (M-1, M-3)

VOLUME - 55 GAL
INSTRUMENTS - LEVEL INDICATION
NOZZLES - 1 ½" BOTTOM DRAIN
1 1" VENT
1 ½" WATER ADDITION
1 1" REAGENT ADDITION
MATERIAL - 304 L STAINLESS STEEL

APPENDIX B

JET LIST

Jet	Function	Size, in.
A1-J1	A1 to C1	1-1/2
A1-J2	A1 to C2	1-1/2
A1-J3	A1 to Valve Pit (capped)	1-1/2
A1-J4	A1 to Valve Pit (capped)	1-1/2
A1-J5	A1 to A2	1
A1-J6	A1 to A2	1
A2-J1	A2 to C1	1-1/2
A2-J2	A2 to Valve Pit to W-6	2
A2-J3	A2 to C2	1-1/2
A2-J4	A2 to Valve Pit to W-5	2
A5-J1	A5 to A2 via A507A1	3/4
A5-J2	A5 to Valve Pit to Tank Farm	3/4
A7-J1	A7 to A5F	3/4
A6-J1	A6 to Valve Pit to Tank Farm	3/4
B6-J1	B6 to B3	3/4
B3-J1	B3 to A2	3/4
C1-J1	C1 to Valve Pit (capped)	1-1/2
C1-J2	C1 to C2Q	1-1/2
C2-J1	C2 to Valve Pit (capped)	1-1/2
C2-J2	C2 to C1Q	1-1/2
C3-J1	C3 to Valve Pit (capped)	1-1/2
C4-J1	C4 to Valve Pit (capped)	1-1/2

APPENDIX C

PIPING LIST

I. Process Piping

A. D-34530

Line Number	Function and Comments	
A101-A1-1/2	A1-J1 to C1E	A1D (see A161B)
A102-A1-1/2	A1-J2 to C2E	A1C (see A162B)
A103-A2	Inlet from Valve Pit	A1E
A104-A2	Inlet from Valve Pit	A1F
A105-A1	A1-J5 to A2H	A1W (see A165B)
A106-A1	A1-J6 to A2H	A1X (see A166B)
A107-A1-1/2	A1-J3 to Valve Pit	A1A
A108-A1-1/2	A1-J4 to Valve Pit	A1B
A109-A-3/4	Inlet for Future Carrier Unloading	A1T
A110-A-3/8	Sample Suction	A1Na
A111-A-1/4	Sample Airlift Air	A1Nb
A112-A2	Spare Inlet from East Valve Pit	A1V
A113-A2	Inlet from W5 via East Valve Pit	A1I
A114-A2	Inlet from W5 via East Valve Pit	A1G
A115-A1-1/2	Vent	A1H (see B203A2)
B203-A2	VOG Header	
M101-A-1/2	M1 to A1V Solution Addition	
M102-A-1/2	M1 to A2F Solution Addition	
A601A-3/4	A6-J1 to East Valve Pit	(see A660B)
A610A-3/8	Sample Suction	
A611A-1/4	Sample Airlift Air	

B. D-34559

A201-A10	Vapor to A3B	A2R
A202-A1-1/2	A2-J3 to C1	A2X
A203-A2	A2-J4 to East Valve Pit to Moyno Pit	A2D
A204-A2	A2-J2 to East Valve Pit to W6	A2E
A205-A1-1/2	A2-J1 to C2	A2W
A206-A2	Inlet from Moyno via East Valve Pit	A2Y
A207-A2	Inlet from Jet via East Valve Pit	A2Z
A208-A3/4	Water to Spray Nozzle	A26
A210-A-3/8	Sampler Suction	A2M3
A211-A-1/4	Sample Air	A2M2
A212-A-3/4	Sample Return	A2M1

