SEQUOYAH NUCLEAR PLANT

Units 1 and 2

VOLUME REDUCTION AND SOLIDIFICATION SYSTEM

TENNESSEE VALLEY AUTHORITY

REQUEST FOR A LICENSE AMENDMENT

NOVEMBER 1982

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SEQUOYAH NUCLEAR PLANT

RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM (VR/SS)

1.0 INTRODUCTION

1.1 Purpose

This document is provided as supporting information for a proposed amendment to the facility operating license for Sequoyah Nuclear Plant (SQNP). The proposed amendment is to allow operation of onsite volume reduction equipment to process low-level radioactive waste (LLRW) at SQNP. This document is intended to be fully adequate for the U.S. Nuclear Regulatory Commission (NRC) staff to make a decision regarding the acceptability of the action and authorize the proposed amendment.

1.2 Background

The Tennessee Valley Authority (TVA) owns SQNP located in Hamilton County, Tennessee. Operation of this plant will result in planned and controlled generation of LLRW. This waste primarily consists of ion exchange resins, evaporator concentrates, spent regenerates, contaminated oils, and dry active waste as described in Table 1.2-1. For the reasons outlined in Section 1.3, 'Need,' TVA is seeking authorization by way of amendment to our facility operating license to operate a volume reduction system (VR) including a permanently installed incinerator and calciner to process LLRW at SQNP. TVA has completed a preliminary safety review and has determined that NRC approval is required for operation of the volume reduction system addition.

The VR is designed to process and reduce the volume of radioactive materials. Dry active waste and contaminated oils will be incinerated while evaporator concentrates and spent regenerates will be calcined. Spent resins will not be incinerated, but will be either dewatered or solidified and packaged in accordance with burial site requirements. The Solidification System (SS) will produce a solidified package that is acceptable for storage onsite or disposal offsite.

1.3 Need

Since the startup of SQNP, TVA has packaged and shipped LLRW generated at SQNP to commercial radioactive waste disposal sites. Recently, however, significant restrictions have been placed on the volume (ft^3) of packaged LLRW that Chem-Nuclear Systems, Inc., (CNSI) will accept for disposal.

TVA has built and received a license to operate an onsite low-level radioactive waste storage facility that will reduce our immediate dependence upon the availability of commercial burial facilities.

TVA believes that it is a prudent policy to reduce the volume of LLRW. Therefore, we are requesting approval for the operation of the volume reduction system addition. We believe this approach is consistent with the NRC 'Policy Statement on Low-Level Waste Volume Reduction' as published in the October 16, 1981 Federal Register notice FR 51101. This proposal, in conjunction with other associated LLRW actions, would be a step towards the NRC stated goals of:

1. Extending the operational lifetime of existing commercial low-level disposal sites;

2. Reducing the number and/or volume of waste shipments.

1.4 Scope

This document is to describe the design and operation of volume-reduction equipment and its associated facility. The information provided consists of the facility design criteria, the environmental and radiological assessments, and a safety or accident analysis, as well as information regarding facility operation and decommissioning.

The design basis for the SQNP VR/SS facility as given in this document is based on NRC Regulatory Guide 1.143 guidelines. Regulatory Guide 1.143 was utilized by TVA as a minimum design basis because it was determined to be the most applicable to the nature of the facility, although it was not specifically prepared and issued for this purpose. The actual design parameters employed by TVA in the facility's design are in some cases more conservative than those required by Regulatory Guide 1.143.

TABLE 1.2-1

ANTICIPATED RADWASTE TO BE PROCESSED
BY EITHER THE VR OR SS PER YEAR

Waste Type		Volume (Ft^3/Yr)
Spent Ion-Exchange Resin		600[a]
Evaporator Concentrates		3,500[b]
Spent Regenerates		12,500[b]
Dry Active Waste[c] (uncompacted average density, 10 lbs/ft^3)		36,000
Contaminated Oil		300
Spent Filter Cartridges and Other Miscellaneous Articles (to be encapsulated)		1,000
	TOTAL	53,900

[a]Dewatered. Volume is twice this value if resin is solidified.

[b]Non-solidified volumes.

[c]Consists of items such as PVC's, polyethylene boots, rubber shoe covers, rubber hose, plastic hose (Nalgene), cotton gloves, cotton glove inserts, cotton coveralls, rubber gloves, surgical masks, paper coveralls, wood crates (pine, oak, plywood), mops, brooms, wood used for scaffolding and ladders, laboratory equipment (vials and plastic bottles), and other combustible objects.

2.0 FACILITY DESIGN DESCRIPTION

2.1 Summary Description

This license amendment is intended to incorporate the VR/SS (Volume Reduction and Solidification System) facility into the existing overall plant radwaste facilities previously covered in the Sequoyah Nuclear Plant Final Safety Analysis Report (FSAR). The contents of this amendment will focus entirely on the VR/SS facility to be added at SQNP. The facility includes process equipment for spent resins; evaporator concentrates; spent regenerates; contaminated oils; and dry active wastes which are products of the overall plant operation and maintenance. The VR/SS facility will be a noncategory I safety-related structure constructed of reinforced concrete and structural steel.

The facility is composed of various subsystems which are designed to collect, treat, volume reduce, recycle, package, and solidify different categories of radioactive material in a safe and economical manner.

The VR is designed to process and reduce the volume of radioactive materials utilizing an incineration and calcination process. The SS will produce a solidified package that is acceptable for storage onsite or disposal offsite. The off-gas scrub system will collect particulates containing effectively all the radioactive contaminants. This system along with associated radiation control monitoring devices ensures that gaseous effluents will be within acceptable levels.

It is estimated that 53,900 ft^3 of waste will be processed by the VR/SS each year from the two units at SQNP. Table 1.2-1 describes the waste types and volumes. The activity and radionuclide distribution contained in the waste are listed in Table 2.1-1. The waste, before processing, will be handled in the manner described in Section 3.0, 'Facility Operations.'

The VR/SS facility will have two truck bays to receive waste for processing and to load solidified waste for offsite disposal or onsite storage. Each truck bay is designed to handle a semitrailer and attached cab. The two truck bays will be separated by a shield wall to allow loading of radwaste containers on a truck for shipment and simultaneous unloading of other (radioactive or nonradioactive) materials. A crane is supplied to handle drums, shield casks, and other equipment. The handling operations are the same for onsite storage or offsite disposal.

The VR/SS facility storage area is capable of accommodating the solidified product of up to 180 days of normal operational waste input. This facilitates system operation in the event removal of packaged wastes from the area is temporarily delayed or is impractical for short periods.

Preliminary equipment arrangement drawings for the VR/SS facility are shown in Figures 2.1-1 through 2.1-8.

2.1.1 Volume Reduction System Description

The VR supplied by Aerojet Energy Conversion Company (AECC), utilizes fluidized bed technology to process a wide variety of low-level radioactive wastes. The AECC VR consists of a fluid bed incinerator, fluid bed dryer, and a common off-gas cleanup and filter system.

Areas for storage of wastes before processing are provided. These include a dry waste storage area located adjacent to the VR to store bagged uncompacted dry waste with a capacity of seven days at maximum plant input. Two resin waste collection and storage tanks have a capacity of 5,000 gallons each and are equipped with a decanting pump and recirculating pump.

Concentrated liquid waste will be stored in two 7,500-gallon capacity tanks equipped with pumps. Tanks and piping associated with the concentrated liquids will be heat traced. The resin storage tanks and the concentrated liquid waste storage tanks will be located in diked rooms which are capable of holding the entire inventory in the event of a pipe or tank rupture.

Piping and instrumentation diagrams as well as mass energy balance diagrams for the VR can be found on Figures 2.1-9 through 2.1-21.

The capability also exists for the compaction of low radiation level, compressible dry active waste into 55-gallon drums. An area is provided for removal of dry, previously compacted waste from 55-gallon drums. The area is located adjacent to the dry active waste storage area discussed above, and is equipped with air, water, and drain services as well as a vent for collection and treatment of airborne radioactive releases.

The dry active wastes (e.g., contaminated paper, wood, cardboard, cloth, rubber and plastics, such as polyethylene), and contaminated oil are processed in the fluid bed incinerator vessel and are converted to an ash residue. Liquid wastes consisting of evaporator concentrates and spent regenerates are processed in the fluid bed dryer and converted to anhydrous, free-flowing salts.

The fluid bed dryer vessel (R-1) used for drying the evaporator concentrates is electrically heated and controlled in several ways. The airflow is determined by a measured pressure drop across an orifice plate to a proportional flow controller which regulates the airflow through a butterfly control valve. The bed temperature is controlled by the preconcentrated feed flow rate input. Thermocouples transmit the temperature to a proportional controller which in turn controls the liquid feed rate.

The fluid bed incinerator (R-3) temperature is controlled using the condensate water from the condenser (S-3), thereby basically controlling the raising and lowering of the temperature due to the heating value variation of the dry active waste feed. The signal from the temperature controller is transmitted to a proportional controller which operates a flow control valve regulating the condensate through a spray nozzle. The incinerator is refractory lined and equipped with an electrical heater for preheating the air during startup. Thereafter, the combustion of dry active waste or contaminated oils generates sufficient heat energy to maintain the process. Fuel oil may be utilized to increase the efficiency of the process.

The incineration of radioactive waste results in a volume reduction factor of about 100 for dry active waste. For the characterized waste volumes given in Table 1.2-1, an overall volume reduction factor of at least 10 can be realized. These estimated volume reduction factors do not take into account the noncombustible and/or noncompactible trash, but do allow for the additional volume of the solidification agent.

The off-gas from each process vessel is processed by an off-gas cleanup system. All waste gas from the process will be treated by dry cyclones, venturi scrubbers, demisters, charcoal adsorbers, and HEPA filters for removal of radioactivity and chemical impurities. Decontamination factors for the off-gas cleanup system are based on actual tests conducted by the VR supplier.

The VR controls are located in the VR/SS control room. The system's main controls are contained in free-standing NEMA-4 cabinets. Instrumentation in the main control panel (CP-1) is composed of solid-state electronic components and is of standard design.

The VR is equipped with control instrumentation which provides for remote, unattended operation, and automatic shutdown in the event of a malfunction. These system features will preclude damage to equipment, and provide adequate safety to plant operating personnel. Process temperatures, pressures, and flow rates are monitored utilizing thermocouples, pressure transmitters, and flow transmitters. Instrumentation and controls maintain process parameters (i.e., temperature, chemistry, radioactivity, pressure, and liquid level) within limits which assure safe and efficient system operation. The major process parameters are continually recorded. Safe operation of the VR is provided by control sequencing and interlocks which prevent improper operation and cause automatic system shutdown if system parameters are not maintained within accepted operating limits. Alarms alert the operator to abnormal conditions.

The VR instrumentation and control system will operate in either automatic or manual modes. Alarms and/or shutdown are provided for specific out-of-tolerance conditions. Shutdown is automatic when initiated by the operator or by certain out-of-tolerance conditions. Under manual mode, the startup and shutdown sequence is under operator control. The process logic provides system interlocking required to prevent out-of-sequence operation, and provides automatic regulation of the process control loops. Access to the control loop setpoints allows adjustment of the system controllers within allowable limits while the system is operating.

