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OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION
POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37830

[redacted]

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SUBJECT: Decommissioning Study for the ORNL Molten-Salt Reactor Experiment (MSRE)

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FROM: C. D. Cagle and L. P. Pugh

ABSTRACT

Job descriptions and cost estimates have been prepared for two methods of decommissioning the shutdown Molten-Salt Reactor Experiment (MSRE). Dismantling of all process equipment for disposal in a solid-waste storage area is estimated to cost $11,600,000. Transferring all contaminated external equipment to the reactor containment cell followed by filling the cell with concrete for in-place entombment is estimated to cost $4,770,000. Also included are a history of the reactor, a description of the components, and a list of references.

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1. INTRODUCTION

Research and development programs dealing with nuclear reactors and their radioactive products have been carried out at ORNL since its beginning in 1943. An increasing number of radioactive and radioactively contaminated facilities have been shut down due to completion of programs or to being supplanted by more up-to-date facilities. Since these shut-down facilities contain hazardous amounts of both fixed and removable radioactive materials, they must be kept under constant surveillance and structurally maintained to preclude unauthorized entry by personnel and to ensure against the release of radioactive contaminants to the environment. A portion of the financing and all personnel attention required for surveillance and maintenance of these facilities must be supplied by on-going programs not related to the original programs which produced the facilities. Although some advantage is gained in delaying final disposition of such shutdown facilities to await decay of relatively short-lived nuclides, further delay not only penalizes other programs but also increases the risk of violation of containments due to deterioration or accident.

The shutdown facilities include four reactors: the Molten-Salt Reactor Experiment (MSRE), shut down in 1969; the Homogeneous Reactor Experiment No. 2 (HRE-2), shut down in 1961; the Low-Intensity Testing Reactor (LITR), shut down in 1966; and the Oak Ridge Graphite Reactor (OGR), shut down in 1963. This report considers the final disposal of the MSRE.

The two methods of disposal considered are: (1) removal and burial of all radioactive and contaminated systems components in a solid-waste disposal area; and (2) entombment of the more radioactive items in concrete within the existing below-grade concrete-shielded cells. Both approaches assume that the ^{233}U now stored in drain tanks in a shielded cell adjacent to the reactor cell will have been removed prior to beginning the decommissioning.

This report contains a brief history of the project and sufficiently detailed descriptions of the radioactive and auxiliary systems to explain

the work that will be required to accomplish the decommissioning. More detailed descriptions of the systems and components can be found in the references.

The MSRE was a 10-MW reactor built to investigate the practicality of the molten-salt concept for central power station applications. The reactor and its accessory components are located in a group of mostly below-grade shielded concrete cells within a mill-type building remote from the main ORNL area. The last charging of fuel salt containing ^{233}U as the fissionable species remains stored in two drain tanks in a cell adjacent to the reactor cell. This salt must be heated to above 300°F annually to recombine radiolytically produced fluorine gas. Due to the presence of the fuel and the residual radioactive fission and corrosion products within it and distributed throughout the reactor primary system and fuel-processing system, a filtered ventilation system must be maintained in operation. Additionally, varying degrees of surveillance and maintenance efforts must be exercised on a daily, a monthly, and an annual basis to guarantee that the reactor remains environmentally safe.

2. GENERAL INFORMATION

2.1 General Description

The MSRE was a single-region, unclad-graphite-moderated, homogeneous-fuel type reactor with a design heat generation of 10 MW. The circulating fuel solution was a mixture of lithium, beryllium, and zirconium fluoride salts containing uranium fluoride as the fuel. The mixture had an euctectoid liquidus point of 840°F and operated normally at 1200°F core outlet temperature. Reactor heat was transferred from the fuel salt to a similar coolant salt and then dissipated to the atmosphere.

2.2 History

The MSRE was constructed during the years 1961-1964 in a building originally built for molten-salt reactor experiments for the Aircraft

Nuclear Propulsion Program (ANP). The purpose of the MSRE was to demonstrate that such a reactor could be constructed and maintained without undue difficulty and could be operated safely and reliably. Additional objectives were to provide the first large-scale, long-term, high-temperature tests in a reactor environment of the fuel salt, graphite moderator, and high-nickel-base alloy (INOR-8) construction material.

The reactor first reached criticality on June 1, 1965, and concluded operation on December 12, 1969. During this time the reactor accumulated 72,441 MW-hrs using ^{235}U fuel and 33,296 MW-hrs using ^{233}U fuel for a total of 105,737 MW-hrs which is equivalent to 13,217 equivalent full-power hours at 8.0 MW full power.

2.3 Reactor Site and Building

The MSRE is located in Melton Valley about one-half mile southeast of the main ORNL area (Figure 1) near the High Flux Isotope Reactor (HFIR) and the Homogeneous Reactor Test (HRT) sites. A plot plan of the reactor building complex is shown in Figure 2. Figures 3 and 4 are views of the front and rear of the building.

The building is constructed of steel framing and asbestos cement type corrugated siding with a sheet steel interior finish. Essentially all portions of the building below grade are constructed of reinforced concrete. Figure 5 is a plan of the reactor building at grade level, and Figure 6 is a plan 12 ft below grade showing the shielded cells and adjacent working areas. Figure 7 is an elevation through the cells. The west half of the building at grade level is about 42 ft wide, 157 ft long, and 33 ft high. This high-bay or "crane-bay" area houses the reactor cell drain-tank cell, coolant-salt "penthouse", and most of the auxiliary cells. It is serviced by two bridge cranes, one equipped with a 30-ton hoist and the other with both a 3-ton and a 10-ton hoist. The east half is 38 ft wide, 157 ft long, about 12 ft high. This section contains the control rooms, maintenance shops, change rooms, and some offices. (As explained in Section 3.5, some of these areas are now in use by groups not related to the MSRE program.)

Most of the west half of the below-grade level is occupied by the reactor cell, drain-tank cell, and auxiliary cells. The east half contained an office, a maintenance shop, and a chemical laboratory.

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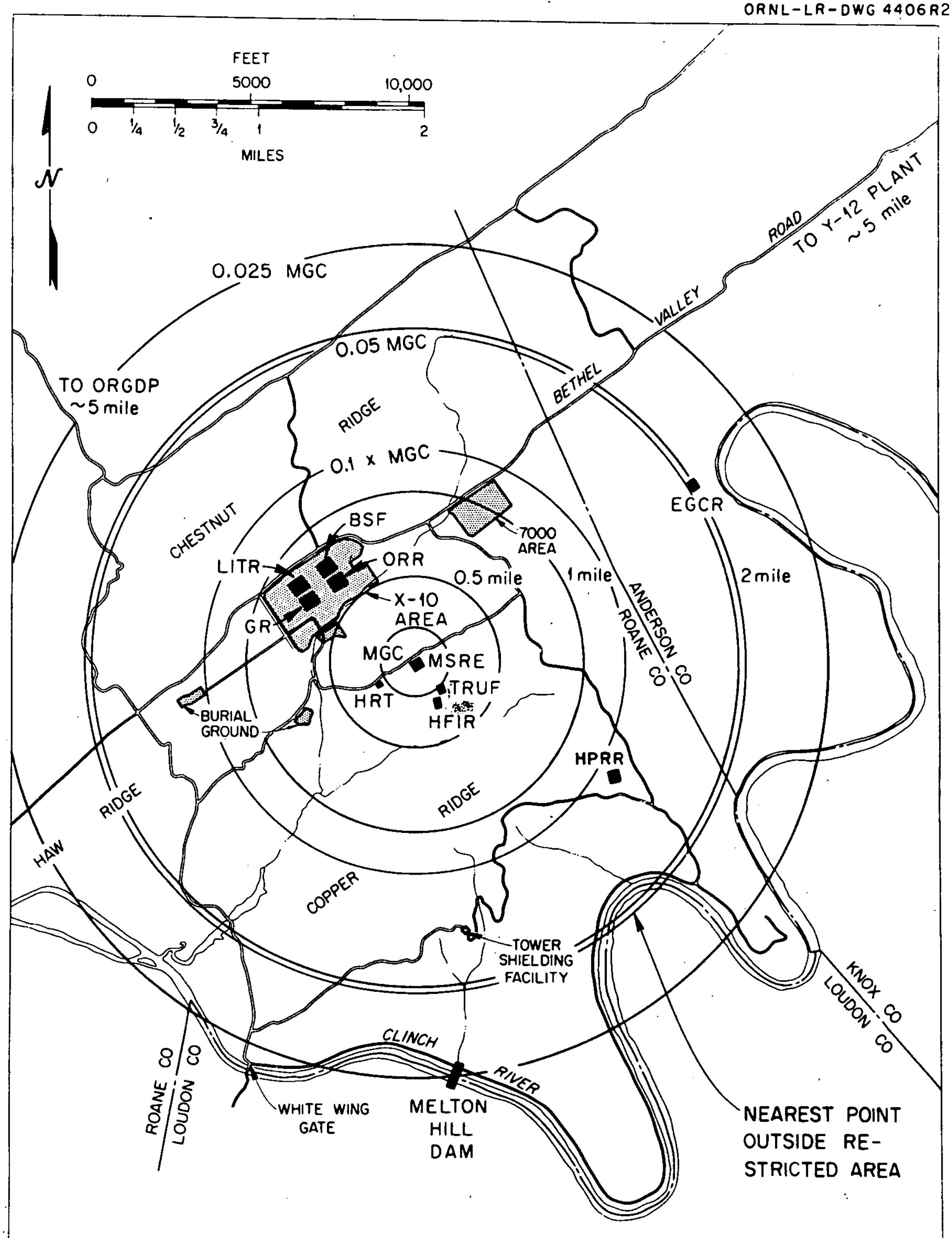

Figure 1. ORNL Area Map

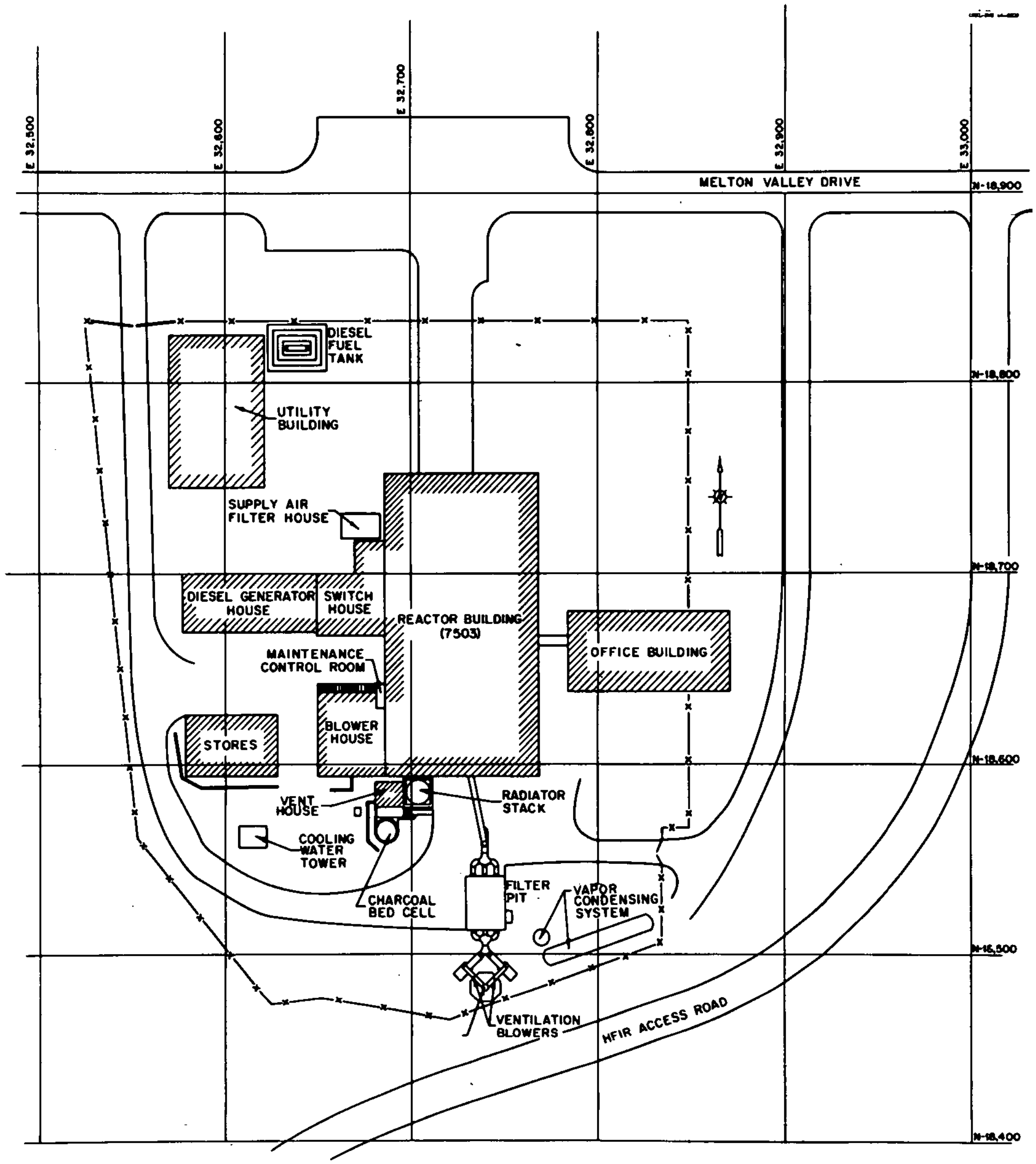

Figure 2. Plot Plan, Molten-Salt Reactor Experiment (Bldg. 7503)

Figure 3. Front View of Bldg. 7503

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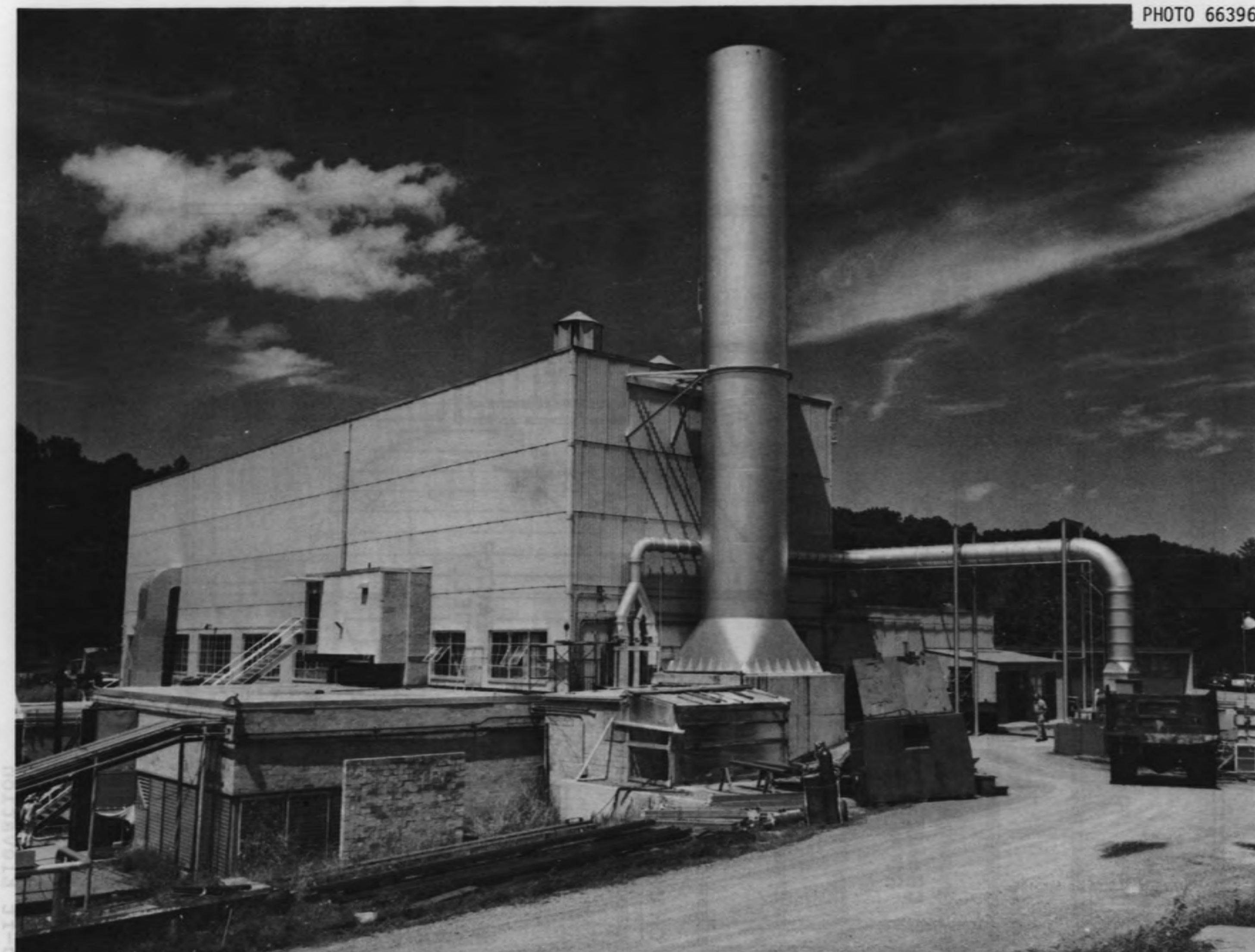

Figure 4. Rear View of Bldg. 7503 During MSRE Construction

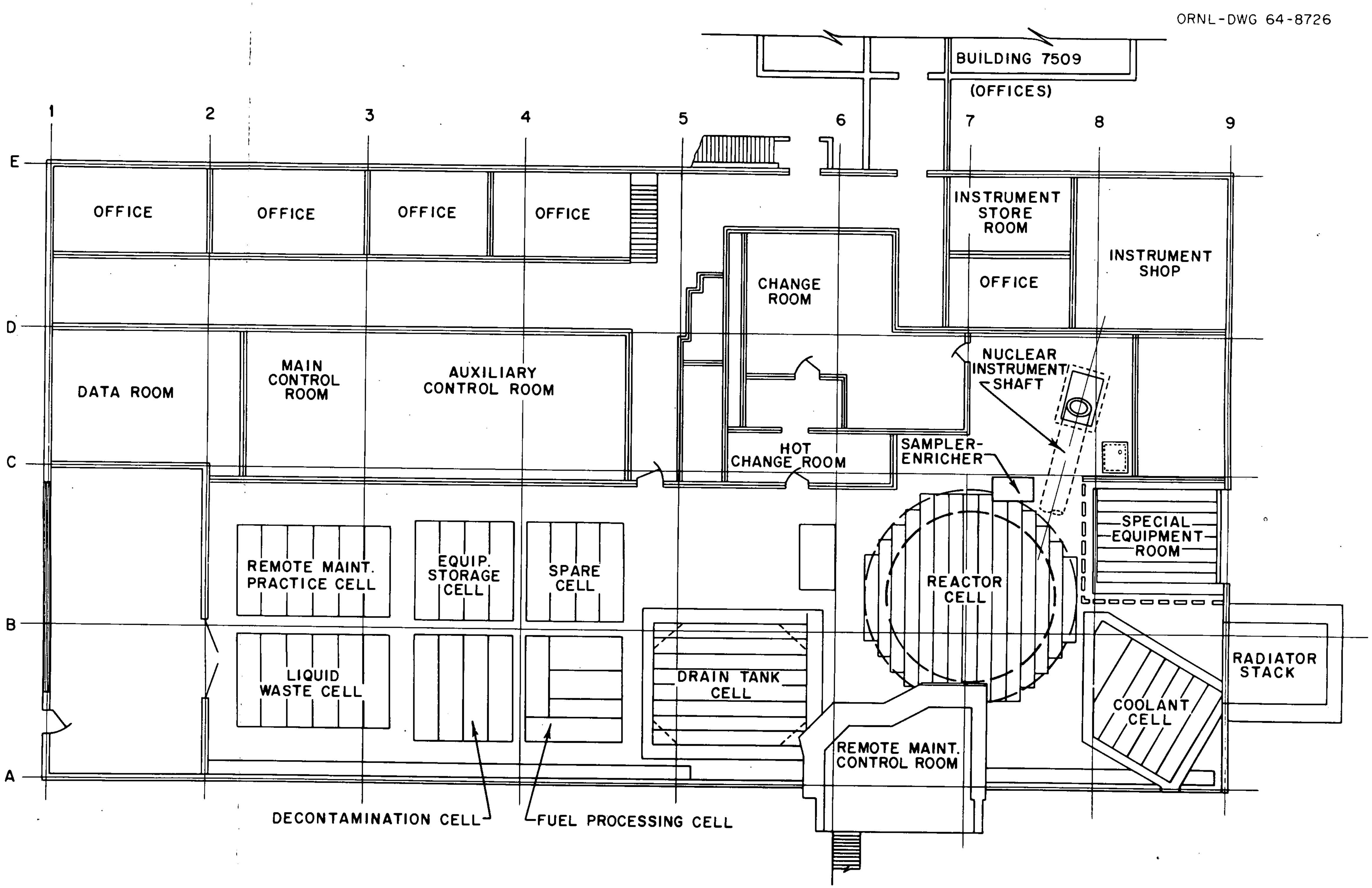

Figure 5. Plan at 825-ft Elevation

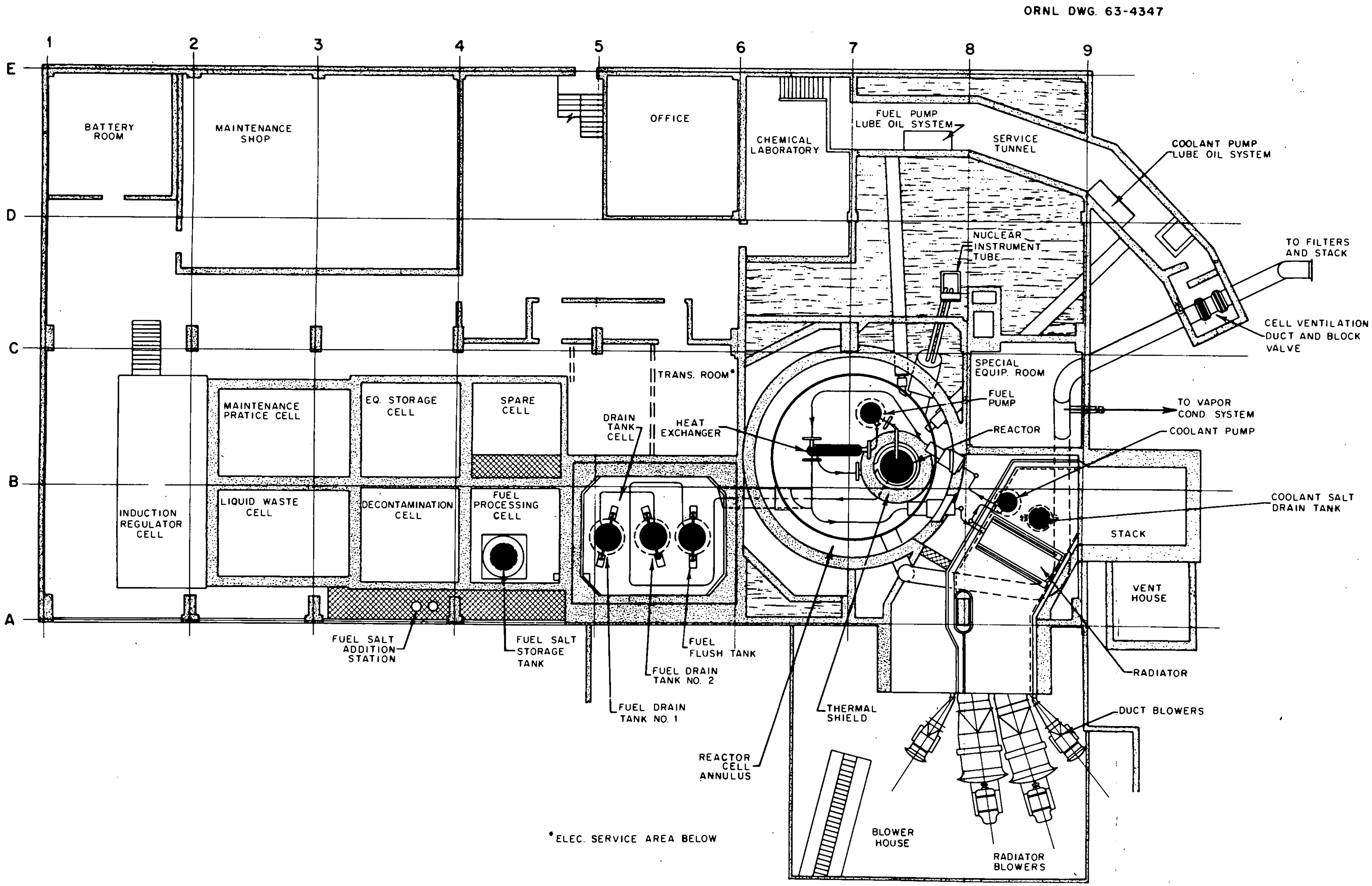

Figure 6. Plan at 840-ft Elevation

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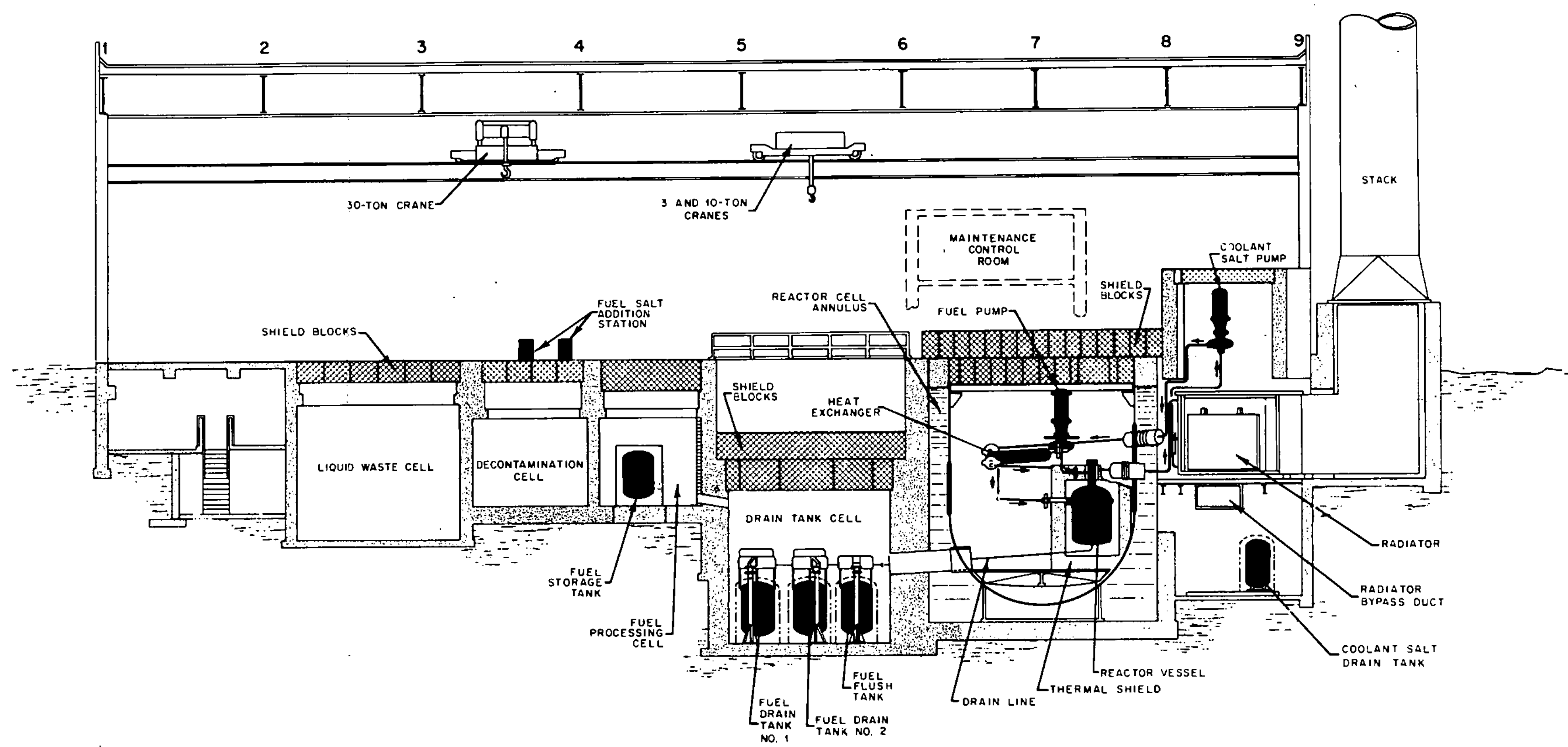

Figure 7. Elevation, Bldg. 7503

2.4 Shielded Containment Cells

As shown in Figures 5 and 6 the reactor and its accessory components are located in a group of shielded cells rather than in a single containment. This arrangement enhanced accessibility for maintenance and greatly reduced the number of components incurring induced radioactivity due to neutron irradiation. Only those components and structures within the reactor shield tank were subjected to neutron irradiation and must be partially or totally removed to reduce the radiation level. All other cells will require only decontamination following either the removal or decontamination of the items within them. Access to the cells is gained by the removal of concrete roof plugs. The reactor cell and the adjacent interconnected fuel-drain-tank cell have an 11-gage stainless steel membrane between the two layers of concrete roof plugs as a containment seal. Access to the cells is gained by cutting an opening in the membrane. When the cell is to be resealed, a patch is welded over the opening. The top shielding arrangements for the reactor cell and drain-tank cell are shown in Figures 8 and 9.

The reactor cell is a cylindrical carbon steel vessel 24 ft in diameter and 33 ft in overall height with a hemispherical bottom and a flat top. The bottom is 1 to 1 1/4 in. thick and the cylindrical portion is 2 in. thick except for the section containing the large penetrations where it is 4 in. thick. The reactor cell vessel is installed within another cylindrical steel tank referred to as the "shield tank". This outer tank is 30 ft in diameter by 35 1/2 ft high. The flat bottom is 3/4 in. thick and the cylindrical section is 3/8 in. thick. The tank is supported on a reinforced concrete base within an enclosure formed by concrete soil-retaining walls and the concrete walls of adjacent cells. The reactor cell vessel rests upon a cylindrical steel skirt supported from the bottom of the shield tank. The annulus between the two tanks is filled with magnetite sand and water; the cavity encompassed by the support skirt is filled only with water.

Penetrations into the reactor cell for pipes and conduits were provided by installing a bellows-equipped sleeve between openings in the two vessels (Figure 10). The purpose of the bellows was to accommodate

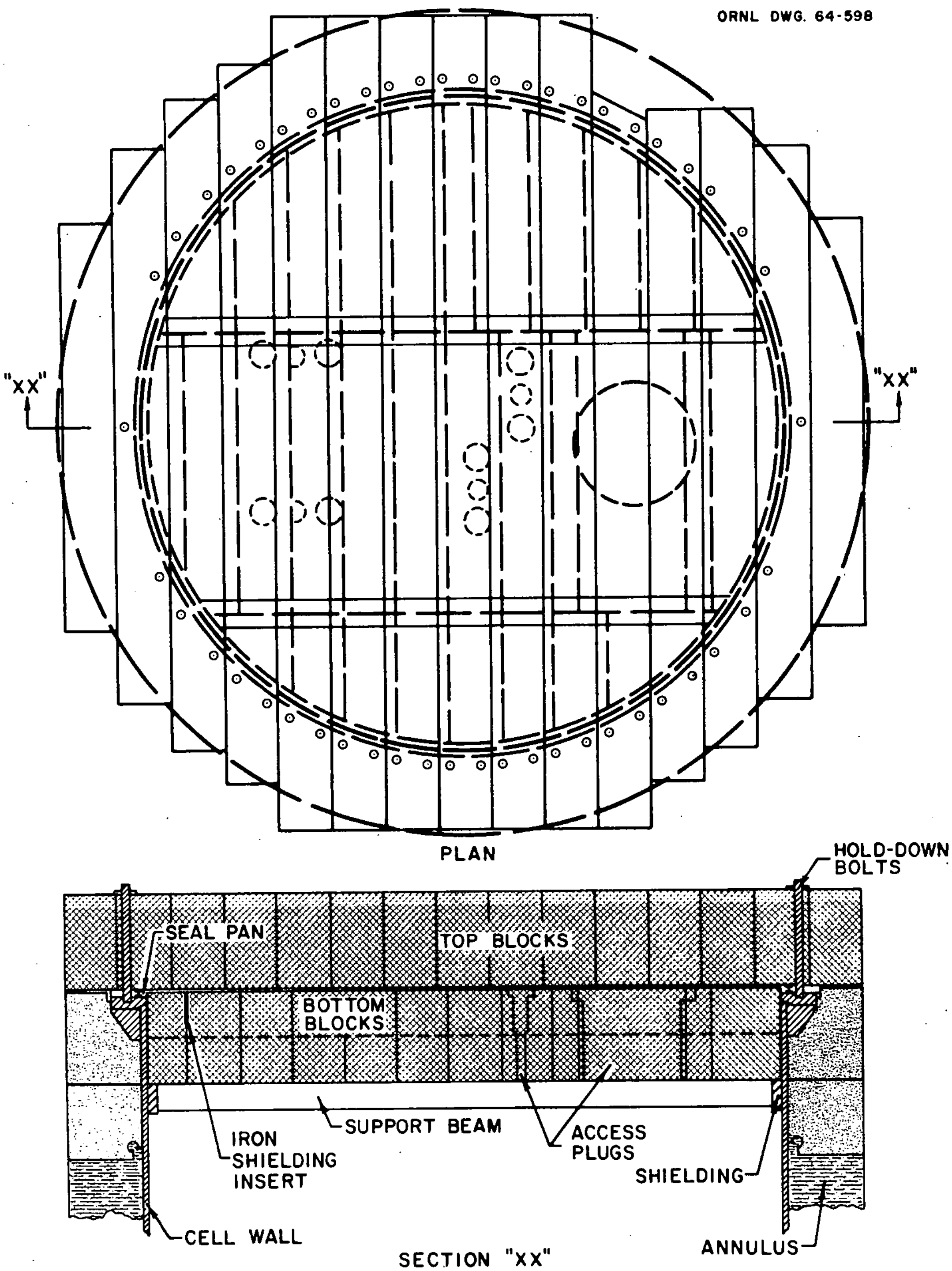

Figure 8. Shield Block Arrangement at Top of Reactor Cell

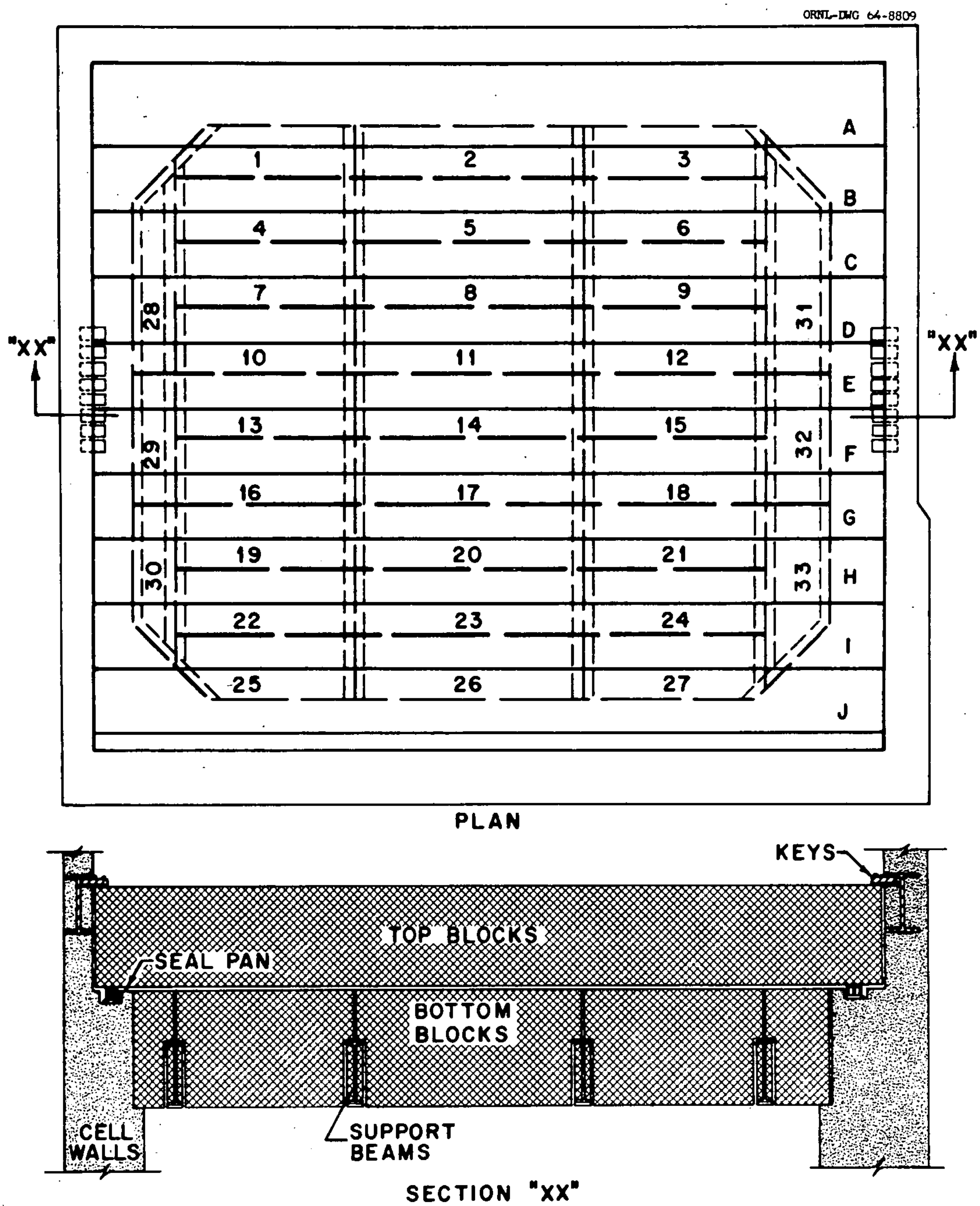

Figure 9. Shield Block Arrangement at Top of Drain-Tank Cell

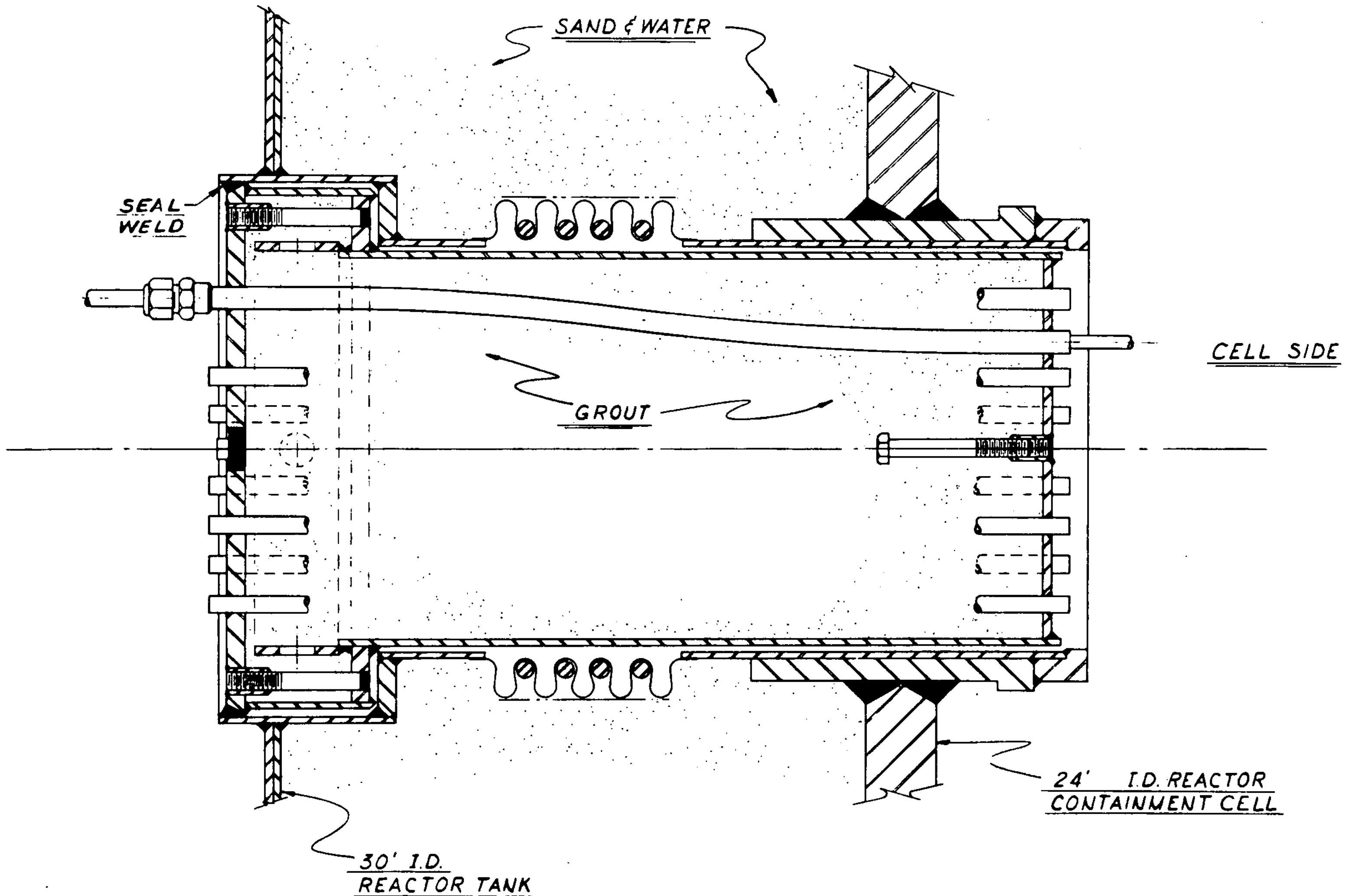

Figure 10. Typical Penetration Assembly - Reactor Cell

dimensional changes due to temperature and pressure. Pipes and conduits pass through stepped shielding plugs which fit into the penetration sleeves. The pipes and conduits are seal-welded to the two faces of the plugs and are curved or offset within the plug to prevent radiation streaming. The outer rim of the shield plug is seal-welded to the sleeve. Since the reactor cell atmosphere extended to this seal weld, the sleeves and shield plugs are contaminated up to that region.

2.5 Reactor Primary System

The major components of the reactor primary system are the reactor vessel, the fuel-salt pump, the heat exchanger, and the interconnecting pipes and flanges. All of these components are located inside the reactor cell. Figure 11 is the fuel system process flow sheet showing both the primary system itself and the various subsystems.

Except for the graphite moderator, all the materials of the primary system that were in contact with the fuel salt are Hastelloy-N (INOR-8), a nickel-molybdenum-iron-chromium alloy which is highly resistant to corrosion by molten fluoride salts and has high strength at elevated temperatures. The properties of this material are listed in Table 1. Figure 12 is a simplified flow diagram of the reactor primary and secondary systems and Figure 13 is a layout of these systems. Figure 14 is a photograph of the reactor cell with the components partially installed.

2.5.1 Reactor Vessel and Core

Physical characteristics of the reactor vessel and its contents are listed in Table 2.

The reactor vessel is 58 in. I.D. and about 94 in. high (Figures 15 and 16). The wall thickness of the cylindrical portion is 9/16 in. except for the top 16 in., which is 1 in. thick. An 8-in.-I.D. half-round welded circumferentially to the tank over the 1-in.-thick section served as the fuel-salt inlet flow distributor. The salt delivered by the distributor entered the tank through 3/4-in.-diameter holes drilled through the 1-in.-thick section. The salt flow from the flow distributor entered the annular space between the vessel and core container and flowed downward providing efficient cooling for the core can and reactor vessel walls

Table 1. Composition and Properties of INOR-8

Chemical Properties:

Ni	66-71%
Mo	15-18
Cr	6-8
Fe, max	5
C	0.04-0.08
Ti + Al, max	0.50
S, max	0.02
Mn, max	1.0
Si, max	1.0
Cu, max	0.35
B, max	0.010
W, max	0.50
P, max	0.015
Co, max	0.20

Physical Properties:

Density, lb/in.^{3}	0.317
Melting point, °F	2470-2555
Thermal conductivity, BTU/hr-ft^2(F/ft) at 1300°F	12.7
Modulus of elasticity at ∿1300°F, psi	24.8×10^6
Specific heat, BTU/lb-°F at 1300°F	0.138
Mean coefficient of thermal expansion, 70-1300°F range, in./in.-°F	8.0×10^6

Mechanical Properties:

Maximum allowable stress,* psi:	at 1000°F	17,000
	1100°F	13,000
	1200°F	6,000
	1300°F	3,500

*ASME Boiler and Pressure Vessel Code Case 1315.