Line Number	Function and Comments	
B. D-34559 (Cont'd)		
A302-A1	Inlet from A3C	A2Q
B102-A1	B1 to A2 Condensate Drain	A2F
C. D-34550		
A302-A1	A3C Drain to A2Q	
A301-A10	A3A to A4A	
A303-A2	VOG to Bottom A3 for Filter Change	
A401-A1-1/2	A4E Drain to A5A	
A402-A2	A4D A4 Vent to B202A4 or 3201A4	
A403-A1	Vent so that A401A1-1/2 is Always Sealed from A5	
A501-A1-1/2	A5P Drain to Plant Low-Level Waste System	
A502-A-1/2	A5 Pump Suction from A5Q	
A503-A-3/8	A5 Pump Discharge to Monitor	
A504-A-1/2	Monitor Drain to A5N	
A505-A1	A5M Vent	
A506-A-3/4	A5-J2 Suction and Discharge A5C	
A507-A1	A5R Overflow to A302A1	
A508-A-3/4	A5B A5-J1 Suction and Discharge	
A510-A-3/8	A5E Sample Suction	
A511-A-1/4	A5D Sample Air	
A701-A-3/4	A7-J1 Suction and Discharge to A5F	
A710-A-3/8	A7 Sample Suction	
A711-A-1/4	A7 Sample Air	
D. D-34551		
C101A-1-1/2	C1-J1 Discharge to Valve Pit -	C1K1
C102A-1-1/2	C1-J2 Discharge to C2F	C1K2 Nozzle
C103A-2-1/2	Emergency VOG- C1N	
C104A-1-1/2	C1 VOG	
C110A-3/8	C1 Sample Suction	C1L1
C111A-3/8	Spare C1 Sample Suction	C1L2
C112A-1/4	Air to C110A-3/8	C1L3
C113A-1/4	Air to C111A-3/8	C1L4
C105A1	Spare Inlet from Crane Area	C1S
C106A2	Inlet from Valve Pit	C1D
A205A-1-1/2	Inlet from Valve Pit	
C301A-3/4	C1-J1 to C2R	
C310A-3/8	C3 Sample Suction	
C311A-1/4	Air to C10A-3/8	
E. D-34621		
C201A-1-1/2	C2-J1 Discharge to Valve Pit	C2K1
C202A-1-1/2	C2-J2 Discharge to C2F	C2K2 Nozzle
C203A-2-1/2	Emergency VOG - C2N	
C204A-1-1/2	C2 VOG	

Line Number	Function and Comments	

E. D-34621 (Cont'd)

C210A-3/8	C2 Sample Suction	C2L1
C211A-3/8	Spare C2 Sample Suction	C2L2
C212A-1/4	Air to C210A-3/8	C2L3
C213A-1/4	Air to C211A-3/8	C2L4
C205A1	Spare Inlet from Crane Area	C2S
C206A2	Inlet from Valve Pit	C2D
A202A-1-1/2	Inlet from Valve Pit	
C401A-3/4	C4-J1 to C2R	
C410A-3/8	C4 Sample Suction	
C411A-1/4	Air to C40A-3/8	

F. D-34552

B101A-2-1/2	C1 and C2 Emergency VOG	B1A
B102A-1	Cond. Drain to A2	B1E to A2F
B103A-2	B1 Vent	B1D to B202A4
B201A-4	B2A VOG Scrubber Outlet	
B202A-4	B2C VOG Inlet to Scrubber	
B203A-2	VOG for Cells to B202A4	
B204A-2	VOG for C1 & C2 to B202A4	
B205A-1	B2D Drain to B3D	
B301A-1	B3 Drain to B4 Pump	
B302A-3/4	B4 Pump to B2B	
B303A-3/4	B3-J1 Suction & Discharge to A2 B3B	
B304A-1	B3A B3 VOG	
B310A-3/8	B3C Sample Suction	
B311A-1/4	Sample Airlift (to B310A-3/8)	
B601A-3/4	B6-J1 Suction & Discharge to B3J	
B601A-3/8	Sample Suction	
B611A-1/4	Sample Airlift (to B610A-3/8)	
M301A-1/2	M3 to B3C	

II. Service Piping

A. D-34530

A120A-1	Steam to A1-J1	A1J
A121A-1	Steam to A1-J2	A1K
A122A-1	Steam to A1-J3	A1L
A123A-1	Steam to A1-J4	A1M
A124A-3/4	Steam to A1-J5	A1S
A125A-3/4	Steam to A1-J6	A1U
A126A-3/4	Air for Sparger	A1Q
A127A-1-1/2	CW to A1Y	(note FE)
A128A-1-1/2	A1Y to Drain	(note TL)