Gaseous wastes will be continuously monitored for radioactivity before release. Radiation monitoring is discussed further in Section 2.5, 'Radiation Protection and ALARA.' Processing will be terminated if the radioactivity levels in the effluent stream would cause offsite doses in excess of regulatory limits. The gaseous effluent stream will be released from a vent located and designed to ensure adequate dispersion characteristics.

Generic system descriptions, tests, and other pertinent supporting data are documented in AECC topical reports which have been previously submitted to the NRC. These include Topical Reports Nos. AECC-1-A (September 30, 1975), AECC-2-P (October 15, 1979), and AECC-3-P (December 1981). These documents supplement the information described herein.

2.1.2 Solidification System Description

The Solidification System (SS), supplied by Stock Equipment Company (SECo), will immobilize the salts resulting from the drying of evaporator concentrates and ash resulting from the incineration of dry active waste, and contaminated oil. The SS is also capable of solidifying spent resins, evaporated concentrates, spent regenerates, and encapsulating spent filter cartridges and other small miscellaneous noncompactible contaminated articles (valves, metal pipes, etc.), into a 55-gallon drum. The primary components of the solidification system include polymer and cement storage, filling, and drumming stations, spent resin storage and decant tanks, a drum inspection station, a crane, and a process control station. Piping and instrumention diagrams for the SS are shown on Figures 2.1-22 through 2.1-31. (Reference SECO Generic Topical Report, SRS-001-P, March 1979, on cement solidification which supplements the information described herein.)

2.1.2.1 Polymer and Cement Filling Stations

Polymer and cement filling stations are provided to measure solidification agent into 55-gallon, tight-head DOT-17C (or similar) drums fitted with a 4-inch threaded bung insert. The polymer filling station consists of a conveyor that transfers empty drums to the fill position, a drip-proof fill nozzle to place polymer and promoter within the drum, a scale assembly to verify that the correct amount of solidification agent is within the drum for a select waste stream, a station control console, and a conveyor to transfer prepared drums to the the crane pickup point for processing.

Metering pumps for handling solidification agent chemicals, valving, filters, ventilation systems, reservoirs, and controls are provided. The polymer recirculation/reservoir delivery pump, located at the fill station, will have a dual function of delivering polymer from the polymer storage tank to the polymer fill station reservoir and also recirculating the polymer back to the storage tank.

If cement solidification is selected, the drum is conveyed to the cement filling station where dry cement is added. The cement filling nozzle has a vent connection leading to a dust collector to prevent dispersion of cement dust.

2.1.2.2 Polymer and Cement Drumming Stations

The Dry Product/Polymer Drumming Station consists of a pressurized vessel designed to receive dry products of the volume reduction system, deposit them in a 55-gallon drum (prefilled with a binding agent), and thoroughly coat the products with polymer. The essential components of the station are the shield wall, to which the chamber is mounted; the pressure vessel, which serves as the containment vessel for the coating process; the pivot and lift mechanism used for positioning of the drum within the chamber; the capper/uncapper mechanism; the fill nozzle/mixer drive; a control system of pressure balance sensors for dust control; and a system of pipes and nozzles for internal washdown.

The drumming station enclosure will be a pressure vessel. The access hatch will be of 'pressure tight' design, and the drain will be equipped with a full flow plug-type valve with a remote manual actuator. The fill nozzle and pressure tight dry product valve separating the drumming station from the product storage hopper will be designed to handle dry product. The fill nozzle will be heated to prevent condensation from accumulating and causing a buildup of dry product on the nozzle. The primary seal, preventing dust from escaping, will be a diaphragm built into the drum which seals on the dry product fill nozzle.

The Wet Waste/Cement Drumming Station is an enclosed, vented, atmospheric assembly designed to uncap 55-gallon, closed top drums, fill the drums, mix the contents, and recap the drums. The assembly is completely enclosed to prevent any escape of radioactive liquid or gas.

The vessel is attached to the processing side of the steel shield wall, with drive motors, limit switches, sensors, and controls on the opposite (safe) side of the shield wall. The vessel is stainless steel. Internal surfaces are free of crevices to limit potential radioactive particle crud traps.

Two platforms are mounted on the sides of the vessel hatch. One platform is a setdown position to facilitate loading the drum processing vessel. The second platform is equipped with load cells for weighing filled drums plus a detector for measuring the drum radiation level before storage. This platform arrangement minimizes drum processing vessel loading and unloading time. The scale and radiation detector are connected to digital solid state readouts on the control console.

2.1.2.3 Spent Resin Storage and Decant Tanks

Two (2) 5,000-gallon, decanting-type holding tanks will be provided for the storage and handling of resins. Each tank is equipped with a mixer assembly, decant arm system and associated hardware, decant pump, and decontamination sprays. A separate centrifugal pump with manifold-valved piping will be provided for each tank. Resins can be recirculated through the sampling station and reagent addition station, back to the 5,000-gallon tank, or they can be transferred to the second 5,000-gallon tank if necessary. Volumes of these tanks will allow a 180-day decay of short-lived radionuclides based on input volumes in table 1.2-1. The holding tank wastes can also be pumped to the 500-gallon decanting station tank for batch processing before drumming.

The 500-gallon decanting station tank accurately proportions resin waste and water to ensure the proper feed for solidification with cement. It is a closed stainless steel cylindrical vessel, approximately 4′ 6″ diameter x 5′ high, with a semi-elliptical upper head, and a conical lower head. It includes a movable decanting nozzle, level sensors, and a mechanical mixer.

2.1.2.4 Drum Inspection Station

The Drum Inspection Station enclosure consists of a 12-inch thick steel shield wall which is welded to the 1/4-inch thick steel plate sides and rear wall assembly. A 3″ x 52″ vertical access opening for swipe applicator tool entry is provided to one side of the shield wall. The bottom of the enclosure weldment is constructed from 3/16-inch steel plate and is equipped with a drain connection. The entire top of the drum inspection station enclosure remains open to provide access for 55-gallon drum loading and unloading to and from the enclosure.

The motor-driven turntable assembly (1,000-pound drum capacity) located in the center of the inspection station is provided for both clockwise and counter-clockwise drum rotation. During the drum swipe test, the drum is rotated to present the entire drum external surface area to the swipe pad for accurate testing.

2.1.2.5 Crane

A bridge crane is provided to transfer drums, shielded casks, and other materials/equipment in the radioactive processing and storage areas. The crane is equipped with a 7-1/2-ton hoist with a drum grab and TV camera with remote and local control capability. A target grid system (located above the crane) with mounted TV cameras provides accurate location capability. The drum grab may be easily located within 1/4-inch tolerance which ensures safety and prompt remote operation. The crane is designed to be washed down for decontamination.

2.1.2.6 Controls

All control and indicating devices required for remote operation of the crane, decant station, drumming stations, and slurry tanks are located on the solidification system control console. The crane control section includes the TV monitors with their control units. The drum processing control section contains a graphic panel of the solidification system and all manual switches and visual indicators for operating the drumming and decanting stations.

2.2 Structural Design

2.2.1 General

The VR/SS facility will be a noncategory I safety-related structure constructed of reinforced concrete and structural steel. It will be located adjacent to the Condensate Demineralizer Waste Evaporator Building (see Figure 2.2-1) and designed to prevent collapse on the adjacent Category I structure, piping, and electrical conduit. All structural systems shall be designed to withstand the design basis events, normal, severe environmental, extreme environmental loads, and combinations of the above loads as described in the following sections.

2.2.2 Design Basis Events

2.2.2.1 Design Basis Earthquake

2.2.2.1.1 Earthquake Definition

The structure will be analyzed and designed to resist the seismically induced motions of the safe shutdown earthquake (SSE) because of its location adjacent to Category I structures and systems. The SSE is defined as a top of ground motion with maximum horizontal and vertical accelerations of 0.25g. Response spectra for the three statistically independent artificial accelerograms, two horizontal and one vertical, were developed and are included as Figures 2.2-2 and 2.2-3. Each record has a total duration of 22 seconds. The three earthquake components are assumed to occur simultaneously.

2.2.2.1.2 Seismic Analysis

The seismic analysis of the structure will be based upon dynamic analysis using an idealized mathematical model. In developing the model, the location and mass of the equipment will be considered. A sufficient number of mass points, located at positions of mass concentration such as floors, will be chosen so that all significant modes of vibration are adequately defined. In general, to adequately define the frequency of the highest mode to be used in the analysis to within 10 percent, the minimum number of lump masses is twice the mode number. For example, if the first three translational modes are to be used in the analysis, at least six lumped masses will be included in the model.

The mass of equipment, components, or systems will be included directly with the appropriate lumped mass. After the locations of the mass points have been established, the number of dynamic degrees of freedom associated with each mass will be considered. Six degrees of freedom exist for all mass points, i.e., three translational and three rotational.

The inertial properties of the models will be characterized by the mass, eccentricity, and mass moment of inertia of each mass point. Stiffness properties will be characterized by the length, moment of inertia, shear shape factor, torsion constant, Young's modulus, and shear modulus. Vertical modes of the structure will be computed and their effects included in the structural response.

The structural response will be computed by the response spectrum modal analysis technique considering three components of the earthquake acting simultaneously. The total structural response (deflections, accelerations, stresses, etc.) will be computed from the individual modal response by the methods described in

NRC Regulatory Guide 1.92, 'Combining Modal Response and Spatial Components in Seismic Response Analysis.'

2.2.2.1.3 Structure-Foundation Interaction

Soil-structure interaction will be taken into account by coupling the structural model with the foundation medium. A finite element or an equivalent analysis as discussed in NRC Standard Review Plan 3.7.2, 'Seismic System Analysis,' will be used.

The acceleration at the top of the ground surface will be considered to be deconvoluted through the soil to the bottom boundary (bedrock). For analysis purposes the bottom of the base slab will be the assumed top of ground motion elevation. The artificially produced accelerograms will be considered the input motion at the top of the ground surface and will be used to generate the time histories of the accelerations at the bottom boundary by deconvolution analysis. This analysis is influenced by the accuracy of the determination of the in situ soil properties, ground water, slanted soil layers, soil density variations, and variations in both finished grade elevation and bottom boundary (bedrock) elevation. Therefore, the soil properties and the depth of soil beneath the structure will be varied using sound engineering judgment to obtain different bottom boundary motion histories which will be used in computing the structural response.

2.2.2.1.4 Effect of Foundation Support

A pile or caisson foundation will be considered in the soil-structure dynamic analysis. Stiffening effect of the soil and pile or caisson combinations will be considered where the stiffening effect on the soil is significant.

2.2.2.2 Design Basis Wind

The structure will be designed to withstand the forces exerted by a wind having a maximum speed of 95 mph at 30 feet above the grade elevation. This design basis wind has a recurrence interval of 100 years.

2.2.2.3 Design Basis Tornado

The structure will be designed to withstand the forces exerted by a tornado wind having a peripheral rotational velocity of 290 miles per hour at a radius of 150 feet from the center of the tornado with a translational velocity of 70 mph, and depressurization load of 3 psi as outlined in NRC Regulatory Guide 1.76, 'Design Basis Tornado for Nuclear Power Plants.' Venting will be utilized if necessary to reduce or eliminate any pressure differentials.

Interior walls, floors, doors, and other internal building elements will be designed to withstand pressure differentials caused by any locally unequal depressurization rates that occur during a planned depressurization or before tornado dampers close, where applicable.