Table 2. Reactor Vessel and Core Design Data and Dimensions

Construction material	INOR-8
Inlet nozzle, Schedule 40, in., IPS	5
Outlet nozzle, Schedule 40, in., IPS	5
Reactor vessel	
O.D., in.	59 1/8 (60 in. max)
I.D., in.	58
Wall thickness, in.	9/16
Overall height, in. (to centerline of 5-in. nozzle)	100 3/4
Head thickness, in.	1
Inlet	Constant area distributor
Cooling annulus I.D., in.	56
Cooling annulus O.D., in.	58
Graphite core	
Diameter, in.	55 1/4
Number of regular graphite core blocks	513
Number of fractional core blocks	104
Core block size, in. (regular)	2 x 2 x ∿67
Core container	
I.D., in.	55 1/2
O.D., in.	56
Wall thickness, in.	1/4
Height, in.	68

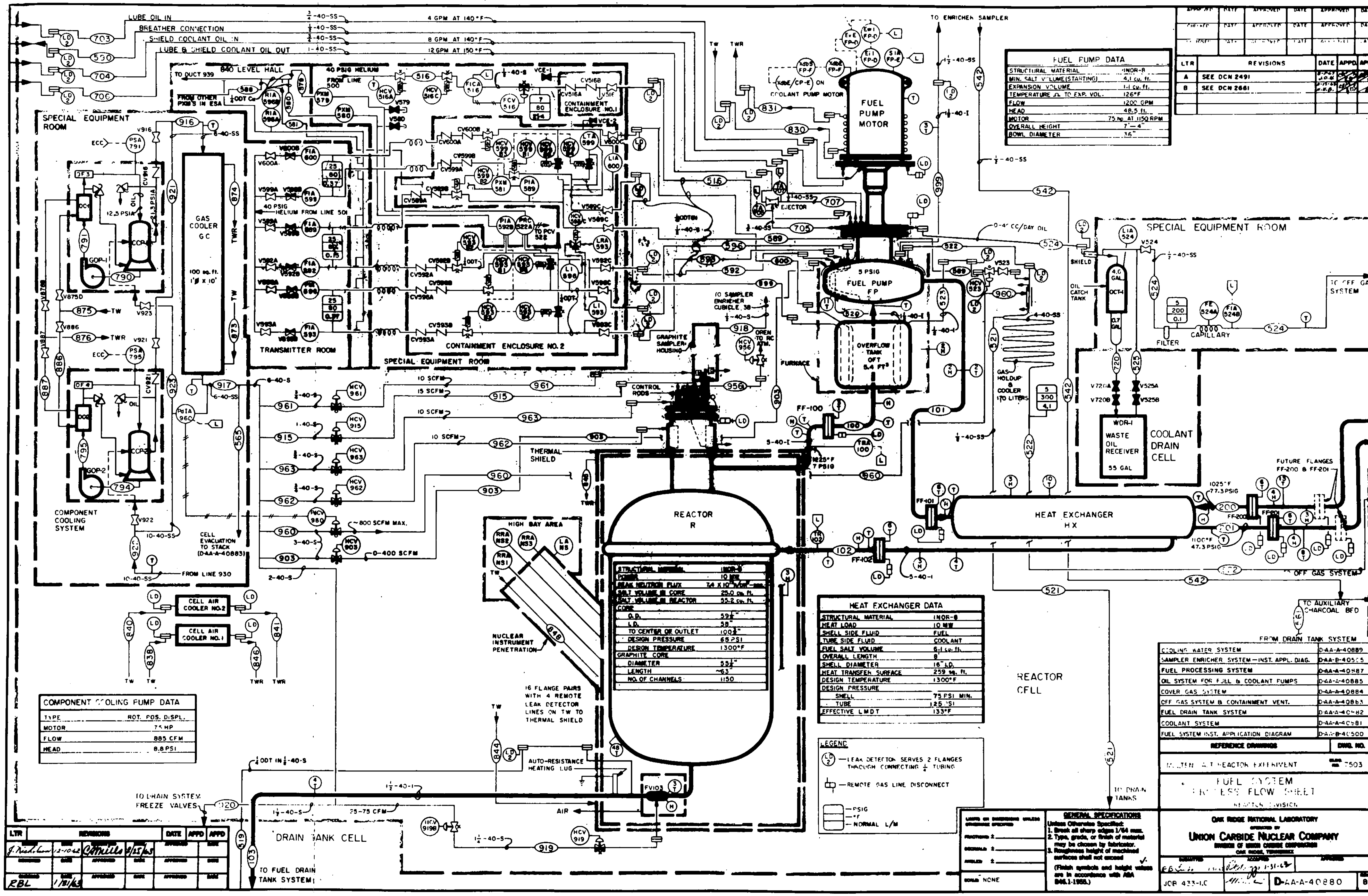

Figure 11. Fuel System Process Flow Sheet

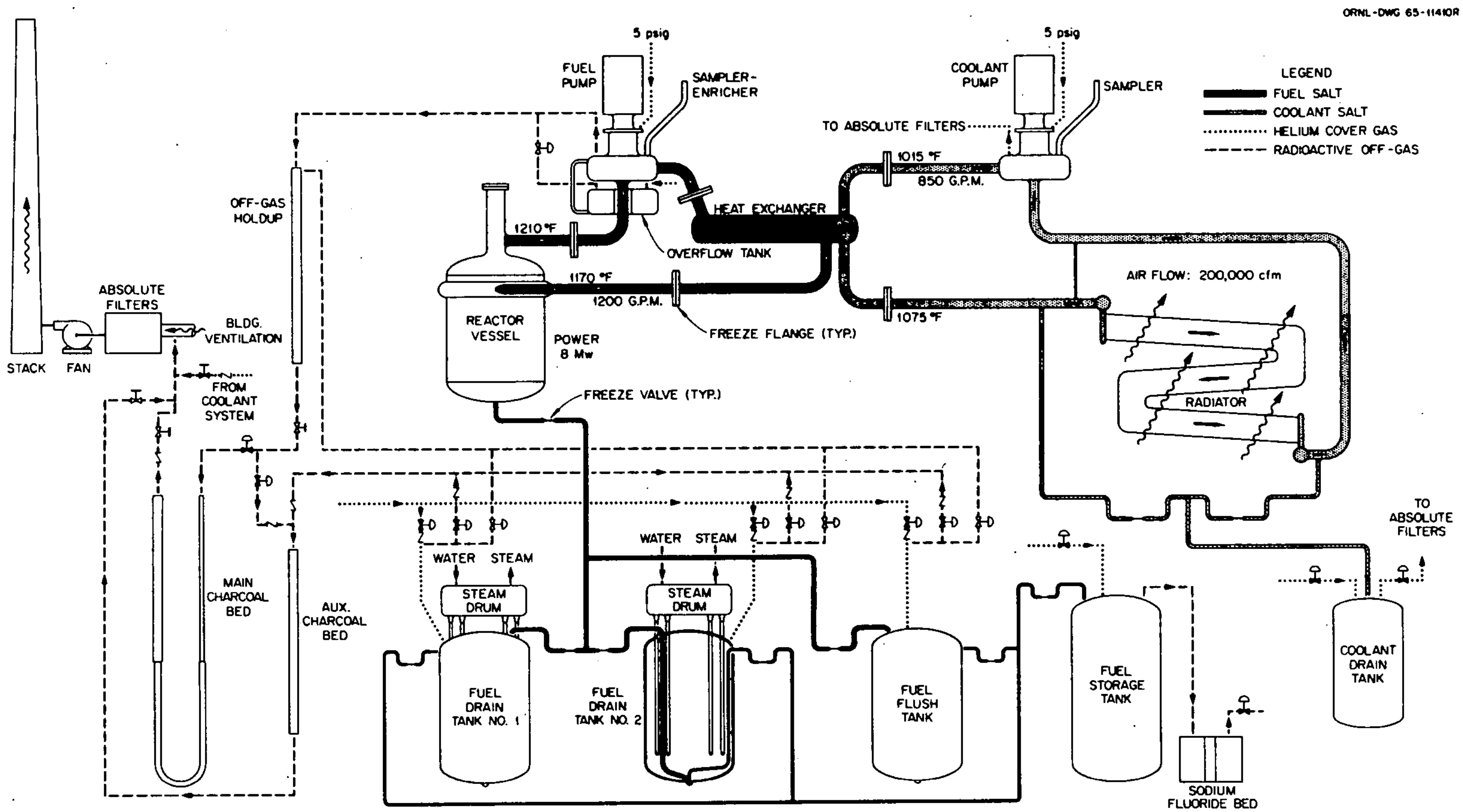

Figure 12. Simplified Design Flow Sheet of the MSRE

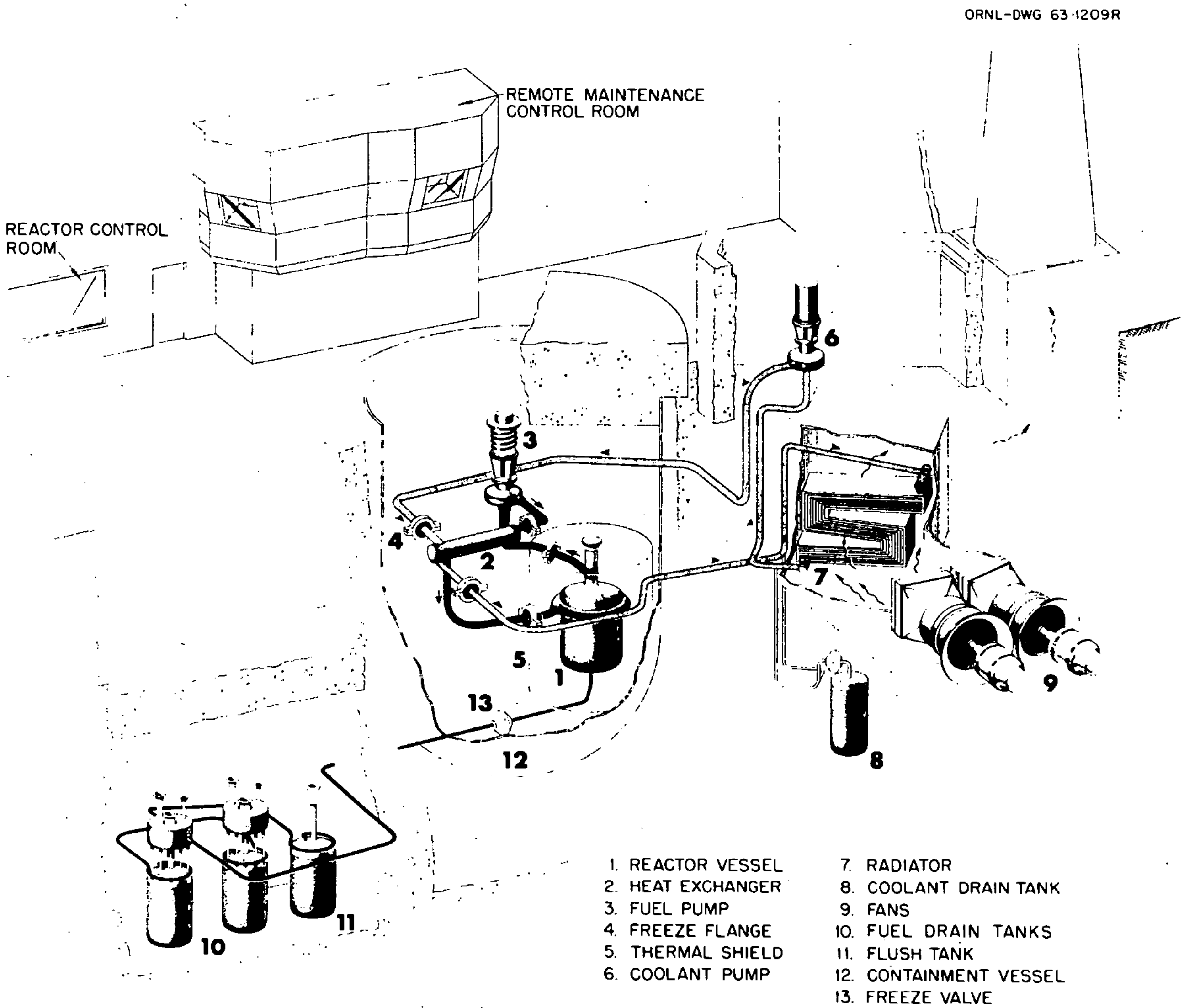

Figure 13. Primary and Secondary Salt Systems

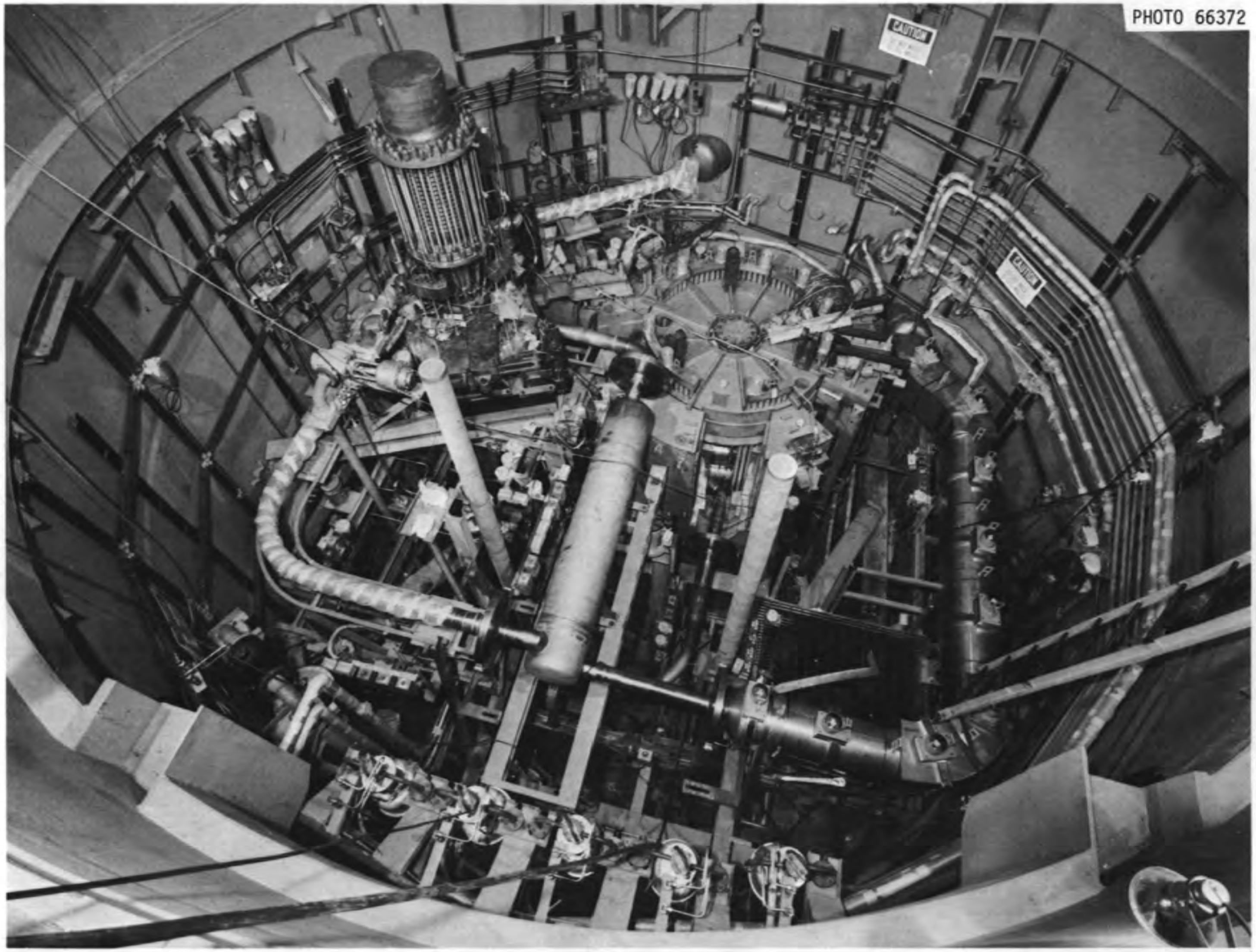

Figure 14. Reactor Cell During Assembly of Components

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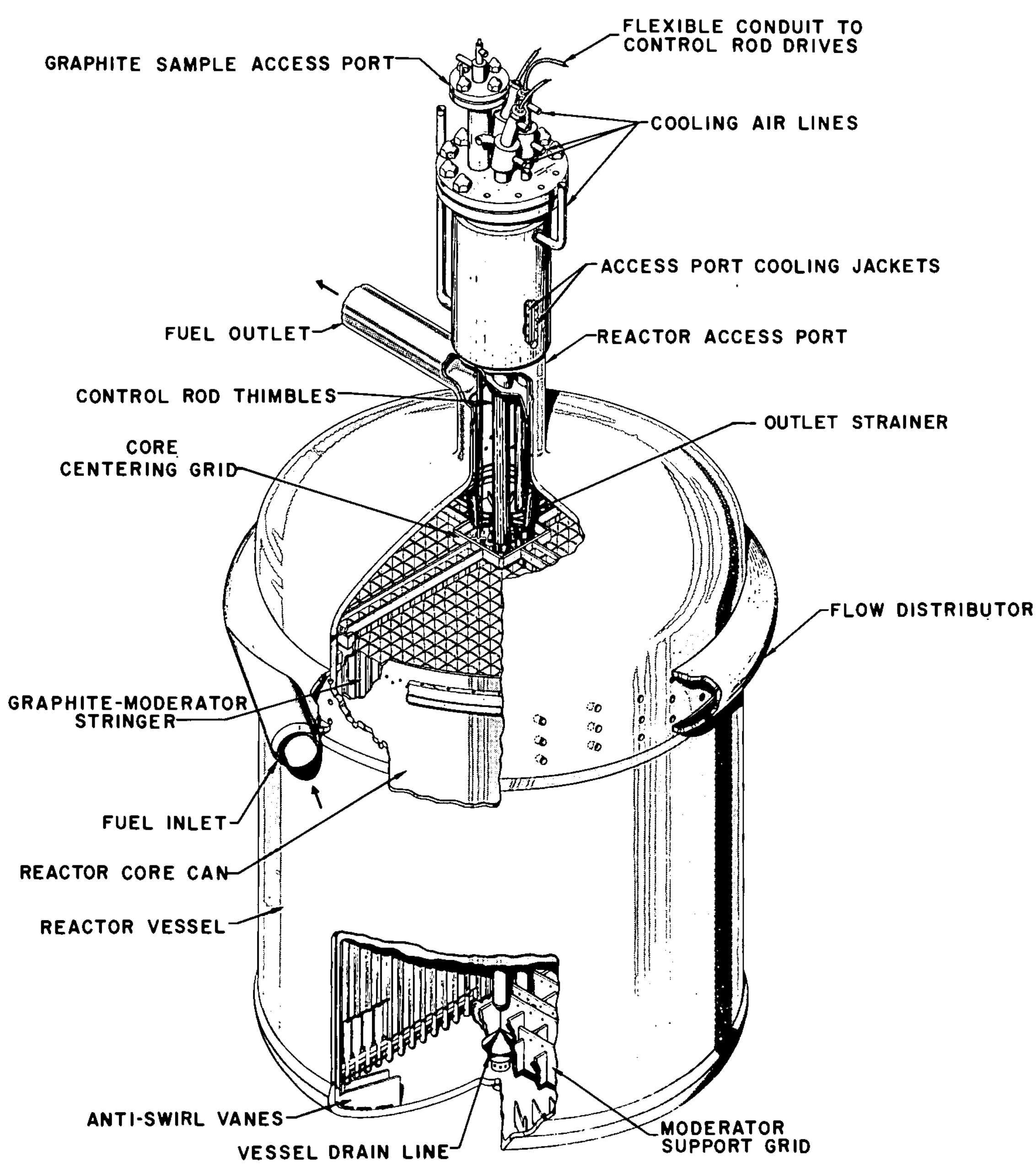

Figure 15. Reactor Vessel

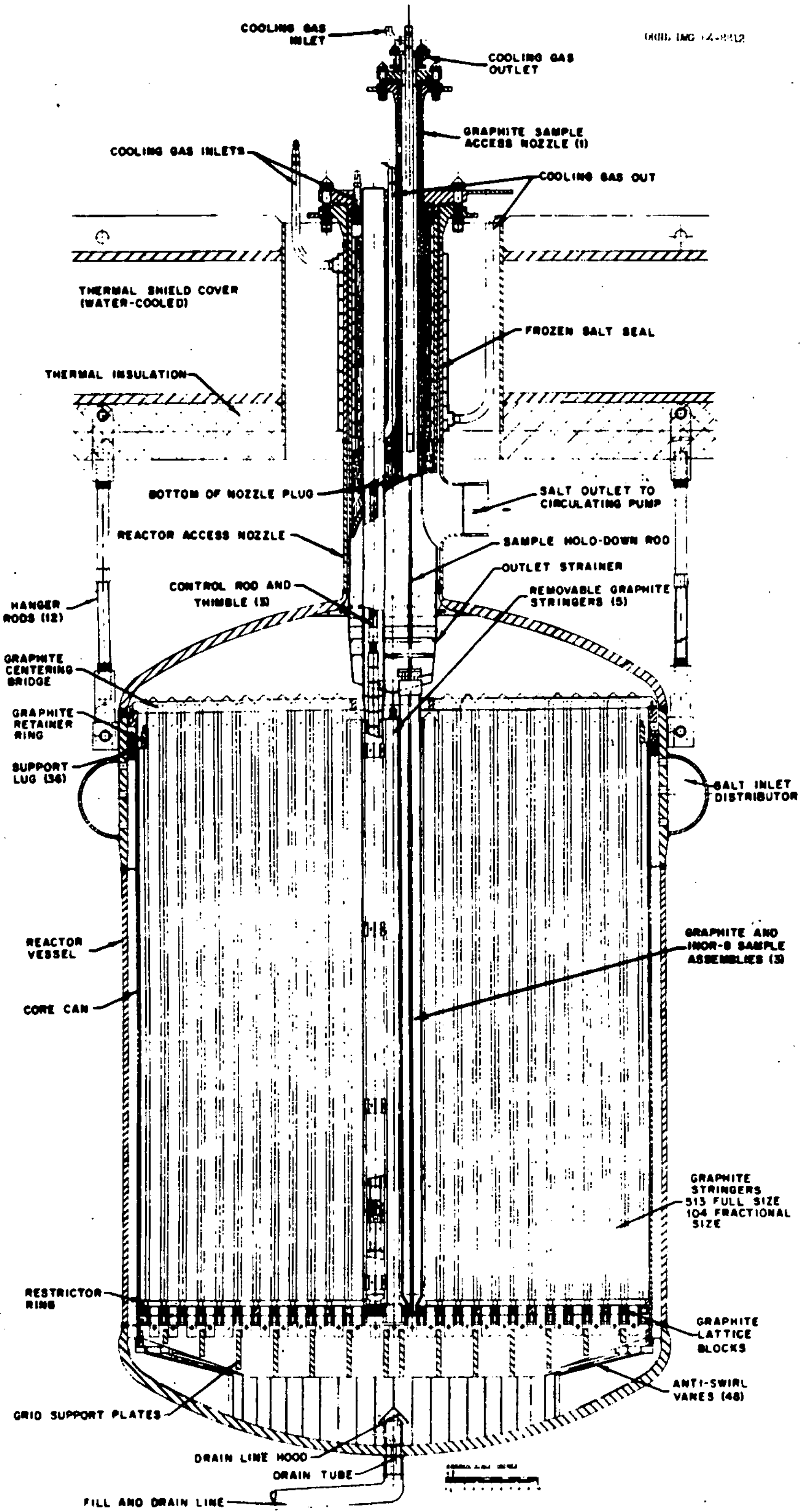

Figure 16. Cross Section - Reactor Vessel and Access Nozzle

by flowing countercurrent to the upflow of heated salt in the core. The top and bottom of the vessel are 58-in.-I.D. flanged and dished heads. The vessel is supported by 12 suspension rods from the top of the thermal shield (to be described later). The suspension rods (Figure 17) are connected to support lugs welded to the reactor vessel above the flow distributor.

The core can, or shell, is 55 1/2 in. I.D. and 67 15/16 in. high with a wall thickness of 1/4 in. The can is supported by a ring at the top of the can which is bolted to 36 lugs welded to the inside of the reactor vessel wall. The can supports the graphite used as the moderator material for the core.

The graphite moderator is formed of 513 blocks, each of which is 2 in. x 2 in. x ∿67 in. These are stacked in a vertical close-packed array as shown in Figure 18. In addition, there are 104 fractional-sized blocks at the periphery. Fuel passages were provided by milling a rectangular vertical groove down each block face. When assembled, these grooves formed 0.4 in. x 1.2 in. vertical channels through which the fuel salt moved from the bottom to the top of the core.

The vertical graphite blocks rest on a lattice of horizontal graphite blocks, about 1 by 1 5/8 in. in cross section, laid in two layers at right angles to each other. Holes in the lattice blocks accept the 1-in.-diameter doweled section at the lower end of each vertical block. The upper horizontal surfaces of both the vertical blocks are tapered to prevent salt from being retained on them when the vessel was drained. The lattice blocks rest on a grid of 1/2-in.-thick INOR-8 plates set on edge and varying in height from 1 5/8 in. at the core periphery to about 5 9/16 in. at the center. This support grid is fastened to the bottom of the core can. Each of the vertical blocks is locked to the grid by 5/16-in.-diameter rods which pass through holes in the grid and holes in the doweled sections of the blocks. Forty-eight vertical fins located around the periphery of the reactor vessel below the core support grid prevented spiraling flow of the fuel salt in the region below the core.

At the center of the bottom of the reactor vessel is a 1 1/2-in. Schedule 40 drain line which extends about 2 3/4 in. into the vessel and

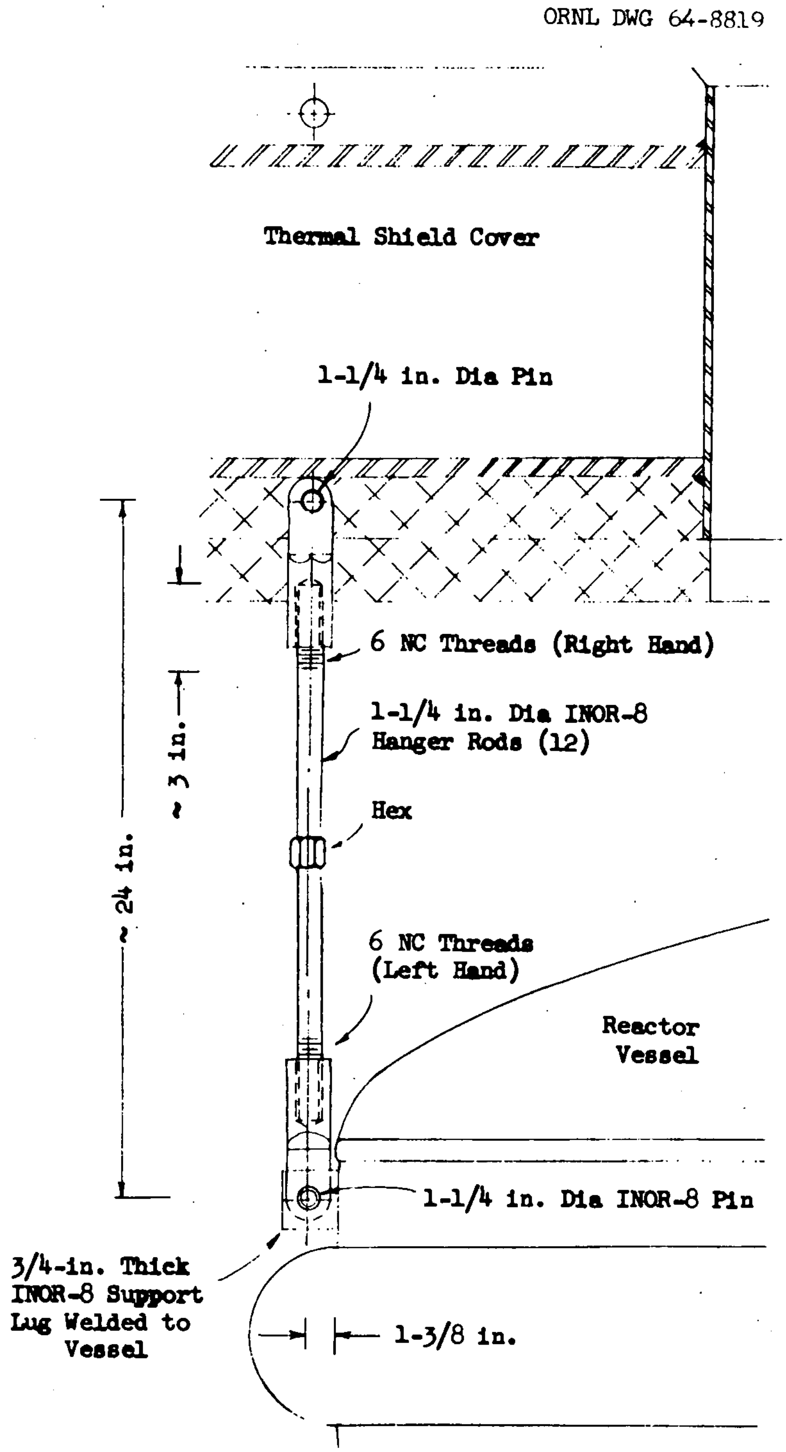

Figure 17. Reactor Vessel Hanger Rods

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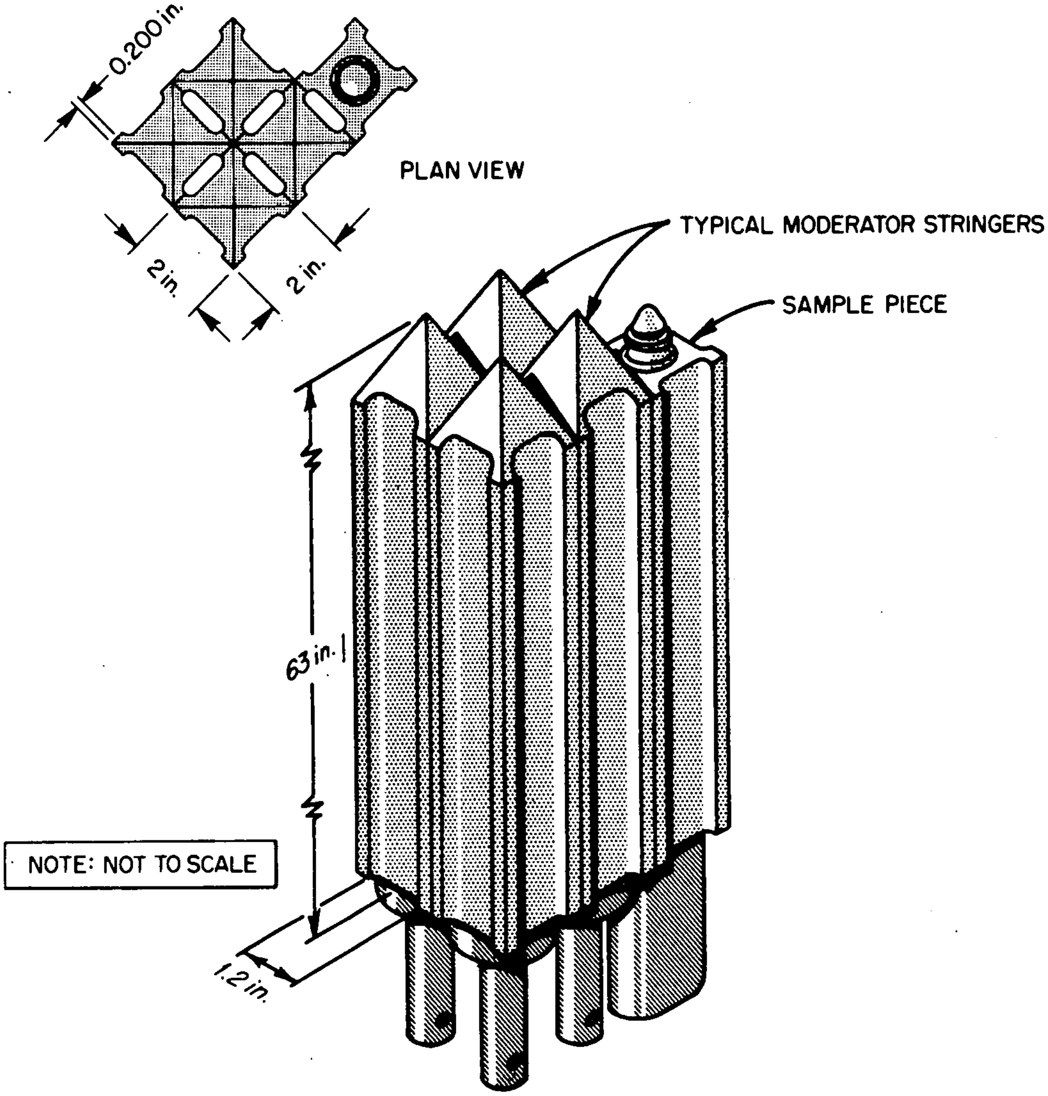

Figure 18. Typical Graphite Block Arrangement

is covered with a protective hood to prevent debris from entering the pipe. A 1/2-in.-diameter tube within the drain line opens into the vessel just above the bottom surface to allow complete draining.

The top head of the reactor vessel is equipped with a 10-in.-diameter, 40-in.-tall nozzle. A 5-in. nozzle emerging from the side of the extension is the fuel-salt exit line from the vessel. The 10-in. nozzle served also as an entry port for the three control rods (Figures 15 and 19) and as an access for inserting and removing replaceable core blocks and materials-testing specimens.

2.5.2 Thermal Shield

The primary functions of the thermal shield (Figures 6, 7, and 20) were to reduce the radiation damage to the reactor containment vessel and to cell equipment, to serve as part of the biological shielding, and to provide the support for the reactor vessel which is suspended within it.

The shield is a water-cooled, steel ball and water filled container which completely surrounds the reactor vessel. It is about 10.4 ft O.D. by 7.8 ft I.D. and 12.5 ft tall. The 14-in.-wide annular space is filled with 1-in.-diameter carbon steel balls. The shield coolant circulated through the interstitial spaces. The shield walls are made of 1-in.-thick 304 stainless steel plate.

Six separate parts make up the thermal shield assembly: the flat semirectangular base, the main cylindrical section, three removable segments of the cylindrical section, and the removable top cover. The removable segments fill slots in the cylindrical sections through which the reactor fill and drain line and the fuel-salt inlet and outlet lines to the reactor passed as the reactor vessel was lowered into position. The base and main cylindrical sections have many equipment support structures attached to them.

2.5.3 Primary System Pump

From the top of the reactor vessel the fuel flowed directly to the primary system pump bowl through a 13.8 ft length of 5-in. Schedule 40 pipe which enlarges to 6 in. below the pump to adapt to the pump suction nozzle size. The components and appearance of the centrifugal sump-type

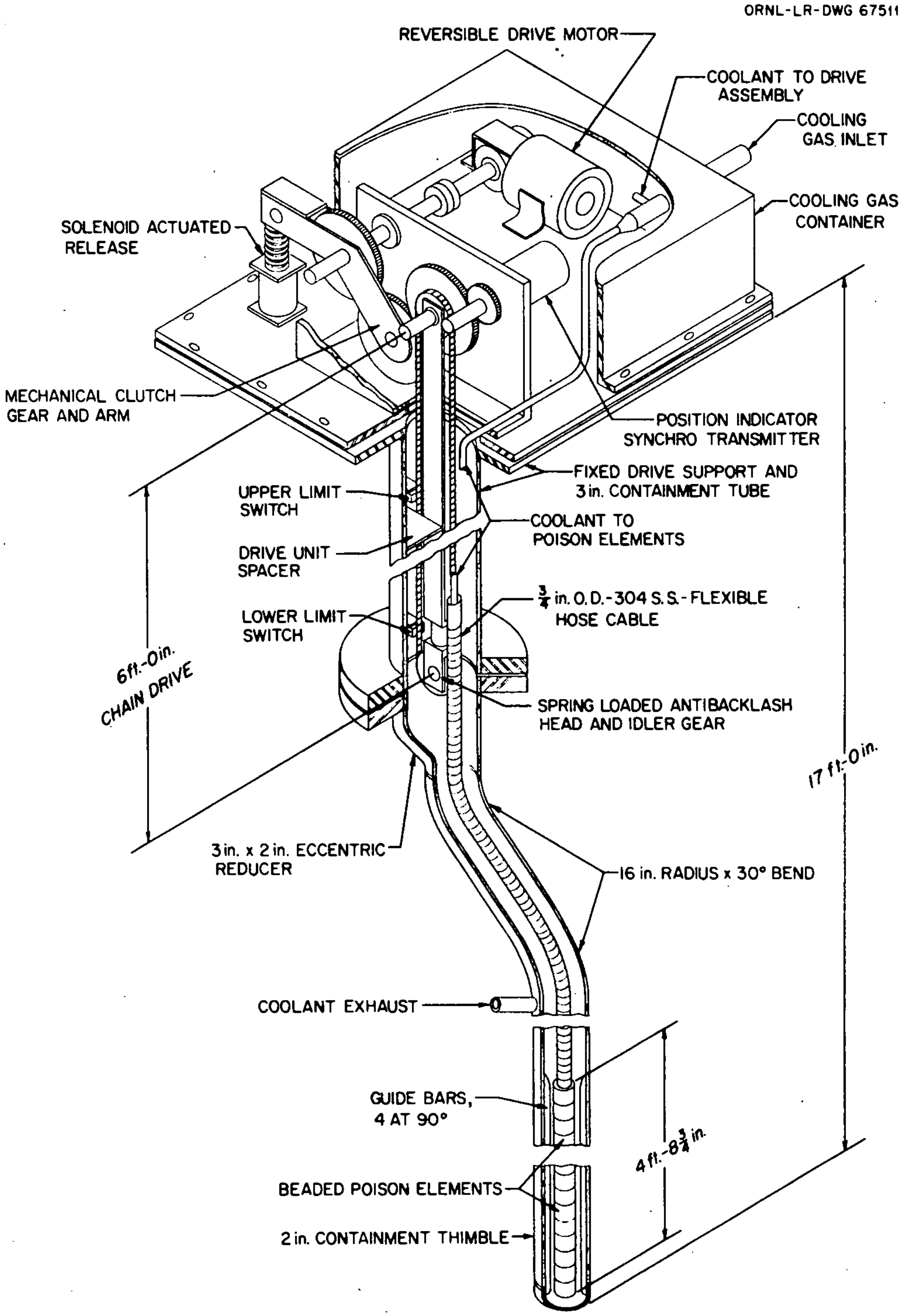

Figure 19. Control Rod and Drive Assembly

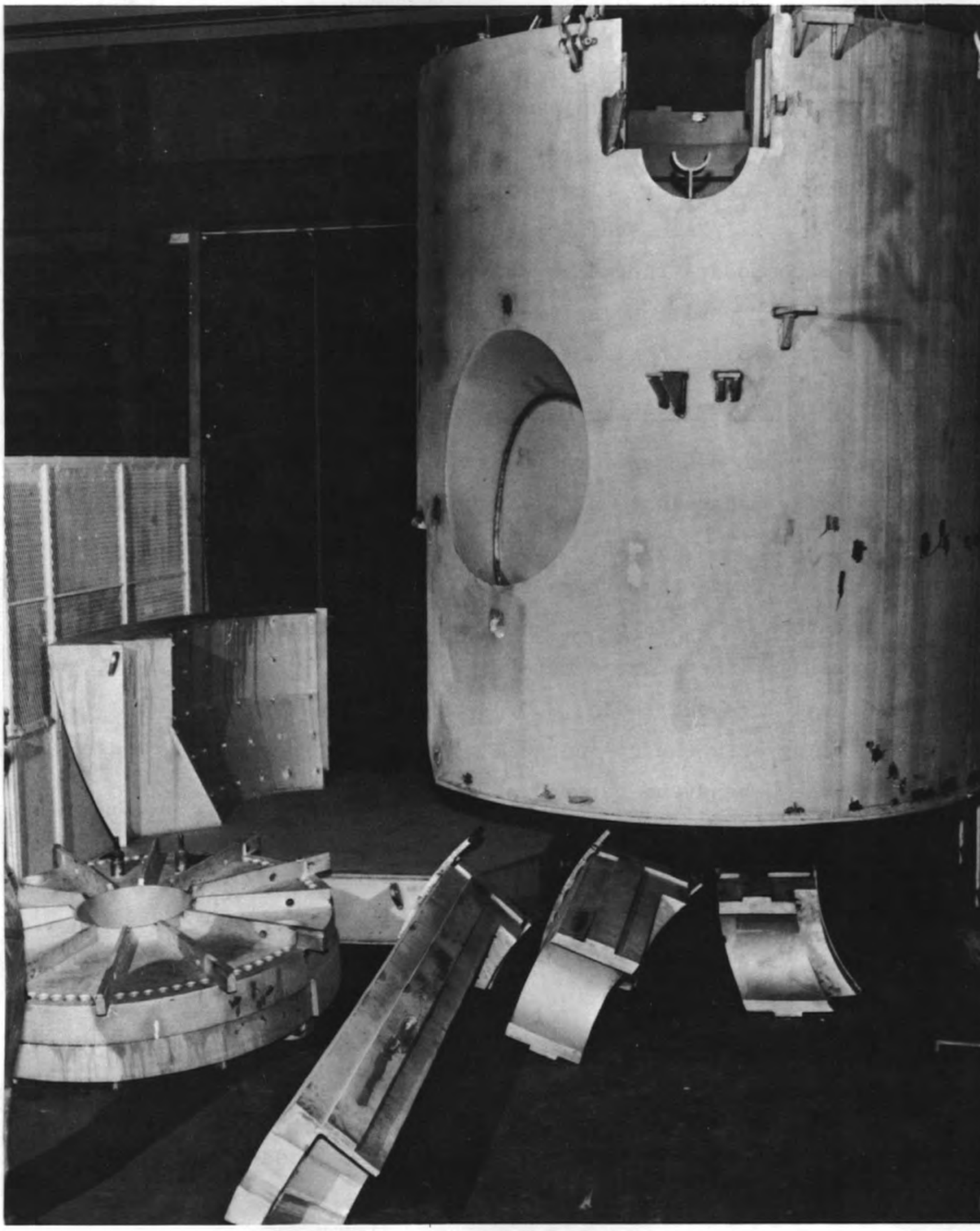

Figure 20. Thermal Shield Components

pump and pump bowl are shown in Figures 21 and 22. The pump bowl is about 36 in. in diameter and contains the pump casing, gas stripping manifold, sampler-enricher cage, and off-gas connections. It served as a surge tank for the loop with a cover-gas pressure maintained above the operating salt level. The removable pump and 75-hp motor assembly is about 8 ft tall and consists of all the rotary elements and bearings of the pump. The assembly is mounted on a 2 1/2-in.-thick plate that can move horizontally and vertically to accommodate thermal expansion of the system. This was necessary since the reactor position is fixed. The mounting plate is, in turn, supported by two 8-in. horizontal I-beams attached to the cell structure.

2.5.4 Primary System Heat Exchanger

From the pump discharge the fuel salt passed directly through a 6.0 ft length of 5-in. Schedule 40 pipe to the primary system heat exchanger (Figures 23 and 24) which is a horizontal, shell and U-tube type, in which the fuel salt circulated through the shell side and the coolant salt through the tubes. It is of all-welded construction and made entirely of INOR-8 except for the brazing material that sealed the tubes to the sheet.

The shell is about 16 in. O.D. by about 8 ft 3 in. long and is 1/2 in. thick including both the cylindrical portion and the heads. The fuel salt entered at the U-bend end through a 5-in. Schedule 40 nozzle and emerged through a 7 in. by 5 in. reducing nozzle at the bottom of the shell at the tube-sheet end and flowed to the reactor inlet through a 17.2 ft length of 5-in. Schedule 40 INOR-8 pipe. The coolant salt entered the top manifold at the tube-sheet end and exited from the bottom manifold. Both the inlet and exit nozzles are 5 in. diameter Schedule 40.

The heat exchanger contains 159 U-tubes which are 1/2 in. O.D. with a wall thickness of 0.042 in. The tube sheet is 1 1/2 in. thick. The tubes are spaced and supported by three baffle plates and one barrier plate (near the tube sheet) and in addition are laced with 1/4 in. x ∿0.017 in. INOR-8 straps to suppress vibrations.

Due to the short lengths of interconnecting pipes and the immovability of the reactor vessel, the heat exchanger, like the fuel pump, had to be supported in a manner that allowed horizontal and vertical movement

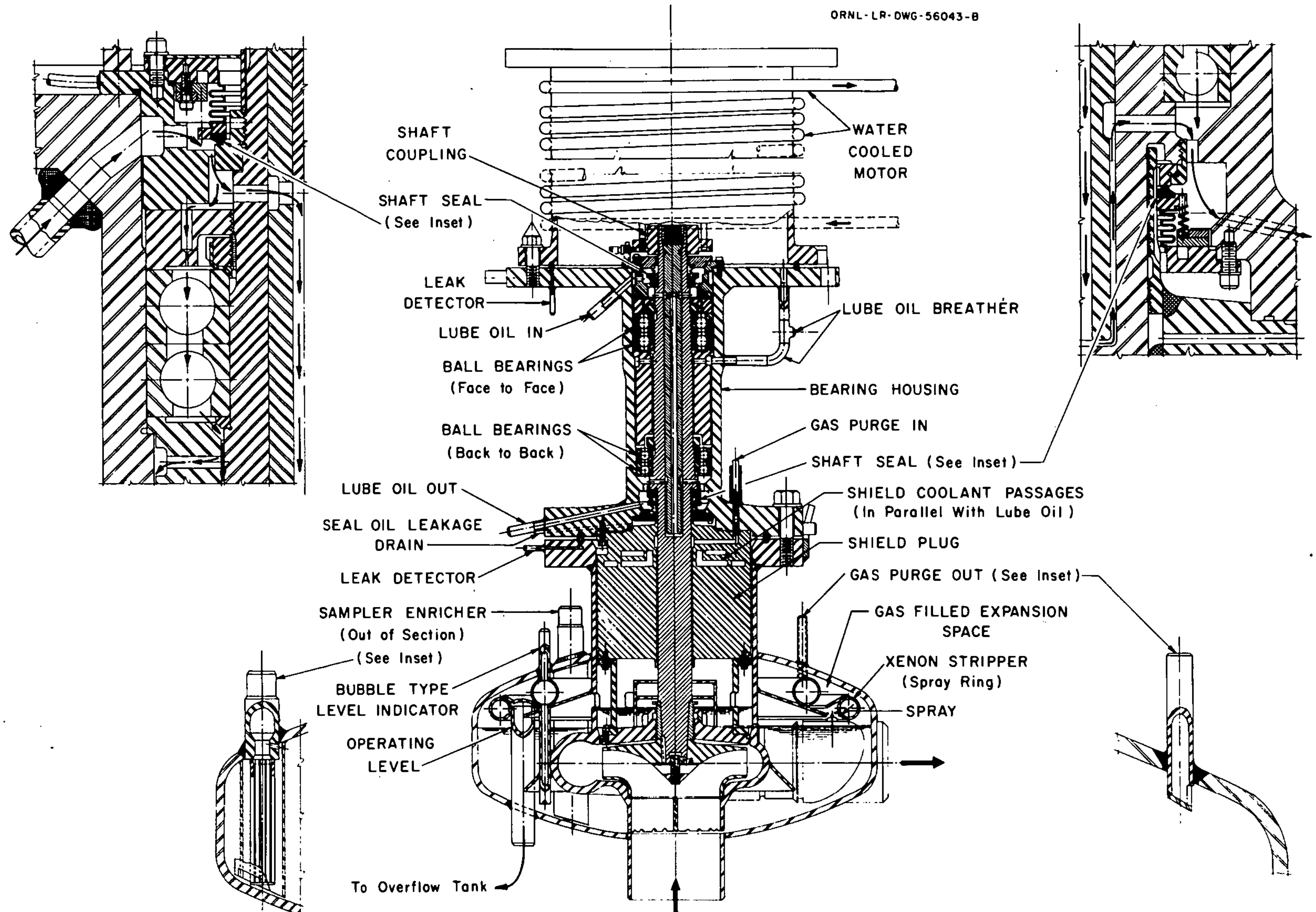

Figure 21. Fuel Pump

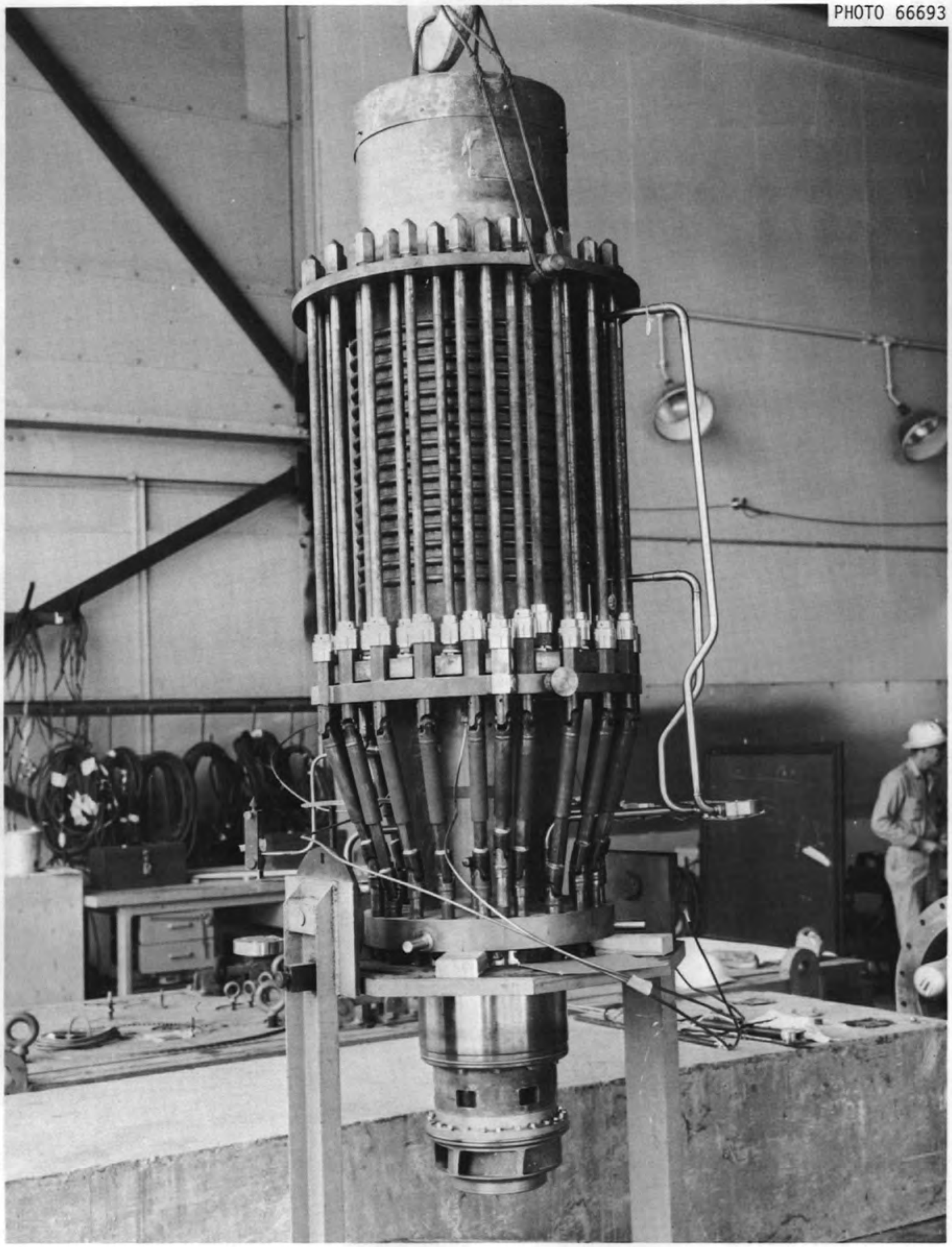

Figure 22. Fuel Pump Motor and Rotor Assembly Showing Flange Bolt Extensions

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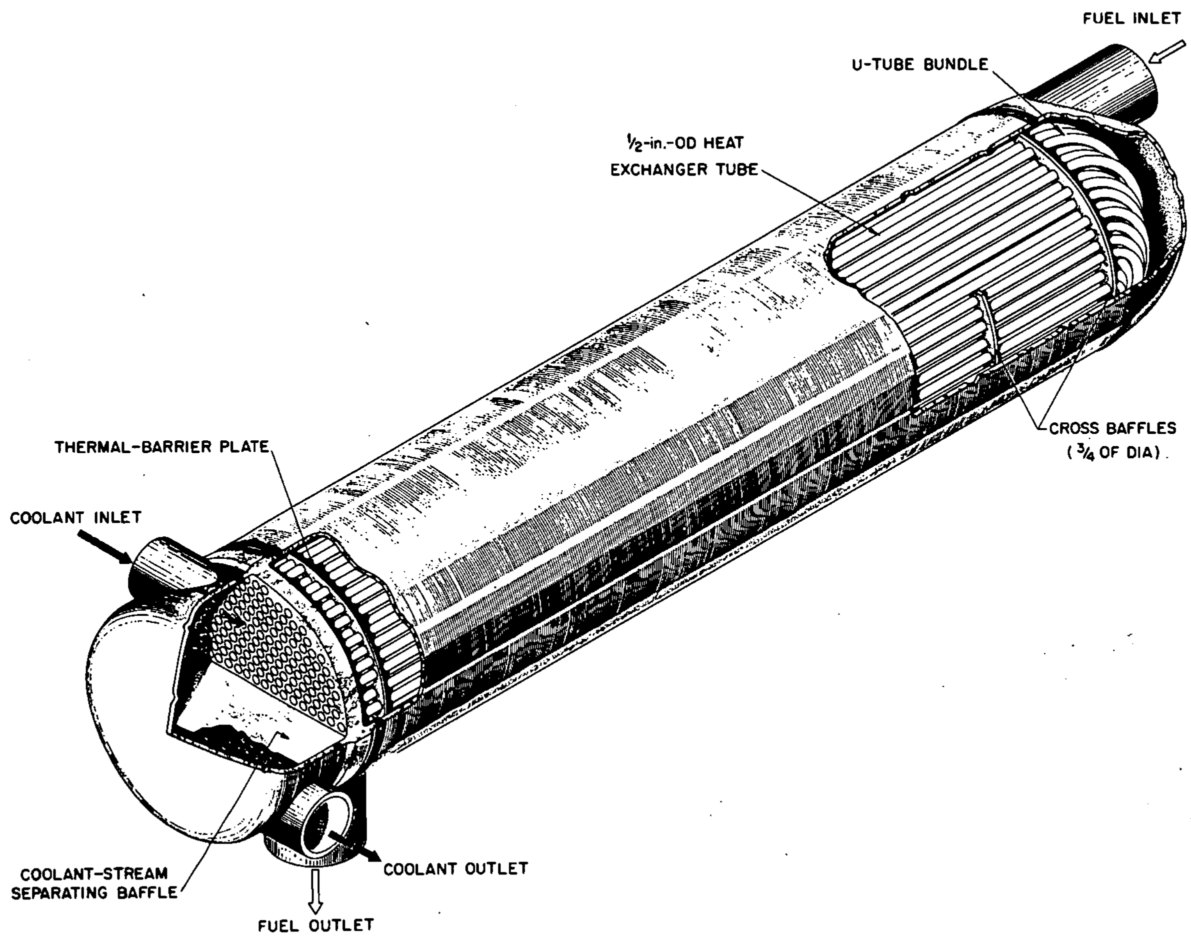

Figure 23. Primary Heat Exchanger

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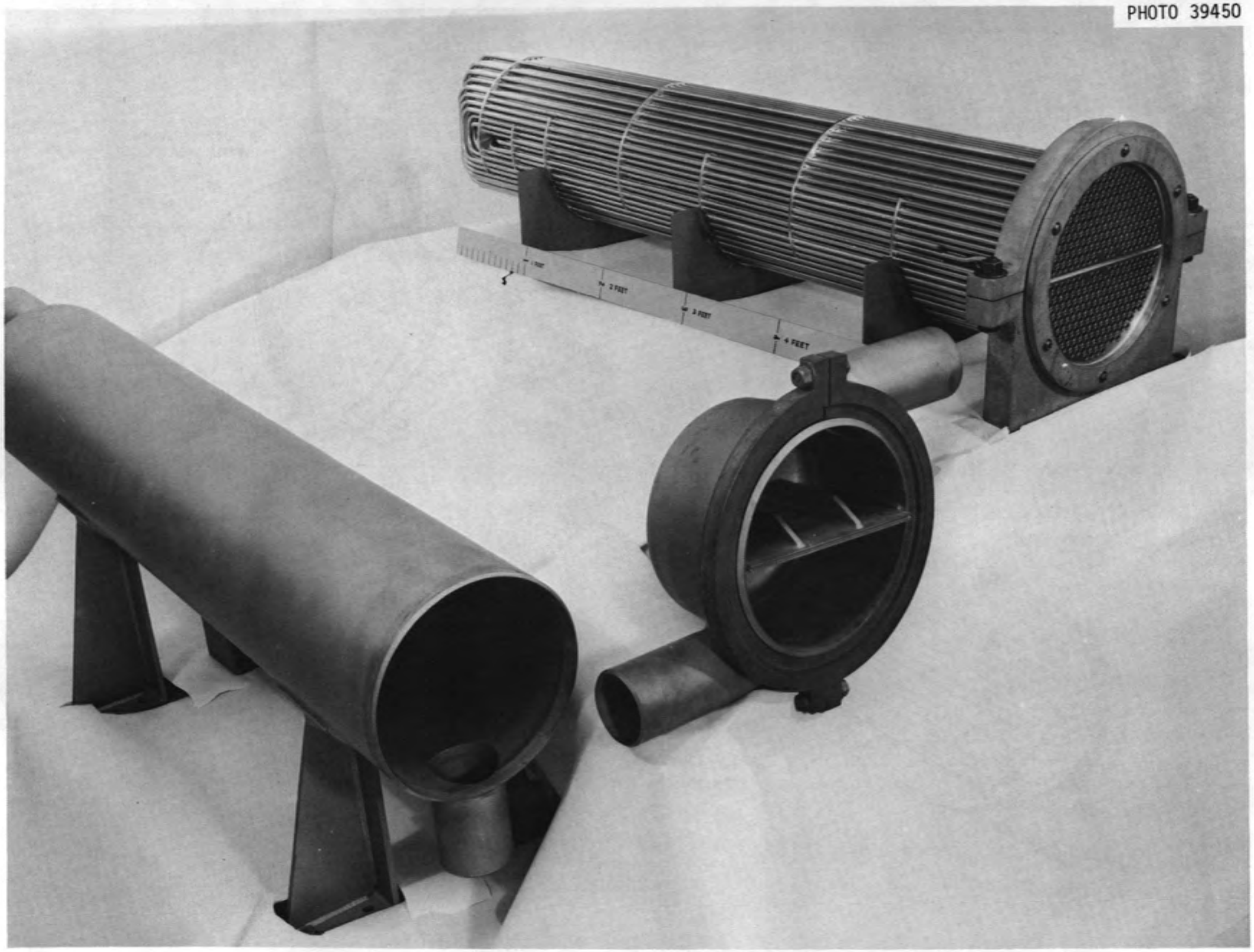

Figure 24. Primary Heat Exchanger Subassemblies

to compensate for thermal expansion. Two support saddles welded to the shell supply support from a complex motion-adapting system which, in turn, rests upon an assembly of 8-in. I-beams fixed to the cell structure.