Line Number	Function & Comments	
A. D-34530 (Contd)		
A620A-1/2	Steam to A6-J1	
Jet Vent Header 2"	Air bleed to jets to relieve any suction caused at end of jetting	
Process Water Drain	To Storm Sewer	3"
Building Steam 4"	125 psig steam	
Jet Steam Header 2"	65 psig steam	
Process Water Header 3"	Building supply	
Air Header 1"	Plant Air	
B. D-34549		
A220A-1-1/4	Steam to A2-J2	A2J
A221A-1-1/4	Steam to A2-J2	A2L
A222A-1	Steam to A2-J1	A2U
A223A-1	Steam to A2-J3	A2V
A224A-1	Condensate Steam to Process Drain	A2S1
A225A-1	Condensate Steam to A2 Coil	A2S2
A226A-1-1/2	Steam or H_2O to A2 Coil	A2A1
A228A-1-1/2	Steam or H_2O to A2 Coil	A2A2
A230A-1-1/2	Steam or H_2O to A2 Coil	A2A3
A232A-1-1/2	Steam or H_2O to A2 Coil	A2A4
A234A-1-1/2	Steam or H_2O to A2 Coil	A2A5
A236A-1-1/2	Steam or H_2O to A2 Coil	A2A6
A227-A-1-1/2	Coil to Trap to Process Drain	A2B1
A229A-1-1/2	Coil to Trap to Process Drain	A2B2
A231A-1-1/2	Coil to Trap to Process Drain	A2B3
A233A-1-1/2	Coil to Trap to Process Drain	A2B4
A235A-1-1/2	Coil to Trap to Process Drain	A2B5
A237A-1-1/2	Coil to Trap to Process Drain	A2B6
A238A-3/4	Air Sparger	A2L
C. D-34550		
A420A-3	CW to A4C	
A421A-3	A4B CW to Drain	
A520A-1/2	Steam to A5-J1	
A521A-1/2	Steam to A5-J2	
A522A-1/2	Air Sparger	A5L
A720A-1/2	Steam to A7-J1	
D. D-34551		
C120A-1-1/2	Cooling Water to Coil	1
C121A-1-1/2	Cooling Water to Coil	2
C122A-1-1/2	Cooling Water to Coil	3
C123A-1-1/2	Cooling Water to Coil	4
C124A-1-1/2	Cooling Water to Coil	5
C-125A-1-1/2	Cooling Water to Coil	Internal Coil

Line Number	Function and Comment	

D. D-34551 (Cont'd)

C126A-1-1/2	Cooling Water to Drain	1
C127A-1-1/2	Cooling Water to Drain	2
C128A-1-1/2	Cooling Water to Drain	3
C129A-1-1/2	Cooling Water to Drain	4
C130A-1-1/2	Cooling Water to Drain	5
C131A-1-1/2	Capped	
C132A-3/4	Air to Sparger	1
C180A-3/4	Air to Sparger	9
C133A-3/4	Future Air to Sparger	2
C134A-3/4	Future Air to Sparger	3
C135A-3/4	Future Air to Sparger	4
C136A-3/4	Future Air to Sparger	5
C137A-3/4	Future Air to Sparger	6
C138A-3/4	Future Air to Sparger	7
C139A-3/4	Future Air to Sparger	8
C181A-1	Steam to C1-J1 Jet	
C182A-1	Steam to C1-J2 Jet	
C320A-1/2	Steam to C3-J1	

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C220A-1-1/2	Cooling Water to Coil	1
C221A-1-1/2	Cooling Water to Coil	2
C222A-1-1/2	Cooling Water to Coil	3
C223A-1-1/2	Cooling Water to Coil	4
C224A-1-1/2	Cooling Water to Coil	5
C225A-1-1/2	Cooling Water to Coil	Internal Coil
C226A-1-1/2	Cooling Water to Drain	1
C227A-1-1/2	Cooling Water to Drain	2
C228A-1-1/2	Cooling Water to Drain	3
C229A-1-1/2	Cooling Water to Drain	4
C-230A-1-1/2	Cooling Water to Drain	5
C-231A-1-1/2	Capped	
C-232A-3/4	Air to Sparger	1
C180A-3/4	Air to Sparger	9
C233A-3/4	Future Air to Sparger	2
C234A-3/4	Future Air to Sparger	3
C235A-3/4	Future Air to Sparger	4
C236A-3/4	Future Air to Sparger	5
C237A-3/4	Future Air to Sparger	6
C238A-3/4	Future Air to Sparger	7
C239A-3/4	Future Air to Sparger	8
C281A-1	Steam to C2-J1 Jet	
C282A-1	Steam to C2-J2 Jet	
C420A-1/2	Steam to C4-J1	

F. D-34552

B120A-1-1/2	B1C	CW Inlet
B121A-1-1/2	B1B	CW Outlet
B320A-1/2	Steam to B3-J1	
B620A-1/2	Steam to B6-J1	

III. Instrument and Electrical Piping

A. D-34530

Line Number	Function and Comments	
A140C-3/8	L&D Hi	A1Pa
A141C-3/8	D Lo	A1Pb
A142C-3/8	L Lo	A1Pc
A143C-3/8	Cell Ventilation P1 Lo	
A160B	Thermocouple A1R	
A161B	A1-J1 Discharge Thermocouple	
A162B	A1-J2 Discharge Thermocouple	
A163B	A1-J3 Discharge Thermocouple (Not Connected at Panel)	
A164B	A1-J4 Discharge Thermocouple (Not Connected at Panel)	
A165B	A1-J5 Discharge Thermocouple	
A166B	A1-J6 Discharge Thermocouple	
A143C-3/8	VOG Lo (see VOG P1 & B203-A2)	
A144C-3/8	Cell Ventilation P1 Lo	
A640C-3/8	A6 L Hi	
A660B	A6-J1 Discharge Thermocouple	