Interior walls, floors, and doors that are between an area designed to depressurize, and one that should not depressurize, will be designed for the differential pressure transient.

Tornado missile impact is not required to be considered by NRC Regulatory Guide 1.143, 'Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Plants.' However, some degree of missile protection is inherently provided by the required radiological shielding thickness for the structure.

2.2.2.4 Design Basis Flood

The structure will be located above the design basis flood elevation (El. 687.5) which is the 500-year recurrence interval flood. In addition, the structural adequacy will be verified up to the probable maximum flood as the structure will be allowed to flood.

2.2.2.5 Design Basis Precipitation

The probable maximum precipitation (PMP) is 29.5 inches of rainfall during an 8-hour time span with a maximum 1-hour depth of 14 inches. Grading for the facility will be such that a buildup of water around the structure during the PMP will be minimized. The drainage of this area will be investigated with respect to effects of PMP drainage in the nuclear plant area to ensure that any change in the PMP elevation in that area does not have an adverse impact on any existing structure.

2.2.3 Loads, Definitions, and Nomenclature

2.2.3.1 Minimuim Live Loads

The minimum roof live load is 50 lb/ft^2.

2.2.3.2 Precipitation Loads

The maximum snow load and ice load for the facility is less than the minimum roof live load specified in section 2.2.3.1. For normal rainfall (4 in/hr), a conventional roof drain and downspout system will discharge all roof runoff into the yard drainage system. However, one or more of the following will be used to prevent buildup of standing water on the roof:

1. The parapets may be deleted on one or more sides of the building.

2. The parapet height may be limited to preclude a buildup of water in excess of the structural capacity of the roof for the design live load on the roof.

3. Scuppers may be installed through the parapets to discharge the standing water over the edge of the building.

2.2.3.3 Definitions of Load Terms

The following terms are used in the load combination equations for this safety-related structure:

Normal loads, which are those loads to be encountered during normal facility operation and include:

D--Dead loads, or their related internal moments and forces including any permanent equipment load.

L--Live loads, or their related internal moments and forces including any movable equipment loads, and other loads which vary with intensity and occurrence.

T_o-Thermal effects and loads during normal operating conditions, based on the most critical transient or steady-state condition.

Severe environmental loads include:

W--Loads generated by the design basis wind.

Extreme environmental loads include:

E--Loads generated by safe shutdown earthquake.

W_t--Load generated by the design basis tornado.

Other loads:

L_c--Construction live loads.

2.2.4 Load Combinations

2.2.4.1 General

The required section strength to be used in the design is the maximum value among the several values of U and S determined from the loading combinations of sections 2.2.4.2 and 2.2.4.3.

Situations occur where one or more loads in a loading combination have opposite signs from the other loads in the same combinations. The following situations will be investigated for possible reversal of net effects, and for determination of maximum moments and forces:

1. Area distribution for live load.

2. Maximum value of live load.

3. Zero value for live load.

Other loads will be combined with these live load situations as specified in section 2.2.4.2 and 2.2.4.3.

Creep has an insignificant effect on design of relatively thick reinforced concrete structures because of its relation to stress with time and relatively low operating stress conditions, and because it primarily serves to relieve stresses without encroaching on structural safety. It is therefore not considered in the design of the VR/SS structure.

Where structural effects of shrinkage or differential settlement may be significant, they shall be included with D in equation (1) of section 2.2.4.2. An estimate of shrinkage will be based on a realistic assessment of such an effect occurring in service.

2.2.4.2 Load Combinations for the Safety-Related Concrete Structure

The strength design method will be used. The required section strength U, as defined in ACI 318-77, will be at least equal to the greatest of load combinations as follows:

1. $U = 1.4D + 1.7L$

2. $U = 0.75\ (1.4D + 1.7L + 1.7W + 1.7T_o)$

3. $U = D + L + E + T_o$

4. $U = D + L + W_t + T_o$

5. $U = 1.4D + 1.7L + 1.7W$

The concrete structure required to contain the maximum expected liquid inventory will meet the requirements for water-tight structures.

2.2.4.3 Load Combination for Safety-Related Steel Structure

The elastic working stress design methods of Part I of the AISC specifications will be used where S is the required section strength. The following load combinations shall be considered:

1. $S = D + L$

2. $S = D + L + W$

3. $1.5S = D + L + T_o$

4. $1.5S = D + L + T_o + W$

5. $1.6S = D + L + T_o + E$

6. $1.6S = D + L + T_o + W_t$

2.2.5 Foundation

2.2.5.1 General

The structure will be supported upon a foundation system of reinforced concrete caissons or steel H-piles, which will rest upon or socket into sound bedrock.

2.2.5.2 Reinforced Concrete Caissons and H-piles

The reinforced concrete caissons or steel H-piles will be designed to withstand all loading combinations as outlined in sections 2.2.4.2 and 2.2.4.3.

For the load on foundation rock or soil, the load combinations in section 2.2.4.2 and 2.2.4.3 will be used with unfactored loads. Design allowables for the rock and soil will be developed based upon information gathered from subsurface investigations and as defined in section 2.5 of the SQNP FSAR. The basis for these design allowables will be documented for design and verified by additional subsurface investigation before construction, if required.

2.2.6 Structural Concrete

All structural cast-in-place concrete shall have a specified minimum design compressive strength of 3000 psi. For verification, concrete cylinders will be prepared and tested up to 180 days to determine the strength gain with age. The weight of concrete will be taken as 150 pcf in all structural calculations. Considering the long range strength gain of fly ash concrete, all structural concrete mixes will attain a static Young's modulus of 5×10^6 psi. Additional concrete properties are:

1. Poisson's Ratio: 0.15 to 0.20

2. Thermal Conductivity: 1.5 to 1.7 BTU per square foot per hour per °F per foot.

3. Thermal Coefficient of Expansion: 5×10^{-6} inches per inch per °F.

2.2.7 Steel

2.2.7.1 Reinforcing Steel

Reinforcing steel will be Grade 60 deformed bars per specification ASTM A615. For tighter bend and tension test requirements, supplementary requirement S1 of ASTM A 615-79 will apply.

2.2.7.2 Structural Steel

Rolled shapes, plates, and bars shall be fabricated per specification ASTM A36. Fabricated high-strength steel will be per specification ASTM A572, and bolting will be per specification ASTM A325 or A490. Anchor bolts will be per ASTM A307 or A36.

2.2.7.3 Shear Walls

Shear walls will be provided for seismic loads such that the maximum combination of lateral forces are transmitted to the base of the structure. The walls will be designed in accordance with ACI 318-77.

2.3 Security

The VR/SS facility is to be located inside the plant protected area and will have the same level of access control as the rest of the plant. The facility is not considered a vital area, so no additional security measures are required.

2.4 Fire Protection

2.4.1 Water Supply

The water supply for the fire protection system for the VR/SS facility is provided by the Sequoyah Nuclear Plant high pressure fire protection (HPFP) system. Refer to SQNP FSAR Section 9.5, 'Fire Protection System,' for a detailed description of the HPFP system.

2.4.2 Automatic Fire Detection System

An automatic fire detection system is provided for the facility and is designed in accordance with National Fire Protection Association (NFPA) Standards No. 72D and 72E. The system's initiating devices consist of fire detectors zoned such that a fire location can be identified and fire protection features controlled. In addition, manual alarm stations are provided at egress points from the facility.

The local detection panel is located at the main control point of the volume reduction and solidification building. The detection panel provides local building alarms and a common alarm signal for annunciation in the nuclear plant's main control room.

2.4.3 Portable Fire Extinguishers

Portable fire extinguishers, approved for use on Class A, B, and C fires, are installed within the facility in accordance with the NFPA Standard No. 10.

2.4.4 A Class III Standpipe and Hose System

A Class III standpipe and hose system designed in accordance with NFPA Standard No. 14 is provided throughout the facility.

2.4.5 Automatic Preaction Sprinkler System

An automatic preaction sprinkler system designed in accordance with NFPA Standard No. 13 is provided throughout the facility, except in isolated rooms containing no combustible material and having limited access. Actuation of the suppression system is by the automatic fire detection system.

2.4.6 Portable Equipment

In addition to a preaction sprinkler system, portable equipment is provided in the vicinity of the Dow Filling Station for applying a foam-water solution on a fire involving the solidification binder which is a styrene monomer cross-linked with a vinyl ester resin.

2.4.7 Outside Fire Protection

Outside fire protection is provided in accordance with NFPA Standard No. 24. Hydrants supplied with hydrant houses with firefighting equipment are appropriately located around the facility.

2.5 Radiation Protection and ALARA

2.5.1 Objectives for Exposures

2.5.1.1 Objectives for Exposure to Plant Occupational Workers

The facility shall be designed such that exposures to plant radiation workers during normal operation are in accordance with 10 CFR 20 and the requirements of TVA's radiation protection plan. The requirements given in the latter two documents constitute maximum acceptable levels, and not design objectives.

2.5.1.2 Objectives for Exposures to Visiting Radiation Workers

The facility is designed such that the whole body dose limits for visiting radiation workers and TVA employees are limited to:

1. 300 mrem/calendar quarter, or

2. 1250 mrem/calendar quarter if dose records are supplied for the individual(s) for the present calendar quarter. The exposure permitted shall be adjusted so that the total received shall not exceed the 1250 mrem/calendar quarter.

3. 3000 mrem/calendar quarter if the requirements of item 2 and 10 CFR 20.101 (b) are met, and written authorization of the individual's employer is obtained.

2.5.1.3 Objectives for Exposures to Nonoccupational Workers and Visitors

The facility shall be designed such that the whole body dose limits to nonoccupational workers and visitors will be in accordance with 10 CFR 20.105(a) and 20.105(b)(1) and (2); i.e., 500 mrem/yr, 2 mrem/hr, and 100 mrem/7 consecutive days for unrestricted areas.

2.5.2 Design Objectives

Shielding of the facility is provided to the design objectives described in section 2.5.3, 'Radiation Shielding,' so that the exposure objectives, described above, can be met.

The plant is designed so that the radiation level in hallways of buildings containing radioactive equipment does not exceed 1.0 mrem/hr during normal operation.

Ventilation of the facility is designed such that the concentrations of radioactive materials in areas can be maintained within acceptable limits.

The area radiation and airborne radioactivity monitoring systems will be designed to comply with detailed criteria that will be developed. These criteria will encompass ALARA and other regulatory requirements.

The solid waste end products, before shipping out for offsite disposal or storage, will be prepared in such a way as to comply with 10 CFR 71, and 49 CFR 171-179, for packaging and transportation of radioactive materials.

2.5.3 Radiation Shielding

The shielding for the facility is designed in compliance with 10 CFR Part 20 and 10 CFR Part 50, Appendix A, Design Criteria 60 and 63, to ensure that:

1. The occupational radiation exposures to individuals in restricted areas are adequately controlled.

2. The intakes of radioactive material by individuals in restricted areas are adequately controlled.

3. The release of radioactive materials to the environment is adequately controlled.

4. Monitoring waste storage is implemented so that conditions leading to excessive radiation levels can be detected.

Efforts shall be made to insure that occupational radiation exposures at the facility will be as low as reasonably achievable in compliance with NRC Regulatory Guide 8.8, and to control the spread of contamination. Also, potential radiation damage to equipment and materials shall be kept within tolerable limits.