2.5.5 Fuel Pump Overflow Tank

The primary system pump bowl has an overflow pipe and catch tank (Figure 25) which was provided to avoid problems from inadvertent overfilling of the system or unexpected volume expansion. The catch tank is torus-shaped and fits around the pump intake line immediately below the pump bowl. The tank is 30 in. O.D. x 18 in. I.D. x 27 3/4 in. tall. The wall thickness is 1/2 in. and the annulus between the inner and outer walls is 5 in. wide. The 1 1/2-in. pump bowl overflow pipe extends from the top of the catch tank through the bottom of the pump bowl to 1 1/2 in. above the normal fuel-salt level. The tank is supported from the pump support with a system of movable plates that allow horizontal motion to accommodate thermal effects.

2.5.6 Fuel-Salt and Flush-Salt Drain and Storage Tanks

The primary system is provided with two fuel-salt drain tanks and a flush-salt drain tank located in a shielded cell adjacent to the reactor containment vessel. Figure 26 is a process flow sheet for the drain tanks and their auxiliary systems. In addition, a fuel storage and reprocessing tank is located in the fuel-processing cell. It is described in Section 2.7.

Each of the two fuel drain tanks (Figure 27) is 50 in. in diameter and about 86 in. tall, not including the steam dome and has a fuel-salt capacity of about 80 ft^3. Each is equipped with thirty-two 1 1/2-in. cooling thimbles. The steam dome which is mounted atop the tank (Figure 28) contains 1-in.-diameter cooling fingers extending into each of the thimbles. Water boiling in the inner 1-in.-diameter fingers in the thimbles removed both residual and fission-product decay heat from fuel salt stored in the tank. The steam was routed to an external condenser and the condensate returned to the fingers in a closed loop.

The flush-salt drain tank is also located in the drain-tank cell and contained the flush salt used to cleanse the primary system prior to

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Figure 25. Fuel Pump Overflow Tank

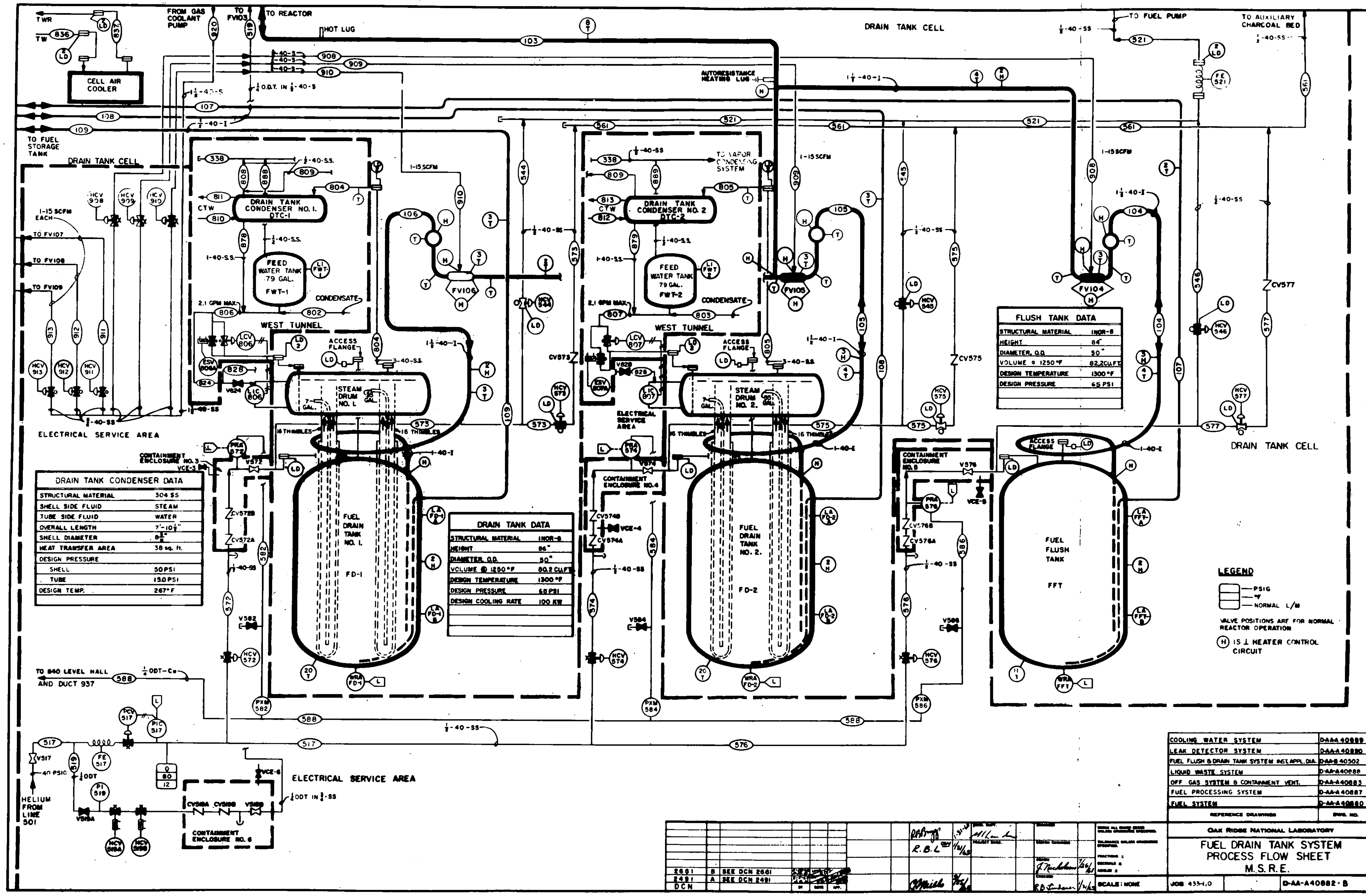

Figure 26. Fuel Drain Tank System Process Flow Sheet

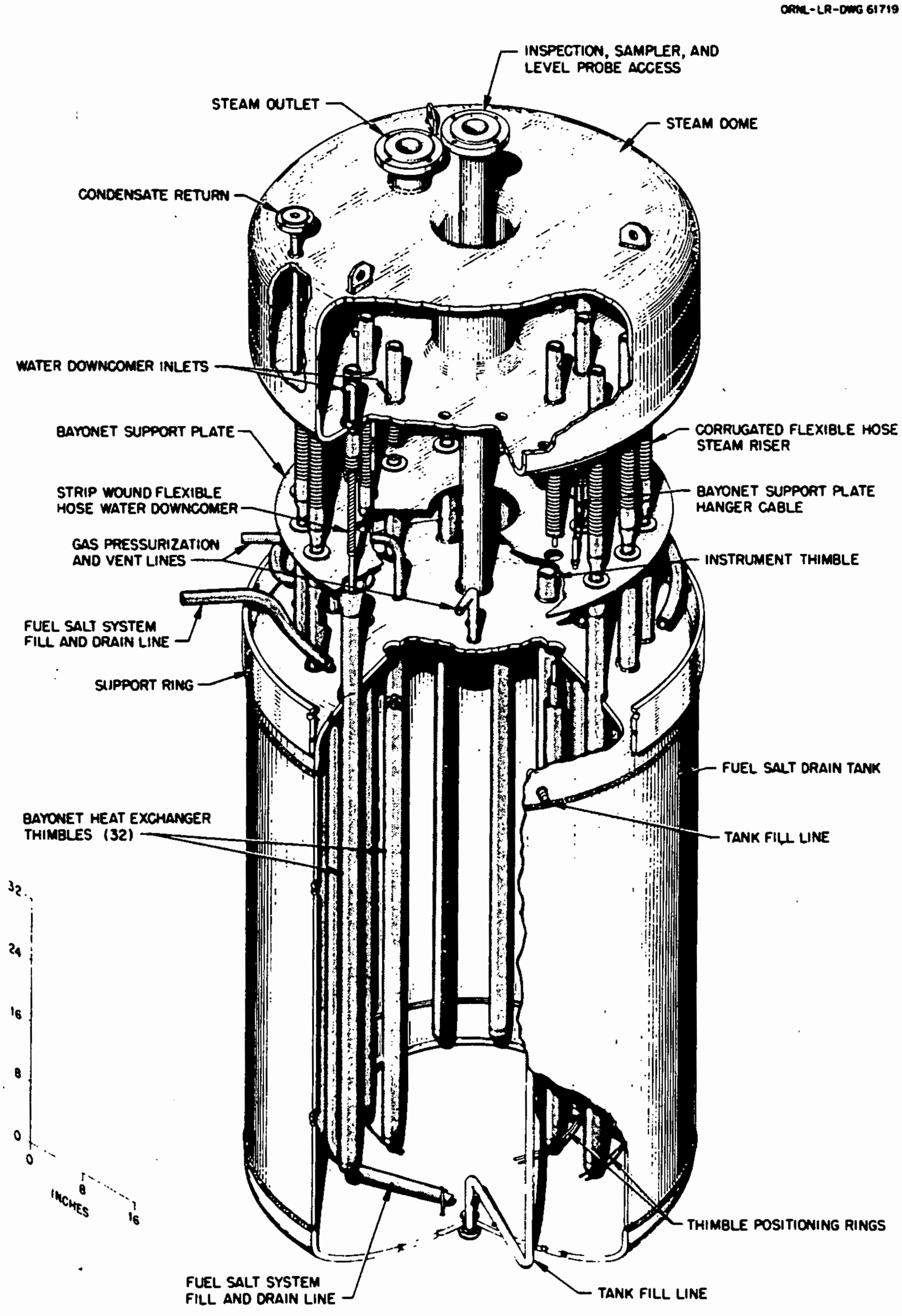

Figure 27. Fuel-Salt Drain Tank

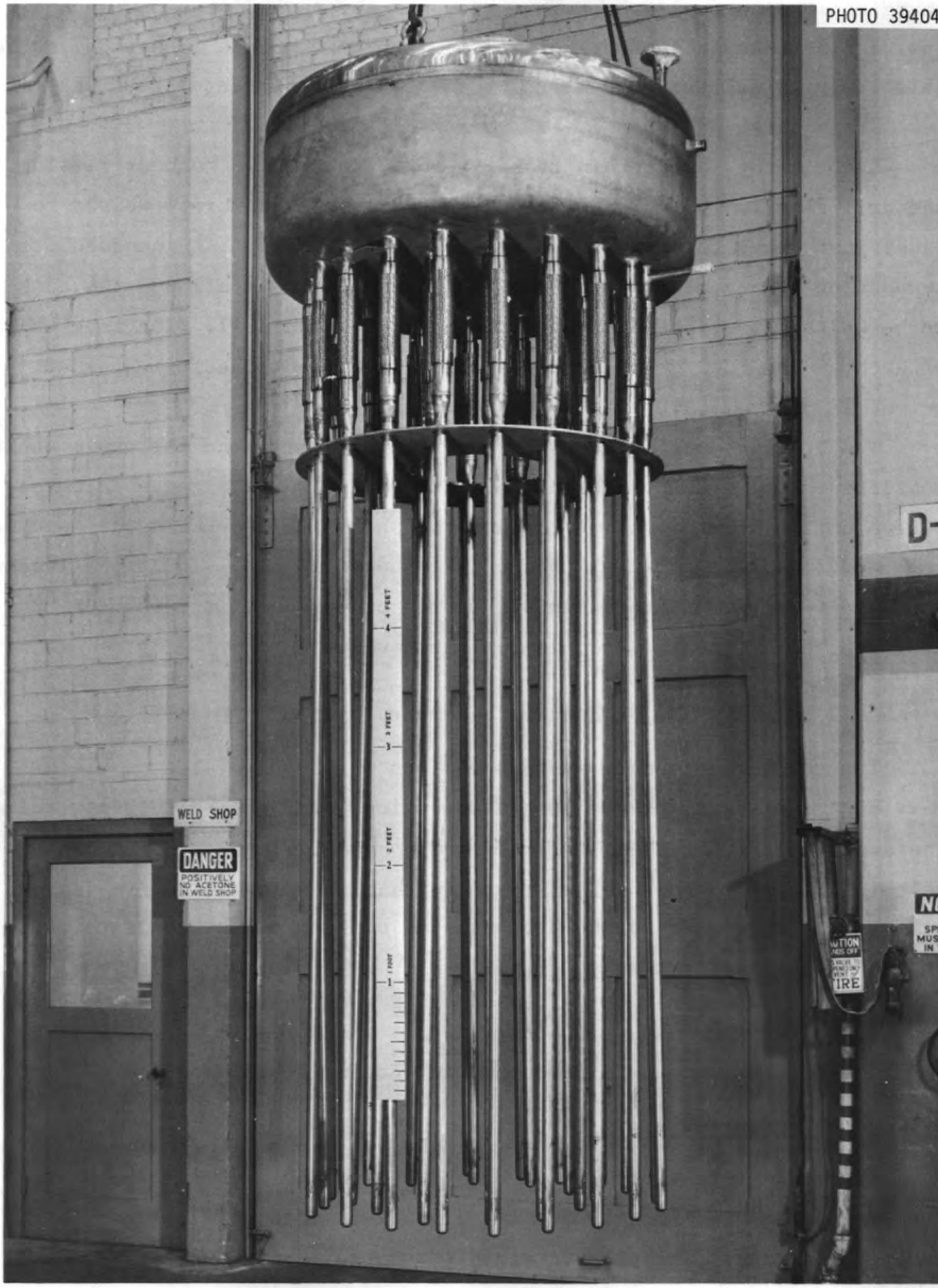

Figure 28. Fuel Drain Tank Steam Dome Bayonet Assembly

charging it with fuel salt. This tank has the same dimensions as the fuel drain tanks except for being 2 in. shorter. Since it has no cooling thimbles, its salt storage capacity is about 2 ft^3 greater than that of a fuel drain tank.

Each of the three drain tanks is supported by two columns resting on the cell floor. The columns are attached to support skirts welded to tanks just above the upper head circumferential weld. An intermediate supporting arrangement between the columns and skirts allowed the tanks to be weighed by a pneumatically-operated weighing cell. The tare weight of each of the fuel drain tanks is about 7,000 lbs; the fully loaded weight is about 17,000 lbs.

The drain connection between the reactor vessel and the drain tanks consists of a 1 1/2-in. Schedule 40 INOR-8 pipe which extends from the bottom of the reactor vessel through the shield wall between the reactor cell and the drain-tank cell where it connects to the 1-in. pipes leading from the tops of the drain tanks. During operation of the reactor, the drain tanks were sealed from it by freeze valves.

2.6 Reactor Secondary System

The reactor secondary system consists of the tube side of the primary heat exchanger, the coolant circulating pump, the salt-to-air radiator, the drain and fill system, and the interconnecting piping. The coolant salt is similar to the fuel salt except that it contains no fissionable materials. Figure 29 is the process flow diagram of the coolant system and its auxiliary systems.

2.6.1 Heat Exchanger

The heat exchanger is described in Section 2.5.4.

2.6.2 Coolant Circulating Pump

The coolant-salt pump is of the same type and overall size as the fuel-salt pump described in Section 2.5.3. It does not, however, have an overflow tank. The pump is rigidly mounted in its own shielded cell which is above the level of the other cells (Figures 7 and 13).

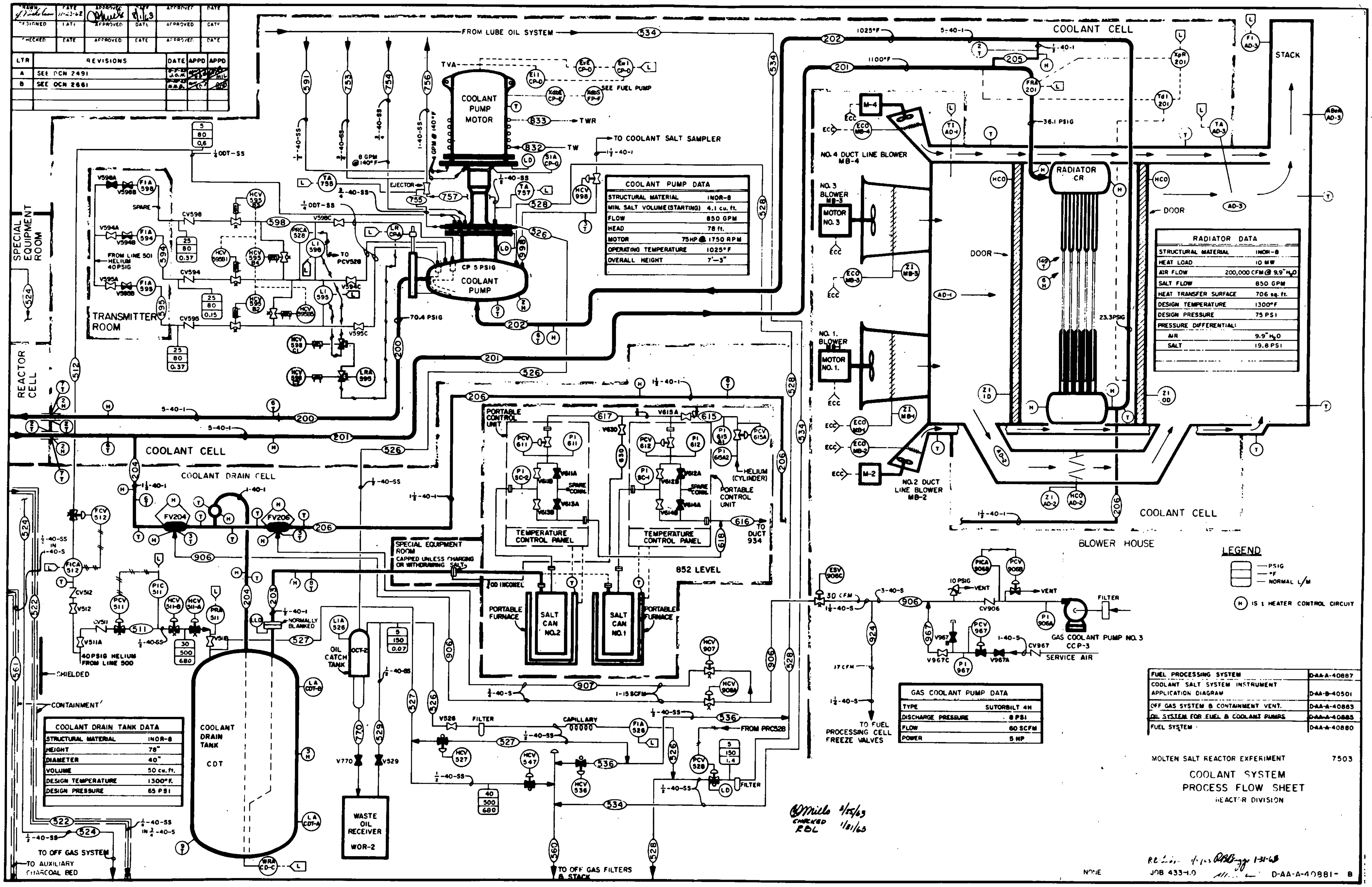

Figure 29. Coolant System Process Flow Sheet

2.6.3 Radiator

The radiator coil is an assembly of one-hundred twenty 30-ft-long "S"-shaped 3/4-in.-O.D. INOR-8 tubes (Figure 30) connected to vertical manifolds which, in turn, are connected to the 9-in.-O.D. inlet and outlet headers. The 5-in. Schedule 40 inlet line connects to the outlet from the heat exchanger, and the 5-in. Schedule 40 outlet line goes directly to the suction side of the pump.

The coil is enclosed in a housing (Figure 31) which is equipped with vertically operated doors which regulated the air flow passing through the coil and thereby the coolant-salt temperature. The total assembly is mounted at the entrance of a double-walled steel duct leading to the 10 ft diameter x 75 ft high steel heat-dump stack. Two 250-hp blowers supplied the 200,000 cfm of air used to remove heat from the coil at the maximum reactor power level of 10 MW. A separate cooling system used two 10-hp, 10,000-cfm blowers to supply air to the annulus around the duct. This was necessary to prevent buckling and damage to adjacent concrete when the coil exhaust air reached temperatures up to 1000°F under low-flow conditions.

2.6.4 Secondary System Piping

Like that of the primary system, the secondary system piping is 5-in. Schedule 40 INOR-8 pipe. The sections of inlet and outlet lines to the heat exchanger which are within the reactor cell are about 36.3 ft and 32.4 ft long, respectively. The lengths and arrangement of the piping both within and outside the reactor cell allowed it to accommodate thermal expansion so that the pump and the radiator could be rigidly mounted.

2.6.5 Coolant Drain Tank

The coolant-salt drain tank is located in a shielded cell almost directly below the radiator. The coolant-salt piping has low points on each side of the radiator; a 1 1/2-in. drain line runs from each of these to the drain tank.

The drain tank is 40 in. O.D. and about 78 in. tall with a wall thickness of 3/8 in. in the cylindrical portion. The dished heads are 5/8 in. thick. The tank and all its attachments are made of INOR-8.

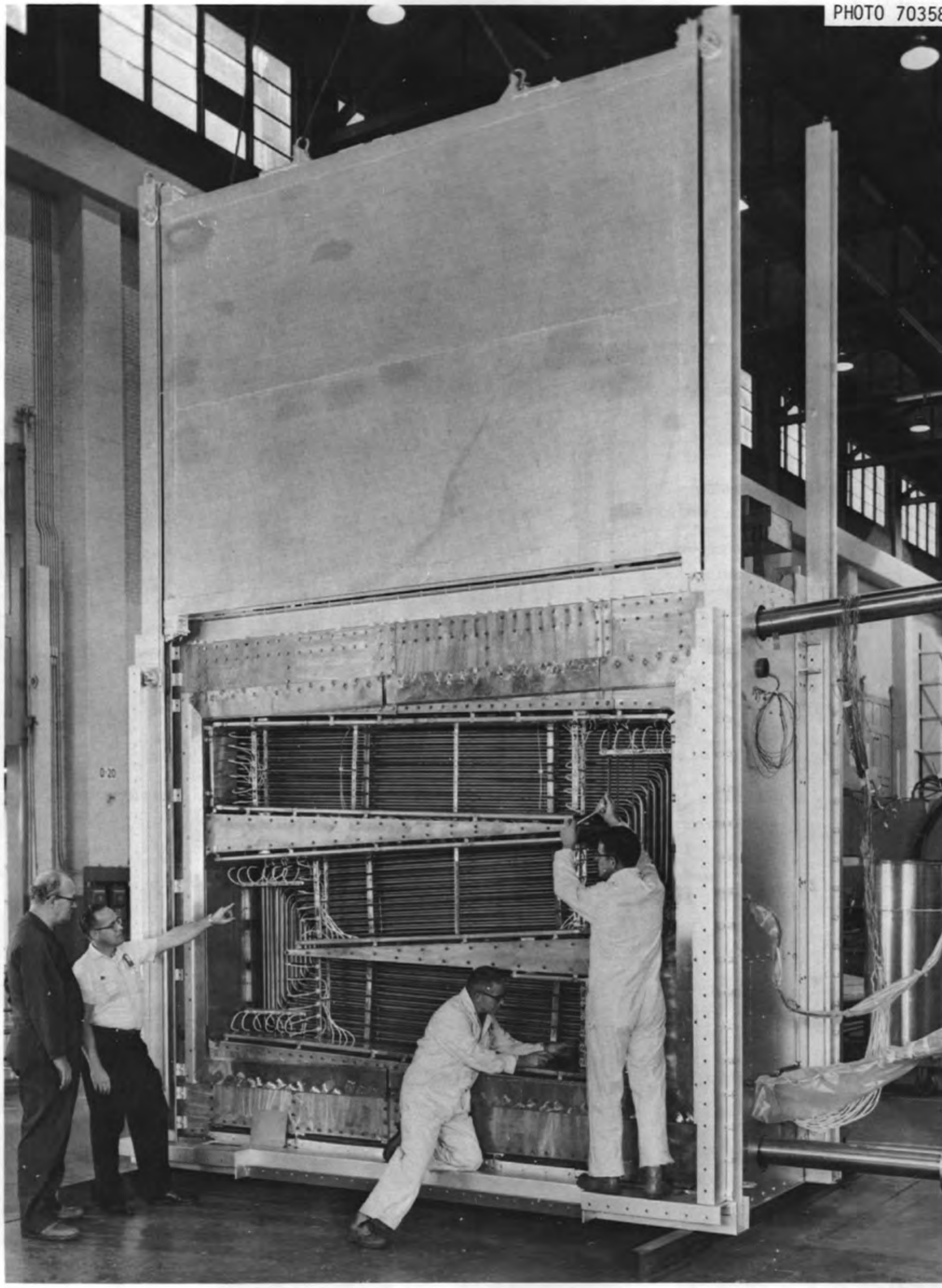

Figure 30. Radiator Assembly

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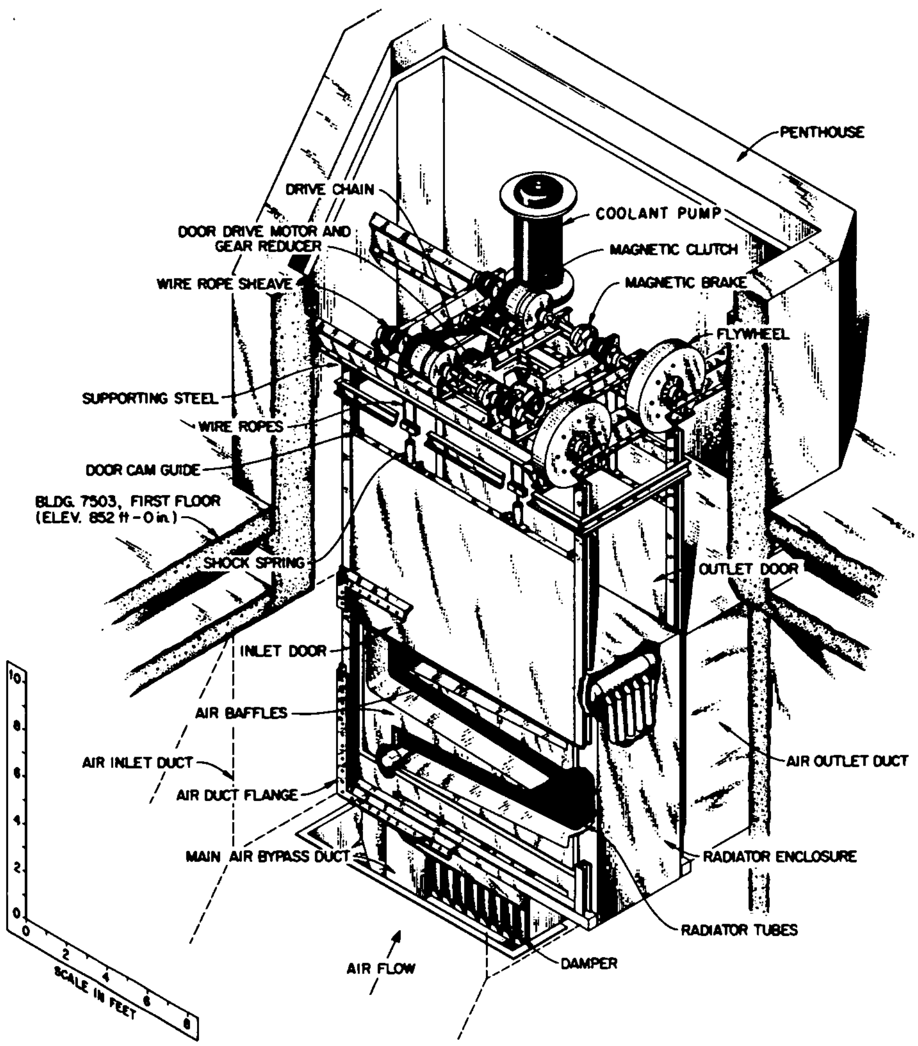

Figure 31. Radiator Coil and Enclosure

2.7 Fuel-Processing System

Other than the reactor primary system and its associated drain tanks, the only other system that contained large quantities of both unirradiated and irradiated fuel salt at any time is the fuel-processing system. The components of this system which contained fuel salt and/or fission products are located in a below-grade-level concrete-shielded cell just north of the drain-tank cell (Figures 6, 7, and 32). The two purposes of the processing were to clean both new and used fuel salt of oxides and water by sparging with hydrogen fluoride and to recover uranium from used fuel salt by sparging with fluorine. A simplified flow diagram of the system is shown in Figure 33. Figure 34 is a complete flow diagram showing both the main system and its auxiliary systems.

The sparging tank, generally called the "fuel storage tank", is the only component of the system that contained fuel salt. A 1/2-in. Schedule 40 pipe from this tank to the fuel-salt and flush-salt storage tanks was used to transfer salt to and from the primary system. The tank (Figure 35) is 50 in. O.D. and 116 in. tall. Its cylindrical section is 1/2 in. thick and the dished heads are 3/4 in. thick. All parts are made of INOR-8. It is mounted on a pneumatically-operated weighing cell supported from the cell floor.

Other large items in the fuel-processing cell include the NaF-filled impurity trap (Figure 36) used to strip undesirable fluorides from UF_6 during fluorination and the 42 in. diameter by 84 in. tall caustic scrubber tank used for HF neutralization. The remaining items are small components, piping, heaters, and insulation.

2.8 Freeze Flanges

Mechanical-type joints were provided in the 5-in. piping of the fuel- and coolant-salt system to permit the major components to be disconnected remotely and removed for maintenance or replacement. The locations of the five flanged joints are shown in Figure 12.

As shown in Figure 37, the design of the flange utilized a large diameter face as a heat sink to maintain a barrier of frozen salt to protect the gasket from contact with molten salt. Each flanged connection

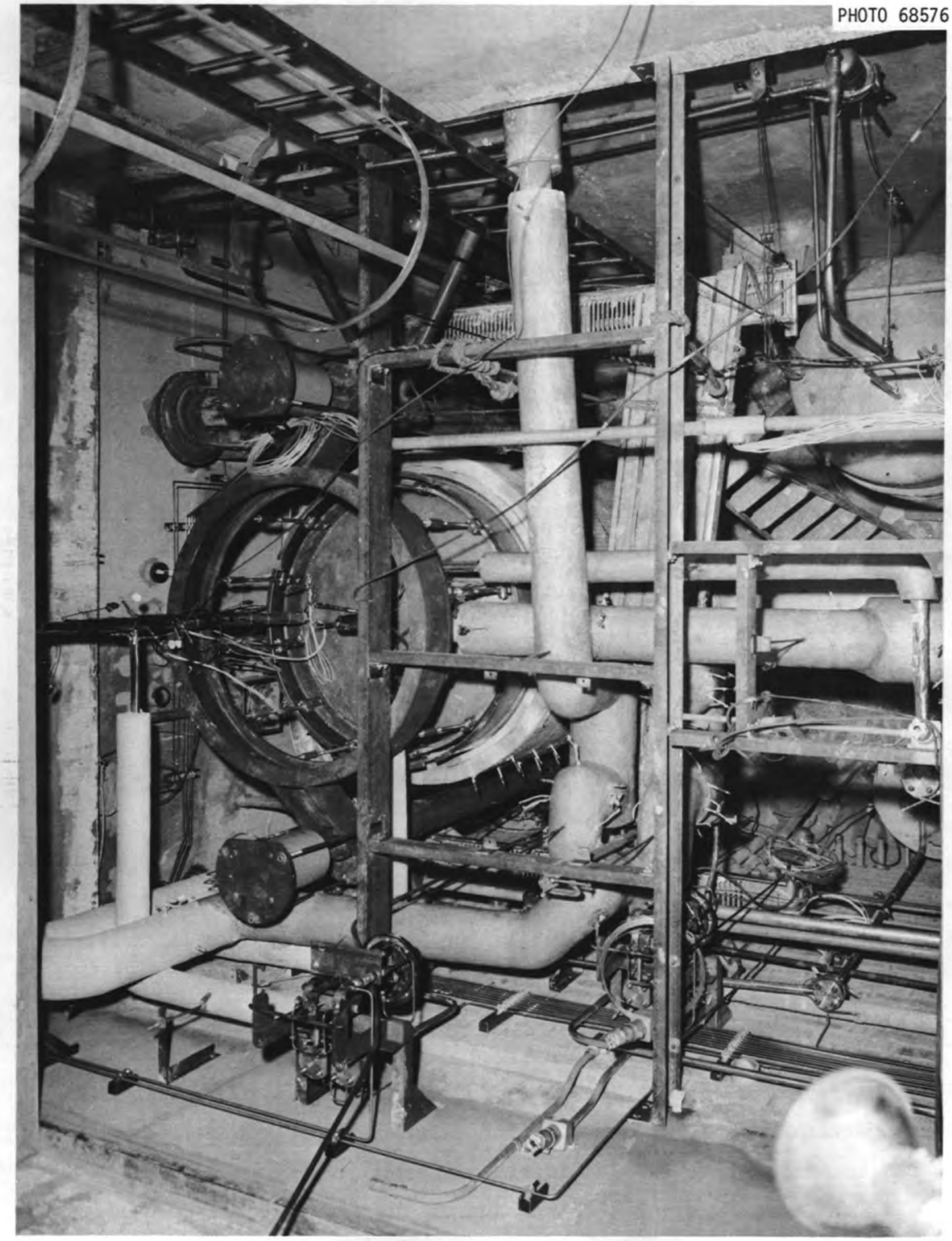

Figure 32. Fuel-Processing Cell

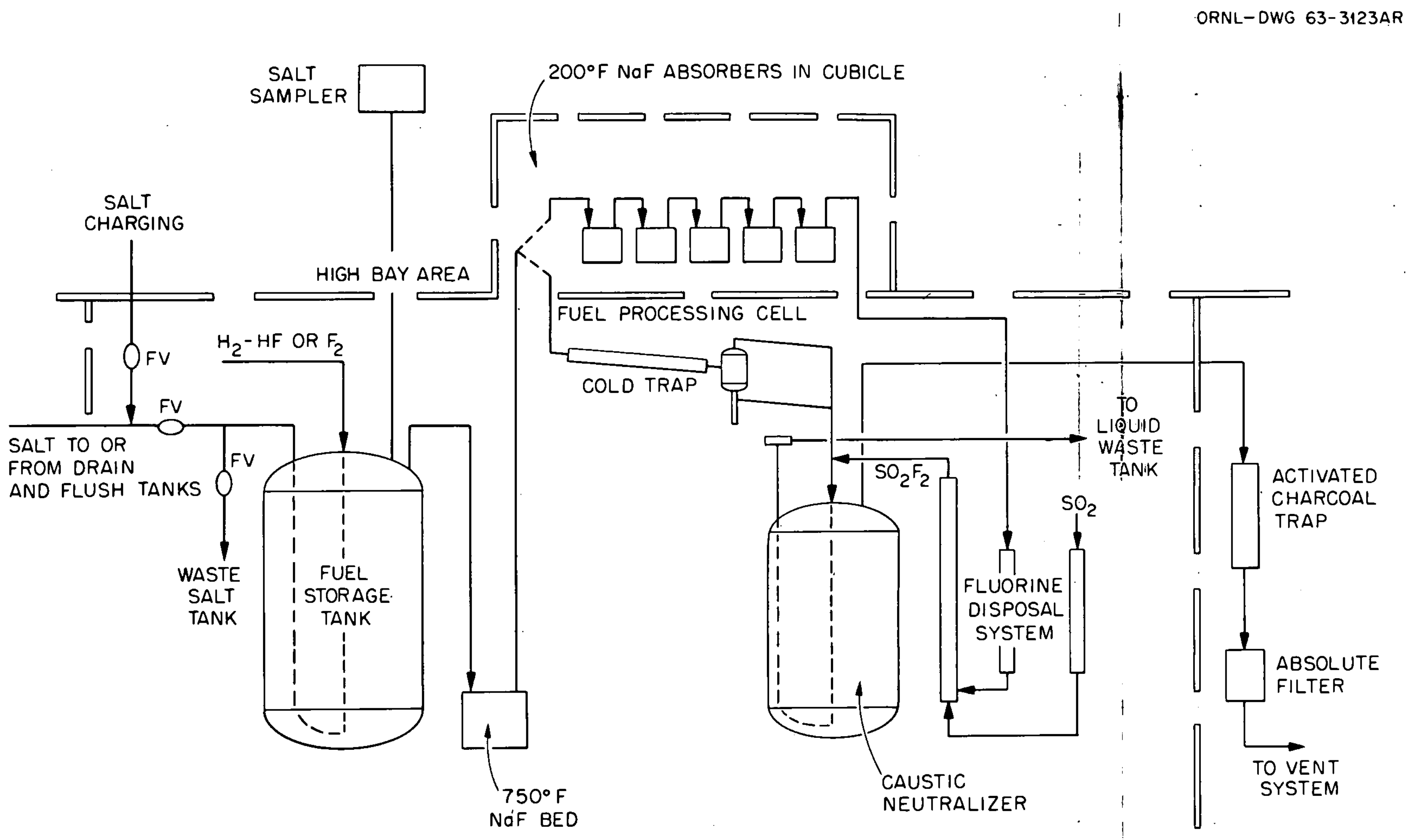

Figure 33. Simplified Fuel-Processing System Diagram

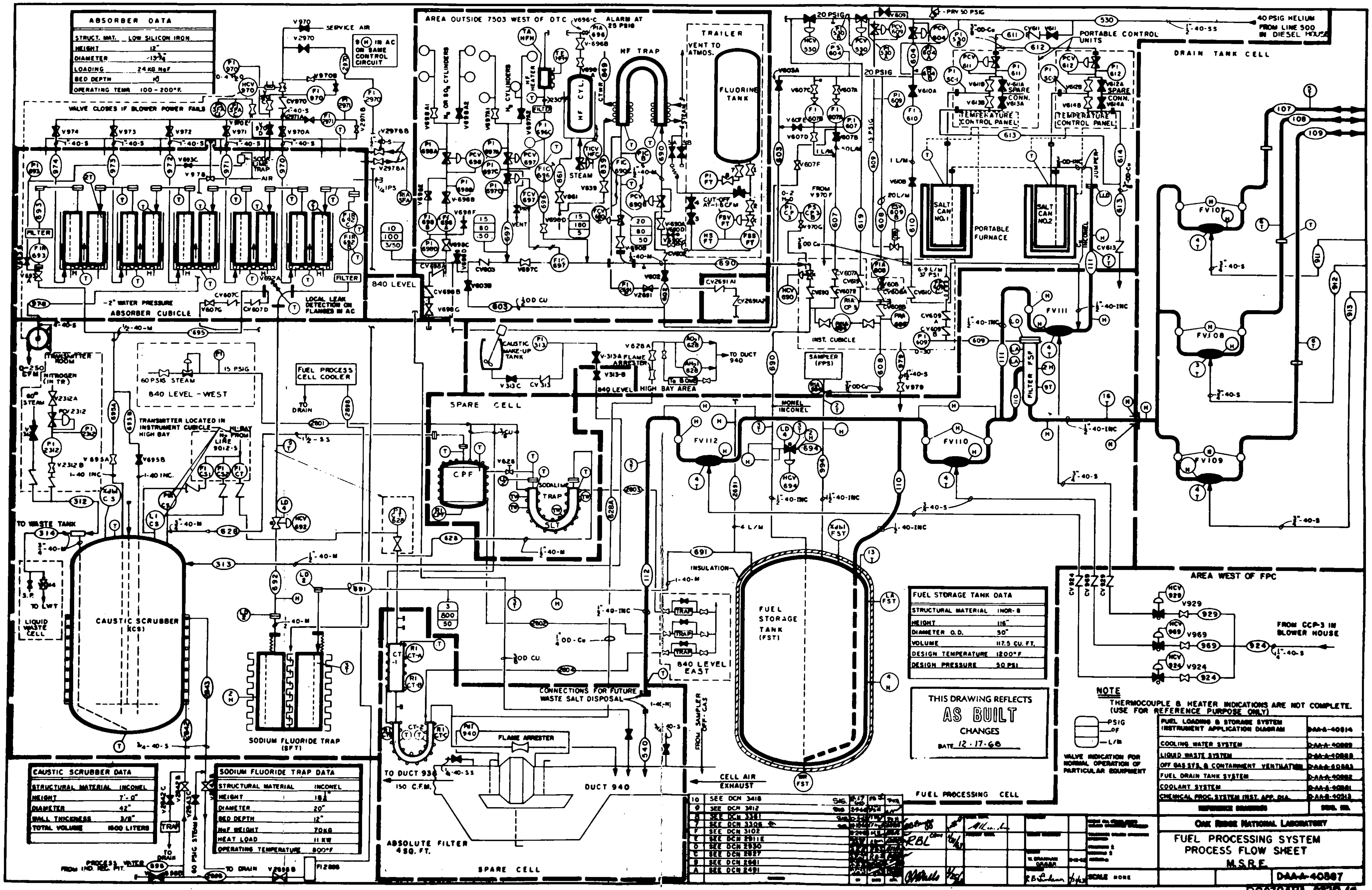

Figure 34. Fuel-Processing System Process Flow Sheet

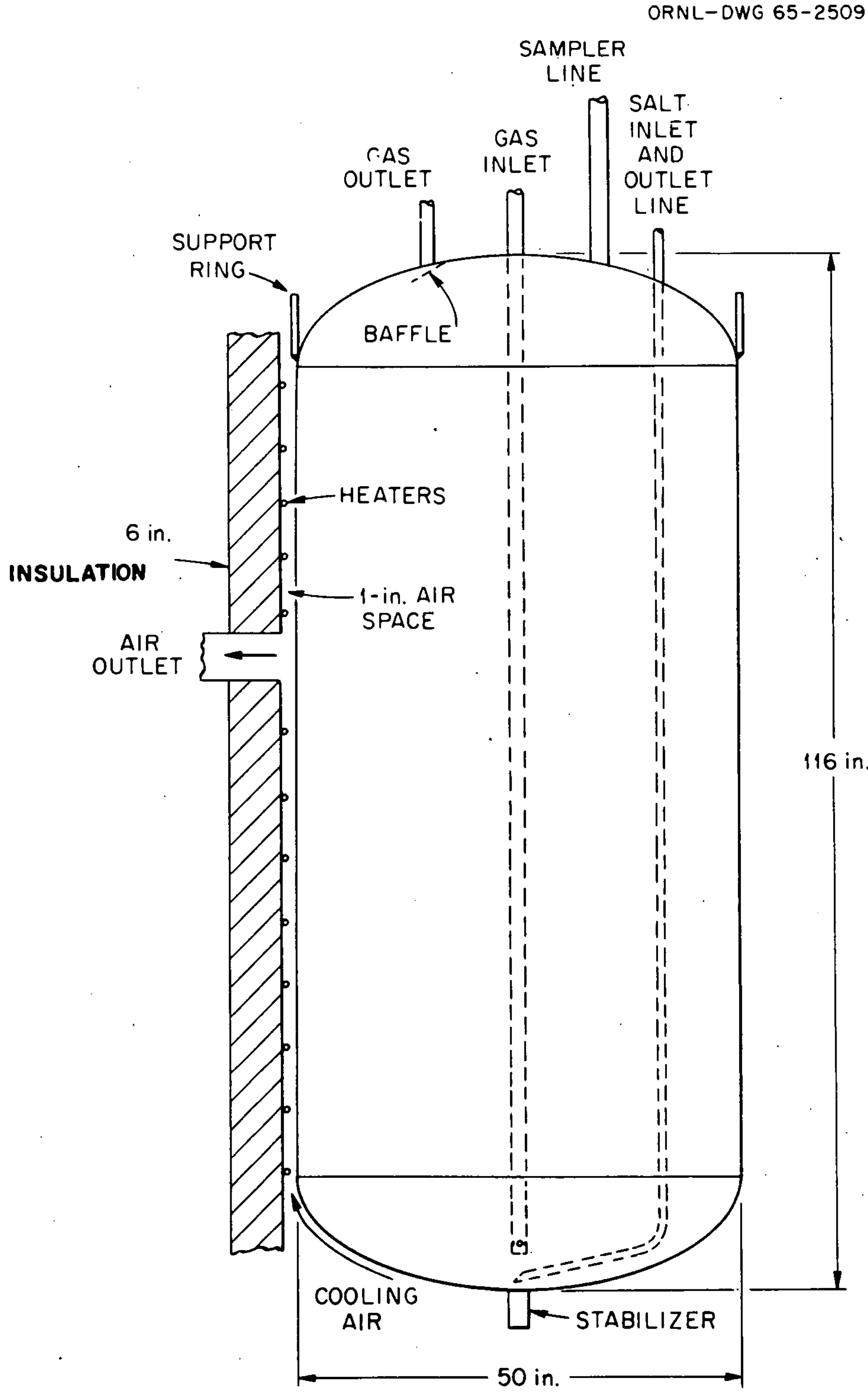

Figure 35. Fuel Storage Tank

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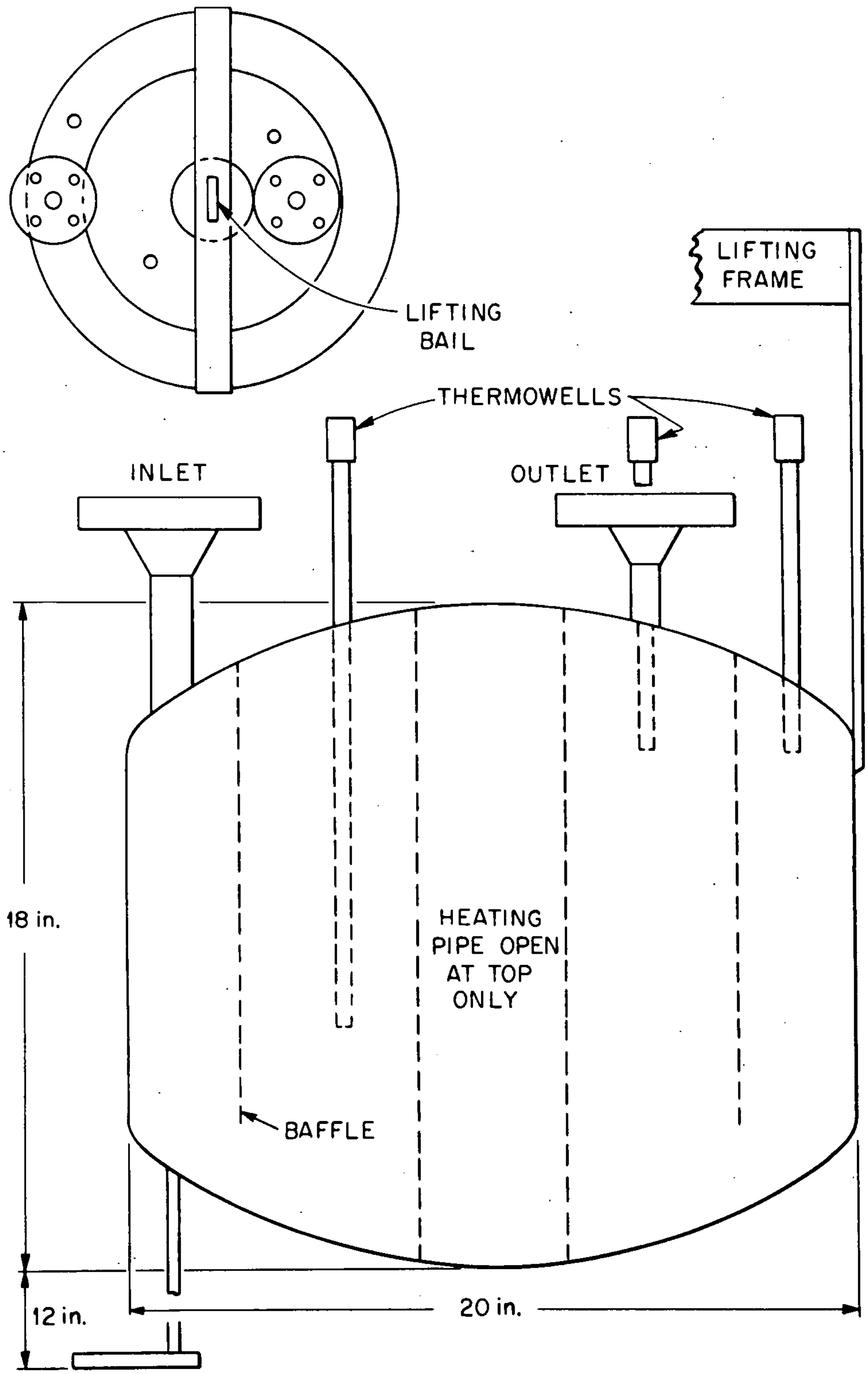

Figure 36. Sodium Fluoride Filled Trap

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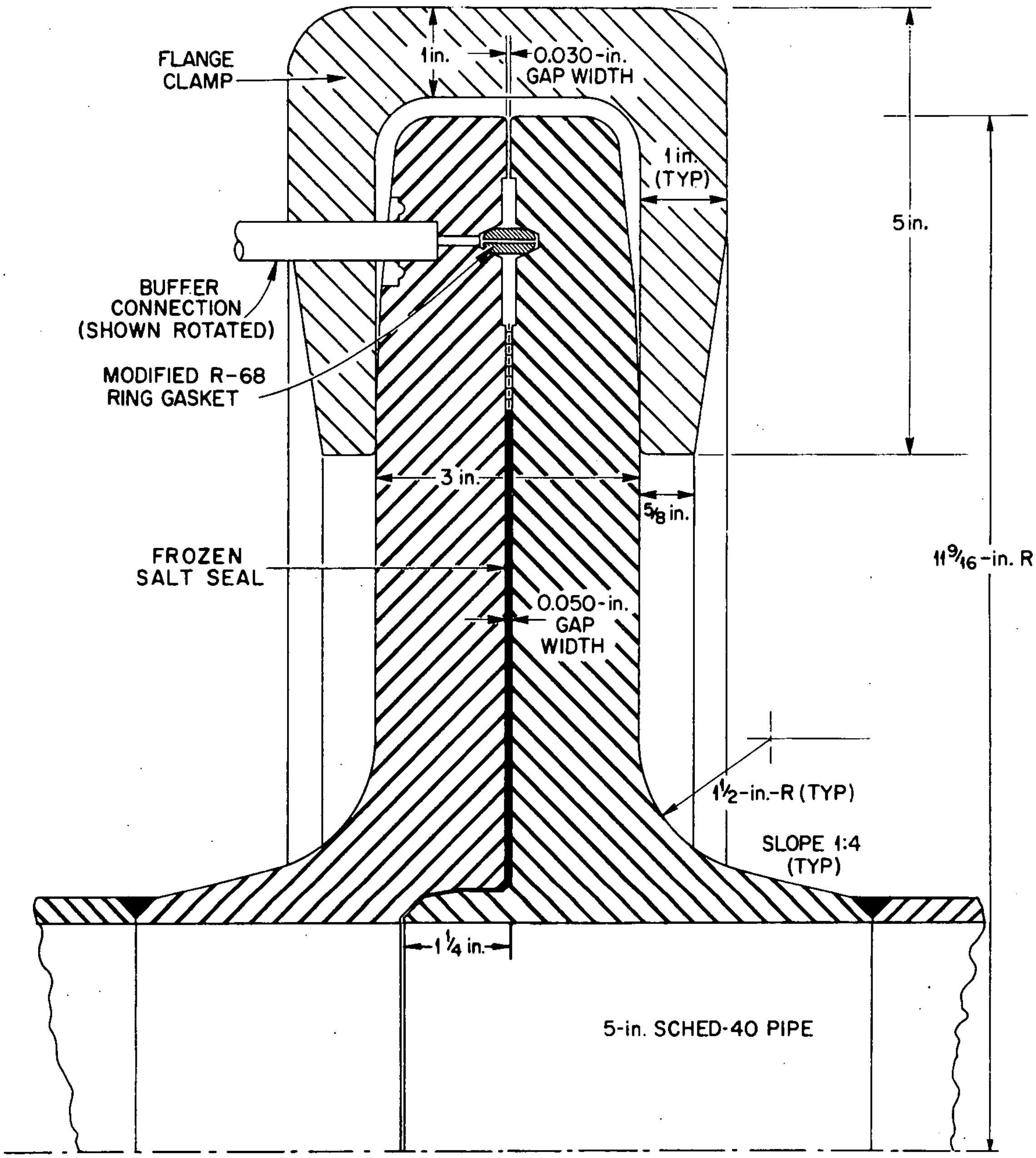

Figure 37. Freeze Flange and Clamp

also contains a leak detecting-buffer gas connection to the ring groove area. The semicircular flange clamps are made of spring steel so that they remain in place when forced around the flange with no bolting being required. Figure 38 shows the installed guide arrangement for the clamps and the simple type of tool required for their removal and installation.