B. D-34549

Line Number	Function and Comments	
A240C-3/8	L Lo	A2N1
A241C-3/8	L & D Hi	A2N2
A242C-3/8	D Lo	A2N3
A260B	A2J2 Discharge Temperature	-
A261B	A2J4 Discharge Temperature	-
A262B	Conductivity #1 ~ Foam Indicator	A2P1
A263B	Conductivity #2	A2P2
A264B	Conductivity #3	A2P3
A265B	A2-J3 Discharge	-
A266B	A2-J4 Discharge	-
A267B	A2 Temperature	A2T1
A243C-3/8	Air to LCV on A1-J6 Jet	1
A268B	Spare Thermocouple	A2T2

C. D-34550

Line Number	Function and Comments
A340C-3/8	Air to A3 Bypass Valve
A341C-3/8	ΔP Hi Probe A3
A342C-3/8	ΔP Lo Probe A3, Hi Probe A4
A440C-3/8	ΔP Lo Probe A4
A540C-3/8	A5G L Hi
A541C-3/8	A5H L Lo
A542C-3/8	A5J D Lo (Capped)
A543C-3/8	Air to A5 Drain Valve
A560B	A5K Thermocouple
A561B	A5 Pump Power Line
A740C-3/8	A7 LS Hi
A741C-3/8	A7 LS Lo & CV Lo

Line Number	Function and Comments	
D. D-34551		
C140C-3/8	C1 D Lo	C1N1
C141C-3/8	C1 L&D Hi	C1N2
C142C-3/8	C1 Spare	C1N3
C143C-3/8	C1 L Lo	C1N4
C160B	C1P1 to TR	
C161B	C1P2 to Junction Box, Sheathed Thermocouple	
C162B	C1P3 to Junction Box, Sheathed Thermocouple	
E. D-34621		
C240C-3/8	C2D Lo	C2N1
C241C-3/8	C2 L&D Hi	C2N2
C242C-3/8	C2 Spare	C2N3
C243C-3/8	C2 L Lo	C2N4
C260B	C2P1	
C261B	C2P2	
C262B	C2P3	
C340C-3/8	C3 L Hi	
C341C-3/8	C3 & C4L Lo	
C440C-3/8	C4 L Hi	
F. D-34552		
B240C-3/8	Air to HCV-B2C on B2 By-Pass	
B241C-3/8	Air to Valve B2B	
B242C-3/8	Air to Valve HCV-B1	
B243C-3/8	Air to Valve PCV-VOG$_b$	
B244C-3/8	B2 P Lo	
B245C-3/8	B2 P Hi & VOG Lo	
B340C-3/8	L Lo B3E	
B341C-3/8	L&D Hi B3F	
B342C-3/8	D Lo B36	
B360B	Thermocouple B3H	
B440C-3/8	Air to B4 Pump Discharge Valve from FC-B4	
B460B	Power to B4 Pump	
B461B	Electronic to Flow Recorder	
B640C-3/8	B6 L Hi	
C-3/8	VOG Hi	

Valve Pit Shown on C-34620

Spec. CT-1.1

Date 5/1/60

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APPENDIX D

SPECIFICATION FOR WELDED TYPE 304L PROCESS EQUIPMENT

1.0 SCOPE

1.1 This specification provides data and special requirements for fabrication, inspection, certification and delivery of welded type 304L process equipment as described by the Purchase Order and the drawings.

2.0 REFERENCES (Material Standards Covered Elsewhere)

2.1 ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels, 1959 Edition as amended by later addenda and Case Interpretations, hereafter referred to as the Pressure Vessel Code.

2.2 Code Case Interpretation 1270N-1 (not for Classes 2 and 3)

2.3 Code Case Interpretation 1273N (not for Classes 2 and 3)

2.4 ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualification, 1959 Edition as amended by later addenda, hereafter referred to as the Boiler Code Section IX.

2.5 American Standard ASA B 31.1-1955, code for pressure piping, hereafter referred to as the Piping Code.

2.6 Standard of the Tubular Exchanger Manufacturer's Association, Latest Edition. (Applicable for heat exchangers only.)

3.0 RESPONSIBILITY

3.1 The Seller shall be responsible for the fabrication, inspection and testing of equipment in conformity with these specifications.

3.2 If the Seller notes any conflict between specifications and drawings, it is the responsibility of the Seller to notify the Company and await clarification before proceeding.