Fabrication and installation of concrete radiation shields shall be done in accordance with Regulatory Guide 1.69.

2.5.4 Radiation Monitoring

The radiation monitoring system for the VR/SS includes: area gamma radiation monitoring and airborne particulate monitoring for personnel protection, building vent effluent monitoring for assessment of radioactive releases to the environment, and process area monitoring for selected equipment cubicles. Liquid effluents will be discharged in accordance with Section 5.1.2.2 Water Quality.

Fixed area radiation monitors and airborne particulate monitors are located in areas occupied by personnel during normal operations and maintenance where changes in operating conditions or equipment failure could result in significant increases in exposure to personnel.

The building vent effluent monitor provides continuous monitoring and quantification of radioactivity in effluents released to the environment in accordance with the requirements of NRC Regulatory Guide 1.21. The capability of grab sampling of the effluent is also provided.

Provisions are made to enable smear surveying and radiation monitoring of each processed waste storage container before storage or loading on a truck.

2.6 Quality Assurance

To ensure confidence in the VR/SS to perform as intended, a quality assurance program will be established and documented. As a minimum, this program will conform to the guidelines of NRC Regulatory Guide 1.143, and will be incorporated in addition to the codes and standards requirements listed in Table 2.8-1.

2.7 Electrical Requirements

The VR/SS facility will be provided with electrical power supplied from a 161/6.9 kV substation located in the transformer yard south of the turbine building.

2.8 Equipment Codes

All VR/SS equipment is designed, procured, constructed, and inspected in accordance with the codes and standards identified in Table 2.8-1.

TABLE 2.1-1

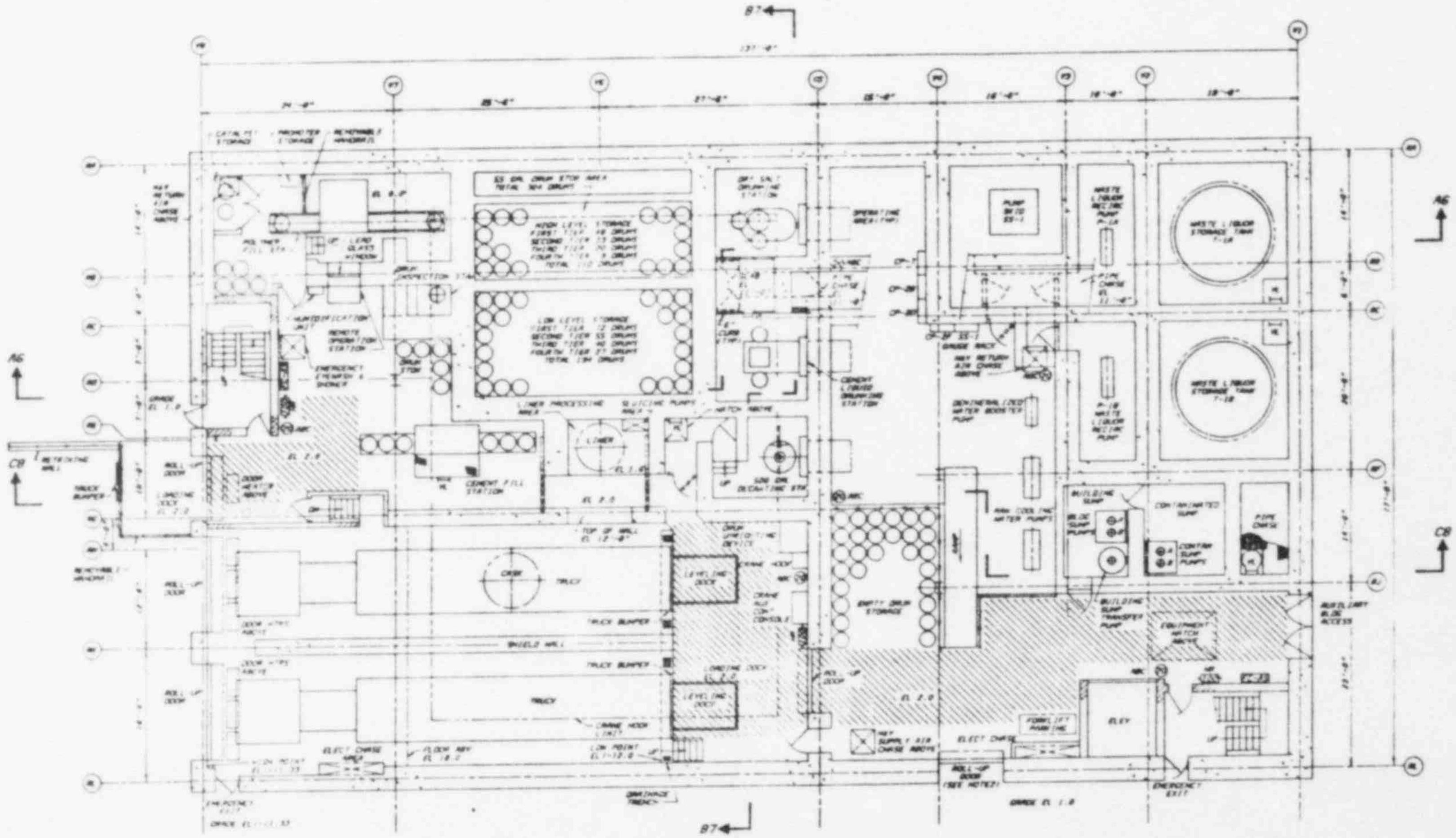
RADIONUCLIDE DISRIBUTION IN INFLOW WASTE STREAMS

Isotope	Concentrated Liquid (μCi/yr)	Spent Regenerant (μCi/yr)	Trash (μCi/yr)	Total (μCi/yr)
Br 84	1.3×10^{3}	2.2×10^{3}		3.5×10^{3}
Rb 88	3.6×10^{4}	2.7×10^{4}		6.3×10^{4}
Rb 89	7.3×10^{2}	5.3×10^{2}		1.3×10^{3}
I 131	1.2×10^{9}	1.7×10^{8}	2.5×10^{7}	1.4×10^{9}
I 132	4.9×10^{7}	1.0×10^{7}	1.1×10^{6}	6.0×10^{7}
I 133	1.3×10^{8}	3.9×10^{7}		1.7×10^{8}
I 134	5.2×10^{4}	7.7×10^{4}		1.3×10^{5}
I 135	1.1×10^{7}	5.7×10^{6}		1.7×10^{7}
Cs 134	8.1×10^{8}	2.4×10^{7}	4.4×10^{6}	8.4×10^{8}
Cs 136	1.1×10^{8}	1.1×10^{7}	1.6×10^{6}	1.2×10^{8}
Cs 137	4.0×10^{9}	1.2×10^{8}	3.2×10^{6}	4.1×10^{9}
Cs 138	3.0×10^{4}	2.2×10^{4}		5.2×10^{4}
Cr 51	1.5×10^{6}	7.3×10^{7}		7.4×10^{7}
Mn 54	2.8×10^{6}	7.1×10^{5}		3.5×10^{6}
Mn 56	2.2×10^{4}	9.8×10^{4}		1.2×10^{5}
Fe 59	2.2×10^{6}	8.4×10^{5}		3.0×10^{6}
Co 58	6.6×10^{7}	2.2×10^{5}	4.2×10^{6}	7.0×10^{7}
Co 60	2.9×10^{6}	6.9×10^{5}		3.6×10^{6}
Sr 89	8.7×10^{6}	4.0×10^{5}	5.9×10^{4}	9.2×10^{6}
Sr 90	4.4×10^{5}	1.3×10^{4}	1.6×10^{3}	4.5×10^{5}
Sr 91	1.8×10^{4}	6.0×10^{3}		2.4×10^{4}
Y 90	4.4×10^{5}	1.3×10^{4}		4.5×10^{5}
Y 91m	1.2×10^{4}	1.9×10^{3}		1.4×10^{4}
Y 91	1.3×10^{7}	5.9×10^{5}		1.4×10^{7}
Y 92	0	5.2×10^{2}		5.2×10^{2}
Zr 95	1.7×10^{6}	7.2×10^{4}		1.8×10^{6}
Nb 95m	0	6.3×10^{2}		6.3×10^{2}
Nb 95	2.2×10^{6}	7.4×10^{4}		2.3×10^{6}
Mo 99	7.9×10^{8}	1.6×10^{8}	7.9×10^{7}	1.0×10^{9}
Tc 99m	7.4×10^{8}	1.5×10^{8}	7.9×10^{7}	9.7×10^{8}
Tc 99	0	1.6×10^{1}		1.6×10^{1}
Te 132	4.7×10^{7}	9.2×10^{6}	1.1×10^{6}	5.7×10^{7}
Te 134	1.7×10^{3}	1.1×10^{3}		2.8×10^{3}
Ba 137m	3.7×10^{9}	1.1×10^{8}	3.2×10^{6}	3.8×10^{9}
Ba 140	$3.3 \times 10^{\text{[illegible]}}$	3.4×10^{5}		3.6×10^{6}
La 140	3.5×10^{6}	3.3×10^{5}		3.8×10^{6}
Ce 144	8.9×10^{5}	3.1×10^{4}		9.2×10^{5}
Pr 144	8.9×10^{5}	3.1×10^{4}		9.2×10^{5}
	1.2×10^{10}	8.9×10^{8}	2.0×10^{8}	1.3×10^{10}

TABLE 2.8-1

Equipment	Design and Fabrication	Materials[1]	Welder Qualification and Procedures	Inspection and Testing
	CODES AND STANDARDS			
Pressure Vessels	ASME Code Section VIII, Div. 1	ASME Code Section II	ASME Code Section IX	ASME Code Section VIII, Div. 1
Atmospheric Tanks	ASME Code[3] Section III, Class 3 or API 650, or AWWA D-100[2]	ASME Code[2] Section II	ASME Code Section IX	ASME Code[3] Section III, Class 3 or API 650, or AWWA D-100[2]
0-15 PSIG Tanks	ASME Code[3] Section III, Class 3 or API 620[2]	ASME Code[2] Section II	ASME Code Section IX	ASME Code[3] Section III, Class 3 or API 620[2]
Heat Exchangers	ASME Code Section VIII, Div. 1 and TEMA	ASME Code Section II	ASME Code Section IX	ASME Code Section VIII, Div. 1
Piping and Valves	ANSI B31.1	ASTM and ASME Code Section II	ASME Code Section IX	ANSI B31.1
Pumps	Manufacturers' Standards[4]	ASME Code Section II or Manufacturers' Standards	ASME Code Section IX (as required)	ASME Code[3] Section III, Class 3; or Hydraulic Institute