2.9 Freeze Valves

The flow of molten salt in the drain, fill, and processing systems was controlled by freezing or thawing a short plug of salt in a flattened section of 1 1/2-in. pipe, called a "freeze valve". This method of valving was necessary because no mechanical-type valve had been developed for molten-salt service. These valves were closed (frozen) by a regulated cooling-air flow through a shroud around the flattened section of pipe and opened (thawed) by shutting off the air and applying electrical heat to the valve. All valves, except the reactor drain valve, also contain a volume tank located vertically nearby to always provide enough residual salt in the line to form the salt plug.

There are twelve freeze valves in the reactor systems, all of which are fabricated of 1 1/2-in. INOR-8 pipe. Six are installed in 1 1/2-in. lines and six in 1/2-in. lines. One valve, which is in the reactor drain and fill line is inside the reactor thermal shield, six are in the drain-tank cell, three are in the fuel-processing cell, and two are in the coolant cell. Figures 39, 40, 41, and 42 show the various arrangements and details of the twelve valves. The locations of the valves with respect to other equipment are shown in the process flow diagrams (Figures 11, 26, 29, and 34).

2.10 Salt Systems Heaters and Thermal Insulation

All salt-containing components and pipes in the MSRE are thermally insulated and equipped with electrical heaters capable of maintaining the salt above the liquidus temperature of 850°F. Because of the diversity of sizes, shapes, orientation, and accessibility of the items to be heated, a variety of both heater types and insulating methods and materials were used.

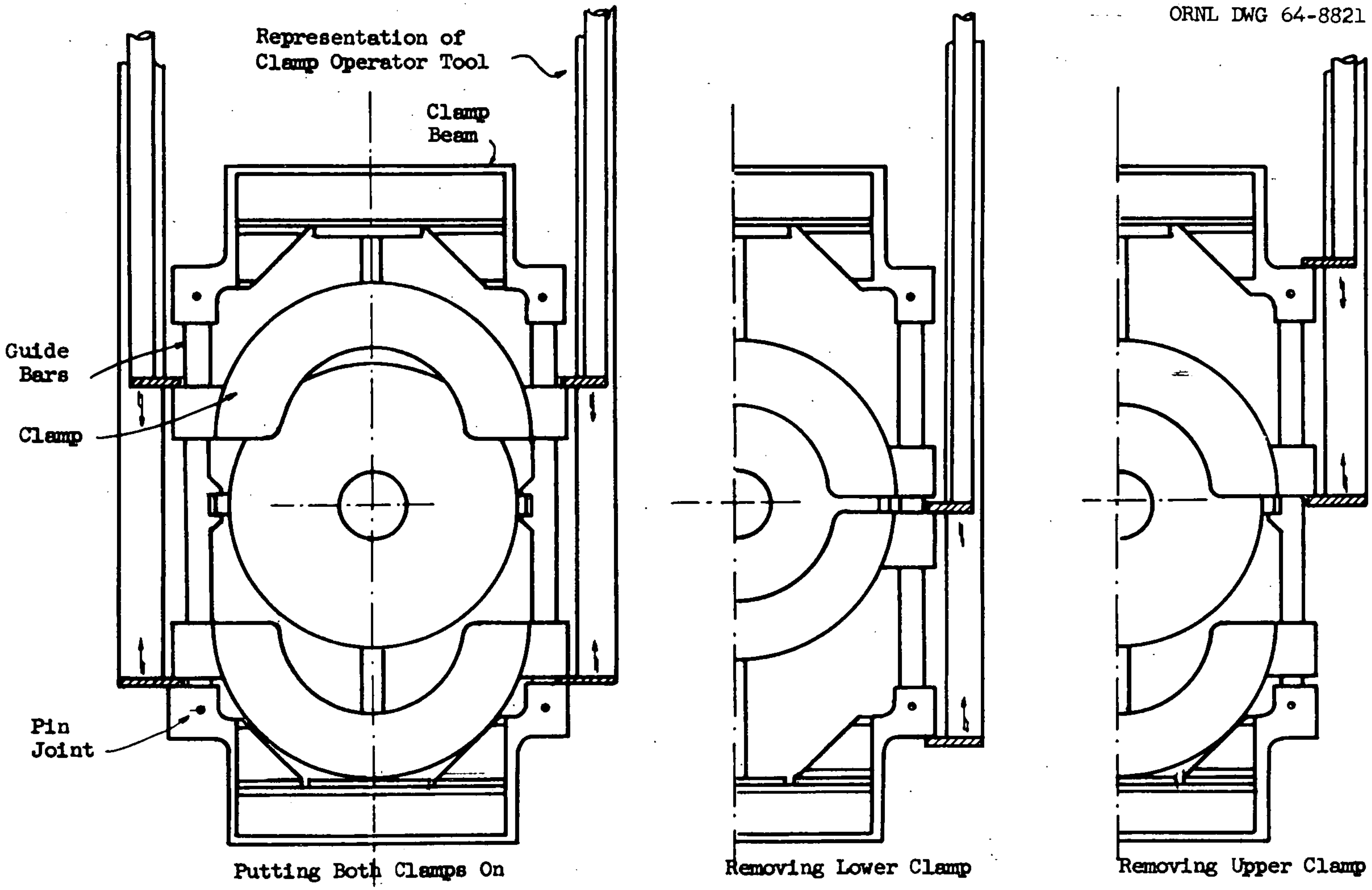

Figure 38. Freeze Flange Clamping Frame Showing Assembly and Disassembly

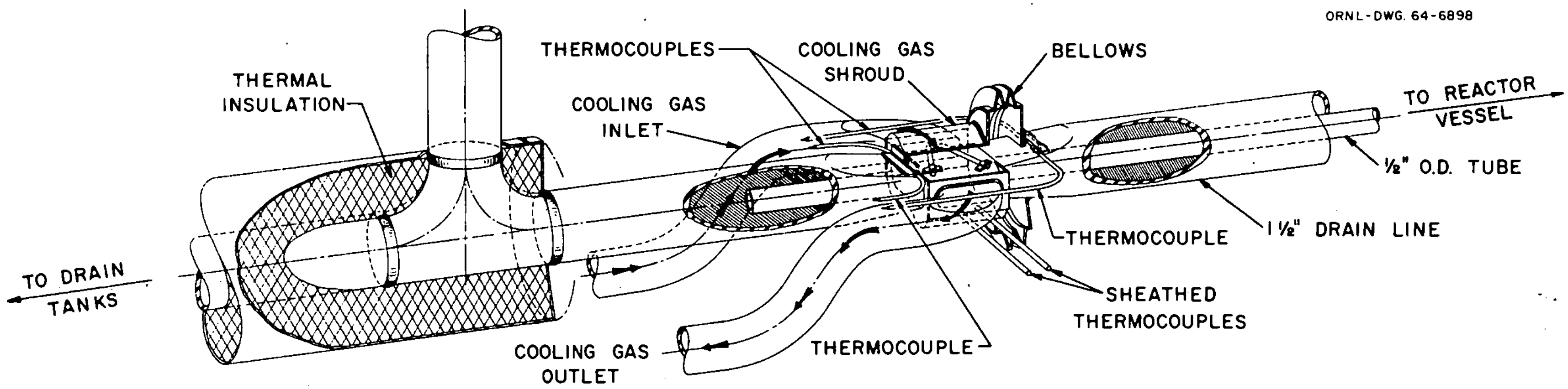

Figure 39. Freeze Valve in Line 103

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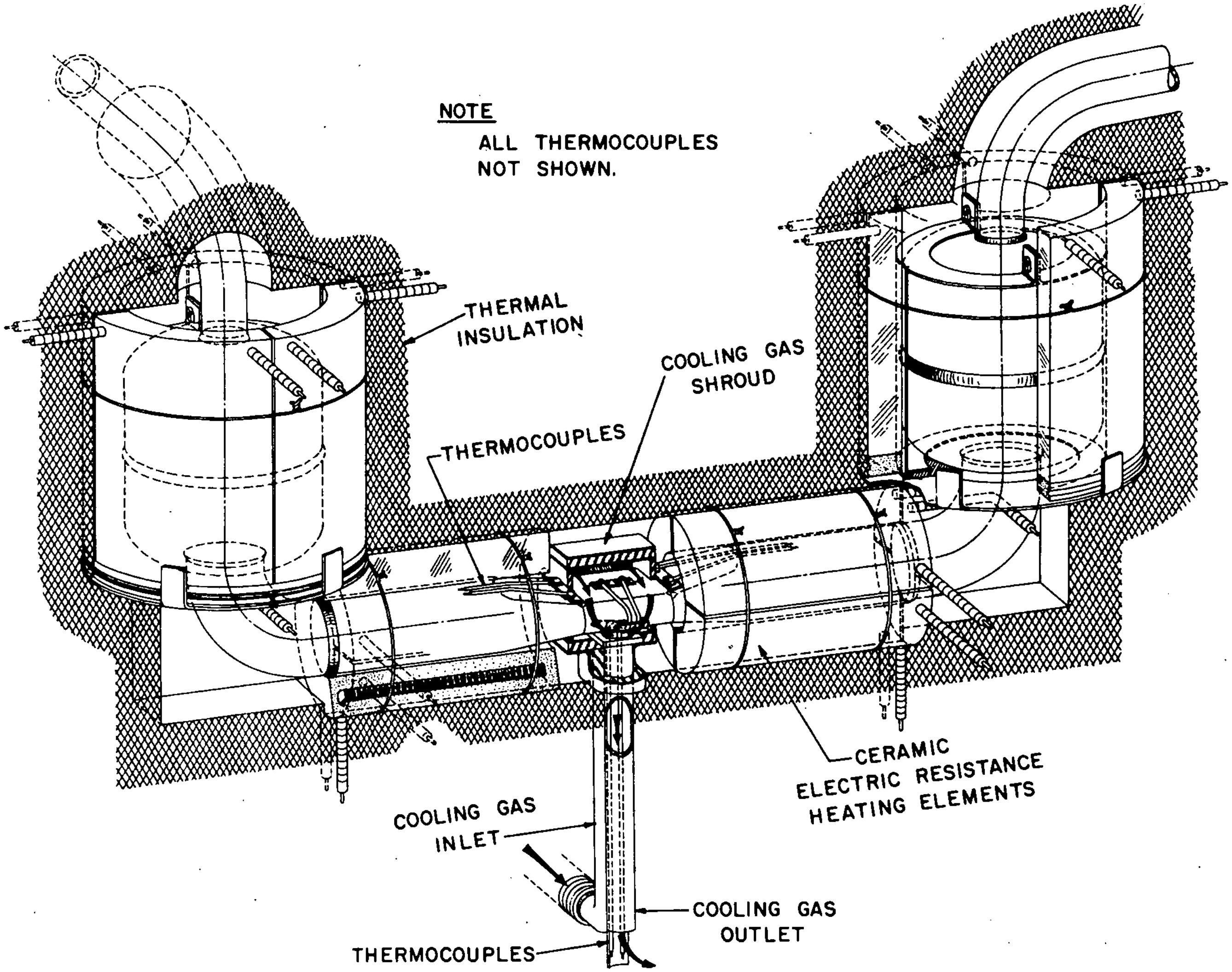

Figure 40. Freeze Valve in Lines 107, 108, 109, and 110

ORNL-DWG. 64-6900

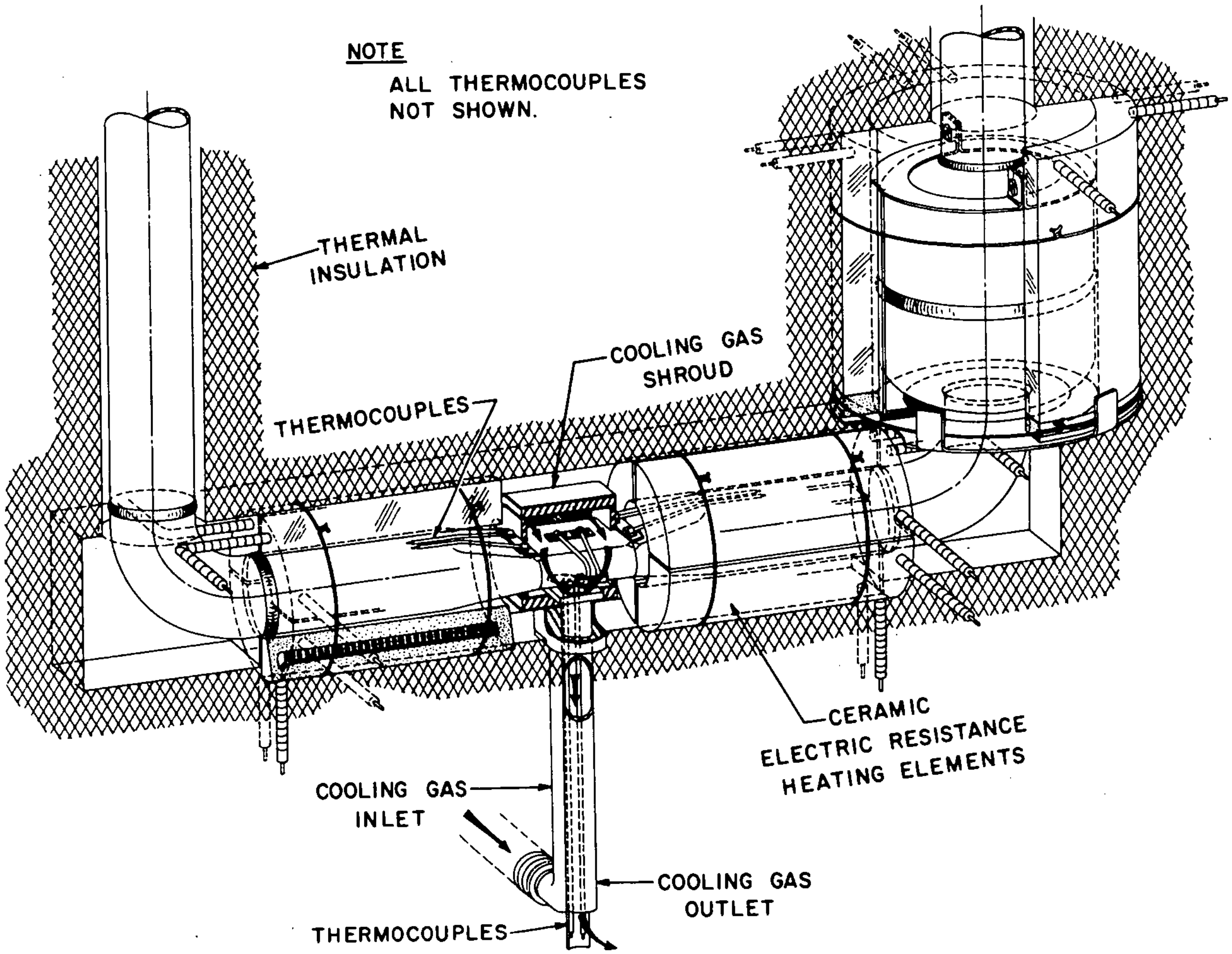

Figure 41. Freeze Valve in Lines 111 and 112

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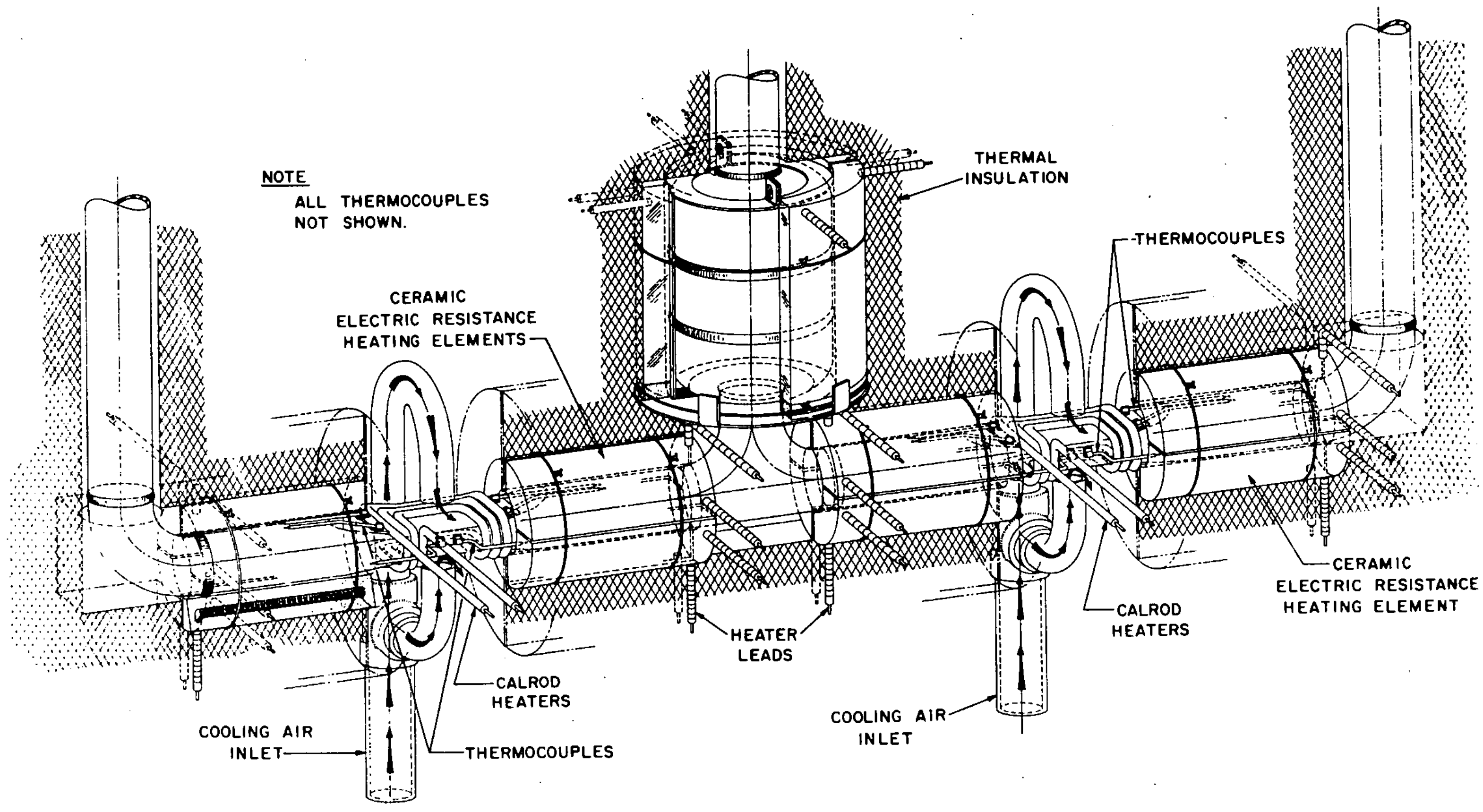

Figure 42. Freeze Valve in Lines 204 and 206

With few exceptions, salt-containing components and piping within the reactor and drain-tank cells are heated with remotely removable heating systems. Consequently, flexible leads and remotely operable disconnects were required for each heater unit. This power feed system, the bulky heater and insulation units along with their respective support structures constitute a very large portion of the total contaminated material within these cells.

2.10.1 Reactor Furnace

The inside of the thermal shield which encloses the reactor vessel is insulated to a builtup thickness of 6 in. with ceramic insulation covered with 16-gage 304 stainless steel sheet. The 11-in.-wide annulus between this insulation and the reactor contains electrical resistance-type heaters to form a furnace surrounding the reactor. The heaters are 126 vertical lengths of 3/8-in.-O.D., 0.035-in.-thick-walled Inconel tubing, each 8 ft 7 1/2 in. to 9 ft 11 in. in length, through which electrical current was passed. The heater tubing is in the form of 63 U-tubes which are arranged in nine removable sections of seven U-tubes each. Each U-tube is contained in a 2-in.-O.D., 0.06 -in.-thick wall 304 stainless steel thimble which is suspended from the top cover of the thermal shield.

2.10.2 Fuel-Salt-Pump Furnace

The lower half of the pump bowl, a 3-ft-long section of the pump suction line, and the overflow tank were all heated in a common furnace which is 51 1/2 in. O.D. by 66 in. tall. The heaters are 3/4-in.-diameter straight tubes of 304 stainless steel containing ceramic-positioned resistance heating elements at the lower ends. Five of the heaters are about 8 ft long and nine are 7 ft long. These 3/4-in.-O.D. heaters are contained in 1-in.-O.D. 304 stainless steel tubes. All the heaters were installed in assemblies with lifting bails to simplify replacement.

The outer walls and bottom of the furnace are 5-in.-thick ceramic block insulation covered with 20-gage 304 stainless steel sheet. The furnace is suspended from the fuel-pump support plates and moved with the pump in response to thermal effects. The heater elements have collars which also rest on the support plate.

2.10.3 Coolant-Salt-Pump Heaters and Insulation

Heat was applied to the coolant-salt pump bowl by fourteen 6 in. x 8 in. x 5/8 in. thick flat-plate ceramic heater units. Six of the heaters are equally spaced at the bottom of the pump bowl and eight are arranged vertically around the sides. The heaters are mounted in brackets in a 304 stainless steel basket which is hung by four hooks from the pump structure.

The outside of the heater basket is insulated with 4 in. of asbestos-based insulation covered with asbestos finishing cement and glass cloth.

2.10.4 Fuel- and Flush-Salt-Drain-Tank Heaters and Insulation

The three drain tanks were heated by cylindrical furnaces made up of insulated tanks with removable lids and removable heater units. The heaters are located within the annuli between the drain tanks and furnace tanks. Each furnace contains seven removable heater units spaced around its respective drain tank.

The outsides and bottoms of the furnaces are insulated by two 2-in.-thick layers of asbestos-based insulation enclosed in 16-gage 347 stainless steel. The removable furnace lids contain ceramic fibers as the insulating material.

2.10.5 Fuel-Storage-Tank Heaters and Insulation

The fuel storage tank in the fuel-processing cell was heated by four sets of heaters at the bottom, the lower half, the upper half, and the top. Each heater had an installed spare and was not replaceable. The top and side heaters are tubular, and the bottom heater is made up of flat ceramic-plate units. The heaters are enclosed in 6 in. of asbestos-based insulation finished with fiber glass cloth and insulating cement.

2.10.6 Coolant-Salt-Drain-Tank Heaters and Insulation

The coolant-salt drain tank was heated on the sides by thirty-two 0.315 in. O.D. x 74 in. long tubular heating units and on the bottom by sixteen flat ceramic heater plates.

The tank is insulated by a 5-in.-thick layer of ceramic-block insulation applied over a 20-gage 304L stainless steel shell which separates the insulation from the heaters. The insulation is finished with fiber glass cloth and insulating cement.

2.10.7 Heat-Dump Radiator Heaters and Insulation

The radiator coil is mounted in an insulated steel enclosure equipped with large (8 ft tall by 11 ft wide) insulated vertically operated doors on the inlet and outlet sides of the coil. Heating was provided by 60 tubular heaters mounted vertically 3 1/2 in. apart across both faces of the coil. These range in length from 48 in. to 102 in. The top and bottom of the coil were heated by sixty 18 in. long by 7 1/2 in. wide flat ceramic heater plates attached to steel baffle plates. The inlet and outlet salt headers were heated by a total of forty-two 4 in. by 12 in. flat ceramic heater plates enclosed with 20-gage 304 stainless steel cans.

All the inside surfaces of the enclosure including the doors are covered with insulating ceramic block or insulating board and protected with a sheath of 16-gage stainless steel where air erosion could be a problem.

2.10.8 Piping Heaters and Insulation

The heater types and insulating methods for the salt-bearing piping depended primarily upon location and accessibility. All horizontal sections of the fuel-salt and coolant-salt 5-in. pipes within the reactor cell and the 1 1/2-in. drain lines in the drain-tank cell are equipped with removable combined heater and reflective insulation modules as shown in Figure 43. These contain molded ceramic heater plates arranged to heat the top and sides of the pipe and rest upon permanently installed insulated bases. The reflective metal insulation consists of nine layers of 0.006-in.-thick stainless steel and one 0.002-in.-thick layer of pure silver encased in a stainless steel shell. The vertical leg of the fuel-salt pipe just below the heat exchanger has permanently installed tubular heaters covered with reflective insulation.

The section of the 1 1/2-in. drain line from the bottom of the reactor vessel to the freeze valve manifold in the drain-tank cell

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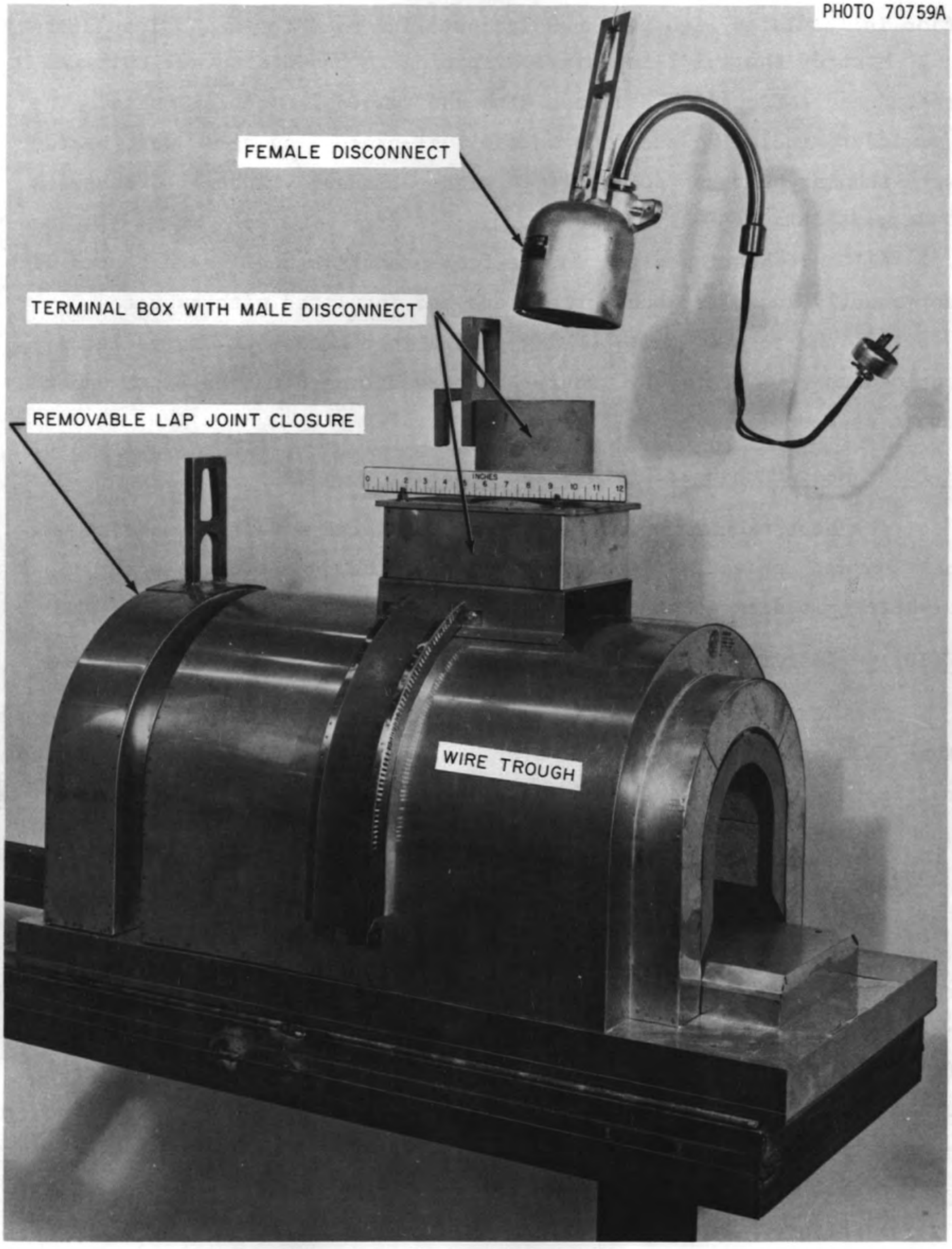

Figure 43. Removable Heater for 5-In. Pipe

was heated by passing an electric current through the line itself. This portion is insulated with permanently installed asbestos-based insulation.

Most of the 1 1/2-in.-diameter piping in the drain-tank cell was heated and reflective insulated with the removable modular units. The remainder, including the line to the fuel-processing cell, were heated with tubular heaters and insulated with permanently installed asbestos-based insulation.

All salt-bearing pipes in the fuel-processing cell were heated with permanently installed tubular heaters and insulated with asbestos.

All the coolant-salt-bearing piping in the coolant and radiator enclosures were heated by tubular heaters strapped to the pipes under asbestos-based insulation.

2.10.9 Heat-Exchanger Heaters and Insulation

The heat exchanger was heated and insulated with removable modular heating and reflective insulating units of the same type used for the 5-in.-diameter pipes except that they were made to fit the 16-in.-O.D. shell.

2.10.10 Heater and Thermocouple Leads

The heater electrical supply leads within the reactor cell and drain-tank cell are 1/2- and 3/8-in.-O.D., copper sheathed, mineral-insulated multiconductor cables having flexible sections between the cable terminus and the heater connector. The flexible length is made with ceramic-beaded nickel alloy wire sheathed in 3/4-in.-O.D. flexible stainless steel hose. The reactor cell contains 79 cables ranging in length from ∿5 to ∿15 ft long, and the drain-tank cell contains 88 cables of about the same length range. The flexible power leads terminate at junction boxes or disconnect boxes that are conveniently located throughout the cells. A transition from the flexible leads to the copper-sheathed cables is made at these boxes. The cables then are routed via cable trays to the containment cell penetrations. The heater power cable system constitutes a large volume of material dispersed throughout the entire volume of the cells.

There are over 1,050 thermocouples installed in the MSRE. A preponderance of these are installed on the salt-containing components and piping. In all cases, except as noted below, the thermocouples are duplex,

mineral-insulated chromel-alumel wires in a 1/8-in.-O.D. Inconel sheath. The thermocouples are attached to lugs on the surface of the pipe and components by means of a small welded tab. The leads are strapped to the pipe or component and are routed in bundles to exit points from the insulation and on to disconnect locations. The number, routing, and manner of attachment of the thermocouples will present problems to be dealt with when considering methods of removal. A few 1/16-in.-O.D. mineral-insulated, Inconel-sheathed single-conductor leads were used in special power monitoring and safety temperature measuring thermocouples. These are located only on the reactor outlet nozzle and on the radiator inlet and outlet headers.

Transition from the Inconel-sheathed couple leads to multiconductor, mineral-insulated, copper-sheathed cables was made at conveniently located disconnect boxes within the cells. The copper-sheathed cables were routed via cable trays to cell penetration points. The total system including leads, cables, disconnects, support structures, trays, and junction boxes constitutes a large volume of material that is dispersed over the entire cell areas.

2.11 Sampler-Enricher

The fuel-salt and coolant-salt pump bowls and the fuel storage tank in the fuel-processing cell are equipped with 1 1/2-in. Schedule 40 access pipes extending to shielded enclosures above the respective cells (Figure 44). These were used for taking samples of the salts as required for analyses and for adding fuel, or other salt constituents, to the salts during operation. The samples were taken simply by lowering open capsules attached to cables through the access pipes into the salt contained in the pump bowls and raising them through appropriate containment seals into shielded transfer casks. Enrichment was accomplished by lowering a capsule filled with concentrated fuel salt into the fuel pump bowl and allowing the salt to melt out.

The access pipes are about 14 ft long and have a bellows-sealed expansion joint at about mid-length. The portion of the pipes below the expansion joint is INOR-8 and the portion above it is 304 stainless steel.

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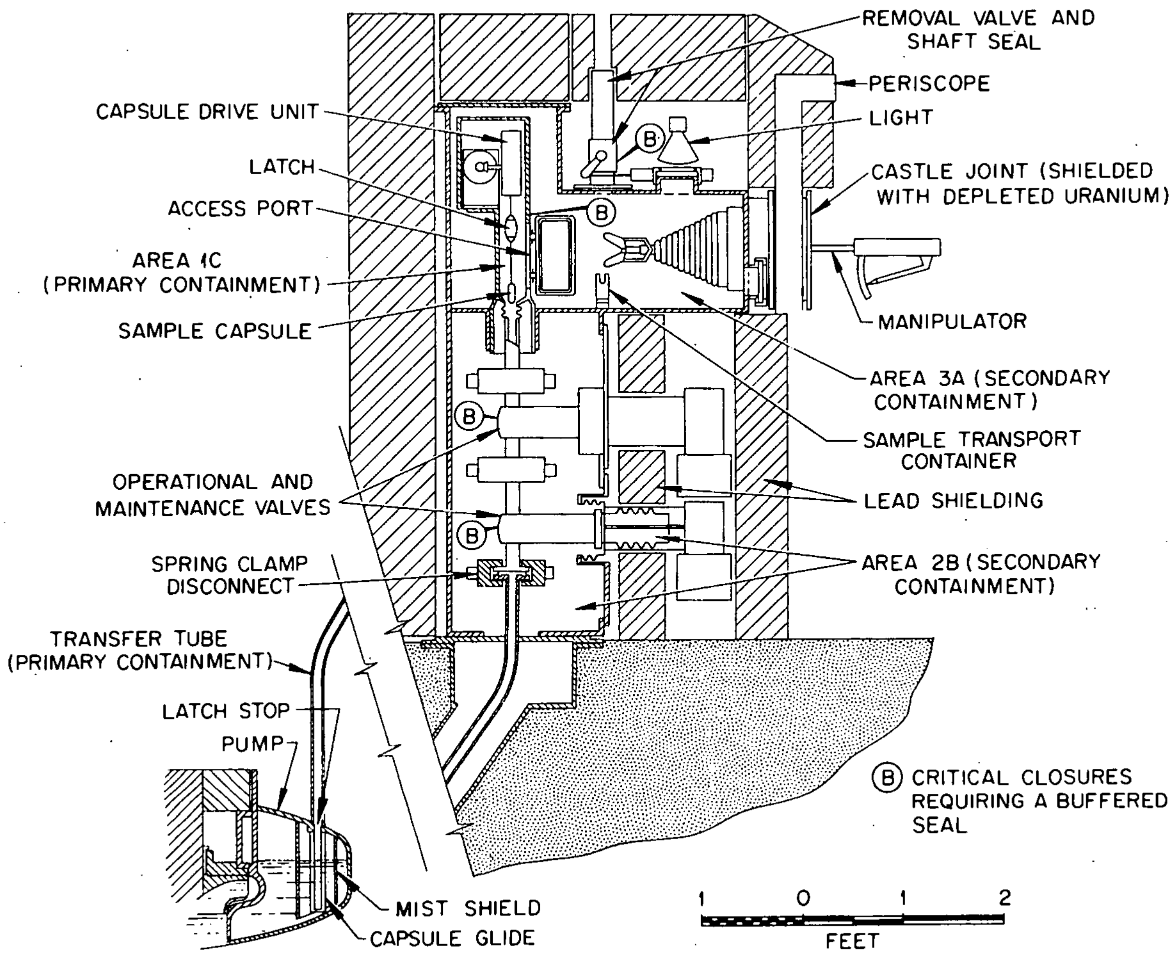

Figure 44. Schematic Representation of Fuel-Salt Sampler-Enricher Dry Box

The fuel-salt sampler-enricher is a complex mechanical, electrical, and pneumatic system, heavily shielded and contained, and is equipped for remote loading into and unloading the capsules from the sampler mechanism and for transferring the capsules between the sampler containment and shielded transport carriers. Since the sampler mechanism was alternately exposed to the pump bowl atmosphere and to the sampler containment enclosure as well as to the exposed salt in the capsules, all equipment inside the enclosure is highly contaminated with fission products.

The coolant-salt sampler is a far simpler manually-actuated system with appropriate interlocking buffer zones which did not require heavy shielding.

The fuel storage tank in the fuel-processing cell is equipped with a shielded sampler system similar to that for the fuel pump bowl but less complex. Since it was used infrequently and was not subject to deposition of daughter products of short-lived fission-product gases, it is far less contaminated than the primary system sampler-enricher.

2.12 Nuclear Instrumentation

Nuclear instrumentation ionization chambers were accommodated by a single 3-ft-diameter slanted thimble shown in Figures 45 and 46. The lower end of the thimble is welded to the reactor cell containment shell and the upper end is embedded in earth fill and concrete. A bellows-type expansion joint between these regions accommodates thermal expansion and contraction.

The thimble contains four 5-in.-I.D. and six 4-in.-I.D. guide tubes for ionization chambers. These tubes are supported by four bulkheads appropriately spaced along the length of the thimble.

For shielding and cooling purposes the thimble was kept full of water. The water contained dissolved lithium nitrite and lithium borate which served as a corrosion inhibitor and enhanced the neutron-shielding properties of the water. A dip tube terminating at the bottom of the thimble allowed a small pump to circulate the water to minimize thermal gradients and keep the corrosion inhibitor evenly dispersed.

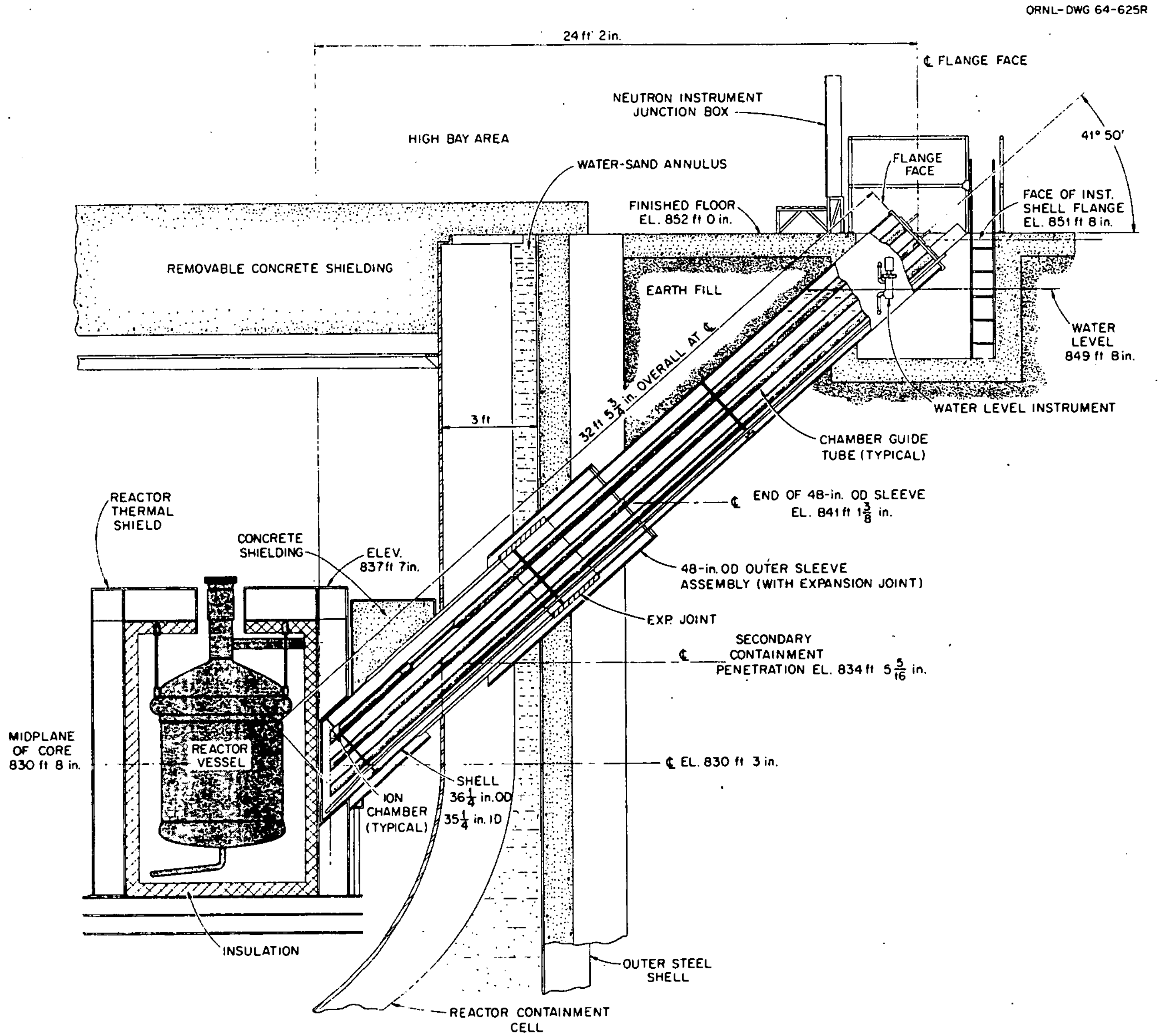

Figure 45. Elevation View of Nuclear Instrument Penetration

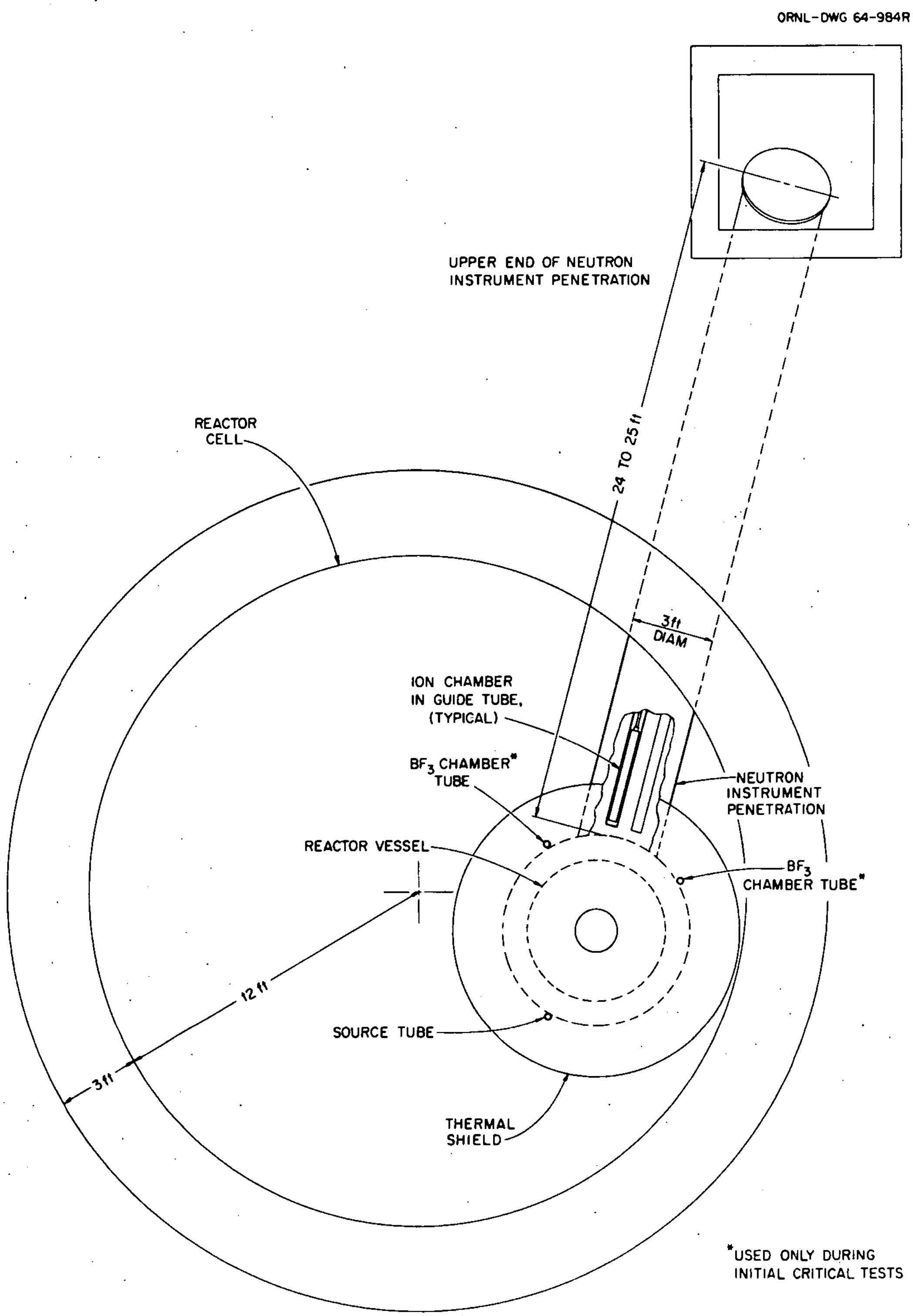

Figure 46. Plan View of Nuclear Instrument Penetration

2.13 Accessory Systems

In addition to the salt-containing systems, eleven accessory systems required the use of piping or ducts either within the containment cells or connected to them. These were: (1) the cover-gas system; (2) the leak-detector system; (3) two component-cooling systems; (4) the cooling-water system; (5) two lubricating-oil systems; (6) the off-gas disposal system; (7) the containment ventilation system; (8) the liquid-waste system; and (9) the instrument air system.

2.13.1 Cover-Gas System

The cover-gas system supplied purified helium for use as an inert gas above the fuel and coolant salts in the pump bowls and drain tanks, as a carrier for removing fission-product gases from the system, as a pressure source for transferring salt from one vessel to another, as a means of pressure control in the salt systems, and as a cover gas for oil storage tanks in the fuel and coolant-salt pump lubricating systems. In addition, a part of the helium purge through the pump bowls and the fuel-pump overflow tank was introduced through bubbler lines to measure the salt depths. All helium was discharged from the various systems to the off-gas disposal system; none was recycled.

Pressure monitoring and flow control instruments for the fuel-salt-pump cover-gas connections were located within containment enclosures located outside the reactor containment cell with individual 1/4-in.-O.D. stainless steel lines encased with 1/2-in. Schedule 40 pipe penetrating the cell wall and connection to the pump. One line introduced the main purge flow at the labrynth seal on the pump shaft. Two lines entering the top of the pump bowl and terminating at the bottom of the bowl served as salt-level-monitor bubblers. One line entering the top of the bowl was used as the reference pressure tap for the bubbler system. Three similar lines to the overflow tank were used to measure its salt level in the same manner. The coolant-salt pump bowl is also equipped with two bubbler tubes, a reference tube, and a purge supply tube.

Helium is also supplied to each of the three tanks in the drain-tank cell by 1/4-in. stainless steel tubes in 1/2-in. stainless steel pipe and

in a similar manner to the fuel-processing system. The gas was used as the cover atmosphere for stored salt and to pressurize the tanks to transfer molten salt out of the tanks.

The cover-gas system supplies helium for the gas volume in the oil storage tanks in the salt-pump lubricating systems and provides purge gas for the fuel and coolant samplers and the graphite sampling equipment.