3.3 The Seller shall notify the Company of any details of the drawings and specifications that do not meet the requirements of the Pressure Vessel Code.

3.4 The Seller shall, on completion of the work, certify that the equipment conforms in all respects to the requirements of this specification.

4.0 APPROVAL OF THE COMPANY

4.1 The Seller shall submit the following items to the Company for approval prior to the actual fabrication of welded parts or assemblies. Seller must receive approval in writing before work is commenced.

4.1.1 Shop drawings* showing welding details, internal and external support details.

4.1.2 Certification that all material provided by Seller conforms to this specification. Mill reports, check analyses and mechanical test reports shall be submitted.

4.1.3 Detailed welding procedures including certified procedure and performance test reports.

4.1.4 Deviations from this specification.

4.1.5 Detailed heat treatment procedures.

4.1.6 Detailed inspection and leak testing procedures.

4.1.7 Detailed procedures for bending pipe.

*The Seller shall pay particular attention to the following: (a) the interior and exterior of all equipment shall be free of crevices which could retain solutions or fine particulate materials, (b) the joint design shall be detailed for all welds which cannot be performed by either single or double butt-welding, and (c) the weld joint design and assembly-inspection sequence for each unit of equipment shall be selected to afford maximum compliance with the fabrication, inspection, and leak testing requirements of this specification.

5.0 STAMPING

5.1 Vessels made under this specification shall be manufactured, inspected and stamped as Primary Vessels (as defined by Par (5) (b) of Code Case Interpretation 1270N-1) in accordance with provisions of Code Cases 1270N-1 and 1273N (class one only).

5.2 Vessels made under this specification shall be manufactured, inspected and stamped in accordance with the provisions of the Pressure Vessel Code.

6.0 MATERIALS

All type 304L stainless steel products, equipment, and/or components shall be as specified on the drawings, or other material procedures, and shall conform to all requirements for that type in the appropriate product form specification listed below; together with such alternate provisions or modifications as may be stated in this specification. The maximum allowable carbon content shall be 0.030%.* Check analyses as permitted in the applicable ASTM specifications are required for all ELC grades of stainless steel.

Manufacturers' certification of compliance with ASTM product form specifications shall be furnished, the certifications to include results of chemical analyses, corrosion tests, mechanical property determinations, and such other tests as are required by the applicable specifications and these modifications. Tests required by this specification, but not by the basic ASTM specification, may be certified by either the Seller or competent testing laboratory. The Company will conduct further tests as described in 6.4.1 on the material to further satisfy himself that the material meets the requirements of this specification.

All pipe and tubing shall be seamless, conforming in all respects to the applicable ASTM specification designated below.

6.1 Applicable ASTM specifications are as follows:

6.1.1 <u>Sheet, plate and strip</u> - ASTM-A167-58 (SA167 modification) or A240-58T

6.1.2 <u>Seamless and welded pipe</u> - ASTM A312-59T

6.1.3 <u>Seamless and welded tubing</u>

6.1.3.1 <u>General Service</u>, Seamless and Welded, ASTM A269-59

6.1.3.2 <u>Heat Exchanger Tubing, Seamless</u> - ASTM A213-59T

*Class 3 - carbon content 0.035% maximum allowable permitted.

6.1.4 Forgings for flanges, fittings and valves - ASTM A182-59T

6.1.5 Bars - ASTM A276-59

6.1.6 Welding Fittings - ASTM A403-59T

6.1.7 Bolting

6.1.7.1 Bolts and Studs

Bolts and studs shall conform to ASTM A193-59T, type 304, and the other requirements of this specification. Studs shall be threaded full length. Type 304L bolts are to be specified if the bolts are to be welded on.

6.1.7.2 Nuts

Nuts shall conform to ASTM A194-59T, type 303 and the additional requirements of this specification.

6.1.8 Welding Filler Metal

6.1.8.1 Bare Rods and Wire

Filler rods for use in inert gas shielded consumable and nonconsumable electrode welding shall conform to the requirements of ASTM A371-53T, with ER308L being used with type 304L, except that the carbon content shall not exceed 0.030%.

6.1.8.2 Coated Welding Electrodes

Coated welding electrodes shall conform to the requirements of ASTM A298-55T, lime coated, Type E308ELC-15; except that the carbon content shall not exceed 0.030%.

6.2 Finishes

Finishes of sheet, plate, and strip shall be as follows:

Sheet - No. 2B
Plate - No. 4
Strip - No. 2

6.3 Heat Treatment and Cleaning

All raw material used by the Seller, except welding rod, shall be obtained in the full annealed or solution heat treated condition, free from scale, cleaned and degreased.