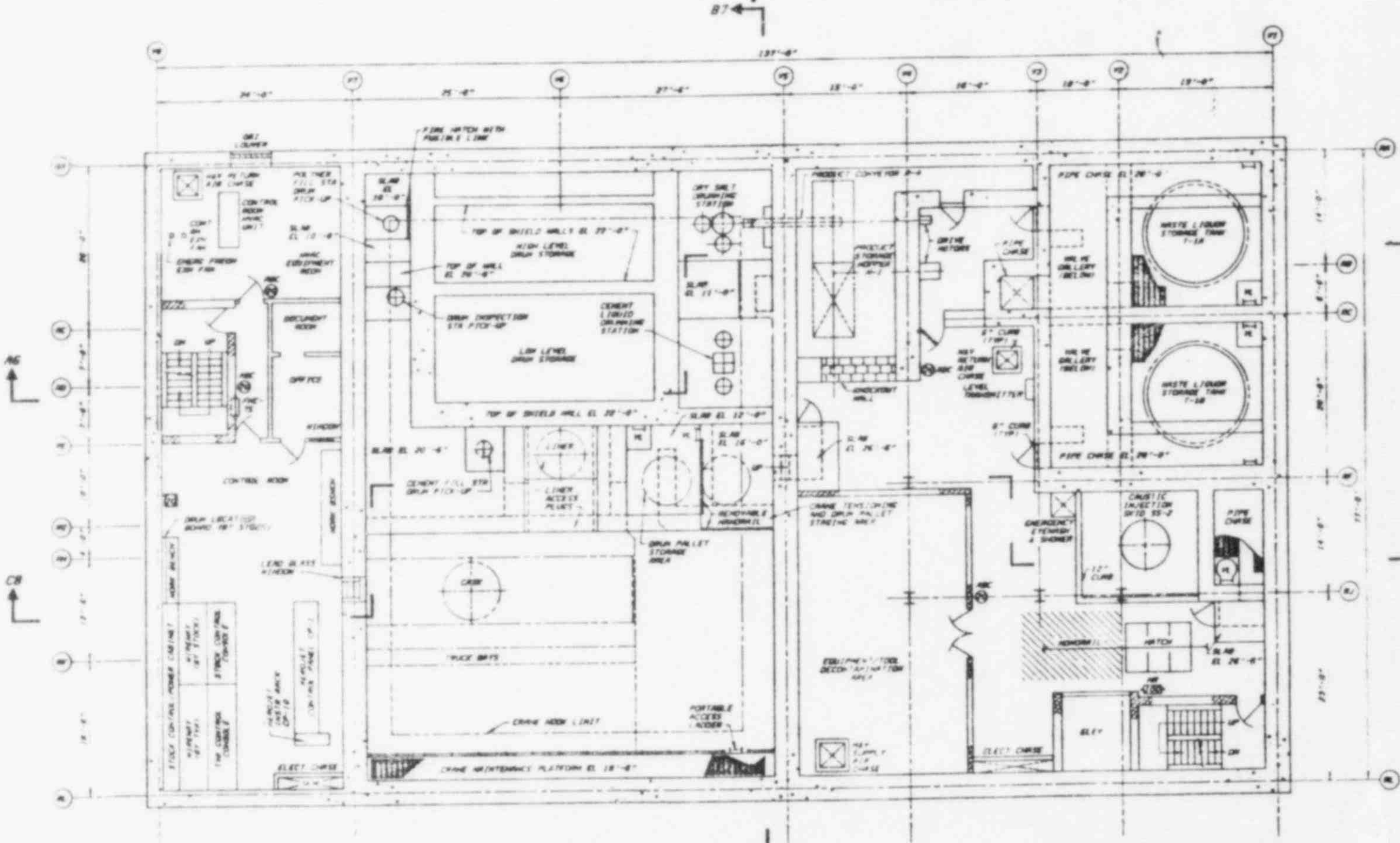
1. Manufacturers' material certificates of compliance with material specifications may be provided in lieu of certified material.
2. Fiberglass-reinforced plastic tanks may be used in accordance with appropriate articles of Section 10 of the ASME Boiler and Pressure Vessel Code for applications at ambient temperature.
3. ASME Code stand, material traceability, and the quality assurance criteria of Appendix B to 10 C.F.R. Part 50 are not required. Therefore, these components are not classified as ASME Code Class 3.
4. Manufacturers' standard for the intended service. Hydrotesting should be 1.5 times the design pressure.



This drawing reflects contracted equipment and process capability for resin incineration. This equipment and process capability will be installed but will not be utilized at this time.

SEQUOYAH NUCLEAR PLANT
VOLUME REDUCTION AND SOLIDIFICATION FACILITY

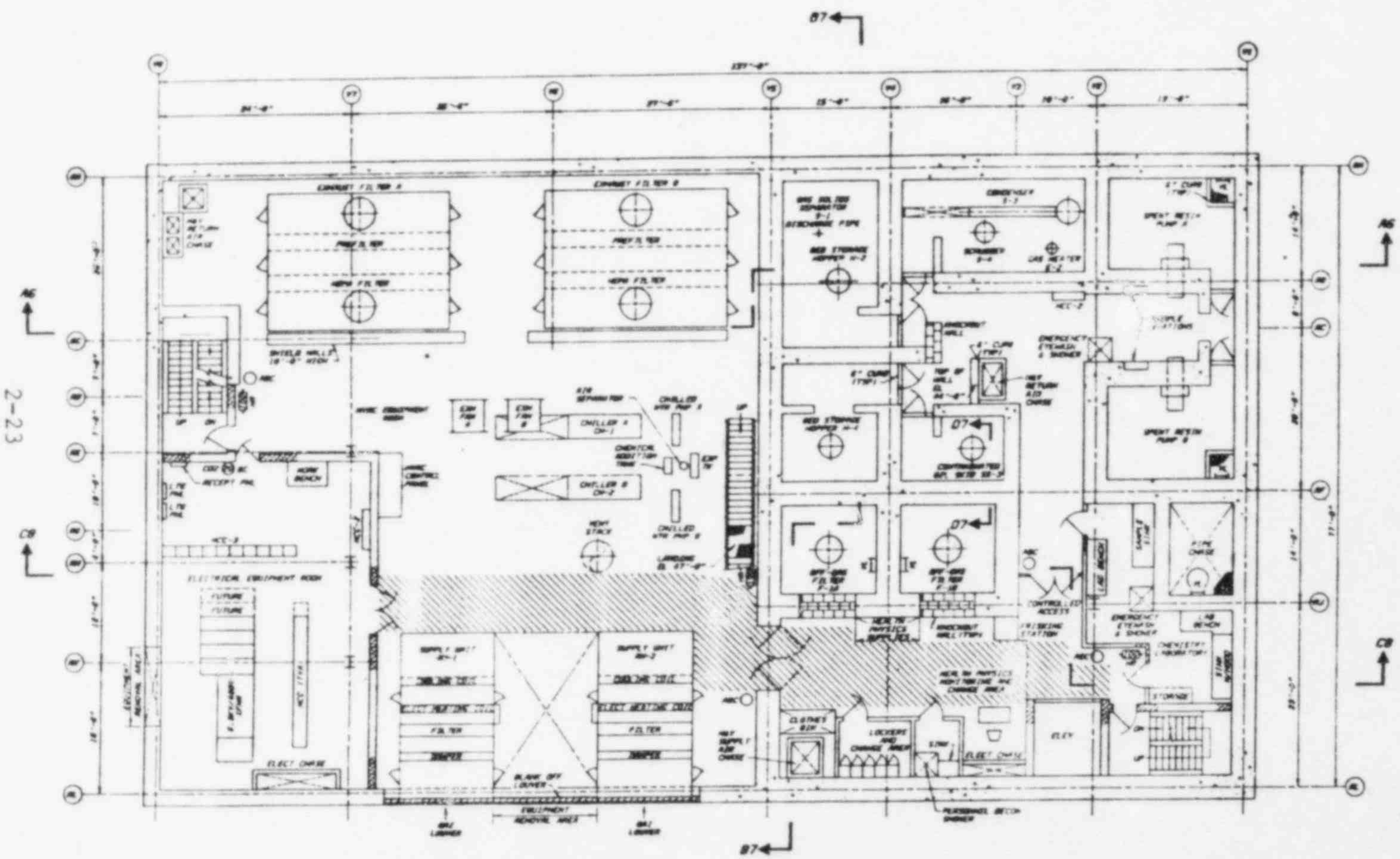
EQUIPMENT
PLAN ELEVATION 6.8
FIGURE 2.1-1



This drawing reflects contracted equipment and process capability for resin incineration. This equipment and process capability will be installed but will not be utilized at this time.

SEQUOYAH NUCLEAR PLANT
VOLUME REDUCTION AND SOLIDIFICATION FACILITY

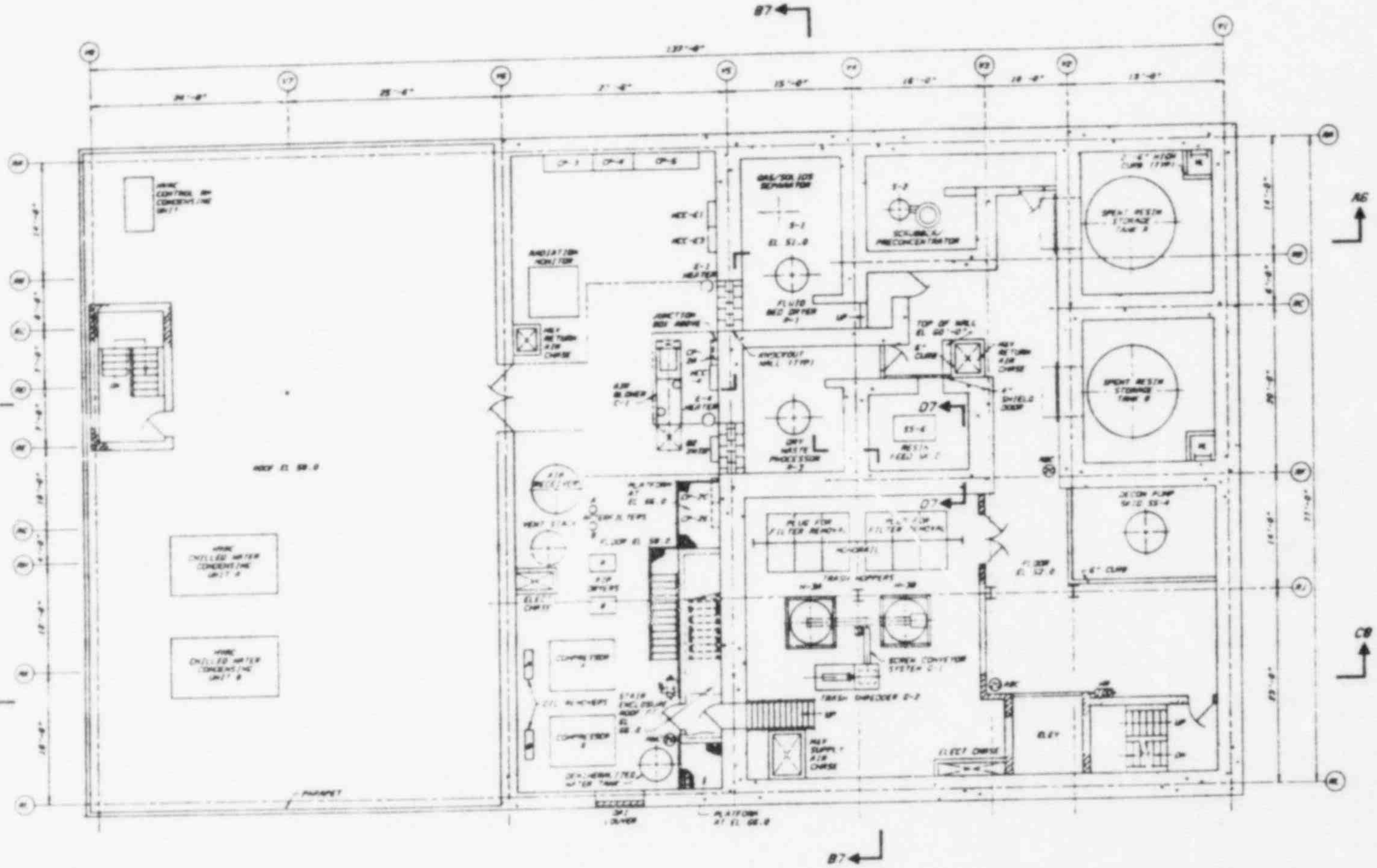
EQUIPMENT
PLAN ELEVATION 18.0
FIGURE 2.1-2



This drawing reflects contracted equipment and process capability for rade incineration. This equipment and process capability will be installed but will not be utilized at this time.