2.13.2 Leak-Detector System

A leak-detector system using pressurized helium was used to monitor all pipe flanges where leaks could have caused the escape of radioactive materials or could have caused leakage of coolants or lubricants important to operation and safety. Another use of the system was to show when remotely coupled flanges were properly sealed. Figure 47 illustrates the use of the pressurized gas to check the leak-tightness of gasket seals. The helium was supplied from the cover-gas system through 1/4-in.-O.D. stainless steel tubing having a wall thickness of 0.083 in. All important pipe flanges in the reactor and drain-tank cells have one to two lines of the leak-detector system connected to them, depending upon whether they were individually monitored or were a part of a monitored group. Throughout the reactor system and its accessory systems, $\sim$100 flanges were gas-monitored.

2.13.3 Lubricating-Oil Systems

Both the fuel-salt and coolant-salt pump bearing assemblies were lubricated and cooled with forced-flow oil systems. The oil reservoir tanks and the pumps are located in the shielded east tunnel. All oil piping to the pumps is Schedule 40 stainless steel. A 3/4-in. pipe delivered oil to the fuel-pump bearings, and a second 3/4-in. pipe supplied oil to cool a shield block located between the pump bowl and motor. A 1/2-in. pipe connecting the gas space in the oil reservoir to the pump bearing assembly equalized the pressure between the two regions. The oil supplied to the bearing and shield block combined to return to the reservoir through a single 1-in. pipe. The small amount of oil that leaked downward past the labrynth seal below the bearing was swept by helium from the cover-gas supply into a 1/2-in. line that carried it to a shielded catch tank

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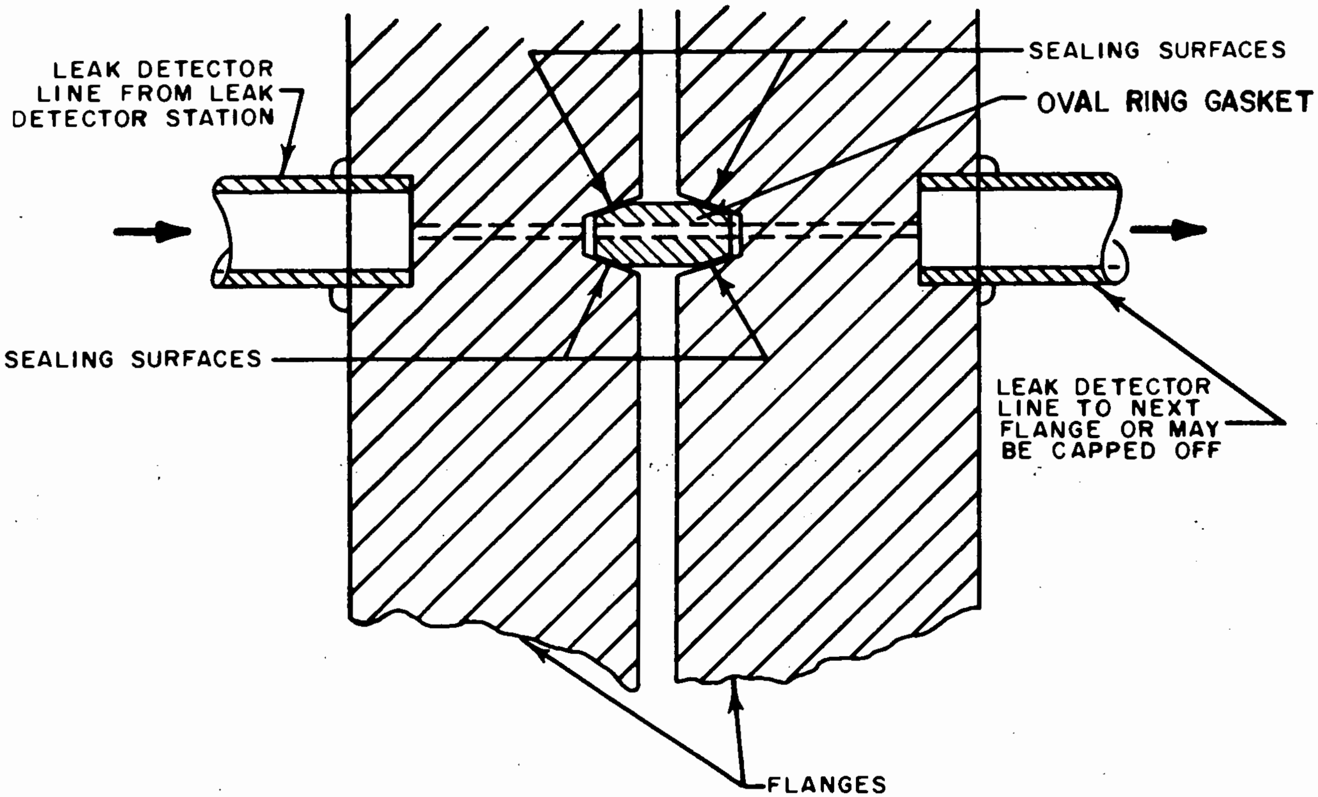

Figure 47. Schematic Diagram of Leak-Detected Flange Closure

in the special equipment room. Because of the low flow rate through this pipe, it is shielded with 1 1/2 in. of lead to reduce radiation damage to the oil. The coolant salt pumps have the same arrangement of piping from their lubricating oil supply except that the 1/2-in. line to the catch tank is not lead-shielded.

2.13.4 Component-Cooling Systems

The reactor-cell and drain-tank-cell atmosphere gas was circulated through an external cooling system and returned to the cells through a distribution system to cool freeze valves, the upper part of the fuel pump bowl, the control-rod drives, the graphite sampler nozzle, the inside and outside of the reactor access nozzle, and the off-gas exhaust line. The external equipment consists of two 75-hp positive-displacement blowers sealed in 6-ft-diameter, 8-ft-tall steel containment tanks located in the adjoining special equipment room. The containment tanks are connected by 10-in.-diameter pipes to a 30-in.-diameter containment ventilation pipe which, in turn, is connected to the reactor cell containment vessel. Supply gas for the blowers was taken from inside the containment tanks. The discharge from the blowers passed through a vertical 8-in.-diameter, 9-ft-long, shell-and-tube, water-cooled heat exchanger also located in the special equipment room. The gas then flowed to a 6-in.-diameter header in the reactor cell from which it was distributed to the components to be cooled. The lines to the pump bowl and the off-gas exhaust line are 3-in.-diameter pipe; the line to the reactor drain freeze valve is 1 1/4 in. in diameter; the line to the control-rod drives is 1 in. in diameter; and the lines to the reactor access nozzle, the graphite sampler nozzle, and the freeze valves in the drain-tank cell are all 3/4 in. in diameter. After cooling the several components, the gas discharged directly back to the cell atmosphere and then returned to the blower suction via the cell containment ventilation line.

The freeze valves in the coolant and fuel-processing cells were cooled by atmospheric air supplied by a 5-hp positive displacement blower located in the blower house at the southwest corner of the reactor building. The supply header from this blower is 3-in.-diameter pipe. The distribution lines to the two freeze valves in the coolant cell are 1-in.-diameter carbon

steel, and those to the three freeze valves in the fuel-processing cell are 3/4-in.-diameter carbon steel. After passing over the surfaces to be cooled, the air discharged directly to the cell atmosphere was then exhausted through the cell containment ventilation system.

2.13.5 Cooling-Water System

The cooling-water system is made up of two parts: the cooling-tower water system and a closed treated-water system cooled by the cooling-tower water.

The cooling-tower water system was cooled by a forced-draft cooling tower located southwest of the reactor building. From the cooling-tower basin, water was circulated by either of two 547-gpm pumps to the treated-water heat exchanger, the fuel-salt and coolant-salt pump lubricating-oil reservoirs, the two fuel-drain-tank steam condensers, the coolant cell coolers, the fuel-processing caustic scrubber and hydrogen-fluoride trap cooling coils, the charcoal beds in the off-gas dispersal system, and the steam condenser that supplied makeup condensate for the treated-water system. It was also used to cool other items not directly related to the reactor system. All the piping in this system is carbon steel.

The treated-water system is a closed cooling system filled with steam condensate to which a corrosion inhibitor was added. This system was used to cool equipment in which it was possible for the water to become radioactively contaminated. The water was circulated by either of two 320-gpm pumps located in the blower house at the southwest corner of the reactor building. The water passed through the tube side of a shell-and-tube heat exchanger located in the diesel house to a header from where it was piped to the items to be cooled. The return lines terminate in a common header leading to the pump suction side. A surge tank connected to the system was used for volume control, makeup, and for adding the chemical corrosion inhibitor.

Treated water was used to cool the reactor thermal shield, the fuel-salt and coolant-salt pump motors, the two reactor cell air coolers, the drain-tank-cell air coolers, the nuclear instrumentation access thimble, and the component-cooling systems gas heat exchanger and blower lubricating

oil system. The in-cell piping for this system is stainless steel ranging from 1 in. to 3 in. depending upon the flow requirements.

All water lines penetrating the containment cells contained check valves on the inlet leg and a pneumatic safety block valve on the exit leg with a rupture disc relief to the vapor condensing system attached to the trapped volume. The thermal shield coolant return line contained a degassing system for the removal of radiolytic gases.

2.13.6 Off-Gas Disposal System

The off-gas disposal system handled three types of gas flow: (1) a continuous discharge of helium and gaseous fission products from the fuel-salt pump bowl; (2) intermittent discharges of contaminated helium during salt-transfer operations; and (3) flows of up to 100 cfm of cell atmosphere. The first two of these off-gas flows passed through a complex system of holdups, filters, and absorbers and were extensively monitored for activity prior to being discharged into the containment ventilation system effluent upstream of the final filters and stack discharge. The ejected cell gas was routed, after monitoring, directly to the containment ventilation connection.

Helium sweep gas and gaseous fission products were drawn from the fuel pump bowl and overflow tank through 1/2-in. stainless steel pipes which merge and connect to a 4-in. pipe a short distance from the pump. This 4-in. pipe with a serpentine section is routed around the inside surface of the reactor cell with a total length of 68 ft providing a holdup volume of about 6 ft^3 and a gas residence time of about one hour. The line continues then as 1/2-in. pipe through the cell wall penetration and then as 1/4-in. stainless steel pipe through the coolant drain-tank cell to a sealed instrument box in the ventilation house. After passing through pressure-control and monitoring systems, the line is joined by the 1/2-in. Schedule 40 line from the fuel-pump seal and continues as 1/4-in. stainless steel pipe to a second holdup volume in the charcoal-trap cell.

The charcoal-trap cell is a 10 ft diameter by 22.7 ft deep pit made of reinforced concrete with a 3-ft-thick removable concrete cover. The cell was kept filled with water, supplied by the cooling-tower water system, to remove the decay heat from fission products trapped by the charcoal.

The second holdup volume consists of six 19.8-ft lengths of 3-in. pipe arranged as close-packed vertical "U" bends connected in series. From the holdup volume, a 1/2-in. stainless steel pipe leads to the main charcoal-trap manifold. The main charcoal trap consists of four parallel charcoal-filter sections each of which is made up of 80 ft of 1 1/2-in. stainless steel pipe, 80 ft of 3-in. stainless steel pipe, and 80 ft of 6-in. stainless steel pipe arranged as compact vertical "U" bends connected in series. The weight of charcoal in each section is 725 lbs.

From the charcoal traps, a 1/2-in. stainless steel pipe connects to a 1 1/2-in. pipe in the ventilation house. This line leads to the containment ventilation system particulate filter enclosure where the gas was filtered and diluted by flows from other areas before being discharged to the atmosphere through a 100-ft-tall steel stack by one of two 21,000-scfm fans.

One-quarter-inch or 1/2-in.-diameter stainless steel off-gas pipes connected to each of the fuel-salt drain tanks, the graphite sampler, the sampler-enricher, the coolant pump bowl and shaft seal, the lubricating-oil reservoirs, the coolant-salt drain tank, and the reactor and drain-tank cells allowed these items to be continuously or intermittently purged to the off-gas system. Those items which did not normally contain radioactive gases but could under abnormal conditions were vented, past monitors, directly to the particulate-filter enclosure. The fuel drain tanks and flush-salt tank were normally vented through the auxiliary charcoal trap located in the charcoal-trap cell but could be valved to discharge through the reactor cell holdup volume and thence to the main charcoal traps.

The auxiliary charcoal trap consists of two vertical ∿19-ft-tall "U" bends, made of 6-in. stainless steel pipe, which are connected in series. The trap contains 530 lbs of charcoal. The discharge from the trap merges with the discharge line from the main charcoal traps ahead of the particulate-filter enclosure.

2.13.7 Containment Ventilation System

In addition to receiving and diluting the reactor off-gas discharge, as previously discussed, the containment ventilation system provided a continuous flow of air or maintained a negative pressure through all areas

where radioactive or beryllium contamination was likely to occur other than the reactor and drain-tank cells. During maintenance operations, however, this system was used to provide 100 linear feet per minute inflow through openings in the reactor and drain-tank cells made by removing sections of the top shields.

A system of steel ducts from the stack area draws air from the reactor building through the six smaller shielded cells, the electric service areas, transmitter room, service tunnel, special equipment room, and coolant cell and from the main high-bay area. Air is also exhausted from the ventilation house and charcoal-bed cell by this system. Many small containment enclosures were either exhausted or maintained at negative pressures by this system.

Air flow through the system is induced by either of two 21,000-cfm centrifugal fans located at the base of the 100-ft-tall steel discharge stack. Before discharge up the stack, the air passes through roughing and high-efficiency filters.

The connection to the combined reactor and drain-tank cells is a 30-in.-diameter duct leading from the bottom of the southwestern sector of the reactor cell containment vessel. This duct was normally kept closed by two motor-operated butterfly valves installed in series. Negative pressure in the sealed cells was maintained by discharging a small portion of the recirculating component-cooling-system flow to the off-gas system.

Figure 48 is a schematic flow diagram of the containment ventilation system.

2.13.8 Liquid-Waste System

Not including the sanitary sewer system, the MSRE building and its auxiliary structures have three waste water accumulation containers (Figure 49) equipped with appropriate volume and radiation monitors and with discharge pumps which route the waste water either to the ORNL radioactive liquid-waste treatment system or to a drainage ditch.

Water discharged by steam- or air-operated jet-type ejectors from the reactor cell, the drain-tank cell, and the auxiliary cells and water from decontamination sinks flowed directly to an 11-ft-diameter, 16-ft-tall, 11,000-gallon stainless steel waste storage tank located in the

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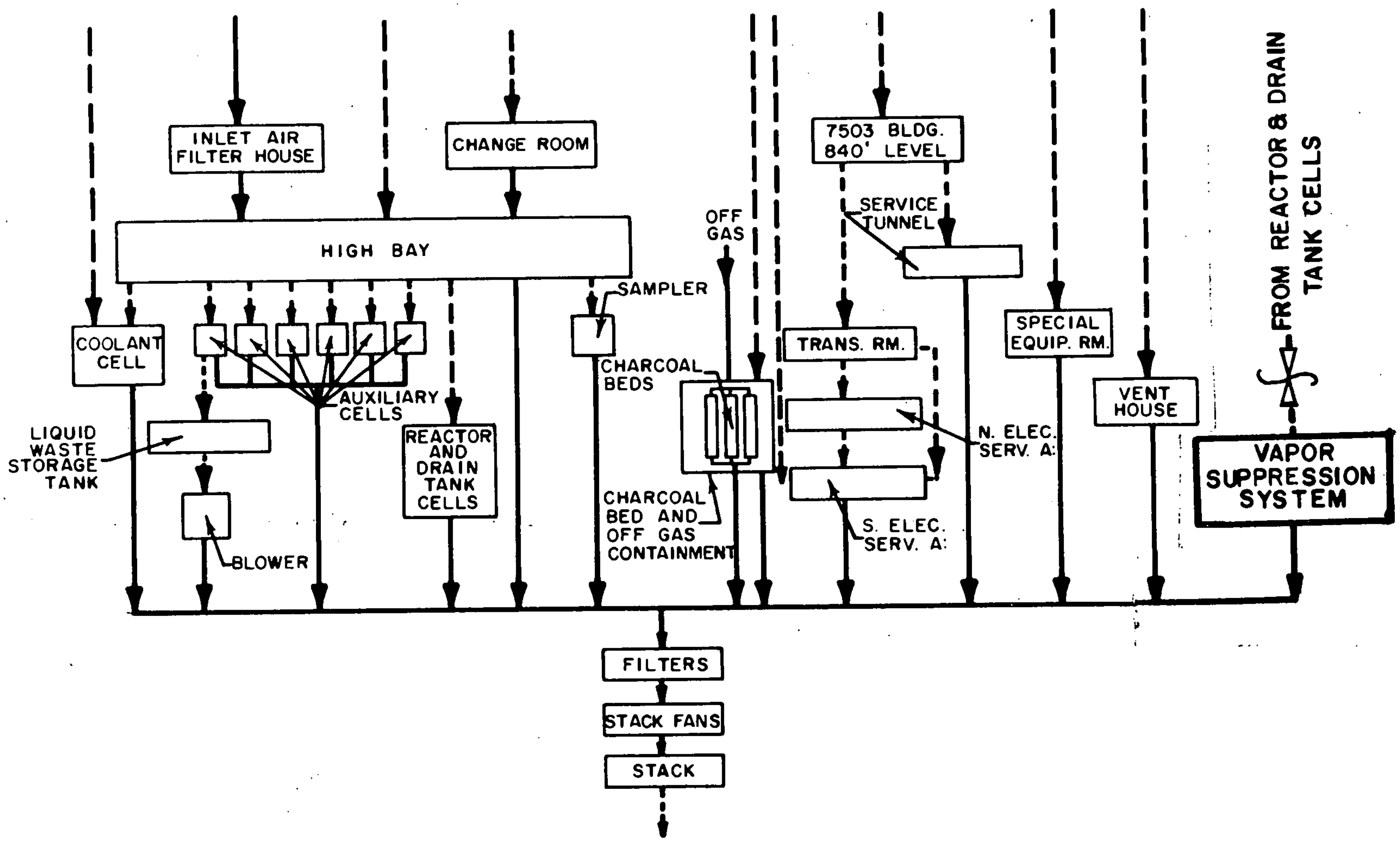

Figure 48. Schematic of Air Flow Diagram Containment Ventilation System

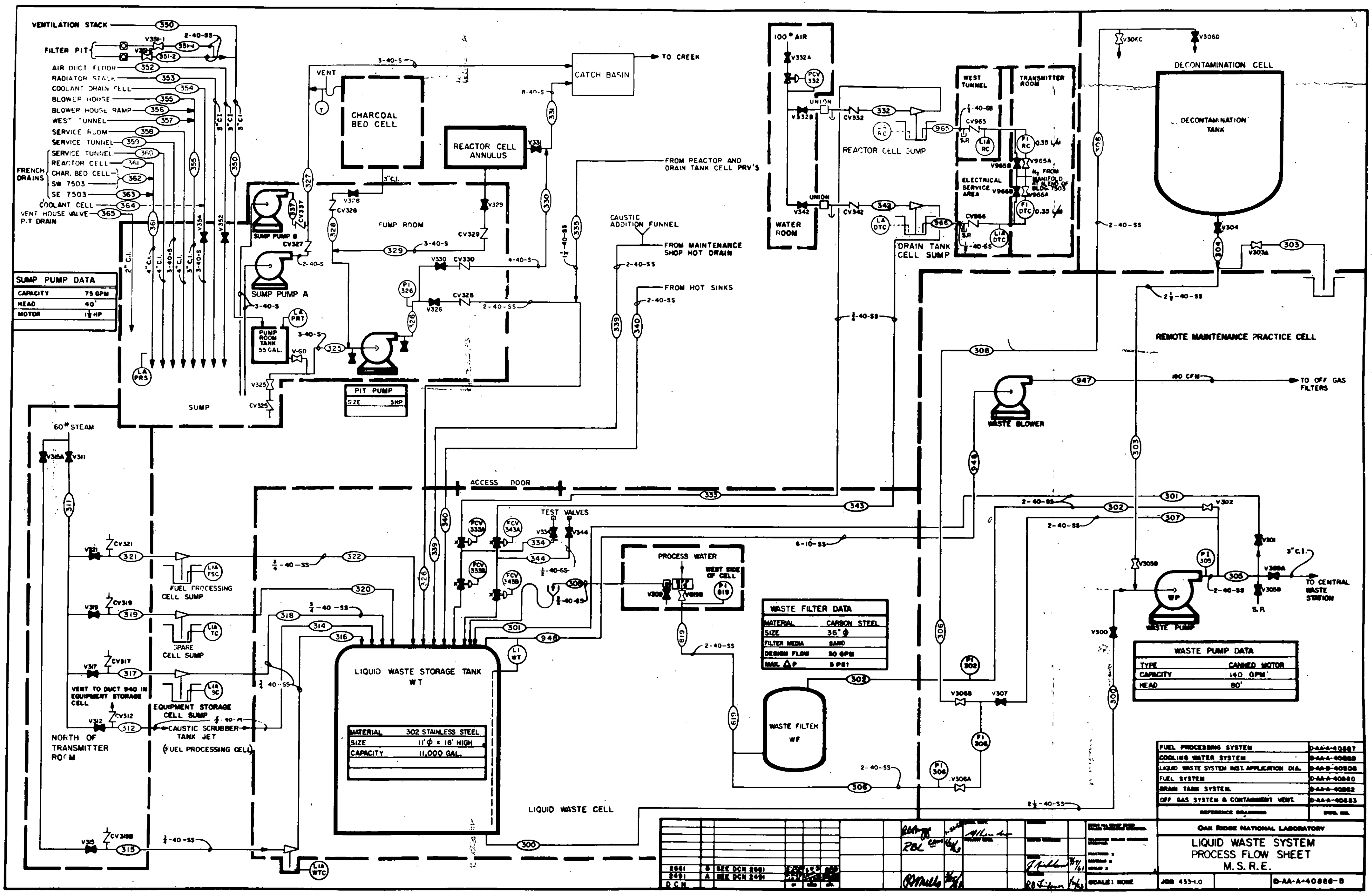

Figure 49. Liquid-Waste System Process Flow Sheet

liquid-waste cell. A 140-gpm pump located in the remote maintenance practice cell is used to discharge accumulated water from the tank to the ORNL liquid-waste treatment system.

A 42 in. diameter by 50 in. tall stainless steel filter tank is also located in the liquid-waste cell. The filter is a 34-in.-deep bed consisting of graded sand and gravel. The intended purpose of this filter was to clarify water circulated through a decontamination tank proposed for the decontamination cell. The decontamination tank, however, was never installed due to lack of need.

A 3 ft by 3 ft by 8 ft deep sump in the below-grade 8 ft by 16 ft by 7 ft high sump room located at the northeast corner of the special equipment room (Figure 6) is the lowest point of the MSRE complex and is used to collect normally uncontaminated waste water from all areas of the MSRE complex. These include the radiator air-duct floor, the blower house, blower-house ramp, west tunnel, service room, service tunnel, coolant cell, ventilation house valve pit, and French drains from the building foundations and charcoal-trap cell. Water from this sump is discharged by either of two 75-gpm pumps, located in the sump room, to a 2 ft by 3 ft by 6 ft deep concrete catch basin located just west of the charcoal-trap cell. From the catch basin, the water drains through a 150-ft-long, 12-in.-diameter reinforced concrete pipe to a drainage ditch.

A 55-gallon stainless steel drum located in the sump room was used to collect drainage from the ventilation stack base and from the filter pit since water from these sources could be contaminated. The drum was equipped with a continuous radiation detector alarm as well as a high liquid level alarm. Each batch of accumulated liquid was sampled prior to being transferred via a 200-gpm pump, also located in the sump room, from the drum to either the liquid-waste storage tank or directly to the catch basin, depending upon whether the water was contaminated or not.

2.14 Vapor Condensing System

As illustrated in Figure 50, the MSRE is equipped with a vapor condensing system to accommodate overpressurization of the reactor containment cell in the event of a catastrophic accident that caused mixing of hot fuel

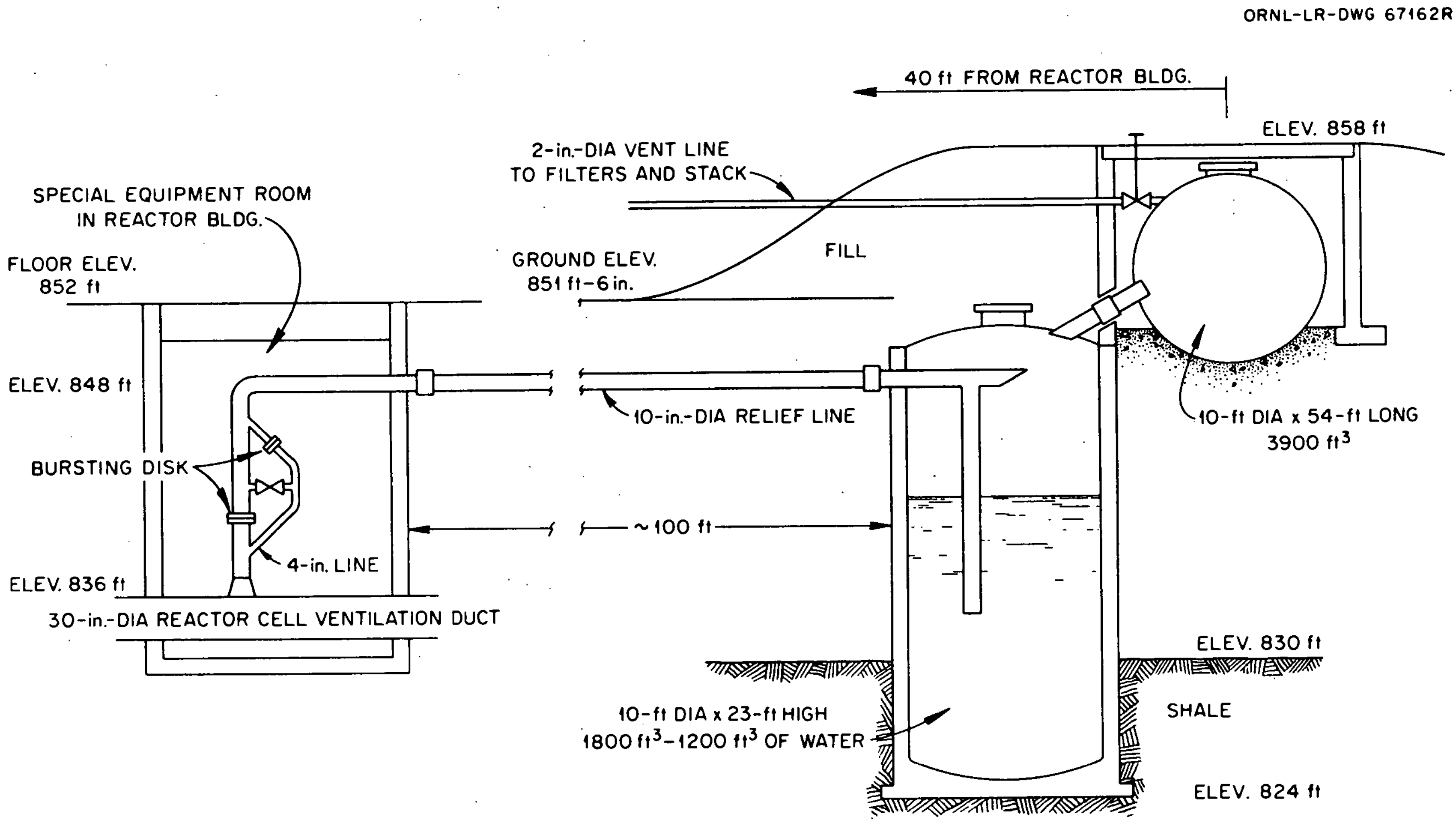

Figure 50. Diagram of Vapor-Condensing System

salt and the water used in the cell for cooling and shielding. This equipment, consisting primarily of a vertical underground water tank and a shielded horizontal gas storage tank, is located about 60 ft from the southeast corner of the MSRE building. A 12-in.-diameter carbon steel line from the system ties into the 30-in. reactor cell ventilation pipe just upstream from the normally closed butterfly valves. Rupture discs in the main 12-in. line and the 4-in. bypass line are designed to rupture at 20 psi and 15 psi, respectively, to cause the system to respond automatically to overpressurization of the reactor cell and to require that the smaller-diameter path be opened first to reduce the dynamic impact on the condensing tank.

3. MSRE PRESENT CONDITIONS

From shutdown of the MSRE in 1969 until now, portions of the reactor system have undergone considerable change from the original operating conditions. These changes will not, however, significantly affect the effort required for decommissioning. Beginning at shutdown: (1) all systems were secured or modified for safe standby; (2) a post-operation examination program was initiated; (3) the system was placed under a continuing surveillance program; (4) excess material and equipment removal began; and (5) nonhazardous building space was made available for offices, shops, and laboratories for research and maintenance groups.

3.1 Securing the Process Systems

In general, preparing for safe standby involved deactivation of process systems so as to minimize surveillance and to prevent mishaps due to freezing, fire, or rain in-leakage; securing the primary system to safeguard the salt solutions, including the ^{233}U fuel; and protecting against radiation and contamination hazards. The salts were all stored in their respective drain tanks; the cooling water systems were drained, and lines penetrating the containment cells were disconnected and blanked at the cell walls; the cover-gas system and other service lines were disconnected and blanked at penetrations; process electrical systems were deactivated and circuits locked open; the instrument and service air systems were shut

down and temporary gas supplies (nitrogen cylinders) were installed at necessary locations; selected radiation monitors with local indicator alarms were retained and remote alarms installed at the ORNL Waste Monitoring Center; selected temperature sensors from the stored salt and cell atmosphere were tied into a local recorder-indicator; and the off-gas and containment ventilation systems were retained complete with the radiation and flow monitoring of the stack flow with remote alarms to the Waste Monitoring Center added.

3.2 Post-Operation Examination

The post-operation examination program was for inspection of the primary system and for obtaining material specimens for technical evaluation.

The sampler-enricher capsule cage was excised from the fuel pump bowl for examination. This operation required the cutting loose or displacing of auxiliary lines and equipment for access. All the loose items, as well as many of the contaminated tools used for the excisions, remain at the pump bowl area or were dropped to the cell floor. A patch was fabricated and installed to seal the pump opening.

Specimens were removed from the heat exchanger shell and from the tube bundle. An oval-shaped patch of about 10 in. x 12 in. was cut out near the top center of the shell. Sections of tubing were removed through this opening. The hole through the shell was sealed by remotely welding a patch over the opening. Since this cutting provided communication between the fission-product-laden fuel-salt loop to the coolant-salt loop, the 5-in. coolant-salt lines were cut and seal-welded immediately outside the cell wall. All the loose material, heaters, etc., along with many of the tools used for this job remain in the vicinity of the heat exchanger.

Control-rod poison elements, 7/8-in. graphite sampler holder and specimens, and a 2-in. graphite bar were removed from the reactor core. This job required taking loose and displacing the graphite sampler containment tank, the control-rod drives, control-rod-drive shielding and supports, the control-rod and reactor nozzle cooling air lines and thermocouple and heater disconnects and supports to gain access to the 10-in. reactor access nozzle flange. The core access plug, containing the graphite sampler flange, its holddown mechanism, and the control-rod thimbles, was

removed and suspended alongside the thermal shield. Other items are atop the thermal shield or were dropped to the cell floor. The reactor was sealed by placing a plain 10-in. blind stainless steel flange on the access nozzle.

In the drain-tank cell, two freeze valves were removed and heaters, leads, and service lines were again moved for access. The open lines were sealed using mechanical plugs.

The post-operation examination was performed in the fall of 1970, approximately one year after shutdown of the reactor. The radiation level had decreased tremendously from that encountered during maintenance while the reactor was still operable. All jobs were performed in the reactor cell using the dry maintenance shield without the need for tool shielding bushings in the access holes. The maximum radiation level above the shield through a 6-in.-diameter hole was 125 mr/hr at the hole opening at the beginning of the work. The maintenance shield was not required in the drain-tank cell. The work there was performed through a 2 ft x 10 ft lower roof plug opening.

A heavy accumulation of dust (~1/2 in. deep on flat surfaces) inside both containment cells was easily handled by flushing the dust to the cell floor using an ordinary water hose. By keeping the work areas wetted, no contaminated dust was allowed to escape the containment cells.

At the completion of the post-operation work, the primary system was leak-tested to ensure that the patches were secure. The cell shielding blocks and seal membrane were replaced and the containment cells leak-tested.

3.3 Surveillance

After futher instrument modification and final shutdown of auxiliaries, the MSRE was placed under a surveillance program as described in ORNL-TM-3253, MSRE Procedures for the Period Between Examination and Ultimate Disposal, dated February 10, 1971. This document describes the condition of the MSRE and specifies procedures to be followed after the post-operation examinations and before the ultimate disposal of the fissile and radioactive material in the reactor. The fuel salt has been kept frozen in the sealed drain tanks, within the sealed containment cell. Surveillance

has been by remote monitoring and daily visits by ORNL personnel, with monthly and annual checks by technical personnel. Remedial actions are prescribed for any abnormal condition. Personnel access is controlled by security fencing around the area as well as specific areas locked to prevent unauthorized entry. Procedures and responsibilities for maintenance, modification, and removal of surplus equipment are also specified.

3.4 Surplus Equipment Removal

All MSRE equipment except the items required for surveillance of the stored fuel and the fuel removal chemical-processing plant were placed on a published list and made available to other projects. Surplus mechanical supplies were all moved out, and the process computer was transferred to the Tennessee Valley Authority's Bull Run Steam Plant.

A large portion of the process instrumentation was removed and used by other ORNL projects. The coolant-salt pump and piping were removed and used by research groups in continuing molten-salt development work. All the remaining noncontaminated process equipment has been declared "excess in place" and is available to others through the ORNL Operations Division.

The coolant-salt piping and pump was the only surplus equipment removal that has affected the decommissioning study. The pump, pump support plate, and the 5-in. piping outside the reactor cell were removed. The radiator, sampler and drain-tank systems, including the coolant salt, remain in place along with all the auxiliary systems. Other items removed, such as process instrumentation, were primarily from clear areas and have no significant effect on the decommissioning effort.

3.5 Site Utilization

Peripheral areas at the site have been and are now being utilized by other Laboratory groups. The office wing (Bldg. 7509) is occupied by a research group; the shop building (Bldg. 7515) is used as an area maintenance shop; the reactor building (Bldg. 7503) offices, high bay, and spare experiment cells have been used by research groups; the stores building (Bldg. 7507) is used for equipment storage; and the reactor building change house and sanitary facilities are used by all personnel at the site.

3.6 Current Radiation and Contamination Levels

Periodic radiation and contamination surveys are conducted within the site area, and all movement of personnel or equipment into or out of the controlled access areas is monitored by the Health Physics Division. No spread of contamination or radiation exposure has occurred since the reactor was shut down.

The results of radiation surveys made in January and February of 1977 with an ionization chamber are shown in Table 3.

Measurements made in the reactor vessel at the top of the graphite with a thermoluminescent dosimeter (TLD) indicate a radiation level of $\sim$2,200 R/hr. A measurement made at the top of the access flange with a TLD indicates a radiation level of 264 R/hr. Measurements made at the top of the graphite with bare and lead-covered TLD's indicate that the effective tenth-value layer for radiation in that area is 1.4 in. of lead. Measurements made at a port over the reactor vessel at working level with a Cutie-Pie indicate that the effective tenth-value layer for the radiation beam through that port is also 1.4 in. of lead. Measurements made with a Cutie-Pie at the top of the opening in the top shield above the reactor vessel indicate that the effective tenth-value layer for the radiation through the opening is also 1.4 in. of lead.

4. DECOMMISSIONING ALTERNATIVES

Two alternatives have been considered for decommissioning the MSRE. These are: (1) removal of all radioactive material except the containment cell walls; and (2) entombment, in concrete, of all radioactive materials at the site within the reactor containment cell.

For both decommissioning alternatives, it is assumed that the fuel and flush salts have been removed from the drain tanks prior to starting the decommissioning. A study and cost estimate for disposal of the salts have been reported by P. N. Haubenreich and R. B. Lindauer in ORNL CF-72-1-1, "Consideration of Possible Methods of Disposal of MSRE Salts", dated January 28, 1972. At present, a total of 4,650 kg of solidified fuel salt is stored in the two fuel drain tanks in the drain-tank cell. Also,

Table 3. Radiation Levels Measured in 1977
Using an Ionization Chamber

Location	Radiation Level (R/hr)
A. Measurements made in the area near fuel pump	
1. Seal pan level over fuel pump with shield plug removed	6
2. Seal pan level at SW corner of hole in shield	1
3. SW corner of the hole in shield even with the bottom edge of shield concrete	15
4. ∿3 ft below bottom of concrete at SW corner of hole in shield	37
5. SW quadrant of pump bowl	140
6. Sampler-enricher nozzle	15
7. SE quadrant of pump bowl	45
8. NW corner of hole in shield even with the bottom edge of shield concrete	19
9. Pump bowl off-gas line (522)	160
10. North quadrant of pump bowl	250
11. Sampler-enricher spool piece	10
B. Measurements made in reactor cell above reactor vessel	
1. Bottom of shield plug	39
2. Core access nozzle at vessel	408
3. Bottom of holddown basket	960
4. Control-rod thimble at ∿18" below basket	3,060
5. Core outlet nozzle	117
6. Core access flange	282

Table 3. (continued)

Location	Radiation Level (R/hr)
C. Measurements made in reactor vessel	
1. Top of flange	312
2. ∿2 1/2 ft below top of flange	1,050
3. Top of graphite	1,740
4. 1 ft below top of graphite	510
5. 2 ft below top of graphite	426
6. 3 ft below top of graphite	510
7. 4 ft below top of graphite	540
D. Measurements made in instrument penetration in guide tube No. 2	
1. At bottom	1,400
2. 6 in. from bottom	775
3. 12 in. from bottom	310
4. 24 in. from bottom	64

4,290 kg of solidified flush salt is stored in a third tank in the same cell. The fuel salt contains 30.8 kg of ^{233}U and the flush salt 0.49 kg.

The cost estimates for both of the decommissioning methods studied include the assumption that an operating solid-waste disposal area exists in the immediate vicinity. If the radioactive and contaminated materials must be packaged for shipment to a disposal site outside the ORNL area, the packaging and shipping costs will be greatly increased, requiring a new methods study and cost estimate.

It is also assumed that knowledgeable, experienced personnel will be available to supervise and participate in the decommissioning activities. If this is not true, the man-hours expended can increase significantly due to lack of familiarity with the reactor components and methods of working with them.

4.1 Removal and Disposal of All Radioactive Material Except the Containment Cell Structure

The first alternative involves cutting out, packaging, and transporting to a solid-waste storage area all contaminated and radioactive materials in the reactor cell, drain-tank cell, fuel-processing cell, and portions of the gaseous-waste disposal system. The cell structures, including the lower tier of shielding blocks over the reactor cell and drain-tank cells, may be left intact for future use. Induced radioactivity in the carbon steel walls of the reactor cell are expected to be very low due to the neutron shielding provided by the thermal shield which completely surrounds the reactor except for the instrumentation thimble. Any areas of the cell wall found to have objectionable levels of induced radioactivity can be overlaid with fixed shielding after final decontamination.

A summary of work required and a cost estimate for this alternative are given in Section 5. A detailed job listing is given in Appendix A.

4.2 Entombment in Place

The second alternative is to entomb, in concrete, all radioactive and contaminated items within the reactor containment cell. The site and the remaining containment cells could then be put to other uses with

essentially no restrictions. This method of decommissioning is far less expensive than dismantling and will provide complete containment indefinitely. Entombment of ^{233}U-contaminated materials in solid concrete, however, violates the present requirement that such materials be stored in a retrievable manner and will require a special permit as implied by ERDA Manual Chapter 0511.

This method will involve a minimal amount of remote cutting. All pipes and conduits entering the cell through penetrations will be severed inside the cell and cut back about 1 ft. Penetrations will be removed where radioactive contamination is present and the openings sealed and filled with concrete. Some cutting and collapsing of in-cell piping will be necessary to permit the emptied drain tanks and the fuel-processing equipment to be added before entombing. The cell will then be filled with concrete to the building floor level to provide a minimum thickness of 14 ft of concrete over the highest part of the reactor vessel.

A summary of work required and a cost estimate of this alternative are given in Section 6. A detailed job listing is given in Appendix B.

4.3 Arguments Favoring Dismantling and Disposal of Radioactive and Contaminated Items

1. The MSRE is remote from populated areas and near a solid-waste storage site so that transport of radioactive items to the storage site can be accomplished with minimal shielding and with little risk to non-involved personnel even in the event of a transport accident. The ^{233}U-contaminated material will be packaged within ∿1,500 drums of 55-gallon capacity (∿13,000 ft^3) and 31 special containers of various sizes (∿3,000 ft^3).
2. Removal of the ^{233}U-contaminated items to retrievable storage will meet the requirements for disposal of this type material.
3. Emptying the containment cells of all MSRE-related items will release the facility for future usages requiring such cells.

4.4 Arguments Favoring Entombing the Reactor and Associated Radioactive and Contaminated Items and Materials in the Reactor Cell

1. Entombment in concrete is far more economical than dismantling and storage.
2. The transport of radioactive and contaminated items would be avoided.
3. A major portion of the building and cells would be released for other usages.

5. WORK INVOLVED IN DISMANTLING AND DISPOSING OF RADIOACTIVE AND CONTAMINATED ITEMS IN A SOLID-WASTE STORAGE AREA

5.1 Preparatory Work

Preparatory work required for dismantling and disposal in a solid-waste storage area includes: (1) provision of a water flushing system for the reactor primary system, the salt drain tanks, and the fuel-processing equipment; (2) provision of a flooding system for the reactor cell; (3) provision of working shielding, transport shields, and disposable waste containers; and (4) tooling for cutting up the reactor tank and thermal shield and for cutting up and handling of pipes, conduits, etc., located within the containment cells.

5.1.1 Flushing System for the Reactor Tank and Other Primary System Components

Although the reactor primary system was flushed out with a nonfuel-bearing molten salt after it was drained of fuel, the system is known to contain large solidified globules of the flush salt which failed to completely drain to the storage tanks. In order to minimize the release of this contaminated salt into the reactor cell during the dismantling operation, the primary system will be flushed with water and decontaminating solutions prior to segmenting. The contaminated solutions can be discharged directly into the existing building liquid-waste system and then to the ORNL liquid-waste disposal system. Based upon a cell volume of 200,000 gallons, a flush rate of 5 gpm, and a project time of one year, the liquid waste generated would be about 3,000,000 gallons.

UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE, TENNESSEE 37830

TABLE 4
DISMANTLING

COST ESTIMATE
SUMMARY SHEET

PROJECT TITLE AND BUILDING

ESO OR ORDER NO.	ACCOUNT CHARGE	DATE	BASE COST DATE	ESTIMATE VALID UNTIL
A-2884A-J1		July, 1977	FY-77	

TYPE OF ESTIMATE: ☐ C ☐ I ☐ II ☐ OTHER ______
CONSTRUCTED BY: ☒ UCND ☒ CPFF ☐ LSSC ☐ ______
ESCALATION (%):

ESTIMATE BASED ON: ☐ VERBAL INFORMATION ☐ SKETCHES ☐ MARKED PRINTS ☐ PRELIM. DESIGN ☐ FINAL DESIGN

FUND SOURCE	ESTIMATED BY	ORIGINALLY EST.	DATE	P. ENGR.	EST. NO.
☐ EXP ☐ EQPT	C. Kirby*			C. D. Cagle	
☐ GPP ☐ ______	SUBMITTED BY: C. Kirby	LAST REVISION:	DATE:	F. ENGR.: L. P. Pugh	

	Page No.	CPFF	UCC-ND	TOTAL
PREPARATORY WORK				
Flushing			$ 94,200	
Flooding			154,100	
Cell Ventilation			47,800	
Work Platforms			126,000	
SUBTOTAL			$ 422,100	
TOOLING			$3,071,100	
SPECIAL TRANSPORT AND STORAGE CONTAINERS			$ 640,200	
REACTOR CELL EQUIPMENT		$ 419,500		
DRAIN-TANK CELL				
General		$ 12,000		
North Bay		77,000		
Center Bay		90,000		
South Bay		84,000		
General		56,000		
		$ 319,000		

UCN-5125E (123 1-72)

*Cost Engineer, UCC-ND ORNL General Engineering.

TABLE 4. (CONTINUED)

COST ESTIMATE

SUMMARY SHEET

(CONTINUATION SHEET)

ESO OR ORDER NO. A-2884A-J1

	Page No.	CPFF	UCC-ND	TOTAL
FUEL-PROCESSING CELL		$ 103,800		
VENTILATION HOUSE AREA		$ 79,900		
SPECIAL EQUIPMENT ROOM		$ 122,100		
COOLANT CELL AREA		$ 116,100		
SOUTH YARD		$ 160,800	$ 11,100	
TREATED WATER SYSTEM		$ 40,500		
SPARE CELL AREA		$ 52,000		
		$1,413,700	$4,144,500	
HEALTH PHYSICS REQUIREMENTS		706,300		
		$2,120,000	$4,144,500	
CPFF INDIRECT @ 35%		743,000		
		$2,863,000	$4,144,500	$ 7,007,500
ENGINEERING 20%				1,401,500
				$ 8,409,000
CONTINGENCY @ 30%				2,591,000
FY-1977 COST				$11,000,000
ADDITIONAL UCC-ND COSTS				
Solid-Waste Storage			$ 400,000	
Liquid-Waste Disposal (one year)			200,000	
			$ 600,000	$ 600,000
				$11,600,000*

UCN-6126F (123 1-72)

*NOTE: This is 1977 costs. Use ERDA-ORO Escalation Chart to escalate for funding purposes.

TABLE 4. (CONTINUED)

COST ESTIMATE

SUMMARY SHEET

(CONTINUATION SHEET)

ESO OR ORDER NO. A-2884A-J1

				TOTAL

ESTIMATE GUIDE LINES:

Labor rates for CPFF contractor $100/day for crafts does not include 35% indirect or radiation allowance.

UCC-ND design based on operating account costs @ $183/day including indirects.

UCC-ND fabrication based on operating account costs @ $156/day including indirects.

G&A on UCC-ND procurement items @ 35%. This was not applied to the plasma torch (Tooling). It was shown under material cost but the $2,550,000 was arrived at by escalating the Elk River costs which include indirects.