6.4 Testing

6.4.1 Corrosion Testing (Class 1 only)

Duplicate specimens of finished wrought products from each heat or lot of type 304L products shall be given a sensitizing heat treatment at 1250°F for one hour, cooled in air, and subjected to the boiling nitric acid test of ASTM A262-55T. The average corrosion rate for five periods shall not exceed 0.0020-inch penetration per month. The electrolytic oxalic acid etching test (Pars. 7, 8, 9, 10 of A262-55T) may be used as an optional screening test. Duplicates of all corrosion samples shall be furnished the Company for additional corrosion tests.

6.4.2 Ultrasonic and/or Eddy Current Testing (Class 1 pipe only)

Pipe and tubing shall be subjected, while in the straight uncut condition, to an ultrasonic or eddy current type inspection. The procedure used shall be capable of detecting discontinuities which would render the material unsuitable by the applicable ASTM standard. Three working days notice shall be given so that the Company's inspector may witness the tests. Test procedures and results shall have the Company's written approval.

6.4.3 Fluid Penetrant

The exterior surfaces of all materials and the internal surfaces of all fittings shall be subjected to a 100% fluid penetrant inspection of the fluorescent post emulsification type. All discontinuity indications shall be explored. If exploration proves a defect exists it may be repaired within the limits defined in the applicable ASTM specification or the material shall be rejected. Penetrant tests shall be witnessed by the Company's inspector. The Seller shall give three working days notice prior to the performance of testing.

7.0 WELDING PROCEDURES AND QUALIFICATIONS

7.1 Procedures shall be prepared and qualified. The type and number of tests required for procedure and performance qualifications in Sections VIII and IX of the Code shall be made employing the materials, welding sequences, and typical joint designs to be used in actual fabrication. Mechanical tests shall not be performed on those joints which are not prescribed by the Code for procedure and welder qualification. All tests, in addition to those required by the Code, however, which are required under this specification (e.g., radiography, visual, and penetrant inspection) shall be performed as part of the qualification procedure for each typical joint design.

Test welds shall be radiographed and shall meet the radiographic standards of 11.3 together with all other requirements of Sections VIII and IX of the Code over the entire length of the weld from which the bend and tensile specimens are to be taken. Starting and stopping extensions, if employed, shall be radiographed and evaluated as part of the tests.

7.2 Welding procedures for tube-to-tube sheet welds shall be qualified by making ten representative welds which shall be inspected metallographically after sectioning by quartering. No porosity, cracking, or tungsten or slag inclusion shall be allowed. If welding is done manually, the welder making tube-to-tube-sheet welds shall have previously qualified for welding as further specified under this specification. The thickness of welds, as measured from the extremity of the annulus between the tube and the tubesheet to the weld bead surface, shall be a minimum of 1-1/4 times the thickness of the tube wall (heat exchangers only).

7.3 Results of all procedure and performance qualification tests shall be submitted to the Company for written approval prior to the beginning of welding.

7.4 The Company's representative shall be permitted to observe any portion of this testing and examine test samples.

7.5 No welding shall be performed under this specification unless the welder has qualified to the approved procedure.

8.0 FABRICATION

8.1 Materials Control

8.1.1 All materials employed in the fabrication of this equipment shall retain their identification markings through all phases of fabrication.

8.1.2 The control of welding materials such as welding wire, not lending themselves to identification by marking, shall be such that only approved welding wire or rods will be used in the fabrication.

8.2 Formed Heads

The formed heads shall be penetrant inspected over their entire area for cracks and other discontinuities that may have developed during forming operations.

8.3 Machined Parts

All material which requires machining operations during fabrication, such as transfer jets, shall be dye penetrant inspected over all machined surfaces in accordance with the provisions of Section 6.4.3 above, subsequent to machining and prior to welding.

8.4 Pipe Bends

8.4.1 Where the bending of tubular products is required, the Seller shall submit for the Company's approval a qualified procedure for bending, control of flattening, wall scoring and thinning, and the control limits to be maintained for these specific cases. The wall thickness of the finished bends shall be not less than 87-1/2% of nominal.

8.4.2 Ultrasonic and penetrant inspection methods shall be used for the detection of cracks and other discontinuities that may encroach on the allowable minimum wall thickness.

9.0 WELDING

9.1 Welding shall, as a minimum, be equivalent to the requirements of Parts UW, UG, and UHA of Section VIII, and Section IX of the ASME Boiler and Pressure Vessel Code, 1959 Edition, subsequent interpretations, modifications and addenda, and shall also meet the additional requirements stated herein, or as may be contained on the drawings.

9.2 Except as specified in Section 9.3 below, all welds joining parts contacting the process fluids shall be either full penetration double welds or single groove welds with backing beads, or equivalent as described in UW-12, Section VIII, 1959 Edition of the ASME Code.