SEQUOYAH NUCLEAR PLANT
VOLUME REDUCTION AND SOLIDIFICATION FACILITY

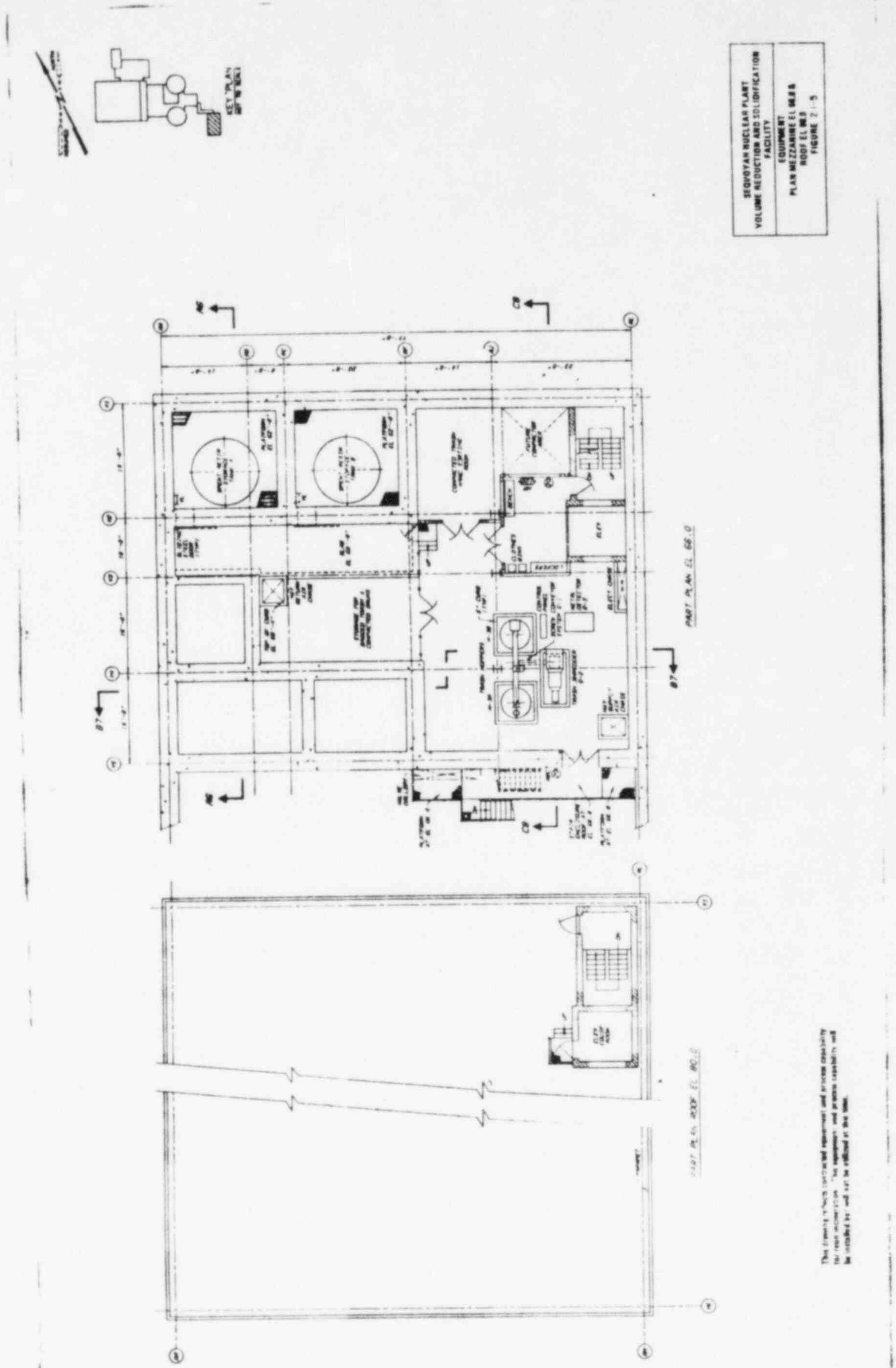
EQUIPMENT
PLAN ELEVATION 36.0
FIGURE 2.1-3

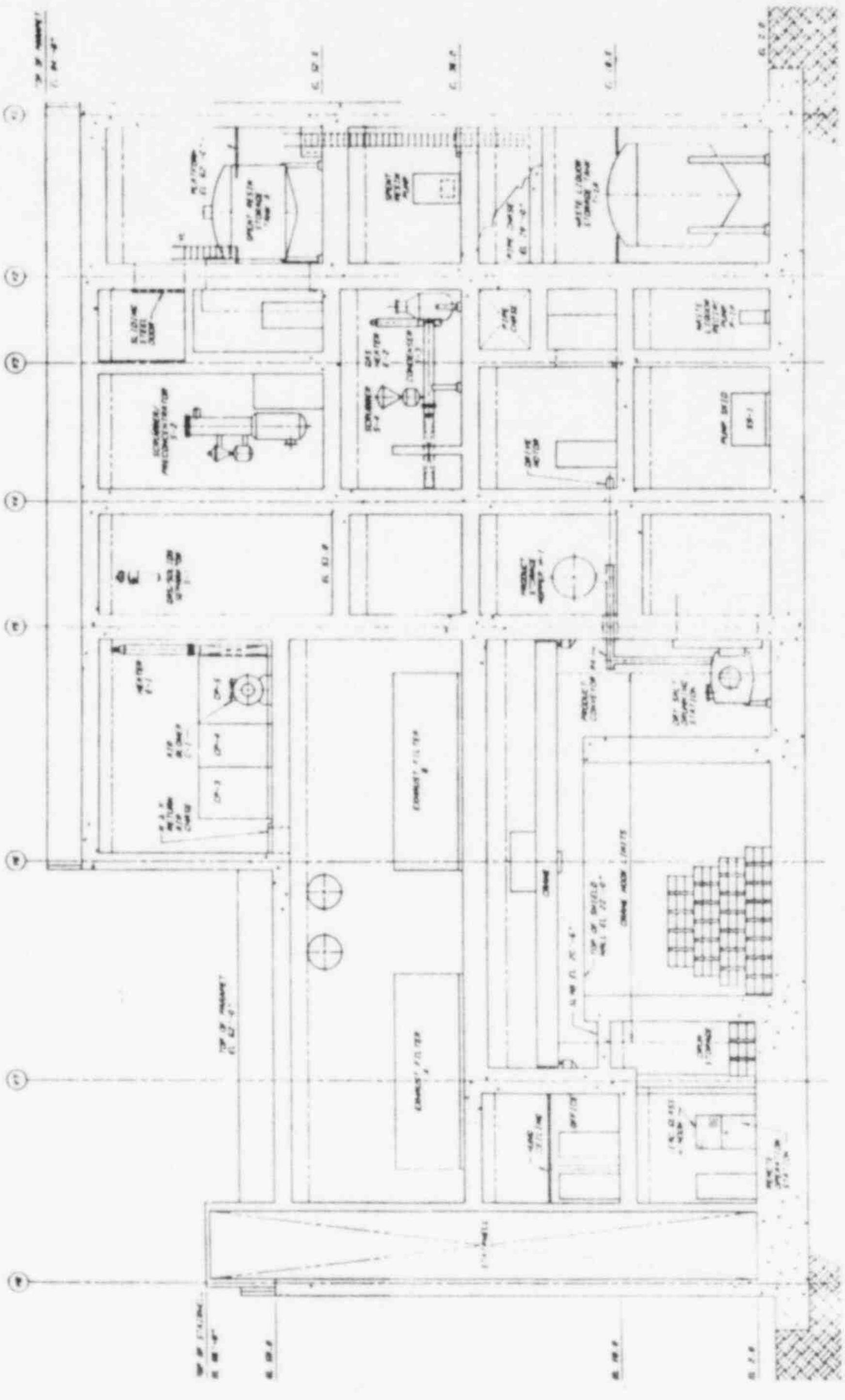


SEQUOYAH NUCLEAR PLANT
VOLUME REDUCTION AND SOLIDIFICATION FACILITY

EQUIPMENT
PLAN ELEVATION 52.0 & 58.0
FIGURE 2.1-4

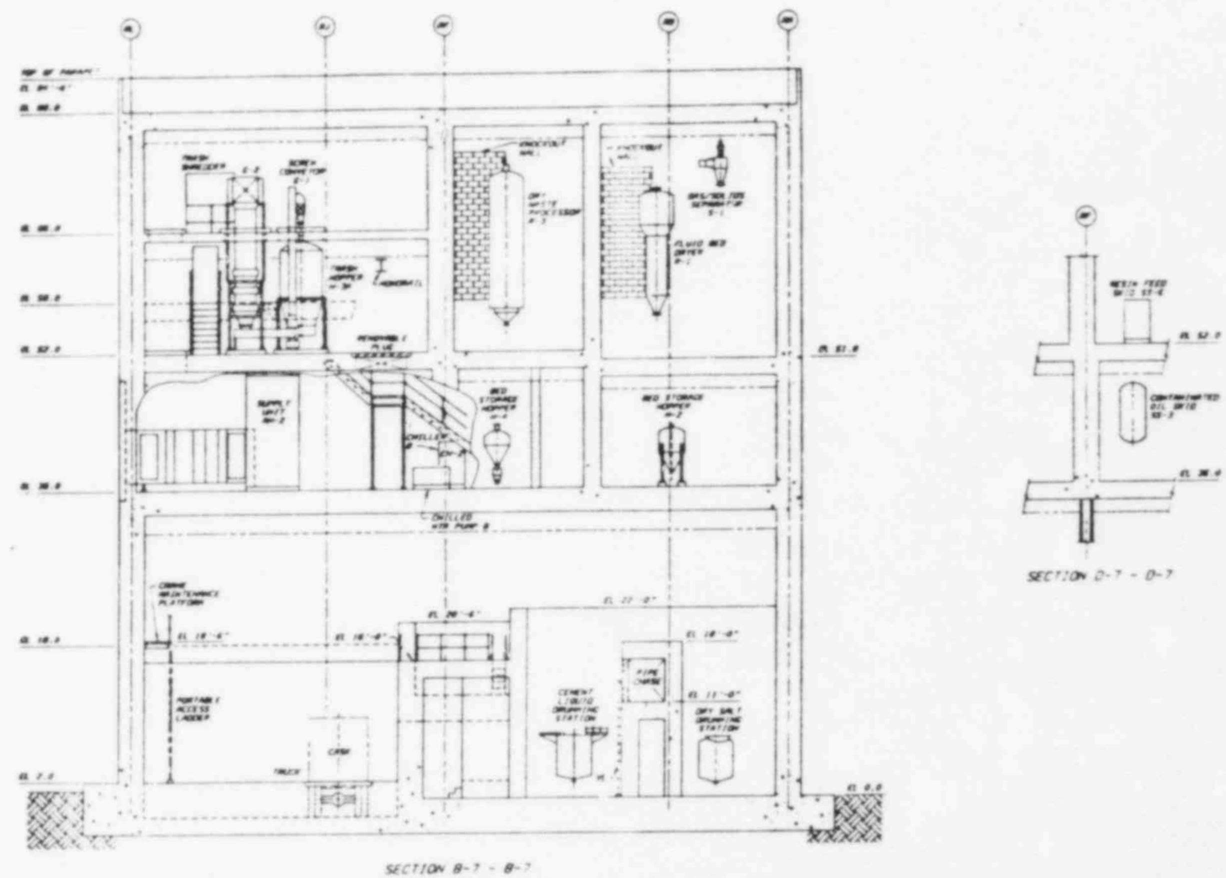
This drawing reflects contracted equipment and process capability for resin incineration. This equipment and process capability will be installed but will not be utilized at this time.