ERDA-ORD

ESCALATION MULTIPLIERS BY QUARTER (End of Quarter)

Date Est. Made / Quarter →	FY-75 1	FY-75 2	FY-75 3	FY-75 4	FY-76 1	FY-76 2	FY-76 3	FY-76 4	FY-76 5	FY-77 1	FY-77 2	FY-77 3	FY-77 4	FY-78 1	FY-78 2	FY-78 3	FY-78 4	FY-79 1	FY-79 2	FY-79 3	FY-79 4	FY-80 1	FY-80 2	FY-80 3	FY-80 4	FY-81 1	FY-81 2	FY-81 3	FY-81 4	FY-82 1	FY-82 2	FY-82 3	FY-82 4	FY-83 1	FY-83 2	FY-83 3	FY-83 4	FY-84 1	FY-84 2	FY-84 3	FY-84 4	FY-85 1	FY-85 2	FY-85 3	FY-85 4
CY			CY-75				CY-76				CY-77				CY-78				CY-79				CY-80				CY-81				CY-82				CY-83				CY-84				CY-85		
Rate		20%				12%			3%			10%				8%				8%				8%				8%				8%				8%				8%				8%	
FY-74																																													
1st Qtr	1.101	1.154	1.206	1.259	1.296	1.334	1.372	1.410	1.452	1.488	1.524	1.561	1.597	1.629	1.661	1.693	1.725	1.759	1.793	1.828	1.862	1.900	1.937	1.974	2.011	2.052	2.092	2.132	2.172	2.216	2.259	2.303	2.346	2.393	2.440	2.487	2.534	2.585	2.635	2.686	2.737	2.792	2.846	2.901	2.956
2nd Qtr	1.084	1.136	1.187	1.239	1.276	1.313	1.351	1.388	1.429	1.465	1.501	1.536	1.572	1.604	1.635	1.666	1.698	1.732	1.766	1.800	1.834	1.870	1.907	1.944	1.980	2.020	2.059	2.099	2.139	2.181	2.224	2.267	2.310	2.356	2.402	2.449	2.495	2.545	2.595	2.645	2.695	2.749	2.803	2.857	2.911
3rd Qtr	1.067	1.118	1.169	1.219	1.256	1.293	1.329	1.366	1.407	1.442	1.477	1.512	1.547	1.578	1.609	1.640	1.671	1.704	1.738	1.771	1.805	1.841	1.877	1.913	1.949	1.988	2.027	2.066	2.105	2.147	2.189	2.231	2.273	2.318	2.364	2.409	2.455	2.504	2.553	2.602	2.651	2.704	2.757	2.810	2.863
4th Qtr	1.050	1.100	1.150	1.200	1.236	1.272	1.308	1.344	1.384	1.419	1.454	1.488	1.523	1.553	1.584	1.614	1.645	1.677	1.710	1.743	1.776	1.812	1.847	1.883	1.918	1.956	1.995	2.033	2.071	2.113	2.154	2.196	2.237	2.282	2.326	2.371	2.416	2.464	2.513	2.561	2.609	2.661	2.713	2.766	2.818
FY-75																																													
1st Qtr	1.000	1.050	1.100	1.150	1.185	1.219	1.254	1.288	1.327	1.360	1.393	1.427	1.460	1.488	1.518	1.547	1.576	1.607	1.639	1.670	1.702	1.736	1.770	1.804	1.838	1.875	1.912	1.948	1.985	2.025	2.064	2.104	2.144	2.187	2.230	2.273	2.316	2.362	2.408	2.454	2.501	2.551	2.601	2.651	2.701
2nd Qtr		1.000	1.050	1.100	1.133	1.166	1.199	1.232	1.269	1.301	1.332	1.364	1.396	1.424	1.452	1.479	1.507	1.537	1.568	1.598	1.628	1.661	1.693	1.726	1.756	1.793	1.828	1.863	1.899	1.937	1.975	2.013	2.050	2.091	2.132	2.173	2.214	2.258	2.303	2.347	2.391	2.439	2.487	2.535	2.584
3rd Qtr			1.000	1.050	1.082	1.113	1.145	1.176	1.211	1.241	1.272	1.302	1.332	1.359	1.386	1.412	1.439	1.468	1.496	1.525	1.554	1.585	1.616	1.647	1.678	1.712	1.745	1.779	1.812	1.848	1.885	1.921	1.957	1.996	2.035	2.074	2.114	2.156	2.198	2.240	2.283	2.328	2.374	2.420	2.465
4th Qtr				1.000	1.030	1.060	1.090	1.120	1.154	1.182	1.211	1.240	1.269	1.294	1.320	1.345	1.370	1.398	1.425	1.453	1.480	1.510	1.539	1.569	1.598	1.630	1.662	1.694	1.726	1.761	1.795	1.830	1.864	1.901	1.939	1.976	2.013	2.053	2.094	2.133	2.174	2.218	2.261	2.305	2.348
FY-76																																													
1st Qtr					1.000	1.030	1.060	1.090	1.123	1.151	1.179	1.207	1.235	1.260	1.284	1.309	1.334	1.360	1.387	1.414	1.440	1.470	1.498	1.527	1.555	1.587	1.618	1.649	1.680	1.713	1.747	1.781	1.814	1.850	1.887	1.923	1.959	1.998	2.038	2.077	2.116	2.158	2.201	2.243	2.285
2nd Qtr						1.000	1.030	1.060	1.092	1.119	1.146	1.174	1.201	1.225	1.249	1.273	1.297	1.323	1.349	1.375	1.401	1.429	1.457	1.485	1.513	1.543	1.574	1.603	1.634	1.666	1.700	1.732	1.764	1.799	1.835	1.870	1.905	1.943	1.981	2.019	2.058	2.099	2.140	2.181	2.222
3rd Qtr							1.000	1.030	1.061	1.087	1.114	1.140	1.167	1.190	1.214	1.237	1.260	1.285	1.311	1.336	1.361	1.388	1.415	1.443	1.470	1.500	1.529	1.558	1.587	1.619	1.651	1.683	1.714	1.748	1.783	1.817	1.851	1.888	1.925	1.962	1.999	2.039	2.079	2.119	2.159
4th Qtr								1.000	1.030	1.056	1.082	1.107	1.133	1.156	1.178	1.201	1.224	1.248	1.273	1.297	1.321	1.348	1.374	1.401	1.427	1.456	1.484	1.513	1.541	1.572	1.603	1.634	1.664	1.698	1.732	1.765	1.798	1.834	1.870	1.906	1.942	1.981	2.020	2.059	2.097
5th Qtr									1.000	1.025	1.050	1.075	1.100	1.122	1.144	1.166	1.188	1.212	1.236	1.259	1.283	1.309	1.334	1.360	1.386	1.413	1.441	1.469	1.496	1.526	1.556	1.586	1.616	1.648	1.681	1.713	1.745	1.780	1.815	1.850	1.885	1.923	1.960	1.998	2.036
FY-77																																													
1st Qtr										1.000	1.025	1.050	1.075	1.097	1.118	1.140	1.161	1.184	1.207	1.231	1.254	1.279	1.304	1.329	1.354	1.381	1.408	1.436	1.462	1.492	1.521	1.550	1.579	1.610	1.642	1.674	1.706	1.740	1.774	1.808	1.842	1.879	1.916	1.953	1.990
2nd Qtr											1.000	1.025	1.050	1.071	1.092	1.113	1.134	1.157	1.179	1.202	1.225	1.249	1.274	1.298	1.323	1.349	1.376	1.402	1.429	1.457	1.486	1.514	1.543	1.574	1.605	1.635	1.666	1.699	1.733	1.766	1.799	1.835	1.871	1.907	1.943
3rd Qtr												1.000	1.025	1.046	1.066	1.087	1.107	1.129	1.151	1.173	1.196	1.220	1.244	1.268	1.292	1.318	1.343	1.369	1.395	1.423	1.451	1.479	1.507	1.537	1.567	1.597	1.627	1.660	1.692	1.725	1.757	1.792	1.827	1.863	1.900
4th Qtr													1.000	1.020	1.040	1.060	1.080	1.102	1.123	1.145	1.166	1.190	1.213	1.236	1.260	1.285	1.310	1.335	1.360	1.388	1.415	1.442	1.469	1.499	1.528	1.557	1.587	1.619	1.650	1.682	1.714	1.748	1.783	1.817	1.851
FY-78																																													
1st Qtr														1.000	1.020	1.040	1.060	1.081	1.102	1.124	1.145	1.168	1.191	1.213	1.236	1.261	1.286	1.310	1.335	1.362	1.389	1.415	1.442	1.471	1.499	1.528	1.557	1.588	1.619	1.651	1.682	1.715	1.749	1.783	1.816
2nd Qtr															1.000	1.020	1.040	1.061	1.082	1.102	1.123	1.146	1.168	1.191	1.213	1.237	1.262	1.286	1.310	1.336	1.363	1.389	1.415	1.443	1.472	1.500	1.528	1.559	1.589	1.620	1.650	1.684	1.716	1.749	1.782
3rd Qtr																1.000	1.020	1.040	1.061	1.081	1.102	1.124	1.146	1.168	1.190	1.214	1.237	1.261	1.285	1.311	1.336	1.362	1.388	1.415	1.443	1.471	1.499	1.529	1.559	1.589	1.619	1.651	1.684	1.716	1.748
4th Qtr																	1.000	1.020	1.040	1.060	1.080	1.102	1.123	1.145	1.166	1.190	1.213	1.238	1.260	1.285	1.310	1.335	1.360	1.388	1.415	1.442	1.469	1.499	1.528	1.557	1.587	1.619	1.650	1.682	1.714
FY-79																																													
1st Qtr																		1.000	1.020	1.040	1.060	1.081	1.102	1.124	1.145	1.168	1.191	1.213	1.236	1.261	1.286	1.311	1.335	1.362	1.389	1.415	1.442	1.471	1.500	1.529	1.557	1.589	1.620	1.651	1.682
2nd Qtr																			1.000	1.020	1.040	1.061	1.082	1.102	1.123	1.146	1.168	1.191	1.213	1.237	1.262	1.286	1.310	1.336	1.363	1.389	1.415	1.443	1.472	1.500	1.528	1.559	1.589	1.620	1.650
3rd Qtr																				1.000	1.020	1.040	1.061	1.081	1.102	1.124	1.146	1.168	1.190	1.214	1.237	1.261	1.285	1.311	1.336	1.362	1.388	1.416	1.443	1.471	1.499	1.529	1.559	1.589	1.619
4th Qtr																					1.000	1.020	1.040	1.060	1.080	1.102	1.123	1.145	1.168	1.190	1.213	1.236	1.260	1.285	1.310	1.335	1.361	1.388	1.415	1.442	1.469	1.499	1.528	1.558	1.587

Escalation Multipliers by FY - Mid Year

From Mid Yr	20% FY-75	12% FY-76	3% 5	10% FY-77	8% FY-78	8% FY-79	8% FY-80	8% FY-81	8% FY-82	8% FY-83	8% FY-84	8% FY-85
FY-74	1.136	1.313	1.408	1.501	1.635	1.766	1.907	2.059	2.224	2.402	2.595	2.803
FY-75	1.000	1.166	1.250	1.332	1.452	1.568	1.693	1.828	1.975	2.132	2.303	2.487
FY-76		1.000	1.076	1.146	1.249	1.349	1.457	1.574	1.700	1.835	1.981	2.140
FY-76A			1.000	1.050	1.144	1.236	1.334	1.441	1.556	1.681	1.815	1.960
FY-77				1.000	1.092	1.179	1.274	1.376	1.486	1.605	1.733	1.871
FY-78					1.000	1.082	1.168	1.262	1.363	1.472	1.589	1.716
FY-79						1.000	1.082	1.168	1.262	1.363	1.472	1.589

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The equipment required for flushing will include a pump, mixing tanks for decontaminating solutions, piping, and valves. The system will require shielding. Multiple connections will have to be made into different regions of the primary system to ensure solution circulation in all portions. (The connections can be made simply by trespanning holes into the primary system and connecting pipes with clamp-on compression fittings.)

5.1.2 Reactor Cell Flooding System

The interconnected reactor and drain-tank cells are capable of being flooded with water if necessary; however, due to differences in elevation it will be best to avoid flooding the drain-tank cell beyond its seal membrane elevation since the water would be in contact with bare concrete. Following flushing of the reactor primary system and the drain tanks, the opening between the cells can be sealed at the drain-tank-cell side to confine flooding to the reactor cell.

The flooding system will consist of a pump capable of delivering a minimum of 1,000 gpm, a strainer, bypass or in-line filter, and necessary piping, valves, and instrumentation. All components containing circulating water will require shielding. The filter will be cleaned periodically by backflushing to the existing liquid-waste disposal system. The concentration of dissolved contaminants can be controlled by continuously or periodically discharging a portion of the circulating water to the liquid-waste disposal system.

5.1.3 Work Shielding

The dismantling work will require the erection of temporary shielding structures around the flushing and cell-flooding systems and elsewhere on an as-needed basis. These shields should be made of material forms that allow some diversity of size, shape, and thickness and which can be readily dismantled and the materials reused as required. The estimated requirements for the dismantling of the reactor system are two-thousand 6 in. x 6 in. x 12 in. solid concrete blocks, six-hundred 2 in. x 4 in. x 8 in. lead bricks, and one-hundred 1/8 in. x 2 ft x 4 ft lead sheets (21,000 lbs of lead total).

5.1.4 Transport Shields and Waste Storage Provisions

Present regulations require that all waste items contaminated with ^{233}U be stored in a retrievable manner. This will apply to all items removed from the reactor cell, drain-tank cell, and fuel-processing cell. Although it is planned to minimize further contamination by flushing the primary system prior to dismantling it, some external contamination already exists due to past maintenance and post-mortem work.

Because of the large amount involved, special provisions will have to be made for storing the material in the solid-waste storage area. For estimating purposes, it is assumed that the present storage method for such materials will be used. This requires that the waste items be placed in specially designed storage shields or be segmented to fit within standard stainless steel 55-gallon drums for storage in 30-in.-diameter stainless steel lined wells which have a concrete bottom and are capped with removable concrete top plugs. In 1976 dollars the cost per drum was $750. Transport shields for 55-gallon drums must be bottom unloading and have a shielding thickness equivalent to 6 in. of lead. At least three such shields should be provided to expedite transfer.

Special sealable storage casks will be provided for large items that are difficult to segment. These include the reactor assembly, the primary heat exchanger, the fuel-salt pump, and the pump motor. Except for the reactor assembly, the radiation level from these items is expected to require only 3 to 4 in. of lead for shielding. The reactor assembly will require 6 to 7 in. of lead.

5.1.5 Disposable Waste Containers

All solid waste contaminated with ^{233}U will be segmented to fit within 55-gallon steel drums. Approximately 1,500 drums will be required.

5.1.6. Miscellaneous Cutting and Handling Tools

A large variety of long-handled tools will be required for unbolting flanges and structures, for severing pipes and conduits, for tearing insulation, and for handling loosened items. For the most part, this type

of tooling will consist of equipping standard items such as abrasive cutting tools and hydraulically operated shears with long handles so that they can be operated remotely.

5.1.7 Retrievable Storage Requirements

The packaging of the ^{233}U-contaminated material from the MSRE will generate a total volume of ∿16,000 ft^3 of packaged material and will require ∿0.2 acres of solid-waste storage area for retrievable storage. The major portion of this volume (∿13,000 ft^3) will be in the form of 55-gallon stainless steel drums (∿1,500) without any attached shielding. The remainder (∿3,000 ft^3) will be packaged within 31 special containers of various sizes and with various thicknesses of attached shielding material.

Current cost for preparatory work and burial at the solid-waste disposal area averages about $25 per ft^3 for retrievable storage.

5.2 Remote Dismantling Work

The first stage of the dismantling work will be to flush out the emptied fuel-salt and flush-salt drain tanks and the fuel-cell processing equipment to reduce the radioactivity level in the drain-tank cell. Piping connections to the flushing system will be made remotely at various locations so that the flushing solutions will reach all portions of salt piping and tanks. Prior to connecting the flushing piping, a gas supply will be connected across each freeze valve. The salt in the valve will then be heated to molten by existing heaters. A gas flow will be maintained through the salt until it has cooled to establish a flow path for water during the flushing operation.

After the flushing is complete and the flushing system removed, the drain-tank-cell equipment and the piping and conduits through the penetration between the drain-tank and reactor cells will be removed and the opening sealed to allow flooding of the reactor cell. The advantages of clearing the drain-tank cell first are that this: (1) allows direct access to the reactor cell penetration for sealing; and (2) allows use of the cell ventilation system while it is still operable.

After all other pipes and conduits leading from the reactor cell have been cut externally and sealed, the cell will be flooded to about 6 in.

below the bottom of the lower roof shield blocks. The top shield blocks will be removed and set aside for possible usage as bridges during dismantling operations. The stainless steel seal pan will be cut up and disposed of in the solid-waste storage area. The lower shield blocks will then be removed, wrapped in plastic, and disposed of in the solid-waste storage area. The water level in the cell will then be raised to within a foot of the cell liner top and the piping for water circulation installed and shielded. After water circulation has been established, working bridges will be installed and the dismantling of the reactor cell components will begin.

5.2.1 Clearing the Cell Around the Reactor

The initial dismantling activity will be to segment and dispose of all items in the cell that are external to the thermal shield. These include the fuel-salt pump, the heat exchanger, the 5-in.-diameter primary and secondary piping, electrical heaters, insulation, off-gas piping, thermocouples, and support structures. The primary heat exchanger, the fuel-salt pump motor, and the pump bowl will be separated from interconnecting structures and placed in specially designed storage casks for disposal in the solid-waste storage area. All other items will be segmented for disposal in 55-gallon drums.

5.2.2 Segmenting and Disposal of the Thermal Shield and the Reactor Vessel

Since the reactor vessel is supported from the thermal shield lid, it will have to be cut loose and lowered to the bottom of the shield prior to removing the lid. Following removal and disposal of the reactor vessel heaters and the removable side sections of the thermal shield, a suspension arrangement will be connected to the reactor vessel access flange and then attached to a bridge across the cell opening to allow the vessel support hangers to be severed. The reactor vessel will then be lowered to the bottom of the thermal shield and the thermal shield lid moved aside to an underwater support frame for segmenting.

Following disposal of the thermal shield lid, the reactor vessel and its contents will be lifted over the side of the thermal shield and lowered to a special support frame for segmenting. When the vessel is in place, a

circumferential cut will be made near the vessel base to allow the vessel sides, top, and the attached core shell to be lifted aside as a unit to expose the graphite core block assembly. After the graphite has been broken out and disposed of, the reactor vessel and core shell will be segmented and disposed of in 55-gallon steel drums. The remainder of the thermal shield will then be segmented and transferred to storage. In addition to the segmented pieces of the thermal shield, there are ∿35 tons of 7/8-in.-diameter carbon steel balls filling the annular space of the cylindrical portion of the shield. These will also be packaged and stored.

5.2.2.a Alternative to Segmenting the Reactor Vessel

An attractive alternative to segmenting the reactor vessel is removing it intact into a large, portable, sealed lead cask for indefinite above-ground storage in the solid-waste storage area. The cask (Figure 51) would be of simple cylindrical construction with a flat base and top and made with a stainless steel liner. It would be top-loading with the top seal-welded to the body following loading. A small filtered vent would be provided to prevent internal pressure buildup due to radiolysis of residual moisture. To shield the present radiation level to the acceptable storage level of <200 mr/hr, a 6-in. thickness of lead would be required. The combined weight of the cask and the intact reactor vessel would be ∿60 tons.

The cost of the cask and the associated handling equipment would be considerably less than the cost of tooling for and segmenting the vessel.

5.2.3 Drain-Tank Cell

The shielding thickness required for storing the emptied and flushed drain tanks cannot be estimated without assuming a higher upper limit for the radiation and prefabricating shields that may be excessively thick. If the decontamination of the tanks is reasonably successful, little or no shielding will be required for transporting the tanks to storage.

Because of the massiveness of the tanks and the material and complexity of their construction, remote segmenting for storage would be comparable in expense to segmenting the reactor vessel even though the radiation levels

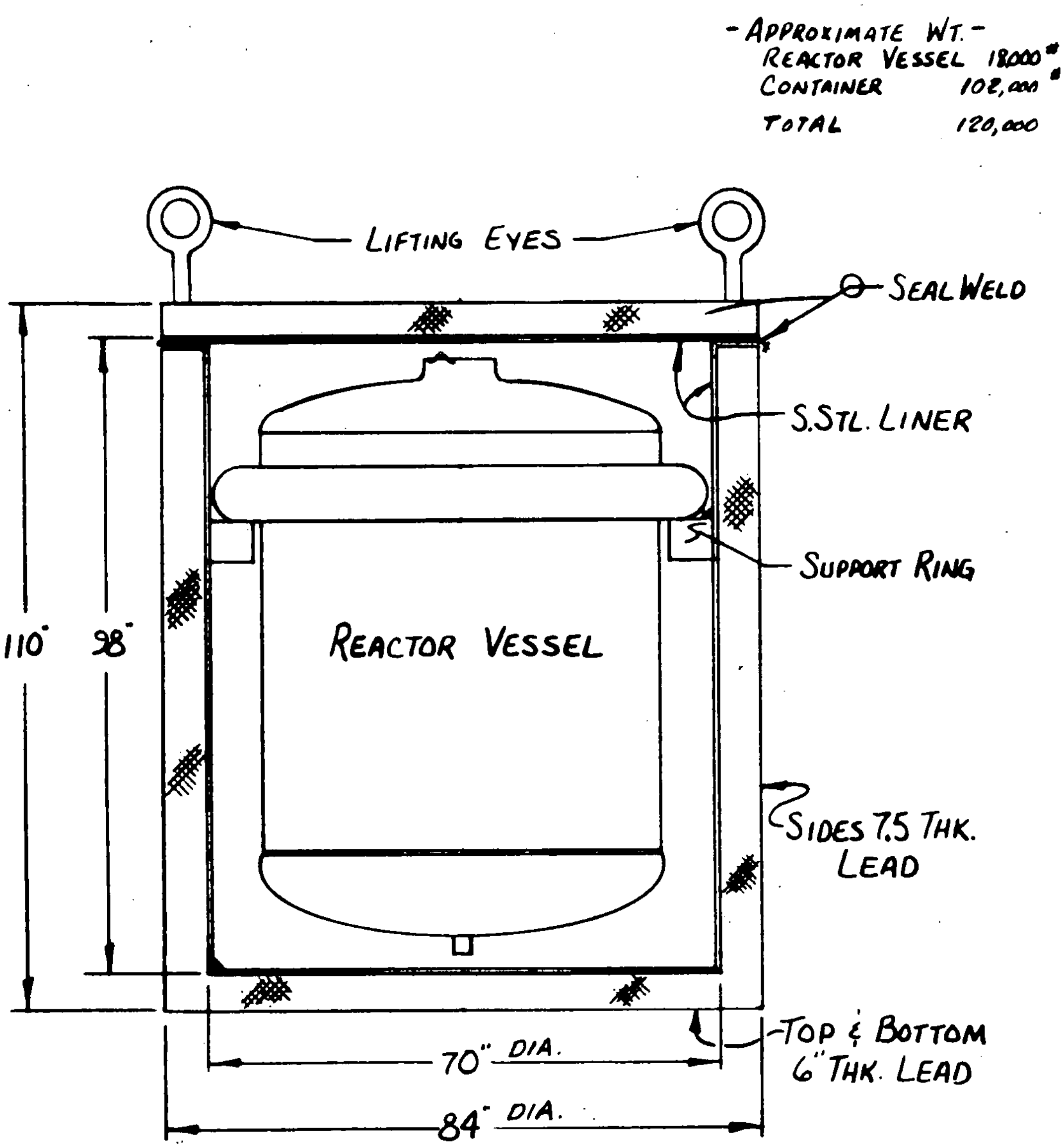

Figure 51. Reactor Assembly Storage Container Concept

are much lower. If shielding is required for transport and storage, the tanks will be lifted out of their furnaces and moved to a temporary shield where transport shields will be built around them. To do this, the tanks will each be surrounded with a stainless steel form into which an annulus of concrete of the required thickness will be poured. The shielded tanks will be disposed of in the solid-waste storage area. All other items in the cell will be segmented for disposal in 55-gallon drums. The cell walls will be decontaminated and the top shield blocks reinstalled.

5.2.4 Fuel-Processing Cell

The fuel storage tank and other items in the fuel-processing cell will be disposed of using the same techniques outlined for the drain-tank cell.

5.2.5 Cell Ventilation System

The 30-in.-diameter carbon steel cell ventilation line from the southwest side of the bottom of the reactor cell was used to maintain a negative pressure in the cell during maintenance operations and is contaminated with radioactive particles and fission products released during these activities. This line, the main 36-in.-diameter duct it joins, the filter pit, and the discharge stack will be decontaminated and left in place. Smaller contaminated ducts from the auxiliary cells will be cut up and disposed of in the solid-waste storage area.

5.2.6 Off-Gas System

Because of the gas holdup volumes in the off-gas line ahead of the charcoal trap, essentially all the residual long-lived fission products in the system will be plated out on the walls of the holdup volume pipes rather than collected in the charcoal traps. The holdup volume which encircles the inside of the reactor cell will be segmented and disposed of along with the other contents of the cell. The remainder of the system up to its juncture with the containment ventilation system particulate filter enclosure will be segmented and disposed of in the solid-waste storage area unless there is a need for retaining the system for future projects using the shielded cells.

5.2.7 Liquid-Waste Disposal System

The portion of the liquid-waste disposal system contaminated with ^{233}U will be removed, segmented, and disposed of up to but not including the waste storage tank in the liquid-waste cell. The storage tank and its connections to the ORNL liquid-waste disposal system will be decontaminated to the extent possible and retained for future programs.

5.2.8 Coolant-Salt System

The coolant salt was drained from the system to the storage tank in the coolant drain cell when reactor operation was terminated. The salt pump, pump support, and the 5-in. piping outside the reactor cell have been removed for use in a development project; but the radiator, sampler, and drain-tank system (including the coolant salt) remain in place along with all the auxiliary systems.

The system has only trace amounts of radioactive contamination and beryllium salt contamination. All the system components will be disposed of by burial in the solid-waste storage area.

5.2.9 Miscellaneous Contaminated Items

Contamination outside the primary and secondary salt systems is confined mainly to the component-cooling system, sampler-enricher, and the treated-water system.

5.2.9.a Component-Cooling Air System

The component-cooling air blowers, heat exchanger, filter, enclosures, and piping are located in the special equipment room immediately south of the reactor containment cell. This system is contaminated internally with cell atmospheric contaminants pulled in from the reactor and drain-tank cells.

The piping, valves, and strainer could be segmented and packaged in 55-gallon drums for storage. The heat exchanger, blowers, and motors will require special containers. The containment enclosures could be decontaminated enough to allow direct burial more economically than segmenting and storing. The radiation level from the components of this system will be very low.

5.2.9.b Sampler-Enricher

Radiation readings taken February 25, 1977, at the 1/2-in.-thick quartz periscope window and at the removal valve opening of the primary system sampler-enricher were 150 mr/hr and 1 R/hr, respectively. Temporary work shielding will be required after the existing shielding is removed in order to disconnect and remove the assembly.

Secondary containment of the assembly is provided by the upper sample transfer box and the lower operational and maintenance valve box. These boxes are joined together with seals at penetrations to prevent the contamination due to sampling from entering the lower box. Removal will require opening of the valve box in order to disconnect the transfer tube as well as to disconnect the box from a floor flange. Making these disconnections plus severing and sealing a multitude of electrical, pneumatic, cover-gas, and off-gas connections will allow the complete assembly to be removed to a special storage container.

Removal of the fuel-processing-system sampler will be done in a similar manner.

5.2.9.c Treated-Water System

The treated-water system is a closed loop system that was used to cool components within the cells. All the in-cell portions will be removed with the cell equipment. The portions outside the cells are located within a pipe chase along the south face of the reactor cell, in the water room and in the diesel shed. Contamination within this system consists of activated oxides and chromates induced by exposure to the reactor system. The contamination level is very low; so these components will not require shielding, only simple containment with plastic wraps, etc., and may be disposed of by burying in a trench in the disposal area.

The equipment in the pipe chase consists of piping and radiation safety block valves. These may be removed by unbolting existing flanges and by simple cutting procedures with direct access available for the work.

The water room contains two pumps, a surge tank, makeup tank, and all valving, flow monitors, and piping for the distribution of the cooling water. Direct access exists for the removal of these items.

The diesel shed contains a heat exchanger and a particle filter. The highest level of contamination within the system is concentrated in the filter. The heat exchanger and filter are connected to the water room piping via underground lines which cross the west yard (∿100 ft of 4-in. carbon steel pipe). Direct access exists for removal of the components in the shed, and there are no obstacles in the way of excavating the underground pipes.

6. WORK INVOLVED IN ENTOMBING ALL RADIOACTIVE AND CONTAMINATED ITEMS IN THE REACTOR CELL

6.1 Preparatory Work

Preparatory work for entombing all radioactive and contaminated items in the reactor cell in concrete includes: (1) provision of a water flushing system for the fuel and flush-salt drain tanks and the fuel-processing equipment; (2) provision of a 5,000 cfm (minimum) air exhaust duct into the top of the reactor cell; and (3) tooling for cutting pipes and structural materials in the reactor cell and for cutting loose and transferring tanks, pipes, and structural materials from the drain-tank and fuel-processing cells to the reactor cell.

6.1.1 Flushing System for the Primary Salt Drain Tanks and the Fuel-Processing Equipment

This system is the same as that described in Section 5.1.1; however, it will not be necessary to flush out the reactor vessel nor the primary system in the reactor cell. The drain tanks and their associated piping as well as the equipment and piping in the fuel-processing cell are to be flushed to reduce radiation levels and the probability of contamination spread during their being cut out and transferred to the reactor cell for entombment.

UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE, TENNESSEE 37830

TABLE 5
ENTOMBMENT

COST ESTIMATE
SUMMARY SHEET

PROJECT TITLE AND BUILDING

ESO OR ORDER NO.	ACCOUNT CHARGE	DATE	BASE COST DATE	ESTIMATE VALID UNTIL
A-2884A-J1		July, 1977	FY-77	

TYPE OF ESTIMATE: ☐ C ☐ I ☐ II ☐ OTHER ______

CONSTRUCTED BY: ☒ UCND ☒ CPFF ☐ LSSC ☐ ______

ESCALATION (%):

ESTIMATE BASED ON: ☐ VERBAL INFORMATION ☐ SKETCHES ☐ MARKED PRINTS ☐ PRELIM. DESIGN ☐ FINAL DESIGN

FUND SOURCE: ☐ EXP ☐ EOPT ☐ GPP ☐ ______

ESTIMATED BY	ORIGINALLY EST.	DATE	P. ENGR.	EST. NO.
C. Kirby*			C. D. Cagle	
SUBMITTED BY	**LAST REVISION**	**DATE**	**F. ENGR.**	
C. Kirby			L. P. Pugh	

	Page No.	CPFF	UCC-ND	TOTAL
PREPARATORY WORK				
Flushing			$ 94,200	
Cell Ventilation		$ 35,500	25,600	
Work Platforms		60,000	36,600	
Miscellaneous Material			6,900	
SUBTOTAL		$ 95,500	$ 163,300	
TOOLING			$ 419,300	
REACTOR CELL EQUIPMENT		$ 322,700		
DRAIN-TANK CELL		$ 273,300		
FUEL-PROCESSING CELL		$ 53,300		
VENTILATION HOUSE AREA		$ 64,000		
SPECIAL EQUIPMENT ROOM		$ 93,900		
COOLANT CELL AREA		$ 96,100		
SOUTH YARD		$ 135,500	$ 11,100	

*Cost Engineer, UCC-ND ORNL General Engineering.

UCN-5125E
(12 3 1-72)

TABLE 5. (CONTINUED)

COST ESTIMATE

SUMMARY SHEET

(CONTINUATION SHEET)

ESO OR ORDER NO. A-2884A-J1

	Page No.	CPFF	UCC-ND	TOTAL
TREATED WATER SYSTEM		$ 40,500		
SPARE CELL AREA		$ 42,000		
		$1,216,800	$ 593,700	
HEALTH PHYSICS REQUIREMENTS		608,200		
		$1,825,000	$ 593,700	
CPFF INDIRECTS @ 35%		639,000		
		$2,464,000	$ 593,700	$ 3,057,700
ENGINEERING 20%				612,300
				$ 3,670,000
CONTINGENCY, FY-1977 COST				1,100,000
				$ 4,770,000*

ESTIMATE GUIDE LINES:

Labor rates for CPFF contractor $100/day for crafts does not include 35% indirect or radiation allowance.

UCC-ND design based on operating account costs @ $183/day including indirects.

UCC-ND fabrication based on operating account costs @ $156/day including indirects.

G&A on UCC-ND procurement items @ 35%.

UCN-8125F (123 1-72) *NOTE: This is 1977 costs. Use ERDA-ORO Escalation Chart (page 103) to escalate for funding purposes.

6.1.2 Air Exhaust System for the Reactor Cell

The existing 30-in.-diameter cell ventilation duct is connected to the cell near the bottom; therefore, it cannot be used to vent the cell while concrete is being poured into it. Also, before concrete can be poured, it must be severed and sealed at the point of emergence from the cell structure and should not be further contaminated by the preparations for entombment. To provide necessary ventilation for particle control, a temporary shielded 30 in. by 30 in. ventilation duct will be provided to exhaust air from the cell at the top near the south edge. This duct will be tied into the existing 30 in. by 30 in. duct located at the east side of the cell that normally exhausts the high-bay area. The existing particulate filters, blowers, and exhaust stack can be used.

6.1.3 Tooling

Required tooling will include remotely operated saws, abrasive cutting tools, hydraulic shears, cutting torches, lifting hooks, and tongs to be used in the reactor cell to make space for other items. The same tools will be used for cutting loose and transferring items from the drain-tank and fuel-processing cells to the reactor cell. Most of these tools can be made by adapting standard tools with long handles to allow remote operation.

6.2 Preparing Reactor Cell to Accommodate Contaminated Items from Other Cells and Areas

6.2.1 Clearing Top of Cell and Installing Temporary Ventilation Duct

To allow access to all areas of the reactor cell, the upper tier of shielding blocks will be set aside and the entire seal pan cut out in easily handled sections and temporarily stored for later disposal in the reactor cell. During this work, a negative pressure will be maintained in the cell using the existing 30-in.-diameter ventilation duct. One of the smaller lower shield blocks on the south side will be removed and replaced with a new shielded cover containing the temporary ventilation duct. When the new duct has been installed, shielded, and opened to the ventilation system, the existing duct will be closed.

6.2.2 Sealing the Existing 30-In. Cell Ventilation Duct at the Cell Wall

The existing cell ventilation duct will be severed and a short section removed in the coolant cell where the duct exits the reactor cell outer tank. The cell side of the opening will be blanked with a flange containing a nozzle for pumping the penetration full of grout. The duct opening to the filters will be temporarily sealed as the remainder of the duct will be removed later.

The duct penetration extends $\sim$8 ft through the sand-filled annulus to the reactor containment tank. The duct is horizontal for about 5 ft and then turns upward at a 31° slope to intersect the hemispherical bottom head of the reactor tank. The open and inside the cell is shielded by a 9-in.-thick carbon steel shadow shield. The grout should be pumped inward until it extrudes from behind the shadow shield ($\sim$40 ft^3).

6.2.3 Closure of the Opening Between the Reactor and Drain-Tank Cells

Before concrete can be poured into the reactor cell, the opening from there into the drain-tank cell must be cleared of pipes and conduits and sealed. Since later work will further obscure the opening on the reactor cell side, it will be necessary to clear and seal the opening first.

To provide ventilation from the drain-tank cell after sealing the opening, the upper layer of shielding blocks and the seal pan will be removed and a lower shield block replaced with one containing an opening for a ventilation duct as will be done for the reactor cell. This duct will tie in to the temporary duct provided for the reactor cell.

When ventilation has been established for both cells, the pipes and conduits passing through the intercell opening will be severed in both cells and drawn into the reactor cell. The opening will then be closed on the reactor cell side with a large prefabricated plug or cap.

6.2.4 Enlarging Space in the Reactor Cell

There are two purposes for cutting loose and rearranging items in the reactor cell. One purpose is to remove, on the inside of the cell, short sections of all pipes and conduits that penetrate the cell walls to ensure that all internal systems will be sealed from external communication following entombment. Prior to doing the internal cutting, the pipes and

conduits will be cut and capped where they emerge externally from the cell. After the cell has been filled with concrete, the caps will be removed to allow backfilling with concrete prior to final sealing. The second purpose is to rearrange some of the existing components to provide space for placing other items in the cell for entombment.

The major items to be disconnected or cut loose and repositioned are the fuel-salt pump and its associated conduits and piping, the heat exchanger, the primary and secondary salt piping and heaters, and the various structures that support these items.

This phase of the work will be relatively slow due both to limited access and the type of work to be done. Since there will be a dust and particle control problem during this work, only one working opening into the cell will be used. The inflow of air through this opening to the ventilation system will prevent the dust and particles from emerging. Additional limited control will be exercised by drenching with water as applicable. The water will collect in the sump at the low point of the containment vessel and will be jetted to the liquid-waste system. The water ejection system will be the last piping cut loose in the cell.

Although preparation of the drain-tank cell components, fuel-processing cell components, and other items for transfer may be done simultaneously with the space preparation in the reactor cell, no transfer of items to the reactor cell will be done until all cutting and rearranging there is complete.

6.3 Transfer of Disposable Items to the Reactor Cell

6.3.1 Drain-Tank and Fuel-Processing Cell Components

While the reactor cell is being prepared to receive them, the emptied and flushed tanks, piping, etc., in the drain-tank cell and the fuel-processing equipment, piping, etc., will be prepared for transfer. Tanks will be transferred as units. Smaller items, such as pipe sections, will be loaded into reusable steel drums or similar containers for transfer.

Prior to the transfer, an opening large enough to receive the items to be transferred can be provided through the reactor cell top by first stacking temporary shielding to a height of about 6 ft above floor level

to form a shielded chimney around the cell top shield blocks to be removed and then removing the shield blocks. The vertical shielding will protect personnel from direct radiation from the cell and allow the access to remain open while transferred items are being positioned in the cell by personnel working through a smaller opening. Between transfers, the top of the chimney will be closed with a light-weight cover. During transfers, the shielded remote maintenance control room will be used by the hoist operator--other personnel will remain at a safe distance while the items being transferred are unshielded.

As an alternative to using the shielded chimney as an access to the cell, appropriate shielding blocks can be removed and replaced as required by operating the hoist from the shielded remote maintenance control room.

As each tank is put into place in the reactor cell, grout will be pumped into it through a pipe opening or a trespanned hole to prevent floating during the filling of the cell with concrete.

6.3.2 Disposal of Existing Reactor Cell Ventilation Duct and Off-Gas Lines

The entire 30-in.-diameter reactor cell ventilation duct between the reactor cell and the 36-in. main ventilation duct will be cut into sections and disposed of in the reactor cell. To do this, sectioning will begin at the point of emergence from the reactor cell (already sealed from the reactor cell) and proceed toward the main duct. This will allow an inward draft of air to be maintained for dust control. Prior to cutting each section, the inner wall will be coated with a sealant to prevent particle release during subsequent handling. Removal of the duct outside the building will involve excavation.

Sectioning of off-gas lines will also be done while maintaining an inward draft; however, due to their small size, coating the sections internally will not be required.

6.3.3 Secondary Decay Volume and Charcoal Traps

Due to only low-level contamination with long-lived fission products, the secondary decay volume and charcoal traps (all located in the charcoal-trap pit) will be sealed and transferred as intact units to the solid-waste storage area for disposal in trenches.

6.4 Filling the Reactor Cell with Concrete

The filling of the reactor cell with concrete and grout will be done in stages as the various items to be disposed of there are added. This procedure will reduce the radiation level through openings in the top of the cell as quickly as possible. One of the first regions to be filled with grout will be the annulus between the reactor vessel and thermal shield to reduce the radiation from the vessel into the cell.

When the reactor cell has been filled with concrete up to the bottoms of the lower shield blocks, the temporary ventilation duct will be removed and all the lower shield blocks will be reinstalled. A final grouting in of the blocks will be made at the building floor level and the surface finished to building floor specifications. The upper shield beams may be checked for contamination and either retained for other uses or disposed of.

6.5 Decontamination of Area

6.5.1 Drain-Tank Cell

When the equipment removed from the drain-tank cell is complete, decontamination of the interior surfaces and cell penetrations will be done. The cell is stainless steel lined and will allow strong solutions to be used for cleaning. The solutions can be jetted to the existing liquid-waste system. The transferrable contamination should be low enough to allow unrestricted use of the cell.

The upper and lower shield plugs will be cleaned and reinstalled over the cell for future use.

6.5.2 Fuel-Processing Cell

After removal of the fuel-processing-cell equipment, the cell will be decontaminated in the same manner as the drain-tank cell except that the cell surfaces are concrete. Chipping may be used where solution cleaning is unsuccessful.

The roof plugs will be cleaned and replaced for future use.

6.5.3 Liquid-Waste Storage Cell

The liquid-waste system will be retained for future use. Contamination in the storage tank, filter, pipes, and pump will be flushed out to the Laboratory ILW system to allow the system to remain for future use with restricted entry only into the waste-tank storage cell.

6.5.4 Containment Ventilation System

After removal of the reactor cell exhaust duct and decontamination of the stack filter bay, very little, if any, contamination will remain in the ventilation system. Repairs to the duct where the cell exhaust line is removed will be made, and the system will remain ready for use.

6.5.5 Special Equipment Room - Coolant Cell Area

A small amount of contamination exists in the special equipment room as a result of maintenance on the component-cooling air blowers. Care must be used to avoid further contamination during the removal of the cell exhaust duct and the component-cooling air system. A simple mopping of the cell area should remove the existing contamination.

7. REFERENCES

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APPENDIX A

JOB LISTING FOR

DECOMMISSIONING THE MSRE BY DISMANTLING AND DISPOSAL

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Design and fabricate flushing system unit with ∿50 gpm flow and ∿500 gallons storage of decontamination solution with connections for discharging solution to the ORNL ILW system. Unit to be portable and shielded for use at various areas in the reactor, drain tank, and fuel processing cell.					
	Design (100 md)				$ 18,300	
	Material			$10,000		
	Fabrication (100 md)				15,600	
6 jobs	Connect and flush various sections of the system and tanks.					
	6 ea. @ 50 md (300 md)				$ 46,800	
	G&A on materials: 10,000 x 0.35			$ 3,500		
	UCC-ND Subtotal			$13,500	$ 80,700	
	NET MATERIAL AND LABOR					
	PREPARATORY WORK - FLUSHING			CPFF	FIXED PRICE	ORNL
						$ 94,200

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Design, fabricate and install filtering and demineralizing system to control clarity and activity level of the reactor cell and drain tank cell flood water. The system is to have a minimum flow capacity of 1,000 gpm and be located within a shielded area with piping connections to the reactor and drain tank cell.					
	Design (200 md)				$ 36,600	
	Materials			$50,000		
	Fabrication & Installation (500 md)				$ 50,000	
	G&A on materials: 50,000 x 0.35			$17,500		
				$67,500	$ 86,600	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
PREPARATORY WORK - FLOODING			$154,100

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Design, fabricate and install a temporary cell ventilation					
	duct from the top of the reactor cell to existing duct					
	work at the east side of the high bay.					
	Design (50 md)				$ 9,200	
	Materials			$5,000		
	Fabrication & Installation (50 md)				5,000	
1 job	Design, fabricate and install a temporary cell ventilation					
	duct from the top of the drain tank cell to existing duct					
	work at the east side of the high bay.					
	Design (50 md)				$ 9,200	
	Materials			$7,500		
	Fabrication & Installation (75 md)				7,500	
	G&A on materials: 12,500 x 0.35			$4,400		
				$16,900	$ 30,900	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
PREPARATORY WORK - CELL VENTILATION			$ 47,800

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Design, fabricate and install a work platform to fit the top of the reactor cell. The platform is to have removable deck sections for access to all work areas of the cell; contain tool securing devices; and lighting and other visual aids necessary for underwater remote work.					
	Design (100 md)				$ 18,300	
	Materials			$10,000		
	Fabrication & Installation (200 md)				31,200	
1 ea.	Design, fabricate and install a work platform to fit the top of the drain tank cell. The platform is to have removable deck sections for access to all areas of the cell; contain tool handling and securing devices; and lighting and other visual aids necessary for underwater remote work.					
	Design (100 md)				$ 18,300	
	Materials			$10,000		
	Fabrication & Installation (200 md)				31,200	
	NET MATERIAL AND LABOR					
	PREPARATORY WORK - WORK PLATFORMS			CPFF	FIXED PRICE	ORNL
						$126,000

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
	G&A on materials: 20,000 x 0.35			$ 7,000		
				$27,000	$ 99,000	
	NET MATERIAL AND LABOR					

PREPARATORY WORK - WORK PLATFORMS	CPFF	FIXED PRICE	ORNL
			$422,100

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Pipe cutter, abrasive, for horizontal 5" INOR-8 pipe.					
	Design (50 md)				$ 9,200	
	Fabrication Labor (50 md)				7,800	
	Materials			$2,500		
	Mockup & Development (50 md)			500	7,800	
1 ea.	Pipe cutter, abrasive, for vertical 5" INOR-8 pipe.					
	Design (50 md)				$ 9,200	
	Fabrication (50 md)				7,800	
	Materials			$2,500		
	Mockup & Development (50 md)			500	7,800	
2 ea.	Pipe cutters, hydraulic, for vertical or horizontal 1/2"					
	thru 2" carbon steel, stainless steel and INOR-8 pipe					
	(commercial hydraulic shears).					
	Design (50 md)				$ 9,200	
	Fabrication (30 md)				4,700	
	Material @ $2,500 each			$5,000		
	Mockup & Development (50 md)			500	7,800	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
TOOLING			

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	Cutters, hydraulic, for miscellaneous 1/4" to 1/2" tubing					
	MI cable, electrical leads, etc. (commercial hydraulic					
	units).					
	Design (50 md)				$ 9,200	
	Fabrication (30 md)				4,700	
	Material @ $500 each			$1,000		
	Mockup & Development (50 md)			500	7,800	
2 ea.	Snips, manual, for cutting thermocouple leads, electrical					
	leads, etc.					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material			$ 500		
	Mockup & Development (10 md)			100	1,600	
	NET MATERIAL AND LABOR					
TOOLING				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	Cutters, torch, acetylene, for cutting horizontal carbon steel support structures.					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material @ $500 each			$1,000		
	Mockup & Development (50 md)			500	7,800	
2 ea.	Cutters, torch, acetylene for cutting vertical carbon steel support structures.					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material @ $500 each			$1,000		
	Mockup & Development (50 md)			500	7,800	
1 ea.	Tool, lifting, for removal of fuel pump motor.					
	Design (existing)					
	Fabrication (30 md)				$ 4,700	
	Material			$ 500		
	NET MATERIAL AND LABOR					

TOOLING	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS		MATERIAL	LABOR	Reference Drawing
		MAT'L	LABOR			
1 ea.	Tool, lifting, for removal of fuel pump rotary element.					
	Design (existing)					
	Fabrication (30 md)				$ 4,700	
	Material			$ 500		
1 ea.	Tool, lifting, for handling fuel pump bowl.					
	Design (existing)					E-56336
	Fabrication (50 md)				$ 7,800	
	Material			$1,000		
1 ea.	Tool, lifting, for handling fuel heat exchanger.					
	Design (existing)					E-56340
	Fabrication (75 md)				$ 11,700	
	Material			$1,500		
1 ea.	Tool, lifting, for removal of drain tank steam domes.					
	Design (existing)					D-56339
	Fabrication (30 md)				$ 4,700	
	Material			$ 500		
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
TOOLING						

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Tool, lifting, for removal of fuel drain tanks.					
	Design (existing)					D-56338
	Fabrication (50 md)				$ 7,800	
	Material			$1,000		
2 ea.	Tool, lifting, for removal of heater units.					
	Design (existing)					
	Fabrication (30 md)				$ 4,700	
	Material			$ 500		
1 ea.	Tool, lifting, for removal of cell coolers.					
	Design (existing)					
	Fabrication (20 md)				$ 3,100	
	Material			$1,000		
1 ea.	Tool, lifting, for removal of thermal shield slides.					
	Design (existing)					E-56345
	Fabrication (50 md)				$ 7,800	
	Material			$ 500		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
TOOLING			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Tool, lifting, for removal of fuel storage tank.					
	Design (30 md)				$ 5,500	
	Fabrication (50 md)				7,800	
	Material			$1,000		
6 ea.	Tool, lifting and handling, various lengths, for removal of segments of large piping (3" to 6").					
	Design (50 md)				$ 9,200	
	Fabrication (50 md)				$ 7,800	
	Material			$1,000		
6 ea.	Tool, lifting and handling, various lengths, for removal of segments of small piping (1/4" to 2").					
	Design (50 md)				$ 9,200	
	Fabrication (50 md)				7,800	
	Material			$1,000		
	NET MATERIAL AND LABOR					
TOOLING				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS		MATERIAL	LABOR	Reference Drawing
		MAT'L	LABOR			
6 ea.	Tool, lifting and handling, various lengths, for removal of segments of structural components.					
	Design (50 md)				$ 9,200	
	Fabrication (50 md)				7,800	
	Material			$1,000		
1 ea.	Tool, lifting, for removal of NaF absorber.					
	Design (20 md)				$ 3,700	
	Fabrication (20 md)				3,100	
	Material			$ 200		
1 ea.	Tool, lifting, for removal of caustic scrubber.					
	Design (10 md)				$ 1,800	
	Fabrication (20 md)				7,800	
	Material			$ 200		
	NET MATERIAL AND LABOR					
	TOOLING			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS		MATERIAL	LABOR	Reference Drawing
		MAT'L	LABOR			
2 ea.	Tool, breaker, for breaking out core graphite bars.					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material			$1,000		
	Mockup & Development (20 md)			500	3,100	
2 ea.	Tool, lifting and handling, for removal of core graphite bars.					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material			$1,000		
	Mockup & Development (30 md)			1,000	4,700	
1 lot	Tools, lifting and handling, for removal of reactor core can and vessel segments.					
	Design (100 md)				$ 18,300	
	Fabrication (100 md)				15,600	
	Material			$5,000		
	Mockup & Development (50 md)			1,000	7,800	
	NET MATERIAL AND LABOR					
TOOLING				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 lot	Long handled hooks, tongs, socket wrench extensions, chisels, punches, saws, drills, hammers, etc., designed for general and special applications (∿100 tools).					
	Design (300 md)				$ 55,000	
	Fabrication (300 md)				46,800	
	Material			$ 5,000		
1 job	Tool, cutting, plasma torch, for segmenting the reactor vessel, reactor core can and the thermal shield.					
	a. Fabricate control console from existing design			$170,000		
	b. Plasma equipment			170,000		
	c. Design			510,000		
	d. Fabricate tools			850,000		
	e. Mockup & development			850,000		
	NOTE: Estimate made on basis of actual cost plus escalation from 1971 to 1977 @ 70% of similar technique used on the Elk River Reactor dismantling.					
	NET MATERIAL AND LABOR					
TOOLING				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 lot	Miscellaneous visual aids; i.e., lights			$10,000		
	binoculars, periscopes, etc.					
	G&A on materials: 0.35(2,602,500 - 2,550,000)			$18,400		
	UCC-ND			$2,620,900	$450,200	
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
	TOOLING					$3,071,100

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Container, shielded, for transport and storage of the					
	fuel pump rotary element. (∿20" ID x 30" tall w/3" Pb					
	shielding)					
	Design (20 md)				$ 3,700	
	Fabrication (40 md)				6,200	
	Materials: 4,000 lbs Pb			$ 1,400		
	Other			500		
1 ea.	Container, shielded, for transport and storage of the					
	fuel pump bowl. (40" ID x 30" tall w/3" thick Pb					
	shielding)					
	Design (20 md)				$ 3,700	
	Fabrication (40 md)				6,200	
	Materials: 9,000 lbs Pb			$ 3,200		
	Other			500		
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
	SPECIAL TRANSPORT AND STORAGE CONTAINERS					

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Container, shielded, for transport and storage of the fuel pump overflow tank. (32" ID x 36" tall w/3" Pb shielding)					
	Design (20 md)				$ 3,700	
	Fabrication (40 md)				6,200	
	Materials: 7,700 lbs Pb			$ 2,700		
	Other			500		
1 ea.	Container, shielded, for transport and storage of primary heat exchanger. (40" x 60" x 100" inside w/3" Pb shielding)					
	Design (30 md)				$ 5,500	
	Fabrication (40 md)				6,200	
	Materials: 33,500 lbs Pb			$11,700		
	Other			1,000		
	NET MATERIAL AND LABOR					
	SPECIAL TRANSPORT AND STORAGE CONTAINERS			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
5 ea.	Containers, shielded, for transport and storage of freeze					40610
	flanges w/clamps. (35" x 60" x 10" inside w/3" Pb					
	shielding)					
	Design (30 md)				$ 5,500	
	Fabrication (100 md)				15,600	
	Materials: 5 @ 9,000 lbs = 45,000 lbs Pb			$15,800		
	Other - 5 @ $500 each			2,500		
10 ea.	Containers, shielded for transport and storage of multiple					
	removable heater units. (30" x 36" x 120" inside w/2" Pb)					
	Design (30 md)				$ 5,500	
	Fabrication: 10 @ 30 md (300 md)				46,800	
	Materials: 10 @ 15,000 lbs = 150,000 lbs Pb			$52,500		
	Other - 10 @ $500 each			5,000		
	NET MATERIAL AND LABOR					
	SPECIAL TRANSPORT AND STORAGE CONTAINERS			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Container, shielded, for transport and storage of Line 100 thermal shield slide. (24" x 30" x 48" w/4" Pb shielding)					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)					
	Materials: 14,000 lbs Pb			$ 4,900		
	Other			500		
1 ea.	Container, shielded, for transport and storage of Line 102 thermal shield slide. (34" x 30" x 72" w/4" Pb shielding)					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)					
	Materials: 19,000 lbs Pb			$ 6,700		
	Other			500		
	NET MATERIAL AND LABOR					