9.3 All welds which are employed in attaching support members to the vessel or its internals and all welds which are used in assembly of transfer jets shall be continuous and shall afford a complete seal of crevices formed by the contacting surfaces. Complete penetration at the root of fillet-type welds shall be assured.

9.4 The portion of the weld which will be in contact with process fluids shall preferably be made by the tungsten inert gas process (TIG) with inert gas backup to a minimum depth of 1/4 inch, except where material dictates a weld thickness of less than 1/4 inch, in which case the entire weld will be made by the TIG process. Filler metal shall be added in each pass. Metal arc welding on the solution side may be used only if the weld reinforcement is ground flush and the ground surface proved completely sound by penetrant inspection.

9.5 Backing rings may be used only if subsequently they are completely removed and the weld reinforcement is ground flush and penetrant inspected.

9.6 In cases where the weld is made from one side only, as in case of a final closure weld of a tank, or a pipe weld, the weld shall be made full penetration, the root and subsequent passes shall be made by the tungsten inert gas process with complete inert gas backup during the first 1/4 inch (depth) deposition of weld metal.

9.7 Particular effort shall be made to ensure that the inaccessible weld surfaces of all welds meet the requirements of Part 11.2.2.2.

9.8 Materials to be welded shall be stainless steel wire brushed and then cleaned for a distance of at least two inches from the weld area, using acetone, or other acceptable chlorine-free solvent. Filler wire shall be cleaned before use by applying an abrasive, such as emery cloth, to the full length of the wire, fillowed by a rinse as described above. After cleaning, the filler wire and base material shall be kept clean.

9.9 All tube-to-tube sheet welds shall be made by the tungsten inert gas process (TIG) (heat exchangers only).

9.10 Filler metal shall be added in all passes, except for those welds described in 9.9 above. (Heat exchangers only.)

10.0 STRESS RELIEVING

All pipe bends, coils and formed heads of vessels shall be given a stress relieving thermal treatment as follows:

The material shall be heated gradually to from 1500°F to 1650°F, held for one hour for each inch of cross section, and air cooled. This treatment shall be performed in a tight muffle furnace with a protective atmosphere which will assure that the product, as removed from the furnaces, shall be bright and free from scale. Prior to heating for stress relief, all surfaces must be clean and dry. All greases, oil, drawing compounds, finger and chalk marks and any other foreign matter shall be removed prior to heating. Details of all stress relief methods shall be submitted by the seller and approved in writing by the company prior to use.

11.0 INSPECTION

11.1 The Seller shall furnish sufficient personnel to perform the inspection required to ensure that the provisions of the specifications are carried out and to maintain adequate records. The presence of the Company's inspector at the Seller's plant shall not relieve the Seller of the responsibility for performing inspection to satisfy these requirements. The inspector representing the Company shall have free entry at all times to all parts of the Seller's works or those of his sub-contractor, where work on the contract is being performed. The Seller shall afford, without charge, all reasonable facilities to satisfy the inspector that the fabrication is being furnished in accordance with these specifications.

All tests and inspection, special or routine, shall be made at the place of manufacture prior to shipment, and at the Seller's expense, unless otherwise specified.

11.2 Visual Inspection

All weld areas and adjacent base metal shall be inspected before, during, and after welding. Visual aids, such as mirrors and boroscopes, shall be employed as required.

11.2.1 Weld deposits shall be thoroughly cleaned with a stainless steel wire brush after each pass. Each bead shall be visually inspected, and the first three layers on the process fluid side shall be penetrant inspected for evidence of cracks, craters, pinholes, lack of fusion and excessive oxidation. All such indications shall be completely removed by grinding or chipping. The cause of excessive oxidation shall be determined and remedied. Before proceeding with the next pass the weld area shall be thoroughly cleaned with acetone or other chlorine-free solvent which shall be the last operation performed prior to welding.

11.2.2 Upon completion of any weld (including attachment welds for internal or external supports) including such grinding and machining as may be employed, the welded joint shall be subjected to visual and liquid penetrant examination for the full length of the weld, both front and back (provided the back side is accessible) and shall conform to the following:

11.2.2.1 The appearance of the welds shall indicate that they were made in a workmanlike manner with no undercut or overlap.

11.2.2.2 The internal and external reinforcement of butt welds shall blend smoothly with the base metal at the weld edges and shall be uniform in width and height and range from flush to the maximum permitted by UW-51(b), Section VIII of the Code, above the surface of the base metal.

11.2.2.3 Any discontinuity or excessive oxidation revealed by visual or fluid penetrant examination shall be ground out and repaired.