SEQUOYAH NUCLEAR PLANT
VOLUME REDUCTION AND SOLIDIFICATION FACILITY
EQUIPMENT
PLAN MEZZANINE EL [illegible]
ROOF EL [illegible]
FIGURE 2.1-5



This drawing reflects contracted equipment and process capability for resin incineration. The equipment and process capability will be installed but will not be utilized at this time.

SEQUOYAH NUCLEAR PLANT
VOLUME REDUCTION AND SOLIDIFICATION FACILITY
EQUIPMENT
LONGITUDINAL SECTION A8-A8
FIGURE 2.1-6



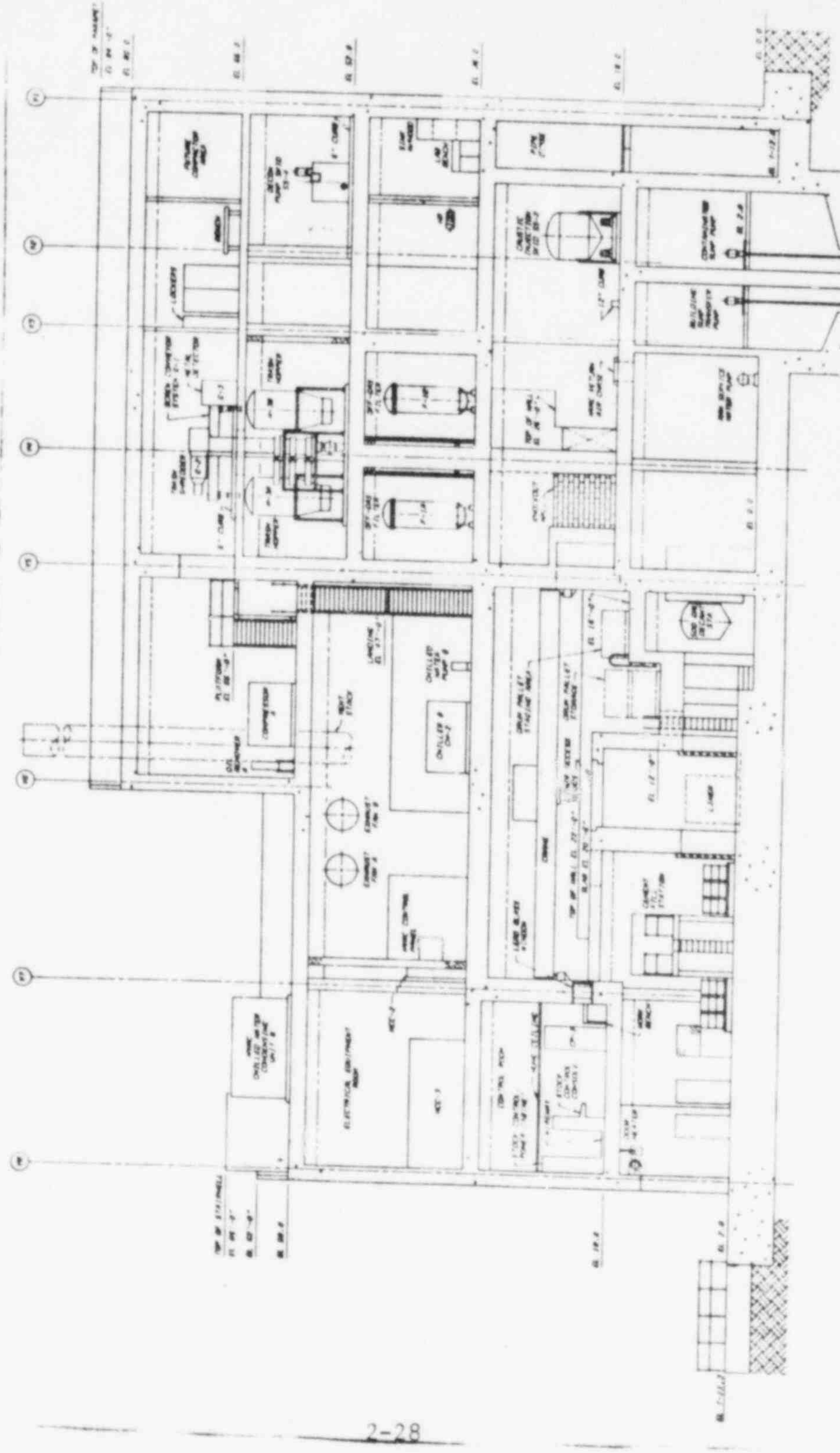
This drawing reflects contracted equipment and process capability for resin incineration. This equipment and process capability will be installed but will not be utilized at this time.

SEQUOYAH NUCLEAR PLANT
VOLUME REDUCTION AND SOLIDIFICATION FACILITY

EQUIPMENT
SECTION B-7 - B-7 &
D-7 - D-7
FIGURE 2.1-7

SEQUOYAH NUCLEAR PLANT
VOLUME REDUCTION AND SOLIDIFICATION FACILITY

EQUIPMENT
LONGITUDINAL SECTION C8-C8
FIGURE 2.1-8



This drawing reflects constructed equipment and process capability for resin incineration. This equipment and process capability will be installed but will not be utilized at this time.

This figure corresponds to AECC drawing number 1193002 Sheet 1 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
VOLUME REDUCTION P & ID'S FIGURE 2.1-9

This figure corresponds to AECC drawing number 1193002 Sheet 2 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
VOLUME REDUCTION P & ID'S FIGURE 2.1-10

This figure corresponds to AECC drawing number 1193002 Sheet 3 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM

VOLUME REDUCTION
P & ID'S
FIGURE 2.1-11

This figure corresponds to AECC drawing number 1193002 Sheet 4 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
VOLUME REDUCTION P & ID'S FIGURE 2.1-12

This figure corresponds to AECC drawing number 1193002 Sheet 5 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
VOLUME REDUCTION P & ID'S FIGURE 2.1-13

This figure corresponds to AECC drawing number 1193002 Sheet 6 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
VOLUME REDUCTION P & ID'S FIGURE 2.1-14

This figure corresponds to AECC drawing number 1193002 Sheet 7 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION
AND SOLIDIFICATION SYSTEM

VOLUME REDUCTION
P & ID'S
FIGURE 2.1-15

This figure corresponds to AECC drawing number 1193002 Sheet 8 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
VOLUME REDUCTION P & ID'S FIGURE 2.1-16

This figure corresponds to AECC drawing number 1193002 Sheet 9 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION
AND SOLIDIFICATION SYSTEM

VOLUME REDUCTION
P & ID'S
FIGURE 2.1-17

This figure corresponds to AECC drawing number 1193002 Sheet 10 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM

VOLUME REDUCTION
P & ID'S
FIGURE 2.1-18

This figure corresponds to AECC drawing number 1193002 Sheet 11 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
VOLUME REDUCTION P & ID'S FIGURE 2.1-19

This figure corresponds to AECC drawing number 1193002 Sheet 12 of 12. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION
AND SOLIDIFICATION SYSTEM

VOLUME REDUCTION
P & ID'S
FIGURE 2.1-20

This figure corresponds to AECC drawing number 1193003.
In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by AECC. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
VOLUME REDUCTION P & ID'S FIGURE 2.1-21

REFERENCE: A
SYMBOL

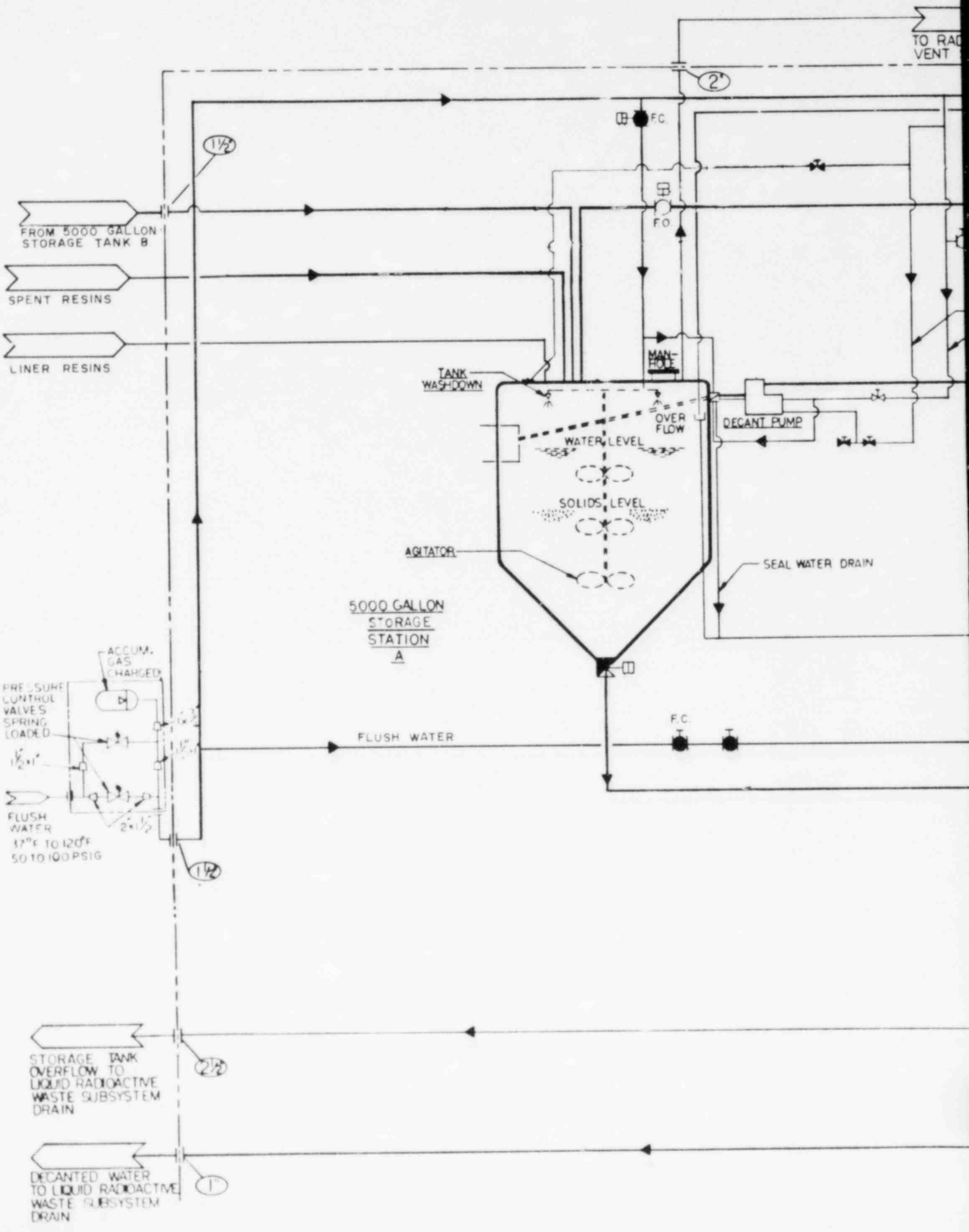
ITEM	
	MOUNTED O
	INTERNALL
	LOCALLY M
	AUTO PERM
	GATE VALV
	ROTARY PL
	SINGLE AC
	THREE-WAY
T	HAND ACTU
	FLANGE
	CHECK VAL
	FOUR-WAY
	FILTER WI
	MAJOR PRO
	AUXILIARY
	PNEUMATIC
	ELECTRIC
	CAPILLARY
	HYDRAULIC
	SONIC SIG
A.S.	AIR SUPPL
F.C.	FAIL CLOS
F.O.	FAIL OPEN
	DIRECTION
	CROSS-OV
	DIFFEREN
	CHEMICAL
	ROTARY P
	DOUBLE A
	GATE VAL
	ROTARY P
	EDUCTOR
	PRESSURE