SPECIAL TRANSPORT AND STORAGE CONTAINERS	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Container, shielded, for transport and storage of Line					
	103 thermal shield slide. (24" x 30" x 140" w/4" Pb					
	shielding)					
	Design (30 md)				$ 5,500	
	Fabrication (40 md)				6,200	
	Materials: 36,000 lbs Pb			$12,600		
	Other			1,000		
1 ea.	Container, shielded, for transport and storage of the					
	off-gas valve box with contents. (48" x 36" x 60" w/2"					
	Pb shielding)					
	Design (20 md)				$ 3,700	
	Fabrication (30 md)				4,700	
	Materials: 10,000 lbs Pb			$ 3,500		
	Other			500		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
SPECIAL TRANSPORT AND STORAGE CONTAINERS			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
3 ea.	Shields, transport, for transporting 55-gallon drums of					
	material, bottom loading and unloading w/6" lead shield-					
	ing. Approximate weight, 16,000 lbs each.					
	Cost: Design, material and fabrication based on pre-					
	vious similar items @ $400/lb = $60,000 each.			$120,000		
1 ea.	Container, shielded, for transport of the charcoal bed					
	valve box w/contents. (30" x 36" x 60" w/2" Pb shielding)					
	Design (20 md)				$ 3,700	
	Fabrication (30 md)				4,700	
	Materials: 9,000 lbs Pb			$ 3,200		
	Other			500		
2 ea.	Containers, wo/shielding, for transport of component					
	cooling air blower motors (75 hp).					
	Design (20 md)				$ 3,700	
	Fabrication (40 md)				6,200	
	Materials: 2 @ $500 each			$ 1,000		
	NET MATERIAL AND LABOR					
	SPECIAL TRANSPORT AND STORAGE CONTAINERS			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIALS	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	Containers, wo/shielding, for containment of the compo-					
	nent cooling air blowers (size 10" x 15", Roots					
	Connersville). (40" x 50" x 60")					
	Design (30 md)				$ 5,500	
	Fabrication: 2 @ 20 md each (40 md)				6,200	
	Material: 2 @ $500 each			$ 1,000		
1 ea.	Container, wo/shielding, for containment of off-gas					
	sampler assembly. (40" x 50" x 50")					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material			$ 500		
3 ea.	Containers, wo/shielding, for containment of the drain					
	and flush salt tanks. (52" x 10" x 90" tall)					
	Design (30 md)				$ 5,500	
	Fabrication: 3 @ 30 md each (90 md)				14,000	
	Material: 3 @ $1,000 each			$ 3,000		
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
	SPECIAL TRANSPORT AND STORAGE CONTAINERS					

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Container, wo/shielding, for containment of the fuel					
	storage tank. (55" OD x 120" tall)					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material			$ 1,000		
1 ea.	Container, shielded, for transport and storage of the					
	fuel sampler enricher. (48" x 48" x 60" w/6" Pb					
	shielding)					
	Design (50 md)				$ 9,200	
	Fabrication (75 md)				11,700	
	Materials: 50,000 lbs Pb			$17,500		
	Other			2,500		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
SPECIAL TRANSPORT AND STORAGE CONTAINERS			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Container, shielded, for transport of the fuel process					
	sampler assembly. (48" x 48" x 60" w/2" Pb shielding)					
	Design (50 md)				$ 9,200	
	Fabrication (75 md)				11,700	
	Materials: 9,000 lbs Pb			$ 3,200		
	Other			2,500		
	G&A on material: 283,400 x 0.35			$ 99,200		
				$382,600	$257,600	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
SPECIAL TRANSPORT AND STORAGE CONTAINERS			$640,200

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS		MATERIAL	LABOR	Reference Drawing
		MAT'L	LABOR			
50 ea.	Remove top beam holdown nuts and studs. (20 md)				$ 2,000	40955
	(2 1/4" OD x 4'-0" long)					
15 ea.	Remove top beams to outside storage. (30 md)				$ 3,000	40951
	2 each 2'-0" x 3'-6" x 15'-0" long					
	2 each 2'-0" x 3'-6" x 20'-4" long					
	2 each 2'-0" x 3'-6" x 24'-0" long					
	2 each 2'-0" x 3'-6" x 26'-6" long					
	7 each 2'-0" x 3'-6" x 30'-0" long					
1 ea.	Remove seal membrane, section and haul to burial ground. (24'-6" OD x 1/8" thick stainless steel) (40 md)				$ 4,000	40972-74
1 job	Flood cell to bottom of lower plugs. (10 md)				$ 1,000	
28 ea.	Remove lower roof plug steel crack fillers. (20 md)				$ 2,000	40954
10 ea.	55-gallon stainless steel drums.			$1,000		
	NET MATERIAL AND LABOR					
	REACTOR CELL EQUIPMENT			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
31 ea.	Remove lower shield plugs. (20 md)				$ 2,000	40954
1 job	Install work platforms over cell. (10 md)				$ 1,000	
1 ea.	Remove and dispose of east cell cooler. (2 roof plugs, cooler w/support) (20 md)				$ 2,000	56292
1 job	Remove and dispose of west cell cooler. (2 roof plugs, cooler and support structure) (20 md)				$ 2,000	56293
24 ea.	Remove spacers from salt piping heaters. (60 md)				$ 6,000	51600
30 ea.	Remove salt piping heaters.					51600
2 ea.	Remove heat exchanger heater spacers. (10 md)				$ 1,000	51600
3 ea.	Remove heat exchanger heaters.					51600
5 ea.	Remove fuel pump bayonett heaters. (10 md)				$ 1,000	51600
5 ea.	55-gallon drums stainless steel.			$ 500		
	NET MATERIAL AND LABOR					
	REACTOR CELL EQUIPMENT			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
9 ea.	Remove reactor bayonett heaters. (20 md)				$ 2,000	51600
10 ea.	55-gallon stainless steel drums.			$1,000		
57 ea.	Remove electrical disconnects w/flexible leads. (30 md)				$ 3,000	56350
20 ea.	55-gallon stainless steel drums.			$2,000		
65 ea.	Remove thermocouple disconnects w/flexible leads. (30 md)				$ 3,000	56350
20 ea.	55-gallon stainless steel drums			$2,000		
1 job	Cut and remove 5" coolant salt piping. (∿55 lin ft; ∿30 cuts) (50 md)				$ 5,000	40700
10 ea.	55-gallon stainless steel drums.			$1,000		
2 ea.	Cut and remove coolant salt line freeze flanges w/support nests. (30 md)				$ 3,000	40700
	NET MATERIAL AND LABOR					

REACTOR CELL EQUIPMENT	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Cut and remove 5" fuel salt piping. (∿12 lin ft; 10 cuts) (30 md)				$ 3,000	40700
3 ea.	55-gallon stainless steel drums.			$ 300		
3 ea.	Cut and remove fuel salt line 5" freeze flanges. (30 md)				$ 3,000	40700
15 ea.	Remove fuel pump auxiliary line jumpers. (1/2" and 3/4" x ∿10' long) (30 md)				$ 3,000	40704
10 ea.	55-gallon stainless steel drums.			$1,000		
1 ea.	Remove fuel pump motor. (20 md)				$ 2,000	9830
1 ea.	Remove fuel pump rotary element. (20 md)				$ 2,000	9830
1 ea.	Remove fuel pump bowl. (30 md)				$ 3,000	10965 9830
1 ea.	Remove fuel pump overflow tank. (20 md)				$ 2,000	56418-19
	NET MATERIAL AND LABOR					

REACTOR CELL EQUIPMENT	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove fuel pump support structure. (30 md)				$ 3,000	41463
10 ea.	55-gallon stainless steel drums.			$1,000		
1 ea.	Remove fuel pump furnace. (30 md)				$ 3,000	51606 51604
3 ea.	55-gallon stainless steel drums.			$ 300		
1 ea.	Remove heat exchanger. (50 md)				$ 5,000	
1 job	Remove heat exchanger heater bases. (10 md)				$ 1,000	
1 job	Remove heat exchanger support structure. (20 md)				$ 2,000	
15 ea.	55-gallon stainless steel drums.			$1,500		
5 ea.	Remove component cooling air control valves w/operators. (Size 1") (20 md)				$ 2,000	
	NET MATERIAL AND LABOR					

REACTOR CELL EQUIPMENT	CPFF	FIXED PRICE	ORNL

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
3 ea.	55-gallon stainless steel drums.			$ 300		
2 ea.	Remove component cooling air control valves w/operators. (Size 3") (10 md)				$ 1,000	
2 ea.	55-gallon stainless steel drums.			$ 200		
1 job	Remove component cooling air valve support structures. (20 md)				$ 2,000	55486 55502
3 ea.	55-gallon stainless steel drums.			$ 300		
2 ea.	Remove cell temperature compensation tanks. (6" OD x 20'-0" long) (20 md)				$ 2,000	40704
5 ea.	55-gallon stainless steel drums.			$ 500		
1 ea.	Remove off-gas holdup volume. (Line 522, 4" OD x ∿45' long; ∿30 cuts) (40 md)				$ 4,000	40704
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
	REACTOR CELL EQUIPMENT					

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
10 ea.	55-gallon stainless steel drums.			$1,000		
1 job	Remove miscellaneous auxiliary piping from cell walls. Water, air, off-gas, etc. (∿1,000 ft, Size 1/2" to 2" pipe, carbon steel and stainless steel) (200 md)				$ 20,000	40704 56267
20 ea.	55-gallon stainless steel drums.			$2,000		
1 job	Remove electrical mineral insulated cables from cell wall to various junction boxes. (3/8" OD Cu sheathed, 84 each 10' to 40' long from penetrations R_2 and R_3) (100 md)				$ 10,000	56232
10 ea.	55-gallon stainless steel drums.			$1,000		
1 job	Remove heater base insulation. (50 md)				$ 5,000	
	NET MATERIAL AND LABOR					

REACTOR CELL EQUIPMENT	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove fuel and coolant salt piping supports w/heater base insulation supports. (∿65 lin ft base insulation carriage, 11 each, pipe support assemblies, 11 each, pipe hanger rods) (100 md)				$ 10,000	41860 41861 41862
15 ea.	55-gallon stainless steel drums.			$1,500		
1 job	Remove equipment support steel. (∿75 lin ft 8" WF 24; 25 lin ft 10" WF 25; 130 lin ft 7" 9.8; miscellaneous clips, etc.) (100 md)				$ 10,000	40518 40579
50 ea.	55-gallon stainless steel drums.			$5,000		
1 job	Remove leak detector tubing from cell wall penetration to various flanged disconnects. (40 each 1/4" OD x 0.083" wall stainless steel x 20' to 50' long) (40 md)				$ 4,000	55494
15 ea.	55-gallon stainless steel drums.			$1,500		
	NET MATERIAL AND LABOR					
	REACTOR CELL EQUIPMENT			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove MI cable and TC lead cable tray. (30 md)				$ 3,000	55489
10 ea.	55-gallon stainless steel drums.			$1,000		
1 job	Remove fuel salt drain line from reactor to drain tank cell penetration. (1 1/2 Sch 40 INOR 8 x 15' long w/insulation) (20 md)				$ 2,000	
6 ea.	55-gallon stainless steel drums.			$ 600		
1 job	Remove drain line supports. (~15' carriage assembly) (20 md)				$ 2,000	
10 ea.	55-gallon stainless steel drums.			$1,000		
1 job	Clear top of thermal shield. Cut brackets, TC, leak detector and heater disconnects, etc. Cut cooling water lines connecting compartments. (30 md)				$ 3,000	41894
	NET MATERIAL AND LABOR					
REACTOR CELL EQUIPMENT				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
6 ea.	55-gallon stainless steel drums.			$ 600		
1 ea.	Remove Line 103 slide assembly. (5 md)				$ 500	40722
1 ea.	Remove Line 100 slide assembly. (5 md)				$ 500	40722
1 ea.	Remove Line 102 slide assembly. (5 md)				$ 500	40722
1 job	Install reactor cutting support fixture. (20 md)				$ 2,000	
1 job	Remove reactor and thermal shield lid to cutting support fixture. (30 md)				$ 3,000	
1 job	Cut reactor hanger rods and remove thermal shield lid. (20 md)				$ 2,000	
1 job	Install cutting tools and cut top head from reactor vessel. (30 md)				$ 3,000	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
REACTOR CELL EQUIPMENT			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
5 ea.	55-gallon stainless steel drums.			$ 500		
1 job	Remove core graphite bars. (636 each 2" x 2" x 67" long) (200 md)				$ 20,000	40416
20 ea.	55-gallon stainless steel drums.			$2,000		
1 job	Cut and remove remainder of reactor vessel and core can. (200 md)				$ 20,000	40402
50 ea.	55-gallon stainless steel drums.			$5,000		
1 job	Install cutting fixture into thermal shield. (30 md)				$ 3,000	
1 job	Cut top from thermal shield main section. (30 md)				$ 3,000	40727-30
10 ea.	55-gallon stainless steel drums.			$1,000		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
REACTOR CELL EQUIPMENT			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove 7/8" diameter steel balls from thermal shield. (~400 ft^3) (100 md)				$ 10,000	40727-30
50 ea.	55-gallon stainless steel drums.			$5,000		
1 job	Section and remove thermal shield main section. (~950 ft^2 1" thick stainless steel plate) (200 md)				$ 20,000	40724
100 ea.	55-gallon stainless steel drums.			$10,000		
1 job	Section and remove thermal shield base. (~350 ft^2 of 3/4" and 1" PL + 135' of 8 WF 20) (200 md)				$ 20,000	40723
100 ea.	55-gallon stainless steel drums.			$10,000		
1 job	Remove cell support platform. (30 md)				$ 3,000	
1 job	Decontaminate cell support platform. (30 md)				$ 3,000	
	NET MATERIAL AND LABOR					
	REACTOR CELL EQUIPMENT			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove Rashig rings from bottom of cell. (20 md) (165 ft^3 Borosilicate glass, 1 1/2" OD x 1 3/16" ID x 1 3/4" long, ~300 pc/ft^3 and 30 lb/ft^3)				$ 2,000	55493
1 job	Decontaminate inside of reactor cell to allow entry. (100 md)				$ 10,000	
30 ea.	55-gallon stainless steel drums.			$3,000		
1 job	Remove sump poison-element strainer insert assembly. Retain sump piping. (11 3/8" OD x 2'-3/4" long) (10 md)				$ 1,000	55493
1 ea.	55-gallon stainless steel drum.			$ 100		
1 ea.	Remove fuel pump auxiliary piping penetration plug. (18" Sch 80 sleeve stainless steel and carbon steel w/8 each 1/2" to 1" pipe penetrations) (20 md)				$ 2,000	40717
	NET MATERIAL AND LABOR					

REACTOR CELL EQUIPMENT	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	55-gallon stainless steel drums.			$ 200		
1 ea.	Remove nuclear instrument tube. (36" OD x 12' long, inside cell only) (30 md)				$ 3,000	40715
1 job	Remove sampler enricher assembly. (100 md)				$ 10,000	
1 job	Remove sampler enricher penetration plug. (20 md)				$ 2,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
2 ea.	Remove coolant salt anchor sleeve furnaces. (20 md)				$ 2,000	51670
2 ea.	Remove coolant salt anchor sleeves. (30 md)				$ 3,000	41858(200) 55498(201)
2 ea.	55-gallon stainless steel drums.			$ 200		
2 ea.	Remove anchor sleeve shielding. (20 md)				$ 2,000	55498
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
REACTOR CELL EQUIPMENT			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove 30" duct shadow shield. (20 md)				$ 2,000	40749
2 ea.	55-gallon stainless steel drums.			$ 200		
6 ea.	Remove cell penetration plugs R thru R_4 and R_7. (180 md)				$ 18,000	41863
	(1'-10 1/2" OD x 3'-10 1/2" long)					
6 ea.	55-gallon stainless steel drums.			$ 600		
6 ea.	Decontaminate cell thimbles. (30 md)				$ 3,000	
1 job	Final decontamination of reactor cell. (50 md)				$ 5,000	
31 ea.	Decontaminate lower shield plugs. (50 md)				$ 5,000	
31 ea.	Replace lower shield plugs. (20 md)				$ 2,000	
15 ea.	Decontaminate top beams. (30 md)				$ 3,000	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
REACTOR CELL EQUIPMENT			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
28 ea.	Decontaminate lower shield plug steel crack fillers. (20 md)				$ 2,000	
28 ea.	Replace lower shield plug crack fillers. (10 md)				$ 1,000	
15 ea.	Replace top beams on cell. (20 md)				$ 2,000	
50 ea.	Decontaminate top beam holddown studs and nuts. (30 md)				$ 3,000	
50 ea.	Replace top beam holddown studs and nuts. (20 md)				$ 2,000	
	NET MATERIAL AND LABOR			$66,000	$353,500	
				CPFF	FIXED PRICE	ORNL
	REACTOR CELL EQUIPMENT			$419,500		

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
82 ea.	Remove steel holddown keys from upper shield plugs. (10" x 4 1/2" x 3 1/2") (5 md)				$ 500	40946
	Decontaminate beams and store for future use. (50 md)				$ 5,000	
10 ea.	Remove upper shield beams. (24'-7 1/2" x 2'-0" x 3'-6") (25 md)				$ 2,500	40933 40946
	Remove seal membrane (21'-10" x 21' x 1/8" thick stainless steel) section and haul to burial ground. (20 md)				$ 2,000	40933
28 ea.	Remove steel shield plates from between lower plugs. (10 md)				$ 1,000	40939
	8 each, 1'-0" x 5'-6 1/2" x 1" thick					
	8 each, 1'-0" x 7'- 1 1/8" x 1" thick					
	8 each, 1'-0" x 5'-8" x 1" thick					
	2 each, 1'-0" x 1'-3 1/4" x 1" thick					
	2 each, 1'-0" x 2'-1/4" x 1" thick					
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
DRAIN-TANK CELL - GENERAL			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
	Decontaminate shield plates and store for future (10 md)				$ 1,000	
	use.					
	NET MATERIAL AND LABOR				$ 12,000	

DRAIN-TANK CELL - GENERAL	CPFF	FIXED PRICE	ORNL
	$ 12,000		

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Flood the cell to bottom of lower plugs. (10 md)				$ 1,000	
12 ea.	Remove lower roof plugs from north bay. (10 md)				$ 1,000	40933 40946
	9 each, 2' x 4' x 5'-6 1/2" long, 6,100 lbs,					
	MK-4					
	1 each, 1'-3 1/4" x 4' x 6'-4 3/4" long,					
	3,700 lbs, MK-13					
	1 each, 1'-3 1/4" x 4' x 3'-11 1/2" long,					
	2,600 lbs, MK-14					
	1 each, 1'-3 1/4" x 4' x 4'-10 1/2" long,					
	2,700 lbs, MK-15					
12 ea.	Decontaminate plugs for future use. (50 md)				$ 5,000	
1 ea.	Remove north shield plug support beam. (8" (1 md)				$ 100	40944
	x 2'-1 1/2" x 17'-5 1/2" long)					
1 ea.	Decontaminate for future use. (2 md)				$ 200	
	NET MATERIAL AND LABOR					

DRAIN-TANK CELL - NORTH BAY	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Install work platform w/vent control panels. (10 md)				$ 1,000	
2 ea.	Remove pneumatic valves HCV-544 and -573. (One barrel) (10 md)				$ 1,000	41512-13
1 ea.	55-gallon stainless steel drum.			$ 100		
2 ea.	Remove valve supports, HCV-544 and -573. (One barrel) (6 md)				$ 600	41877
1 ea.	55-gallon stainless steel drum.			$ 100		
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL

DRAIN-TANK CELL - NORTH BAY

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove miscellaneous auxiliary piping, thermo- (200 md)				$ 20,000	41512-13 40708-09
	couple leads, heater leads, leak detector lines,					
	and instrument air lines above drain tanks.					
	~100 ft pipe, 1/2" to 1" Sch 40					
	~22 each flexible heater lead assemblies					40878
	~200 ft air lines, 1/4" and 3/8" ODT					
	~100 ft leak detector tubing, 1/4" OD stainless					55404, 55405, 55406
	steel					
	Steam dome jumper lines, 3" and 2"					
	22 each heater disconnect junction boxes					
	18 each thermcouple junction boxes					40878, 55404, 55405, 55406, 55478
	~25 ft, 6" x 6" cable trough					
	~50 ft, 4" x 4" cable trough					
	~500 ft mineral insulated cable from cell wall					
	to junction boxes, 3/8" OD copper sheathed					
	~2,500 ft thermocouple leads from cell wall to					40878
	junction boxes, 1/4" OD copper sheathed and					
	1/8" OD stainless steel sheathed					
	NET MATERIAL AND LABOR					

DRAIN-TANK CELL - NORTH BAY	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
50 ea.	55-gallon stainless steel drums.			$5,000		
1 ea.	Remove FDT-1 steam dome assembly. (20 md)				$ 2,000	40463, 40731, 40708
5 ea.	Remove heaters from Line 106. (5 md)				$ 500	57490 MIC-G-116
5 ea.	55-gallon stainless steel drums.			$ 500		
1 ea.	Remove FV-106. (1 1/2" INOR-8) (10 md)				$ 1,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
15 ft	Remove Line 106. (1 1/2" Sch 40 INOR-8) (10 md)				$ 1,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
8 ea.	Remove Line 106 heater base insulation units (B-106-A thru B-106-G2). (10 md)				$ 1,000	MIC-G-117
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL - NORTH BAY			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
4 ea.	55-gallon stainless steel drums.				$ 400		
1 job	Remove heater base support structure.	(20 md)				$ 2,000	
4 ea.	55-gallon stainless steel drums.				$ 400		
7 ea.	Remove FDT-1 heater units.	(30 md)				$ 3,000	
20 ea.	55-gallon stainless steel drums.				$ 2,000		
1 ea.	Remove disconnect support from FDT-1.	(10 md)				$ 1,000	
1 ea.	Remove FDT-1 furnace lid.	(20 md)				$ 2,000	51869
2 ea.	55-gallon stainless steel drums.				$ 200		
1 job	Remove drain tank (FDT-1).	(20 md)				$ 2,000	40457
1 job	Remove drain tank weigh cells.	(20 md)				$ 2,000	
	NET MATERIAL AND LABOR						
DRAIN-TANK CELL - NORTH BAY					CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	55-gallon stainless steel drums.			$ 200		
1 job	Remove drain tank furnace. (50 md)				$ 5,000	
10 ea.	55-gallon stainless steel drums.			$ 1,000		
1 job	Remove drain tank supports. (20 md)				$ 2,000	
4 ea.	55-gallon stainless steel drums.			$ 400		
1 job	Remove transfer line #109. (~15 ft, 1/2" Sch 40 INOR-8 w/Calrod heaters and insulation attached) (20 md)				$ 2,000	
3 ea.	55-gallon stainless steel drums.			$ 300		
1 job	Remove transfer line #110 from north wall to south side of bay. (~10 ft, 1/2" Sch 40 INOR-8 w/Calrod heaters and insulation attached) (40 md)				$ 4,000	41512
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL - NORTH BAY			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	55-gallon stainless steel drum.			$ 100		
1 ea.	Remove FV-109 w/heaters attached. (10 md)				$ 1,000	41512
1 ea.	55-gallon stainless steel drum.			$ 100		
1 job	Clean up remaining miscellaneous support clips, lines, cables, etc. (25 md)				$ 2,500	
10 ea.	55-gallon stainless steel drums.			$ 1,000		
1 job	Replace north shield plug support beam. (1 md)				$ 100	
1 job	Replace lower shield plugs in north bay. (10 md)				$ 1,000	
	NET MATERIAL AND LABOR			$12,000	$ 65,000	
	DRAIN-TANK CELL - NORTH BAY			CPFF: $77,000	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
9 ea.	Remove lower shield plugs from center bay. (10 md)				$ 1,000	40933
	8 each, 2' x 4' x 7'-1 1/2" long, 8,000 lbs, MK-3					
	1 each, 1'-6" x 4' x 7'-1 1/2" long, 6,100 lbs, MK-16					
1 job	Decontaminate lower plugs. (50 md)				$ 5,000	
1 job	Install work platform w/vent control panels. (10 md)				$ 1,000	
2 ea.	Remove pneumatic valves HCV-545 and -575. (10 md)				$ 1,000	41512 41513
1 ea.	55-gallon stainless steel drum.			$ 100		
2 ea.	Remove valve supports, HCV-545 and -575. (10 md)				$ 1,000	41877
1 ea.	55-gallon stainless steel drum.			$ 100		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
DRAIN-TANK CELL - CENTER BAY			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove miscellaneous auxiliary piping, thermo- (200 md)				$ 20,000	41512-13
	couple leads, heater leads, leak detector lines					
	and instrument air lines.					
	∿100 ft pipe, 1/2" to 1" Sch 40					
	∿27 flexible heater lead assemblies					40878
	∿200 ft air lines, 1/4" and 3/8" ODT					
	2 each steam dome jumper lines					
	∿100 ft leak detector tubing, 1/4" OD					55404, 55405, 55406
	∿500 ft mineral insulated cable from north bay					
	to junction boxes, 3/8" OD copper sheathed					
	∿2,000 ft mineral insulated thermocouple leads					
	from north bay to junction boxes, 1/4" OD					
	copper sheathed					
	22 each thermocouple junction boxes					40878
	27 each heater disconnects					
	∿20 ft, 4" x 4" cable trough					55478
	∿10 ft, 6" x 6" cable trough					
50 ea.	55-gallon stainless steel drums.			$5,000		
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
	DRAIN-TANK CELL - CENTER BAY					

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove FDT-2 steam dome. (20 md)				$ 2,000	40463, 40471, 40708
8 ea.	Remove FDT-2 heater units. (30 md)				$ 3,000	
20 ea.	55-gallon stainless steel drums.			$2,000		
1 ea.	Remove disconnect support ring from FDT-2. (10 md)				$ 1,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
1 ea.	Remove FDT-2 furnace lid. (20 md)				$ 2,000	51869
2 ea.	55-gallon stainless steel drums.			$ 200		
1 ea.	Remove FDT-2. (20 md)				$ 2,000	40457
2 ea.	Remove FDT-2 weigh cells. (10 md)				$ 1,000	
2 ea.	55-gallon stainless steel drums.			$ 200		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
DRAIN-TANK CELL - CENTER BAY			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove FDT-2 furnace. (50 md)				$ 5,000	
10 ea.	55-gallon stainless steel drums.			$1,000		
2 ea.	Remove FDT-2 supports. (20 md)				$ 2,000	
4 ea.	55-gallon stainless steel drums.			$ 400		
5 ea.	Remove heater spacers from Lines 103, 104 and 105 heaters. (10 md)				$ 1,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
10 ea.	Remove removable heater units from Lines 103, 104 and 105. (10 md)				$ 1,000	MIC-116 57490
10 ea.	55-gallon stainless steel drums.			$1,000		
2 ea.	Remove FV-104 and -105. (1 1/2" INOR-8) (10 md)				$ 1,000	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
DRAIN-TANK CELL - CENTER BAY			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	55-gallon stainless steel drums.			$ 200		
~20 ft	Remove uninsulated portion of Line 103 and Lines 104 and 105. (1 1/2"-40 INOR-8) (30 md)				$ 3,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
21 ea.	Remove heater base insulation units. (20 md)				$ 2,000	MIC-G-117
6 ea.	55-gallon stainless steel drums.			$ 600		
1 job	Remove heater base support structure. (40 md)				$ 4,000	
6 ea.	55-gallon stainless steel drums.			$ 600		
2 ea.	Remove freeze valves FV-108 and -109 w/heaters attached. (12 md)				$ 1,200	41512
2 ea.	55-gallon stainless steel drums.			$ 200		
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL - CENTER BAY			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
20 ft	Remove transfer lines 108, 109 and 110. (~20 ft, 1/2" Sch 40 INOR-8 w/Calrod heaters and insulation attached) (25 md)				$ 2,500	
4 ea.	55-gallon stainless steel drums.			$ 400		
20 ft	Remove resistance heated portion of Line 103 w/insulation and TC's attached. (20 ft, 1 1/2"-40 INOR-8 w/3" thick insulation) (25 md)				$ 2,500	
4 ea.	55-gallon stainless steel drums.			$ 400		
2 ea.	Remove Line 103 welding and brazing platforms. (40 md)				$ 4,000	41514
6 ea.	55-gallon stainless steel drums.			$ 600		
5 ea.	Remove drain line supports. (S-8, S-9, S-10, S-11 and S-13) (25 md)				$ 2,500	E-41505
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL

DRAIN-TANK CELL - CENTER BAY

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QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
5 ea.	55-gallon stainless steel drums.			$ 500		
1 job	Clean up miscellaneous support clips, lines, cables, etc. (25 md)				$ 2,500	
10 ea.	55-gallon stainless steel drums.			$1,000		
9 ea.	Replace lower shield plugs in center bay. (10 md)				$ 1,000	E-40933
	NET MATERIAL AND LABOR			$14,800	$ 75,200	
	DRAIN-TANK CELL - CENTER BAY			CPFF $90,000	FIXED PRICE	ORNL

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
10 ea.	Remove steel shield plates from lower plugs. (10 md)				$ 1,000	
10 ea.	Decontaminate steel plates. (10 md)				$ 1,000	
12 ea.	Remove lower roof plugs from south bay. (10 md)				$ 1,000	E-40933
	7 each, 2' x 4' x 5'-8 1/2" long, 6,200 lbs, MK-5					
	1 each, 2' x 4' x 5'-8 1/2" long, 6,200 lbs, MK-8					
	1 each, 2' x 4' x 5'-8 1/2" long, 6,200 lbs, MK-9					
	1 each, 2'-0" x 4' x 7'-1 3/4" long, 6,700 lbs, MK-10					
	1 each, 2'-0" x 4' x 3'-11 1/2" long, 4,400 lbs, MK-11					
	1 each, 2' x 4' x 5'-7 1/2" long, 5,000 lbs, MK-12					
12 ea.	Decontaminate lower shield plugs. (50 md)				$ 5,000	
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL - SOUTH BAY			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove south lower shield plug support beam. ((1 md)				$ 100	E-40944
	(8" x 2'-1 1/2" x 17'-5 1/2" long)					
1 ea.	Decontaminate support beam. (2 md)				$ 200	
	Remove space cooler w/support. (30 md)				3,000	E-56291
2 ea.	Remove HCV-546 and -577. (6 md)				$ 600	E-41512 E-41513
1 ea.	55-gallon stainless steel drum.			$ 100		
1 job	Remove HCV-546 and -577 support structures. (15 md)				$ 1,500	E-41877 E-56424
1 ea.	55-gallon stainless steel drum.			$ 100		
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL

DRAIN-TANK CELL - SOUTH BAY

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove miscellaneous auxiliary piping, thermo- (200 md)				$ 20,000	
	couple leads, heater leads, and instrument air					
	lines.					
	∿100 ft pipe, 1/2" to 1 1/2" Sch 40					
	20 each flexible heater lead assemblies					E-40878
	300 ft leak detector tubing, 1/4" OD x 0.083"					E-40878
	wall					
	14 each leak detector disconnects w/supports					E-55405
	20 each heater disconnects					
	10 each thermocouple junction boxes					
	20 ft, 6" x 6" cable trough					
	20 ft, 4" x 4" cable trough					
	500 ft mineral insulated cable from center bay					
	to junction boxes					
	∿2,500 ft thermocouple leads from center bay					
	to junction boxes, 1/4" OD copper sheathed					
	and 1/8" OD stainless steel sheathed					
50 ea.	55-gallon stainless steel drums.			$5,000		
	NET MATERIAL AND LABOR					
DRAIN-TANK CELL - SOUTH BAY				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
3 ea.	Remove heaters from Line 104. (10 md)				$ 1,000	
3 ea.	55-gallon stainless steel drums.			$ 300		
6 ft	Remove Line 104. (6 ft, 1 1/2" Sch 40 INOR-8) (10 md)				$ 1,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
5 ea.	Remove Line 104 heater base insulation units (B-104A, B, C, D-1 and D-2). (10 md)				$ 1,000	MIC-G-117 E-48758
2 ea.	55-gallon stainless steel drums.			$ 200		
1 job	Remove heater base support structure. (20 md)				$ 2,000	
2 ea.	55-gallon stainless steel drums.			$ 200		
7 ea.	Remove flush salt tank (FFT) heater units. (30 md)				$ 3,000	
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL - SOUTH BAY			CPFF	FIXED PRICE	ORNL

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
20 ea.	55-gallon stainless steel drums.				$2,000		
1 ea.	Remove flush salt tank furnace lid.	(20 md)				$ 2,000	
2 ea.	55-gallon stainless steel drums.				$ 200		
1 ea.	Remove flush salt tank (FFT).	(20 md)				$ 2,000	
2 ea.	Remove flush salt tank weigh cells.	(10 md)				$ 1,000	
2 ea.	55-gallon stainless steel drums.				$ 200		
1 ea.	Remove flush salt tank furance.	(75 md)				$ 7,500	
10 ea.	55-gallon stainless steel drums.				$1,000		
1 job	Remove flush salt tank supports.	(10 md)				$ 1,000	
4 ea.	55-gallon stainless steel drums.				$ 400		
	NET MATERIAL AND LABOR						
					CPFF	FIXED PRICE	ORNL
	DRAIN-TANK CELL - SOUTH BAY						

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove transfer line #107 from center bay to FFT. (~6 ft, 1/2" Sch 40 INOR-8 w/Calrod heaters and insulation attached) (20 md)				$ 2,000	
2 ea.	55-gallon stainless steel drums.			$ 200		
1 ea.	Remove freeze valve FV-107. (1 1/2" Sch 40 INOR-8) (6 md)				$ 600	
1 ea.	55-gallon stainless steel drum.			$ 100		
1 job	Remove resistance heater line 103 w/insulation and thermocouples attached. (~25 ft, 1 1/2" Sch 40 INOR-8 w/3" thick insulation) (30 md)				$ 3,000	E-41505 E-41506 E-41883
16 ea.	55-gallon stainless steel drums.			$1,600		
1 job	Remove Line 103 supports S-6 and S-7. (10 md)				$ 1,000	E-41505 E-41506
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL – SOUTH BAY			CPFF	FIXED PRICE	ORNL

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE WASTE	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference - Drawing
4 ea.	55-gallon stainless steel drums.			$ 400		
1 job	Remove resistance heating transformer. (10 md)				$ 1,000	E-56240 E-56241
	(15 KVA, 1'-6" x 2' x 2')					
1 ea.	55-gallon stainless steel drum.			$ 100		
1 job	Remove transformer support. (2' x 2' x 9' high) (10 md)				$ 1,000	E-56240 E-56241
2 ea.	55-gallon stainless steel drums.			$ 200		
2 ea.	Remove Line 103 welding and brazing platforms. (40 md)				$ 4,000	E-56240
6 ea.	55-gallon stainless steel drums.			$ 600		
1 job	Clean up remaining miscellaneous support clips, (25 md)				$ 2,500	
	lines, cables, etc.					
10 ea.	55-gallon stainless steel drums.			$1,000		
	NET MATERIAL AND LABOR			$14,000	$ 70,000	
DRAIN-TANK CELL - SOUTH BAY				CPFF	FIXED PRICE	ORNL
				$84,000		

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove lower roof plugs from north and center bays. (20 md)				$ 2,000	
1 job	Dewater the coil to ILW. (20 md)				$ 2,000	
1 job	Decontaminate inside of cell to allow limited personnel access. (100 md)				$ 10,000	
1 job	Erect work platforms for penetration assembly removal from east and south walls. (10 md)				$ 1,000	
1 job	Remove lines from penetration XXIV from reactor cell to DT cell. (1 1/2" INOR-8 drain line, 1 1/2" carbon steel air line, 2 each 1/2" stainless steel off-gas and vent lines) (20 md)				$ 2,000	E-56240 Page 48, Design Manual
3 ea.	55-gallon stainless steel drums.			$ 300		
1 job	Remove support structures from penetration XXIV. (10 md)				$ 1,000	E-41505 D-40713
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL - GENERAL			CPFF	FIXED PRICE	ORNL

UCN-1297 (3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	55-gallon stainless steel drums.			$ 200		
1 ea.	Decontaminate penetration XXIV from reactor cell. (10 md) (36" OD x $\sim$6' long)				$ 1,000	D-41413
12 ea.	Remove air, water and leak detector penetration (60 md) shield plugs at east wall. (6" diameter)				$ 6,000	D-40947 Page 52 of Design Manual
12 ea.	55-gallon stainless steel drums.			$ 1,200		
12 ea.	Decontaminate cell sleeves at above penetrations. (12 md)				$ 1,200	
327	Remove cables and lines from penetrations A, B, (50 md) C, D, E, and F; 3/4" pipe at east wall.				$ 5,000	D-40947
327	Decontaminate 3/4" penetrations A, B, C, D, E, (30 md) and F at east wall.				$ 3,000	D-40947
12 ea.	Cap penetrations thru south wall. (3/4" thru 3") (10 md)				$ 1,000	D-40947
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
	DRAIN-TANK CELL - GENERAL					

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove penetration shield plug thru north wall to fuel processing cell. (10" diameter) (20 md)				$ 2,000	D-40947
1 ea.	Decontaminate sleeve to fuel processing cell. (10 md)				$ 1,000	D-40947
1 job	Decontaminate entire drain tank cell to lowest practical level. (100 md)				$ 10,000	
1 job	Replace all lower shield plugs in drain tank cell. (20 md)				$ 2,000	
1 job	Replace lower shield plug steel shield plates. (10 md)				$ 1,000	
1 job	Replace all upper shield beams and holddown keys in drain tank cell. (30 md)				$ 3,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
	NET MATERIAL AND LABOR			$ 1,800	$ 54,200	

	CPFF	FIXED PRICE	ORNL
DRAIN-TANK CELL - GENERAL	$56,000		

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TOTAL $319,000

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove fuel process sampler.	(60 md)				$ 6,000	Job #10415
4 ea.	Remove sampler instrument panels.	(16 md)				$ 1,600	Job #10415
1 ea.	Remove absorber cubicle w/contents.	(30 md)				$ 3,000	55435 55452
4 ea.	55-gallon stainless steel drums.				$ 400		
6 ea.	Remove cell roof plugs to storage. (6 each various sizes)	(20 md)				$ 2,000	55431
1 ea.	Remove space cooler from roof plug P-6 and dispose.	(10 md)				$ 1,000	
1 job	Set up work platforms and "C" zone.	(10 md)				$ 1,000	
1 job	Cut, place into containers, and remove piping, valves, heater and thermocouple leads, disconnects, junction boxes, etc.	(200 md)				$ 20,000	
				NET MATERIAL AND LABOR			

FUEL-PROCESSING CELL	CPFF	FIXED PRICE	ORNL

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
50 ea.	55-gallon stainless steel drums.			$5,000		
1 ea.	Remove fuel storage tank. (50" OD x 116" high w/heaters and insulation) (30 md)				$ 3,000	40430
1 ea.	Remove caustic scrubber. (3'-6" OD x 7'-0" tall w/heaters and insulation) (20 md)				$ 2,000	55441
1 job	Remove sodium fluoride trap shielding. (~3' x 3' x 4" thick lead) (10 md)				$ 1,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
1 ea.	Remove sodium fluoride trap. (1'-8" diam x 1'-10" tall) (20 md)				$ 2,000	55446
1 ea.	55-gallon stainless steel drum.			$ 100		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
FUEL-PROCESSING CELL			

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove salt line filter assembly. (6" pipe x 8'-0" long) (20 md)				$ 2,000	49036
1 job	Remove miscellaneous small gas system components. (50 md) (F_2 reactor, cold trap, F_2 preheater, SO_2 preheater)				$ 5,000	55442 55443 55444 55445
6 ea.	55-gallon stainless steel drums.			$ 600		
1 ea.	Remove HF trap. (30 md)				$ 3,000	55443
2 ea.	55-gallon stainless steel drums.			$ 200		
1 ea.	Remove NAF absorber. (30 md)				$ 3,000	55447
1 ea.	55-gallon stainless steel drum.			$ 100		
1 job	Remove remaining miscellaneous supports, service lines, electrical trays, etc. (100 md)				$ 10,000	
	NET MATERIAL AND LABOR					
FUEL-PROCESSING CELL				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
25 ea.	55-gallon stainless steel drums.			$2,500		
1 job	Decontaminate interior of cell. (50 md)				$ 5,000	
1 ea.	Remove salt line penetration assembly to drain tank cell. (30 md)				$ 3,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
1 job	Decontaminate salt line penetration sleeve to DT cell. (10 md)				$ 1,000	
1 job	Remove salt addition and transfer lines from east wall. (10 md)				$ 1,000	
1 ea.	55-gallon stainless steel drum.			$ 100		
1 job	Decontaminate salt line penetration sleeve through east wall. (10 md)				$ 1,000	
	NET MATERIAL AND LABOR					
	FUEL-PROCESSING CELL			CPFF	FIXED PRICE	ORNL

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove distillation experiment from spare cell. (100 md)				$ 10,000	
20 ea.	55-gallon stainless steel drums.			$2,000		
1 job	Remove filters, iodine trap, duct, and dampers (50 md) from spare cell.				$ 5,000	
10 ea.	55-gallon stainless steel drums.			$1,000		
	NET MATERIAL AND LABOR			$12,200	$ 91,600	
	FUEL-PROCESSING CELL			CPFF	FIXED PRICE	ORNL
				$103,800		

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove ventilation house roof. (20 md)				$ 2,000	
1 job	Remove all equipment above floor level (off-gas sampler instrument panels, piping valves, etc.) (100 md)				$ 10,000	E-56252 E-56253
10 ea.	55-gallon stainless steel drums.			$1,000		
1 job	Remove floor grating and dry stacked lead and concrete shielding blocks from room. (~75 yd^3, 2" x 4" x 8" lead brick and 6" x 8" x 12" concrete blocks) (100 md)				$ 10,000	E-40755
1 ea.	Remove off-gas valve box with contents. (50 md)				$ 5,000	E-40771
1 ea.	Remove charcoal bed valve box w/contents. (50 md)				$ 5,000	E-40519 E-41852 E-48783
1 ea.	Remove off-gas particle trap assembly. (30 md)				$ 3,000	E-48792
	NET MATERIAL AND LABOR					

VENTILATION HOUSE AREA

CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	55-gallon stainless steel drums.			$ 200		
1 ea.	Remove off-gas sampler assembly. (50 md)				$ 5,000	E-40798
1 job	Remove all piping supports, etc., from ventilation house thru pipe chase to coolant drain cell. (100 md)				$ 10,000	E-56252 E-56253
1 job	Remove all miscellaneous auxiliary systems support structures, etc., to burial ground. (30 md)				$ 3,000	
10 ea.	55-gallon stainless steel drums.			$ 1,000		
1 job	Decontaminate ventilation house. (30 md)				$ 3,000	
2 ea.	Remove roof plugs from charcoal absorber pit. (10 md) (2 each, 10' OD x 1'-6" thick)				$ 1,000	E-41519
1 job	Remove piping from charcoal absorbers; seal ends. (30 md)				$ 3,000	E-41519
	NET MATERIAL AND LABOR					
	VENTILATION HOUSE AREA			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Drain water from absorber pit. (10 md)				$ 1,000	
5 ea.	Remove absorbers; 1-A, 1-B, 2-A, 2-B, and 3-A. (50 md)				$ 5,000	E-41519
5 ea.	Remove absorber support structure. (30 md)				$ 3,000	E-41519
5 ea.	55-gallon stainless steel drums.			$ 500		
1 job	Remove remaining piping and TC leads from charcoal absorber pit and penetration from ventilation house. (30 md)				$ 3,000	E-41519
2 ea.	55-gallon stainless steel drums.			$ 200		
1 job	Clean and decontaminate charcoal absorber pit. (~8' OD x 25' deep) (20 md)				$ 2,000	
2 ea.	Replace charcoal absorber pit roof plugs. (10' OD x 1'-6" thick) (10 md)				$ 1,000	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
VENTILATION HOUSE AREA			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Replace ventilation house roof. (20 md)				$ 2,000	
	NET MATERIAL AND LABOR			$ 2,900	$ 77,000	

VENTILATION HOUSE AREA	CPFF	FIXED PRICE	ORNL
	$79,900		

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QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
20 ea.	Remove special equipment room roof plugs. (20 md)				$ 2,000	
2 ea.	Segment and remove component cooling air enclosures. (5' OD x 10' high carbon steel) (100 md)				$ 10,000	E-55412 E-55413 E-55414 E-41472
20 ea.	55-gallon stainless steel drums.			$2,000		
2 ea.	Remove component cooling air blower motors. (75 HP electric) (30 md)				$ 3,000	E-41472
2 ea.	Remove component cooling air blowers. (10 x 15 Roots type) (30 md)				$ 3,000	E-41472
1 job	Segment and remove blower and motor support structures. (20 md)				$ 2,000	E-41472
4 ea.	55-gallon stainless steel drums.			$ 400		
1 ea.	Remove component cooling air heat exchanger. (30 md)				$ 3,000	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
SPECIAL EQUIPMENT ROOM			

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIALS	UNIT COSTS		MATERIAL	LABOR	Reference Drawing
		MAT'L	LABOR			
25 ft	Segment and package cell exhaust line in special (200 md)				$ 20,000	E-41026
	equipment room. (30" OD x 0.312 wall carbon steel)					
10 ea.	55-gallon stainless steel drums.			$1,000		
2 ea.	Remove pump bowl bubbler containment enclosures. (50 md)				$ 5,000	E-55423
	(24" OD x 36" long flanged heads, stainless steel)					
2 ea.	55-gallon stainless steel drums.			$ 200		
1 job	Remove miscellaneous auxiliary piping, valves, (100 md)				$ 10,000	E-55412 E-55413 E-55414
	and instruments (air, water oil, cover gas,					
	etc.).					
25 ea.	55-gallon stainless steel drums.			$2,500		
1 job	Remove electrical cables and cable trays. (50 md)				$ 5,000	E-55412 E-55413 E-55414
	NET MATERIAL AND LABOR					
SPECIAL EQUIPMENT ROOM				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Demolish concrete wall, excavate and remove 30" cell exhaust line from special equipment room to service tunnel.	(200 md)				$ 20,000	E-41026
25 ft	Segment and package 30" cell exhaust line from special equipment room to service tunnel. (30" OD x 0.312 wall carbon steel)	(200 md)				$ 2,000	E-41026
10 ea.	55-gallon stainless steel drums.				$ 1,000		
1 job	Repair cell walls. (5 yd^3 concrete)	(50 md)				$ 5,000	E-41026
1 job	Clean and decontaminate special equipment room.	(50 md)				$ 5,000	
20 ea.	Replace special equipment room roof plugs.	(20 md)				$ 2,000	
				NET MATERIAL AND LABOR	$ 7,100	$115,000	
	SPECIAL EQUIPMENT ROOM				CPFF	FIXED PRICE	ORNL
					$122,100		

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
21 ea.	Remove coolant cell penthouse roof plugs. (20 md)				$ 2,000	E-40979
	(1'-0" x 2'-0" x 18' long)					
1 ea.	Remove coolant salt sampler assembly. (20 md)				$ 2,000	M-10333-RF-001-E
1 ea.	Remove radiator door lifting mechanism. (30 md)				$ 3,000	D-40450 D-40451 D-40452
1 job	Remove coolant pump auxiliary piping. (15 md)				$ 1,500	
1 job	Remove radiator top insulation. (30 md)				$ 3,000	D-40440 E-40470 E-40471 E-40472 E-40473 E-40746
1 job	Remove radiator doors. (20 md)				$ 2,000	E-55510
1 job	Remove radiator door lifting and coolant pump support structures. (30 md)				$ 3,000	E-41515 E-41866
1 job	Remove radiator and enclosure assembly. (100 md)				$ 10,000	E-40470
	NET MATERIAL AND LABOR					
	COOLANT CELL AREA			CPFF	FIXED PRICE	ORNL

UCN-1297 (3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove radiator supports and radiator door tracks. (50 md)				$ 5,000	E-55516
1 job	Remove coolant salt drain lines. (20 md)				$ 2,000	E-40702 E-41860 E-41861 E-41862
1 ea.	Remove coolant salt drain tank. (50 md)				$ 5,000	E-40702
~32,500 lbs	Remove lead shielding from off-gas pipe chase. (100 md)				$ 10,000	E-41893
	(44' x 9" OD x 1" ID = 19.2 ft^3 + ~40' lead brick					
	2" thick = 26.7 ft^3)					
44 ft	Segment and remove off-gas lines. (1 each (20 md)				$ 2,000	
	1/4" ODT in 1/2" pipe; 1 each 1/2" pipe in 1"					
	pipe)					
1 ea.	55-gallon stainless steel drum.			$ 100		
5 ea.	Remove off-gas line supports. (10 md)				$ 1,000	E-41892
	NET MATERIAL AND LABOR					
	COOLANT CELL AREA			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
~60 ft	Segement and remove reactor cell exhaust line. (400 md)				$ 40,000	
	(30" OD x 0.312 wall carbon steel)					
25 ea.	55-gallon stainless steel drums.			$2,500		
1 job	Remove miscellaneous auxiliary lines from (100 md)				$ 10,000	E-41893
	coolant cell area (water, oil, gas, off-gas,					
	etc.)					
20 ea.	55-gallon stainless steel drums.			$2,000		
1 job	Clean and decontaminate coolant cell area. (100 md)				$ 10,000	
	NET MATERIAL AND LABOR			$4,600	$111,500	
				CPFF	FIXED PRICE	ORNL
	COOLANT CELL AREA			$116,100		

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
100 ft	Remove lube oil and water piping from reactor cell to service tunnel penetration. (20 md)				$ 2,000	E-40735
100 ft	Remove lube oil and water piping from special equipment room to service tunnel penetration. (20 md)				$ 2,000	E-55411 E-55414
2 ea.	Remove reactor cell exhaust line valves. (30" butterfly w/operators) (30 md)				$ 3,000	D-41026
75 yd^3	Machine excavate w/shoring 30" exhaust line from special equipment room to service tunnel (~20' deep). (100 md)			$3,000	$ 10,000	D-41026 D-41027 D-41028
2 yd^3	Demolish reinforced concrete service tunnel wall at 30" exhaust line penetration. (10 md)				$ 1,000	D-41028
18 ft	Segment and remove 30" exhaust line from special equipment room to service tunnel. (30" OD x 0.312 wall carbon steel) (200 md)				$ 20,000	D-41027
	NET MATERIAL AND LABOR					