11.3 Radiography (Class 1 only)

All welds except those employed in attaching support members to vessels or their internals shall be radiographed in accordance with the provisions of this specification and shall show no porosity, tungsten contamination or slag inclusions greater than size "fine" and shall contain not more than the amount of such indications as allowed for size "medium" in the porosity charts of Appendix IV of Section VIII of the ASME Boiler and Pressure Vessel Code. For materials thinner than 1/4 inch the size of the porosity, inclusions, etc., shall not exceed 12-1/2% of the material thickness. Indications of cracks, lack of fusion or incomplete penetration shall be cause for rejection.

12.0 TESTING

All leaks found by the following tests shall be repaired in an approved manner and the tests that revealed leakage shall be reapplied. If repairs are made following heat treatment, heat treatment shall be reperformed at the discretion of the Company.

12.1 Hydrostatic Test of Vessel

A hydrostatic test shall be applied to the vessel at a pressure and duration as specified on the drawing. At the Seller's request and on approval by the Company the hydrostatic test may be applied after the helium leak testing prescribed in 12.2.

12.2 Helium Leak Testing

After the vessels are fabricated and all welding attachments have been made, a helium leak test will be performed. A mass spectrometer type leak detector (Consolidated Engineering Corporation Model 24-101A or 24-102 or equal) will be applied to one vessel nozzle. To a second nozzle, as remote from the first as feasible, a standard helium leak (furnished by the Company) will be attached. A standard leak will have a leak rate of 21 x 10^{-7} atmospheric cc/sec (0.18 atmospheric cc per day). The elapsed time of appearance of helium admitted through the standard leak at the detector shall be noted. Helium flooding the outside of the vessel (at least three volumes) shall be maintained for at least twice the former observed elapsed time. If no leakage is indicated the test shall be terminated.

12.3 After the hydrostatic test, a rate of rise leak test may be substituted for the helium leak test (par 12.2) at the request of the Seller and the approval of the Company.

12.3.1 All vessels and or volumes of vessels which can contain a full vacuum shall be evacuated individually to a pressure of less than 5 microns and subjected to a rate of rise leak test. Leakage in excess of 0.02 cc (STP) of air per hour in a two-consecutive hour period shall be cause for rejection.

12.3.2 Vessels and or volumes of vessels which cannot contain a full vacuum shall be individually leak tested at the maximum allowable vacuum which the vessel or volume can stand. Leakage in excess of 0.05 cc (STP) of air equivalent per hour shall be cause for rejection.

13.0 RADIOGRAPHIC TECHNIQUE

Radiographic technique shall be as specified in UW-51, Section VIII of the Code, with the quality standards of 11.3 substituted for the requirements of UW-51(m).

14.0 CLEANING

All equipment components shall be delivered free from scale and degreased. No sand blasting shall be permitted. No chlorine or chloride containing agent shall be used for cleaning.

15.0 CERTIFICATIONS

Seller shall submit to the Company, prior to shipment of the equipment, three (3) copies of all material certifications, check analyses and reports of all mechanical and other tests required by this specification.

16.0 NAMEPLATE

The nameplate shall be of type 304L stainless steel as used in the fabrication and shall be continuously welded to the vessel (see Section 9.3).

17.0 PREPARATION FOR SHIPMENT

17.1 The equipment shall be free of trash and other foreign matter on the inside.

17.2 All openings shall be covered with protective closures which shall be taped at the edges. Galvanized materials shall not be used for caps or covers.

17.3 The Seller shall be responsible for the proper packing and/or crating of the complete equipment to prevent damage during shipment and handling and shall further provide additional wooden supports within each vessel as deemed necessary to prevent damage from coil movement or vibration. The use of springs or other cushion-type materials shall be at the discretion of the Seller.

APPENDIX E

TELEMETERING FOR THE HIGH AND INTERMEDIATE LEVEL WASTE FACILITY

The initial instrumentation estimate will include the cost of telemetering the points below as a sub-unit separable from the over-all estimate:

1) Level Recorder:

LR-A1	Feed Tank	D-34530
LR-A2	Evaporator	D-34549

2) Temperature Recorder - six points

3) Foam Indicator:

   CI-A2 - This multipoint indicator will be installed so that when uppermost probe indicates foam, the steam to the evaporator is shut down - D-34549

4) Two process water waste monitors requiring radiation recorder, flow recorder and proportional sampler. One of these units will be the latest Laboratory Standard for manhole installation for total building process waste discharge. The second will be installed in the Sampling Area shown on E-34525 and draw its sample from A5. For this second unit a recording flowmeter will replace the weir and actuate the proportional sampler. Flows for this stream will range from 0 to 750 gph.

5) Pressure Alarms:

   PA-VOG

   PA-CV

Distribution

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