SOUTH YARD	CPFF	FIXED PRICE	ORNL

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
8 ea.	55-gallon stainless steel drums.			$ 800		
75 yd^3	Machine excavate w/shoring 30" exhaust line from service tunnel to stack filter (~20' deep). (100 md)			$3,000	$ 10,000	D-41028
1 yd^3	Demolish reinforced concrete wall of service tunnel at 30" line penetration. (5 md)				$ 500	D-41027 D-41028
50 ft	Segment and remove 30" exhaust line from service tunnel to stack filters. (30" OD x 0.312 wall carbon steel) (500 md)				$ 50,000	D-41028
20 ea.	55-gallon stainless steel drums.			$2,000		
1 job	Check and remove all contaminated soil from excavated area. (50 md)				$ 5,000	
	NET MATERIAL AND LABOR					
SOUTH YARD				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Form and pour concrete at special equipment room					D-41026 D-41028
	wall, and two walls of service tunnel.					
	Labor (20 md)				$ 2,000	
	Material: 3 yds^3 concrete form material			$ 500		
150 yd^3	Backfill excavation from tunnel area (10 md)			$1,500	$ 1,000	
	w/stabilized fill to existing grade level.					
1 job	Remove and decontaminate inlet manifold to stack (50 md)				$ 5,000	D-41071 D-41072
	filter bays.					
3 ea.	Remove and decontaminate stack filter inlet (20 md)				$ 2,000	D-41071 D-41072
	dampers. (24" x 18")					
31 ea.	Remove and decontaminate stack filter pit roof (50 md)				$ 5,000	D-41117
	plugs.					
105 ea.	Remove prefilters, decontaminate frames and (50 md)				$ 5,000	D-41075
	replace filter media.					
	NET MATERIAL AND LABOR					
	SOUTH YARD			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
6 ea.	Remove final filters, decontaminate frames and replace filters. (50 md)				$ 5,000	D-41076
1 job	Decontaminate interior of filter pit. Flush solutions to the Laboratory ILW system thru existing drain lines. (30 md)				$ 3,000	D-41117 D-41273
6 ea.	Replace final filters. (30 md)			$2,000 (UCC-ND)	$ 3,000	D-41076
105 ea.	Replace prefilters. (50 md)			$2,000 (UCC-ND)	$ 5,000	D-41075
31 ea.	Replace and seal filter pit roof plugs. (30 md)			$ 500	$ 3,000	D-41117
3 ea.	Replace filter inlet dampers. (20 md)				$ 2,000	D-41071
1 ea.	Replace filter inlet manifold. (30 md)				$ 3,000	D-41072
	NET MATERIAL AND LABOR					
	SOUTH YARD			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Design, fabricate and install blanking fixture					D-41028 D-41071 D-41072
	where cell exhaust line was removed.					
	Design (10 md)				$ 1,800 (UCC-ND)	
	Fabrication (20 md)			$ 500 (UCC-ND)	3,200 (UCC-ND)	
	Installation (20 md)				2,000	
	G&A on material: 4,500 x 0.35			$1,600		
	UCC-ND Subtotals			$6,100	$ 5,000	
	NET MATERIAL AND LABOR			$11,300	$149,500	
SOUTH YARD				CPFF $160,800	FIXED PRICE	ORNL $11,100

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(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	Remove treated water storage tanks. (10 md)				$ 1,000	D-41252
2 ea.	Remove treated water pumps (20 hp). (20 md)				$ 2,000	D-41252
1 lot	Remove piping, valves, instruments, etc., from (50 md)				$ 5,000	D-41252
	water room.					
1 lot	Remove piping and valves from radiator tunnel. (30 md)				$ 3,000	D-41252
1 job	Remove thermal shield gas separation system from (30 md)				$ 3,000	
	fan house.					
100 yd^3	Machine excavate underground 4" and 6" lines to (20 md)				$ 2,000	
	diesel shed.					
∿250 ft	Remove 4" and 6" lines from water room to diesel (20 md)				$ 2,000	D-41254
	shed.					
1 ea.	Remove treated water filter from diesel shed. (10 md)				$ 1,000	D-41254
	NET MATERIAL AND LABOR					

TREATED-WATER SYSTEM	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	Remove treated water heat exchangers from diesel shed. (30 md)				$ 3,000	D-41254
~150 ft	Remove piping and valves from diesel shed. (4" and 6" carbon steel) (30 md)				$ 3,000	D-41254
2 ea.	Remove steam dome heat exchangers from west tunnel. (20 md)				$ 2,000	
2 ea.	Remove steam dome surge tanks from west tunnel. (20 md)				$ 2,000	
1 lot	Remove piping and valves from west tunnel. (30 md)				$ 3,000	
1 job	Decontaminate west tunnel. (30 md)				$ 3,000	
1 job	Decontaminate water room. (30 md)				$ 3,000	
1 job	Decontaminate diesel shed. (10 md)				$ 1,000	
	NET MATERIAL AND LABOR					

TREATED-WATER SYSTEM	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
100 yd^3	Backfill west yard between water room and diesel shed to existing grade. (5 md)			$1,000	$ 500	
	NET MATERIAL AND LABOR			$1,000	$ 39,500	

TREATED-WATER SYSTEM	CPFF	FIXED PRICE	ORNL
	$40,500		

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Disconnect and remove distillation experiment valve box.	(25 md)				$ 2,500	
1 job	Remove roof plugs and set up temporary work shielding.	(50 md)				$ 5,000	
1 job	Remotely disconnect all lines from distillation experiment.	(30 md)				$ 3,000	
1 ea.	Remove distillation experiment assembly to transport-storage shield.	(200 md)				$ 20,000	
1 job	Remove temporary work shielding. Install ladders.	(50 md)				$ 5,000	
2 ea.	Remove fuel process system charcoal traps.	(10 md)				$ 1,000	49026 E-55454
1 ea.	Remove fuel process ventilation filters.	(20 md)				$ 2,000	E-55454
	NET MATERIAL AND LABOR						
	SPARE CELL AREA				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	REMOVAL OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove fuel process soda lime trap. (20 md)				$ 2,000	E-55454
1 lot	Remove miscellaneous piping, supports, etc. (50 md)				$ 5,000	E-55454 E-55456
~200	Remove dry stacked block from west wall. (25 md)				$ 2,500	
1 job	Decontaminate cell. (30 md)				$ 3,000	
1 job	Replace roof plugs (10 md)				$ 1,000	
	NET MATERIAL AND LABOR				$ 52,000	

	CPFF	FIXED PRICE	ORNL
SPARE CELL AREA	$52,000		

UCN-1297
(3 7-72)

APPENDIX B

JOB LISTING FOR

DECOMMISSIONING THE MSRE BY ENTOMBMENT

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Design and fabricate flushing system unit with ∿50 gpm flow and ∿500 gallons storage of decontamination solution with connections for discharging solution to the ORNL ILW system. Unit to be portable and shielded for use at various areas in the reactor, drain tank, and fuel processing cell.					
	Design (100 md)				$ 18,300	
	Material			$10,000		
	Fabrication (100 md)				15,600	
6 jobs	Connect and flush various sections of the system and tanks.					
	6 ea. @ 50 md (300 md)				$ 46,800	
	G&A on materials: 10,000 x 0.35			$ 3,500		
				$13,500	$ 80,700	
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
	PREPARATORY WORK - FLUSHING					$ 94,200

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS		MATERIAL	LABOR	Reference Drawing
		MAT'L	LABOR			
1 job	Design, fabricate and install a temporary cell ventilation					
	duct and shielded filter box from the top of the reactor					
	cell to existing duct work at the east side of the high					
	bay.					
	Design (70 md)				$ 12,800	
	Materials			$10,000		
	Fabrication & Installation (75 md)				7,500	
1 job	Design, fabricate and install a temporary cell ventilation					
	duct and shielded filter box from the top of the drain					
	tank cell to existing duct work at the east side of the					
	high bay.					
	Design (70 md)				$ 12,800	
	Materials			$10,500		
	Fabrication & Installation (75 md)				7,500	
	NET MATERIAL AND LABOR			$20,000	$ 15,000	
	PREPARATORY WORK - CELL VENTILATION			CPFF	FIXED PRICE	ORNL
				$35,000		$ 25,600

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Design, fabricate and install a work platform to fit the top of the reactor cell. The platform is to have removable deck sections for access to all work areas of the cell; contain tool securing devices; and lighting and other visual aids necessary for remote work.					
	Design (100 md)				$ 18,300 (ORNL)	
	Materials			$10,000		
	Fabrication & Installation (200 md)				20,000	
1 ea.	Design, fabricate and install a work platform to fit the top of the drain tank cell. The platform is to have removable deck sections for access to all areas of the cell; contain tool handling and securing devices; and lighting and other visual aids necessary for remote work.					
	Design (100 md)				$ 18,300 (ORNL)	
	Materials			$10,000		
	Fabrication & Installation (200 md)				20,000	
	NET MATERIAL AND LABOR			$20,000	$ 40,000	
				CPFF	FIXED PRICE	ORNL
	PREPARATORY WORK - WORK PLATFORMS			$60,000		$ 36,600

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 lot	Contamination control equipment:					
	Hoses for flushing tools and items.			$ 200		
	Pumps for removing wash water from cell.			1,000		
	Miscellaneous plastic sheeting, blotter paper, tape, etc.			5,000		
	G&A on materials: 6,200 x 0.35			$ 700		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
PREPARATORY WORK - MISCELLANEOUS MATERIAL			$ 6,900

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Pipe cutter, abrasive, for horizontal 5" INOR-8 pipe.					
	Design (50 md)				$ 9,200	
	Fabrication Labor (50 md)				7,800	
	Materials			$ 2,500		
	Mockup & Development (50 md)			500	7,800	
1 ea.	Pipe cutter, abrasive, for vertical 5" INOR-8 pipe.					
	Design (50 md)				$ 9,200	
	Fabrication (50 md)				7,800	
	Materials			$ 2,500		
	Mockup & Development (50 md)			500	7,800	
1 ea.	Pipe cutters, hydraulic, for vertical or horizontal 1/2"					
	thru 2" carbon steel, stainless steel and INOR-8 pipe					
	(commercial hydraulic shears).					
	Design (50 md)				$ 9,200	
	Fabrication (30 md)				4,700	
	Material			$ 2,500		
	Mockup & Development (50 md)			500	7,800	
	NET MATERIAL AND LABOR					

TOOLING	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	Cutters, hydraulic, for miscellaneous 1/4" to 1/2" tubing,					
	MI cable, electrical leads, etc. (commercial hydraulic					
	units).					
	Design (50 md)				$ 9,200	
	Fabrication (30 md)				4,700	
	Material @ $500 each			$ 1,000		
	Mockup & Development (50 md)			500	7,800	
2 ea.	Snips, manual, for cutting thermocouple leads, electrical					
	leads, etc.					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material			$ 500		
	Mockup & Development (10 md)			100	1,600	
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
TOOLING						

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	Cutters, torch, acetylene, for cutting horizontal carbon					
	steel support structures.					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material @ $500 each			$ 1,000		
	Mockup & Development (50 md)			500	7,800	
2 ea.	Cutters, torch, acetylene for cutting vertical carbon					
	steel support structures.					
	Design (30 md)				$ 5,500	
	Fabrication (30 md)				4,700	
	Material @ $500 each			$ 1,000		
	Mockup & Development (50 md)			500	7,800	
1 ea.	Tool, lifting, for handling fuel pump motor.					
	Design (existing)					
	Fabrication (30 md)				$ 4,700	
	Material			$ 500		
	NET MATERIAL AND LABOR					
	TOOLING			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Tool, lifting, for removal of fuel pump rotary element.					
	Design (existing)					
	Fabrication (30 md)				$ 4,700	
	Material			$ 500		
1 ea.	Tool, lifting, for handling fuel pump bowl.					
	Design (existing)					E-56336
	Fabrication (50 md)				$ 7,800	
	Material			$ 1,000		
1 ea.	Tool, lifting, for handling fuel heat exchanger.					
	Design (existing)					E-56340
	Fabrication (75 md)				$ 11,700	
	Material			$ 1,500		
1 ea.	Tool, lifting, for removal of drain tank steam domes.					
	Design (existing)					D-56339
	Fabrication (30 md)				$ 4,700	
	Material			$ 500		
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
	TOOLING					

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Tool, lifting, for removal of fuel drain tanks.					
	Design (existing)					D-56338
	Fabrication (50 md)				$ 7,800	
	Material			$ 1,000		
2 ea.	Tool, lifting, for removal of heater units.					
	Design (existing)					
	Fabrication (30 md)				$ 4,700	
	Material			$ 500		
1 ea.	Tool, lifting, for removal of cell coolers.					
	Design (existing)					
	Fabrication (20 md)				$ 3,100	
	Material			$ 1,000		
1 ea.	Tool, lifting, for removal of fuel storage tank.					
	Design (30 md)				$ 5,500	
	Fabrication (50 md)				7,800	
	Material			$ 1,000		
	NET MATERIAL AND LABOR					

TOOLING	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
3 ea.	Tool, lifting and handling, various lengths, for removal					
	of segments of large piping (3" to 6").					
	Design (50 md)				$ 9,200	
	Fabrication (25 md)				3,900	
	Material			$ 500		
3 ea.	Tool, lifting and handling, various lengths, for removal					
	of segments of small piping (1/4" to 2").					
	Design (50 md)				$ 9,200	
	Fabrication (25 md)				3,900	
	Material			$ 500		
3 ea.	Tool, lifting and handling, various lengths, for removal					
	of segments of structural components.					
	Design (50 md)				$ 9,200	
	Fabrication (25 md)				3,900	
	Material			$ 500		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
TOOLING			

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Tool, lifting, for removal of NaF absorber.					
	Design (20 md)				$ 3,700	
	Fabrication (20 md)				3,100	
	Material			$ 200		
1 lot	Long handled hooks, tongs, socket wrench extensions,					
	chisels, punches, saws, drills, hammers, etc., designed					
	for general and special applications (∿100 tools).					
	Design (300 md)				$ 55,000	
	Fabrication (300 md)				46,800	
	Material			$ 5,000		
1 lot	Miscellaneous visual aids; i.e., lights, binoculars,			$10,000		
	periscopes, etc.					
	NET MATERIAL AND LABOR					

TOOLING	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
6 ea.	Drums, 55-gallon w/bails and dumping levers, for transferring material from all areas to reactor cell.					
	Design (20 md)				$ 3,700	
	Fabrication (30 md)				4,700	
	Material @ $150 each			$ 900		
1 lot	Miscellaneous concrete pouring and compacting equipment; i.e., buckets, vibrators, chutes, etc.			$ 5,000		
	G&A on materials: 44,200 x 0.35			$15,500		
	NET MATERIAL AND LABOR			$59,700	$359,600	
				CPFF	FIXED PRICE	ORNL
	TOOLING					$419,300

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
50 ea.	Remove top shield beam holddown nuts and studs.	(20 md)				$ 2,000	D-40955
	(2-1/4" OD x 4'-0" long)						
15 ea.	Remove top beams to outside storage.	(30 md)				$ 3,000	D-40951
	2 each 2'-0" x 3'-6" x 15'-0" long						
	2 each 2'-0" x 3'-6" x 20'-4" long						
	2 each 2'-0" x 3'-6" x 24'-0" long						
	2 each 2'-0" x 3'-6" x 26'-6" long						
	7 each 2'-0" x 3'-6" x 30'-0" long						
1 ea.	Remove seal membrane; section and package for	(40 md)				$ 4,000	D-40972 D-40973 D-40974
	disposal into cell. (24'-6" OD x 1/8" thick						
	stainless steel)						
28 ea.	Remove lower roof plugs steel crack fillers.	(20 md)				$ 2,000	D-40954
1 job	Remove reactor access lower plug and set up dry	(10 md)				$ 1,000	D-40954
	maintenance shield over core vessel.						
	NET MATERIAL AND LABOR						
	REACTOR CELL				CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove core access flange and source tube plugs (10 md)				$ 1,000	E-40954
	from thermal shield lid.					
1 job	Pump grout into core, filling to core access					E-40400
	flange elevation.					
	Labor (20 md)				$ 2,000	
	Material: 2 yd^3 grout			$ 100		
1 job	Pump grout through existing penetrations through					E-40727 E-40730
	thermal shield lid filling the annulus between					
	the core vessel and thermal shield.					
	Labor (30 md)				$ 3,000	
	Material: 15 yd^3 grout			$ 700		
1 job	Remove roof plugs and set up maintenance shield (10 md)				$ 1,000	D-40951
	over the primary heat exchanger.					
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL
	REACTOR CELL					

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Cut opening and fill heat exchanger shell with grout.					D-40873
	Labor (20 md)				$ 2,000	
	Material: 2 yd^3 grout			$ 100		
1 job	Cut heat exchanger loose and lower to floor of cell. (4 cuts of 5" INOR-8 pipe and support structures) (50 md)				$ 5,000	D-40873
1 job	Collapse all support structures and auxiliary equipment in the heat exchanger area to the cell floor. (200 md)				$ 20,000	~~E-40700~~ E-40704
1 job	Set up maintenance shield over the fuel circulating pump. (10 md)				$ 1,000	D-40951
1 job	Remove fuel pump motor and rotary element and lower to cell floor. (50 md)				$ 5,000	F-9700
	NET MATERIAL AND LABOR					

REACTOR CELL	CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Pump fuel pump bowl full of grout.					F-9700
	Labor (20 md)				$ 2,000	
	Material: 1 yd^3 grout			$ 100		
1 job	Cut fuel pump bowl loose and lower to cell floor. (100 md)				$ 10,000	F-9700
1 job	Connect existing nozzle on fuel pump overflow tank and pump full of grout.					E-56418
	Labor (30 md)				$ 3,000	
	Material: 1 yd^3 grout			$ 100		
1 job	Remove fuel pump furnace and lower to floor of cell. (50 md)				$ 5,000	E-51604 E-51606
1 job	Collapse all support and auxiliary materials in the fuel pump area to the cell floor. (300 md)				$ 30,000	E-40700 E-40704
	NET MATERIAL AND LABOR					
REACTOR CELL				CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Collapse all support and auxiliary equipment at area east of thermal shield. (200 md)				$ 20,000	E-40700 E-40704
1 job	Collapse all support and auxiliary equipment at area west of thermal shield. (200 md)				$ 20,000	E-40700 E-40704
1 job	Flush cell walls and thermal shield to bottom of cell. (10 md)				$ 1,000	
1 job	Cut and remove section of cell exhaust line in coolant cell at cell penetration to reactor cell. Transfer removed section to reactor cell. (30 md)				$ 3,000	D-41026
1 job	Fabricate and install blanking flange w/nozzle onto 30" cell exhaust penetration.					
	Labor (30 md)				$ 3,000	
	Material			$ 500		
	NET MATERIAL AND LABOR					
	REACTOR CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Attach hose and pump 30" cell exhaust penetration full of grout.					
	Labor (20 md)				$ 2,000	
	Material: 5 yd^3 grout			$ 300		
1 job	Clear entrance to penetration from reactor cell to drain tank cell. Remotely install blanking fixture at reactor cell opening. (200 md)				$ 20,000	
1 job	Pour concrete into cell to an elevation of ~6 ft above equipment support platform.					
	Labor (30 md)				$ 3,000	
	Material: 50 yd^3 concrete			$ 2,000		
1 ea.	Remove component cooling air heat exchanger from special equipment room. Fill shell with grout and transfer to reactor cell.					E-41472
	Labor (25 md)				$ 2,500	
	Material: 1 yd^3 grout			$ 100		
	NET MATERIAL AND LABOR					
	REACTOR CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Fabricate and install flange w/grout nozzle onto					E-41472
	component cooling air penetration. Pump penetra-					
	tion full of grout.					
	Labor (30 md)				$ 3,000	
	Material: 1 yd^3 grout			$ 100		
	Other			500		
						E-55428
∿20 ea.	Cut auxiliary lines penetrating south wall of					E-56377
	cell, pump full of grout and cap off. (water,					
	air, gas, etc., 1/4" to 3" size)					
	Labor (50 md)				$ 5,000	
	Material: 2 yd^3 grout			$ 100		
	Other			500		
1 job	Pump interior compartments of sampler enricher					EJN-10301
	full of grout through existing nozzles.					
	Labor (20 md)				$ 2,000	
	Materials: 2 yd^3 grout			$ 100		
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
REACTOR CELL			

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove sampler-enricher assembly to reactor cell. (50 md)				$ 5,000	EJN-10301
1 job	Remove sampler-enricher floor flange and cell (20 md)				$ 2,000	E-55479
	penetration to reactor cell.					
1 job	Cut auxiliary lines penetrating north wall at the					E-41863
	north electric service room area and pump lines					
	full of grout and seal ends.					
	Labor (100 md)				$ 10,000	
	Material: 5 yd^3 grout			$ 300		
	Other			500		
1 job	Cut auxiliary lines penetrating the west wall at					
	the west tunnel area and pump lines full of grout					
	and seal ends.					
	Labor (50 md)				$ 5,000	
	Material: 1 yd^3 grout			$ 100		
	Other			500		
	NET MATERIAL AND LABOR					
REACTOR CELL				CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
	Continue pouring and vibra-packing concrete into					
	cell as other items from drain tank cell and fuel					
	processing cell are moved in. Pour to bottom					
	elevation of lower roof plugs.					
	Labor (300 md)				$ 30,000	
	Material: ∿250 yd^3 concrete			$10,000		
1 job	Cut access door(s) into cell annulus from (500 md)				$ 50,000	
	coolant drain tank cell. Remove magnetite sand					
	from annulus to burial ground. (∿400 yd^3 sand;					
	hand load and machine convey out of coolant					
	drain cell)					
1 job	Core drill through annulus ring at top of cell,			$ 6,000	$ 6,000	E-40974
	4 places 12" diameter. Seal openings at coolant					
	drain cell and fill annulus with concrete.					
	(∿400 yd^3 concrete)					
	NET MATERIAL AND LABOR					
	REACTOR CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Replace all lower roof shield plugs over cell and					E-40951
	grout in place. Finish floor smooth to existing					
	high bay elevation.					
	Labor (50 md)				$ 5,000	
	Material: 10 yd^3 grout			$ 500		
	NET MATERIAL AND LABOR			$23,200	$299,500	
REACTOR CELL				CPFF	FIXED PRICE	ORNL
				$322,700		

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
82 ea.	Remove steel holddown keys from upper shield plugs. (5 md)				$ 500	E-40946
10 ea.	Remove upper shield plugs. (25 md)				$ 2,500	E-40933 E-40946
10 ea.	Decontaminate upper shield plugs and store for future use. (50 md)				$ 5,000	
1 ea.	Remove seal membrane from cell, section and transfer to reactor cell. (20 md)				$ 2,000	E-40933
28 ea.	Remove steel shield plates from between lower plugs. (10 md)				$ 1,000	E-40939
28 ea.	Decontaminate shield plates for future use. (10 md)				$ 1,000	
12 ea.	Remove lower roof plugs from north bay. (10 md)				$ 1,000	E-40933 E-40946
12 ea.	Decontaminate plugs for future use. (50 md)				$ 5,000	
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove north shield plug support beam.	(1 md)				$ 100	E-40944
1 ea.	Decontaminate support beam for future use.	(2 md)				$ 200	
1 job	Install work platform w/vent control panels.	(10 md)				$ 1,000	
2 ea.	Remove pneumatic valves and transfer to reactor cell. (HCV-544 and -573)	(10 md)				$ 1,000	E-41512 E-41513
2 ea.	Remove valve supports.	(6 md)				$ 600	E-41877
1 job	Remove all miscellaneous auxiliary piping, thermocouple loads, heater leads, etc., from the north bay area to the reactor cell.	(200 md)				$ 20,000	E-40708 E-40709 E-40878 E-41512 E-41513 E-55404 E-55405 E-55406
1 ea.	Remove FDT-1 steam dome assembly to reactor cell.	(20 md)				$ 2,000	E-40463 E-40708 E-40731
5 ea.	Remove heaters from line 106 to reactor cell.	(5 md)				$ 500	E-57490 MIC-G-116
		NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
DRAIN-TANK CELL			

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove FV-106 (1-1/2" INOR-8) to reactor cell. (10 md)				$ 1,000	
∿15 ft	Remove line 106 to reactor cell. (1-1/2" INOR-8) (10 md)				$ 1,000	
8 ea.	Remove line 106 heater base insulation units to reactor cell. (10 md)				$ 1,000	MIC-G-117
1 job	Remove line 106 heater base support structure to reactor cell. (20 md)				$ 2,000	E-55504
7 ea.	Remove FDT-1 heaters to reactor cell. (30 md)				$ 3,000	E-51686
1 ea.	Remove disconnect support ring from FDT-1. (10 md)				$ 1,000	
1 ea.	Remove FDT-1 furnace lid to reactor cell. (20 md)				$ 2,000	E-51686
1 ea.	Remove FDT-1 to reactor cell. (20 md)				$ 2,000	
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Emplace FDT-1 in reactor cell and pump tank full of concrete.					
	Labor (20 md)				$ 2,000	
	Material: 3 yd^3 concrete			$ 200		
1 job	Replace steam dome into FDT-1 and fill steam dome with concrete.					
	Labor (20 md)				$ 2,000	
	Material: 1 yd^3 concrete					
2 ea.	Remove drain tank weigh cells to reactor cell. (10 md)				$ 1,000	E-41500
1 job	Segment and remove drain tank furnace to reactor cell. (50 md)				$ 5,000	E-51686
2 ea.	Remove drain tank supports to reactor cell. (20 md)				$ 2,000	E-41500
	NET MATERIAL AND LABOR					
				CPFF	FIXED PRICE	ORNL

DRAIN-TANK CELL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove transfer line #109 to reactor cell. (20 md)				$ 2,000	E-41512 E-41513
	(~15 ft, 1/2" Sch 40 INOR-8 w/Calrod heaters					
	and insulation attached)					
1 job	Remove transfer line #110 from FDT-1 to north (20 md)				$ 2,000	E-41512 E-41513
	wall. (~10 ft, 1/2" Sch 40 INOR-8 w/Calrod					
	heaters and insulation attached)					
1 ea.	Remove FV-109 to reactor cell. (10 md)				$ 1,000	E-55509
1 job	Clean up remaining miscellaneous support clips, (25 md)				$ 2,500	
	lines, cables, etc., and move to reactor cell.					
1 ea.	Replace north shield plug support beam. (1 md)				$ 100	
12 ea.	Replace lower shield plugs in north bay. (10 md)				$ 1,000	
9 ea.	Remove lower shield plugs from center bay. (10 md)				$ 1,000	E-40933
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
9 ea.	Decontaminate lower shield plugs for future use. (50 md)				$ 5,000	
1 job	Install work platform w/vent control panels. (10 md)				$ 1,000	
2 ea.	Remove pneumatic valves to reactor cell. (6 md) (HCV-545 and -575)				$ 600	E-41512 E-41513
2 ea.	Remove valve supports to reactor cell. (HCV-545 and -575) (10 md)				$ 1,000	E-41877
1 job	Remove miscellaneous auxiliary piping, thermocouple leads, heater leads, leak detector lines, instrument lines, etc., to reactor cell. (200 md)				$ 20,000	E-40708 E-40709 E-40878 E-41512 E-41513 E-55404 E-55405 E-55406
1 ea.	Remove FDT-2 steam dome to reactor cell. (20 md)				$ 2,000	E-40463 E-40471 E-40708
8 ea.	Remove FDT-2 heater units to reactor cell. (30 md)				$ 3,000	E-51686
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove disconnect support ring from FDT-2. (10 md)				$ 1,000	E-51686
1 ea.	Remove FDT-2 furance lid to reactor cell. (20 md)				$ 2,000	E-51686
1 ea.	Remove FDT-2 to reactor cell. (20 md)				$ 2,000	
1 job	Emplace FDT-2 in reactor cell and pump tank full of concrete.					
	Labor (20 md)				$ 2,000	
	Material: 3 yd^3 concrete			$ 200		
1 job	Replace steam dome into FDT-2 and fill steam dome with concrete.					
	Labor (20 md)				$ 2,000	
	Material: 1 yd^3 concrete					
2 ea.	Remove FDT-2 weigh cells to reactor cell. (10 md)				$ 1,000	E-41500
1 ea.	Segment and remove FDT-2 furnace to reactor cell. (50 md)				$ 5,000	E-51686
	NET MATERIAL AND LABOR					

DRAIN-TANK CELL	CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
2 ea.	Remove FDT-2 supports.	(20 md)				$ 2,000	E-41500
5 ea.	Remove heater spacers from line 103, 104, and 105 heaters.	(5 md)				$ 500	MIC-G-116
10 ea.	Remove removable heater units from lines 103, 104, and 105.	(20 md)				$ 2,000	MIC-G-116
2 ea.	Remove FV-104 and -105. (1-1/2" Sch 40 INOR-8)	(10 md)				$ 1,000	E-55509
~20 ft	Remove uninsulated portion of lines 103, 104, and 105. (1-1/2" Sch 40 INOR-8)	(20 md)				$ 2,000	E-41512 E-41513
21 ea.	Remove heater base insulation units.	(20 md)				$ 2,000	MIC-G-117
1 job	Remove heater base support structure.	(40 md)				$ 4,000	E-55504
2 ea.	Remove freeze valves FV-108 and -109 w/heaters and insulation attached.	(12 md)				$ 1,200	E-55509
		NET MATERIAL AND LABOR					
	DRAIN-TANK CELL				CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
∿20 ft	Remove transfer lines 108, 109, and 110. (1/2" Sch 40 INOR-8 w/Calrod heaters and insulation attached) (25 md)				$ 2,500	E-41512 E-41513
∿20 ft	Remove line 103 w/insulation and thermocouples attached. (1-1/2" Sch 40 INOR-8 w/3" thick insulation) (25 md)				$ 2,500	E-41512 E-41513
2 ea.	Remove line 103 welding and brazing platforms. (40 md)				$ 4,000	E-41514
5 ea.	Remove line 103 supports. (25 md)				$ 2,500	E-40708 E-41505
1 job	Clean up miscellaneous support clips, lines, cables, etc. (25 md)				$ 2,500	
9 ea.	Replace lower shield plugs in center bay. (10 md)				$ 1,000	
12 ea.	Remove lower roof plugs from south bay. (10 md)				$ 1,000	E-40933 E-40946
	NET MATERIAL AND LABOR					

DRAIN-TANK CELL	CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS		MATERIAL	LABOR	Reference Drawing
		MAT'L	LABOR			
12 ea.	Decontaminate lower roof plugs for future use. (50 md)				$ 5,000	
1 ea.	Remove south lower shield plug support beam. (1 md)				$ 100	E-40944
1 ea.	Decontaminate south support beam. (2 md)				$ 200	
1 ea.	Remove cell cooler w/support. (20 md)				$ 2,000	E-56291
2 ea.	Remove HCV-546 and -577. (10 md)				$ 1,000	E-41512 E-41513
1 job	Remove miscellaneous auxiliary piping, thermo- (200 md) couple leads, heater leads, instrument lines, etc.				$ 20,000	E-40708 E-40709 E-40878 E-41512 E-41513
3 ea.	Remove heaters from line 104. (10 md)				$ 1,000	MIC-G-116
6 ft	Remove line 104. (1-1/2" Sch 40 INOR-8) (10 md)				$ 1,000	E-41512 E-41513
5 ea.	Remove line 104 heater base insulation units. (10 md)				$ 1,000	MIC-G-117
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove line 104 heater base support structure. (20 md)				$ 2,000	E-55504
7 ea.	Remove FFT heater units. (30 md)				$ 3,000	E-51686
1 ea.	Remove FFT furnace lid. (20 md)				$ 2,000	E-51686
1 ea.	Remove FFT to reactor cell. (20 md)				$ 2,000	
1 ea.	Emplace FFT in reactor cell and pump full of concrete.					
	Labor (20 md)				$ 2,000	
	Material: 4 yd^3 concrete			$ 200		
2 ea.	Remove FFT weigh cells. (10 md)				$ 1,000	E-41500
2 ea.	Segment and remove FFT furnace. (50 md)				$ 5,000	E-51686
2 ea.	Remove FFT supports. (10 md)				$ 1,000	E-41500
	NET MATERIAL AND LABOR					
DRAIN-TANK CELL				CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
~6 ft	Remove line 107. (1/2" Sch 40 INOR-8 w/Calrod) (20 md) heaters and insulation attached)				$ 2,000	E-41512 E-41513
1 ea.	Remove freeze valve FV-107. (1-1/2" Sch 40 (6 md) INOR-8 w/heaters and insulation attached)				$ 600	E-55509
~25 ft	Remove drain line 103 w/insulation attached. (30 md) (~25 ft, 1-1/2" Sch 40 INOR-8 w/3" thick insulation)				$ 3,000	E-41512 E-41513
2 ea.	Remove line 103 supports. (10 md)				$ 1,000	E-41505
1 ea.	Remove resistance heating transformer. (15 kVA) (10 md)				$ 1,000	E-56240 E-56241
1 ea.	Remove transformer support stand. (2' x 2' x 9') (10 md)				$ 1,000	E-56241
2 ea.	Remove line 103 welding and brazing platforms (40 md) and stands. (~3' x 3' x 10')				$ 4,000	E-41514
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Clean up remaining miscellaneous support clips, lines, cables, etc. (25 md)				$ 2,500	
1 job	Remove lower shield plugs from north and center bay to outside storage. (20 md)				$ 2,000	
1 job	Decontaminate inside of drain tank cell to allow limited personnel access. (100 md)				$ 10,000	
1 job	Erect work platforms for removal of penetration contents from east and south walls. (10 md)				$ 1,000	
1 job	Remove lines from penetration XXIV from reactor cell to drain tank cell. (1-1/2" INOR-8 line; 1-1/2" carbon steel line; 2 each 1/2" stainless steel lines) (20 md)				$ 2,000	E-40947 E-40948
1 job	Remove support structures from penetration XXIV. (10 md)				$ 1,000	D-40713 D-41505
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBEMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Decontaminate penetration XXIV from reactor cell. (10 md)				$ 1,000	D-41505
12 ea.	Remove air, water and leak detector penetration shield plugs from east wall. (6" diameter) (60 md)				$ 6,000	D-40947 Page 52 of MSRE Design Manual
12 ea.	Decontaminate cell sleeves at east wall. (12 md)				$ 1,200	D-40947
327 ea.	Decontaminate cables and lines from penetrations A, B, C, D, E, and F thru east wall. (3/4" pipe sleeves) (50 md)				$ 5,000	D-40947
327 ea.	Decontaminate 3/4" penetrations thru east wall. (30 md)				$ 3,000	D-40947
12 ea.	Cap penetrations thru south wall. (3/4" thru 3") (10 md)				$ 1,000	D-40947
1 ea.	Remove penetration shield plug thru north wall to fuel processing cell. (10" diameter) (20 md)				$ 2,000	D-40947
1 ea.	Decontaminate sleeve to fuel processing cell. (10 md)				$ 1,000	D-40947
	NET MATERIAL AND LABOR					
	DRAIN-TANK CELL			CPFF	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Decontaminate entire drain tank cell to lowest practical level. (100 md)				$ 10,000	
1 job	Replace all lower shield plugs in drain tank cell. (20 md)				$ 2,000	
1 job	Replace lower shield plug steel shield plates. (10 md)				$ 1,000	
1 job	Replace all upper shield beams and holddown keys in drain tank cell. (30 md)				$ 3,000	
	NET MATERIAL AND LABOR			$ 400	$272,900	
	DRAIN-TANK CELL			CPFF $273,300	FIXED PRICE	ORNL

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QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove fuel process sampler assembly to reactor cell. (60 md)				$ 6,000	EJN-10415
4 ea.	Remove sampler instrument panels to salvage. (16 md)				$ 1,600	EJN-10415
1 ea.	Remove absorber cubicle contents to reactor cell. (15 md)				$ 1,500	E-55435 E-55452
1 job	Remove miscellaneous auxiliary equipment from cell top area to salvage. (10 md)				$ 1,000	
6 ea.	Remove cell roof plugs to storage. (20 md)				$ 2,000	E-55431
1 ea.	Remove cell cooler to burial ground. (10 md)				$ 1,000	
1 job	Set up work platforms and "C" zone over cell. (10 md)				$ 1,000	
1 job	Remove salt piping and miscellaneous auxiliary piping, valves, heaters, etc., to reactor cell. (150 md)				$ 15,000	E-55449 E-55450 E-55455
	NET MATERIAL AND LABOR					

FUEL-PROCESSING CELL	CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove fuel storage tank to reactor cell.				$ 2,000	E-40430
1 job	Emplace fuel storage tank into reactor cell and pump full of concrete.					
	Labor (20 md)				$ 2,000	
	Material: 5 yd^3 concrete			$ 200		
1 job	Remove sodium fluoride trap shielding to salvage. (10 md)				$ 1,000	E-55446
1 ea.	Remove sodium fluoride trap to reactor cell. (20 md)				$ 2,000	
1 ea.	Remove salt line filter to reactor cell. (20 md)				$ 2,000	E-49036
1 job	Check remaining material; remove only the contaminated items to the reactor cell. (30 md)				$ 3,000	
1 job	Remove remaining material to salvage or burial ground (support structures, cables, gas lines, instrument lines, etc.). (50 md)				$ 5,000	
	NET MATERIAL AND LABOR					
	FUEL-PROCESSING CELL			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Decontaminate interior of cell to lowest practical level. (50 md)				$ 5,000	
1 job	Replace cell roof plugs. (20 md)				$ 2,000	
	NET MATERIAL AND LABOR			$ 200	$ 53,100	

	CPFF	FIXED PRICE	ORNL
FUEL-PROCESSING CELL	$53,300		

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove ventilation house roof to storage. (20 md)				$ 2,000	
1 job	Remove all equipment above floor level to salvage and burial ground (instrument panels, auxiliary piping, etc.) (50 md)				$ 5,000	
1 job	Remove floor grating and dry stacked lead and concrete shielding blocks from the room. (~75 yd^3 total material) (100 md)				$ 10,000	
1 ea.	Remove off-gas valve box w/contents to reactor cell. (50 md)				$ 5,000	
1 ea.	Remove charcoal bed valve box w/contents to reactor cell. (50 md)				$ 5,000	
1 ea.	Remove off-gas particle trap assembly to reactor cell. (30 md)				$ 3,000	
	NET MATERIAL AND LABOR					
	VENTILATION HOUSE AREA			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove off-gas sampler assembly to reactor cell. (30 md)				$ 3,000	
1 job	Remove all off-gas piping from ventilation house to charcoal beds and to coolant cell and move to reactor cell. (50 md)				$ 5,000	
1 job	Remove all miscellaneous auxiliary systems, support structures, etc., to burial ground. (30 md)				$ 3,000	
1 job	Decontaminate ventilation house. (30 md)				$ 3,000	
1 job	Replace ventilation roof. (20 md)				$ 2,000	
2 ea.	Remove roof plugs from charcoal absorber pit. (10 md)				$ 1,000	
1 job	Remove piping from absorber beds; seal ends. (30 md)				$ 3,000	
5 ea.	Remove absorber beds to burial ground. (30 md)				$ 3,000	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
VENTILATION HOUSE AREA			

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Drain water from pit and remove support structures to burial ground. Check and decontaminate pit as required. (50 md)				$ 5,000	
2 ea.	Replace absorber pit roof plugs. (10 md)				$ 1,000	
	NET MATERIAL AND LABOR				$ 64,000	

VENTILATION HOUSE AREA

CPFF	FIXED PRICE	ORNL
$64,000		

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove special equipment room roof plugs to	(20 md)				$ 2,000	
	storage.						
2 ea.	Remove component cooling air enclosures to reac-	(25 md)				$ 2,500	
	tor cell.						
2 ea.	Emplace component cooling air enclosures in reac-						
	tor cell and fill with concrete.						
	Labor	(25 md)				$ 2,500	
	Material: 15 yd^3 concrete				$ 600		
2 ea.	Remove component cooling air blower motors to	(20 md)				$ 2,000	
	reactor cell. (75 hp)						
2 ea.	Remove component cooling air blowers to reactor	(20 md)				$ 2,000	
	cell. (10 x 15 Roots type)						
2 ea.	Remove component cooling air bottom domes	(50 md)				$ 5,000	
	w/piping manifolds to reactor cell.						
	NET MATERIAL AND LABOR						

	CPFF	FIXED PRICE	ORNL
SPECIAL EQUIPMENT ROOM			

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove component cooling air heat exchanger to reactor cell.	(20 md)				$ 2,000	
~25 ft	Segment and remove 30" OD cell exhaust line to reactor cell.	(100 md)				$ 10,000	
2 ea.	Remove pump bowl bubbler containment enclosures w/contents to reactor cell.	(30 md)				$ 3,000	
1 job	Remove remaining auxiliary and support material to reactor cell or burial ground as required by survey.	(100 md)				$ 10,000	
1 job	Demolish concrete wall, excavate, and remove 30" OD duct from special equipment room to service tunnel.	(200 md)				$ 20,000	
25 ft	Remove cell exhaust line from special equipment room to service tunnel.	(200 md)				$ 20,000	
		NET MATERIAL AND LABOR					
	SPECIAL EQUIPMENT ROOM				CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS		MATERIAL	LABOR	Reference Drawing
		MAT'L	LABOR			
1 job	Repair cell wall.					
	Labor (50 md)				$ 5,000	
	Material: 5 yd^3 concrete			$ 300		
1 job	Clean and decontaminate special equipment room. (50 md)				$ 5,000	
1 job	Replace special equipment room roof plugs. (20 md)				$ 2,000	
	NET MATERIAL AND LABOR			$ 900	$ 93,000	
	SPECIAL EQUIPMENT ROOM			CPFF	FIXED PRICE	ORNL
				$93,900		

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(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
NOTE:	All material except as noted is to be removed to the burial ground.					
21 ea.	Remove coolant cell penthouse roof plugs. (20 md)				$ 2,000	E-40979
	(1'-0" x 2'-0" x 18' long)					
1 ea.	Remove coolant salt sampler assembly. (20 md)				$ 2,000	M-10333-RF-001-E
1 ea.	Remove radiator door lifting mechanism. (30 md)				$ 3,000	D-40450 D-40451 D-40452
1 job	Remove coolant pump auxiliary piping. (15 md)				$ 1,500	
1 job	Remove radiator top insulation. (30 md)				$ 3,000	D-40440 E-40470 E-40471 E-40472 E-40473 E-40746
1 job	Remove radiator doors. (20 md)				$ 2,000	E-55510
1 job	Remove radiator door lifting and coolant pump support structures. (30 md)				$ 3,000	E-41515 E-41866
	NET MATERIAL AND LABOR					
	COOLANT CELL AREA			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Remove radiator and enclosure assembly.	(100 md)				$ 10,000	E-40470
1 job	Remove radiator supports and radiator door tracks.	(50 md)				$ 5,000	E-55516
1 job	Remove coolant salt drain lines.	(20 md)				$ 2,000	E-40702 E-41860 E-41861 E-41862
1 ea.	Remove coolant salt drain tank.	(50 md)				$ 5,000	E-40702
∿32,500 lbs	Remove lead shielding from off-gas pipe chase. (44' x 9" OD x 1" ID = 19.2 ft^3 = 13,587 lbs and ∿40' lead brick 2" thick = 26.7 ft^3 = 18,872 lbs)	(100 md)				$ 10,000	E-41893
44 ft	Segment and remove off-gas lines to reactor cell. (1 each 1/4" OD in 1/2" pipe; 1 each 1/2" pipe in 1" pipe)	(20 md)				$ 2,000	
	NET MATERIAL AND LABOR						
COOLANT CELL AREA					CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
5 ea.	Remove off-gas line supports. (10 md)				$ 1,000	E-41892
~60 ft	Segment and remove reactor cell exhaust line to reactor cell. (30" OD x 0.312 wall carbon steel) (200 md)				$ 20,000	
1 job	Remove miscellaneous auxiliary lines from coolant cell area (water, oil, gas, off-gas, etc.) to reactor cell or burial ground as required. (100 md)				$ 10,000	E-41893
1 job	Clean and decontaminate coolant cell area. (100 md)				$ 10,000	
1 lot	Miscellaneous packaging, lifting, and handling materials.			$ 4,600		
	NET MATERIAL AND LABOR			$ 4,600	$ 91,500	
	COOLANT CELL AREA			CPFF	FIXED PRICE	ORNL
				$96,100		

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(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
NOTE:	All material except as noted is to be removed to the burial ground.					
100 ft	Remove lube oil and water piping from reactor cell to service tunnel penetration. (20 md)				$ 2,000	E-40735
100 ft	Remove lube oil and water piping from special equipment room to service tunnel penetration. (20 md)				$ 2,000	E-55411 E-55414
2 ea.	Remove reactor cell exhaust line valves to reactor cell. (30" butterfly w/operators) (30 md)				$ 3,000	D-41026
75 yd^3	Machine excavate w/shoring 30" exhaust line from special equipment room to service tunnel (∿20' deep). (100 md)			$ 3,000	$ 10,000	D-41026 D-41027 D-41028
2 yd^3	Demolish reinforced concrete service tunnel wall at 30" exhaust line penetration. (10 md)				$ 1,000	D-41028
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
SOUTH YARD			

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
18 ft	Segment and remove to reactor cell 30" exhaust line from special equipment room to service tunnel. (30" OD x 0.312 wall carbon steel) (125 md)				$ 12,500	D-41027
75 yd^3	Machine excavate w/shoring 30" exhaust line from service tunnel to stack filter (∿20' deep). (100 md)			$ 3,000	$ 10,000	D-41028
1 yd^3	Demolish reinforced concrete wall of service tunnel at 30" line penetration. (5 md)				$ 500	D-41027 D-41028
50 ft	Segment and remove to reactor cell 30" exhaust line from service tunnel to stack filters. (30" OD x 0.312 wall carbon steel) (350 md)				$ 35,000	D-41028
1 job	Check and remove all contaminated soil from excavated area. (50 md)				$ 5,000	
	NET MATERIAL AND LABOR					
	SOUTH YARD			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Form and pour concrete at special equipment room wall, and two walls of service tunnel.					D-41026 D-41028
	Labor (20 md)				$ 2,000	
	Material: 3 yd^3 concrete form material			$ 500		
150 yd^3	Backfill excavation from tunnel area w/stabilized fill to existing grade level. (10 md)			$ 1,500	$ 1,000	
1 job	Remove and decontaminate inlet manifold to stack filter bays. (50 md)				$ 5,000	D-41071 D-41072
3 ea.	Remove and decontaminate stack filter inlet dampers. (24" x 18") (20 md)				$ 2,000	D-41071 D-41072
31 ea.	Remove and decontaminate stack filter pit roof plugs. (50 md)				$ 5,000	D-41117
105 ea.	Remove prefilters, decontaminate frames and replace filter media. (50 md)				$ 5,000	D-41075
	NET MATERIAL AND LABOR					
	SOUTH YARD			CPFF	FIXED PRICE	ORNL

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(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS		MATERIAL	LABOR	Reference Drawing
		MAT'L	LABOR			
6 ea.	Remove final filters, decontaminate frames and replace filters. (50 md)				$ 5,000	D-41076
1 job	Decontaminate interior of filter pit. Flush solutions to the Laboratory ILW system thru existing drain lines. (30 md)				$ 3,000	D-41117 D-41273
6 ea.	Replace final filters. (30 md)			$2,000 (UCC-ND)	$ 3,000	D-41076
105 ea.	Replace prefilters. (50 md)			$2,000 (UCC-ND)	$ 3,000	D-41075
31 ea.	Replace and seal filter pit roof plugs. (30 md)			$ 500	$ 3,000	D-41117
3 ea.	Replace filter inlet dampers. (20 md)				$ 2,000	D-41071
1 ea.	Replace filter inlet manifold. (30 md)				$ 3,000	D-41072
	NET MATERIAL AND LABOR					
	SOUTH YARD			CPFF	FIXED PRICE	ORNL

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(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Design, fabricate and install blanking fixture					D-41028 D-41071 D-41072
	where cell exhaust line was removed.					
	Design (10 md)				$ 1,800 (UCC-ND)	
	Fabrication (20 md)			$ 500	3,200 (UCC-ND)	
	Installation (20 md)				$ 2,000	
	G&A on materials: 4,500 x 0.35			$ 1,600		
	UCC-ND Subtotal			$ 6,100	$ 5,000	
	NET MATERIAL AND LABOR			$ 8,500	$127,000	
SOUTH YARD				CPFF	FIXED PRICE	ORNL
				$135,500		$11,100

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(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
NOTE:	All material is to be removed to the burial ground.					
2 ea.	Remove treated water storage tanks. (10 md)				$ 1,000	D-41252
2 ea.	Remove treated water pumps. (20 hp) (20 md)				$ 2,000	D-41252
1 lot	Remove piping, valves, instruments, etc., from water room. (50 md)				$ 5,000	D-41252
1 lot	Remove piping and valves from radiator tunnel. (30 md)				$ 3,000	D-41252
1 job	Remove thermal shield gas separation system from fan house. (30 md)				$ 3,000	
100 yd^3	Machine excavate underground 4" and 6" lines to diesel shed. (20 md)				$ 2,000	
~250 ft	Remove 4" and 6" lines from water room to diesel shed. (20 md)				$ 2,000	D-41254
	NET MATERIAL AND LABOR					
	TREATED-WATER SYSTEM			CPFF	FIXED PRICE	ORNL

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(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove treated water filter from diesel shed. (10 md)				$ 1,000	D-41254
2 ea.	Remove treated water heat exchangers from diesel shed. (30 md)				$ 3,000	D-41254
~150 ft	Remove piping and valves from diesel shed. (4" and 6" carbon steel) (30 md)				$ 3,000	D-41254
2 ea.	Remove steam dome heat exchangers from west tunnel. (20 md)				$ 2,000	
2 ea.	Remove steam dome surge tanks from west tunnel. (20 md)				$ 2,000	
1 lot	Remove piping and valves from west tunnel. (30 md)				$ 3,000	
1 job	Decontaminate west tunnel. (30 md)				$ 3,000	
1 job	Decontaminate water room. (30 md)				$ 3,000	
	NET MATERIAL AND LABOR					

	CPFF	FIXED PRICE	ORNL
TREATED-WATER SYSTEM			

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(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 job	Decontaminate diesel shed. (10 md)				$ 1,000	
$100\ yd^3$	Backfill west yard between water room and diesel shed to existing grade. (5 md)			$ 1,000	$ 500	
	NET MATERIAL AND LABOR			$ 1,000	$ 39,500	
	TREATED-WATER SYSTEM			CPFF: $40,500	FIXED PRICE:	ORNL:

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(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL	UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
NOTE:	All material except as noted is to be removed to the burial ground.					
1 ea.	Disconnect and remove distillation experiment (25 md)				$ 2,500	
	valve box.					
1 job	Remove roof plugs and set up temporary work (50 md)				$ 5,000	
	shielding.					
1 job	Remotely disconnect all lines from distillation (30 md)				$ 3,000	
	experiment.					
1 ea.	Remove distillation experiment assembly to (100 md)				$ 10,000	
	reactor cell.					
1 job	Remove temporary work shielding. Install (50 md)				$ 5,000	
	ladders.					
2 ea.	Remove fuel process system charcoal traps. (10 md)				$ 1,000	49026 E-55454
	NET MATERIAL AND LABOR					
	SPARE CELL AREA			CPFF	FIXED PRICE	ORNL

UCN-1297
(3 7-72)

QUANTITY UNIT	ENTOMBMENT OF RADIOACTIVE MATERIAL		UNIT COSTS MAT'L	UNIT COSTS LABOR	MATERIAL	LABOR	Reference Drawing
1 ea.	Remove fuel process ventilation filters.	(20 md)				$ 2,000	E-55454
1 ea.	Remove fuel process soda lime trap.	(20 md)				$ 2,000	E-55454
1 lot	Remove miscellaneous piping, supports, etc.	(50 md)				$ 5,000	E-55454 E-55456
~200	Remove dry stacked block from west wall.	(25 md)				$ 2,500	
1 job	Decontaminate cell.	(30 md)				$ 3,000	
1 job	Replace roof plugs.	(10 md)				$ 1,000	
	NET MATERIAL AND LABOR					$ 42,000	

	CPFF	FIXED PRICE	ORNL
SPARE CELL AREA	$ 42,000		

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