SI Y32.20 INSTRUMENTATION S AND IDENTIFICATION
EXPLANATION
N CONTROL CONSOLE
Y PANEL MOUNTED
OUNTED
ISSIVE SEQUENCE CONTROL-INTERLOCK
E
UG VALVE
TING CYLINDER
SOLENOID VALVE
ATOR
VE
SOLENOID VALVE
TH MANUAL DRAIN
CESS FLOWS
PROCESS FLOWS
SIGNAL
SIGNAL
TUBING (FILLED SYSTEM)
SIGNAL
NAL
Y
SED
N
N OF FLOW
ER
TIAL (PRESSURE, TEMP, ETC.)
SEAL
UMP
CTING CYLINDER
VE - NORMALLY CLOSED
UG VALVE - NORMALLY CLOSED
CONTROL VALVE WITH INDICATOR

SEQUOYAH NUCLEAR PLANT

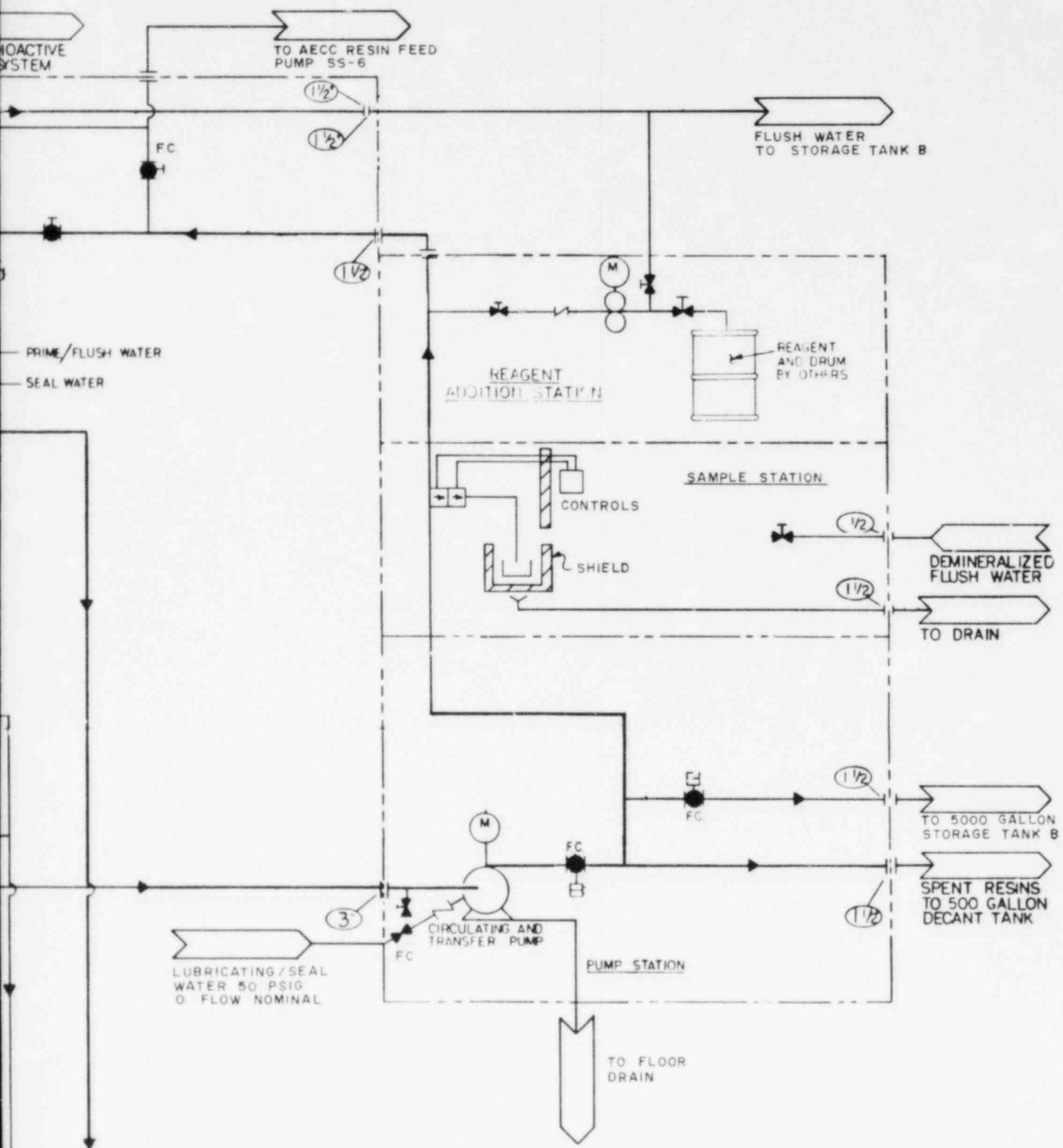
SE CO DRAWING NUMBER D17467, Sheet 1

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
SOLIDIFICATION SYSTEM P & ID'S FIGURE 2.1-22



TO RAD
VENT
2"
F.C.
1½"
FROM 5000 GALLON
STORAGE TANK B
F.O.
SPENT RESINS
LINER RESINS
MAN-HOLE
TANK WASHDOWN
OVER FLOW
DECANT PUMP
WATER LEVEL
SOLIDS LEVEL
AGITATOR
SEAL WATER DRAIN
5000 GALLON STORAGE STATION A
ACCUM. GAS CHARGED
PRESSURE CONTROL VALVES SPRING LOADED
1½×1"
FLUSH WATER
F.C.
FLUSH WATER 37°F TO 120°F 50 TO 100 PSIG
2×1½
1½
STORAGE TANK OVERFLOW TO LIQUID RADIOACTIVE WASTE SUBSYSTEM DRAIN
2½
DECANTED WATER TO LIQUID RADIOACTIVE WASTE SUBSYSTEM DRAIN
1"

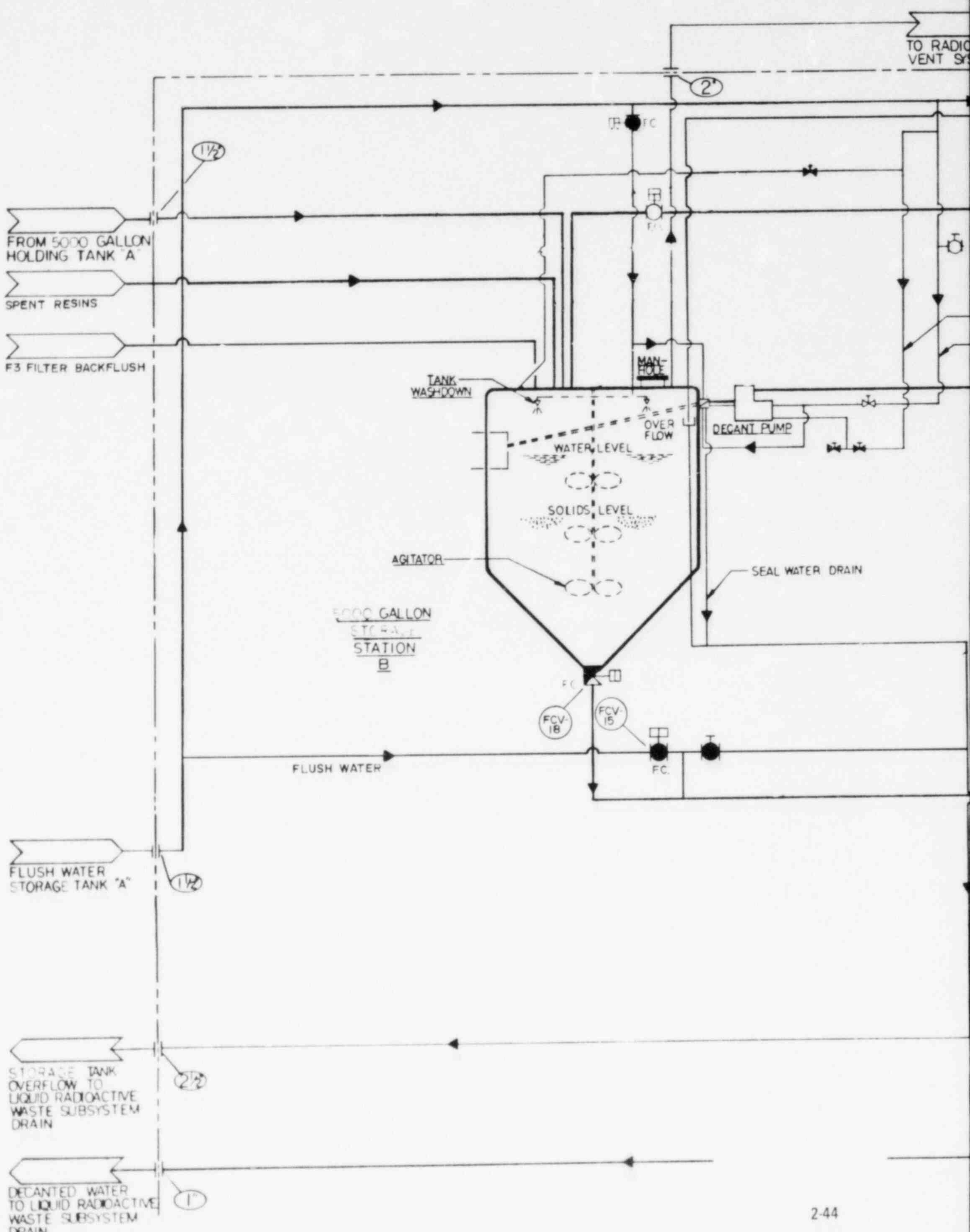
SEQUOYAH NUCLEAR PLANT

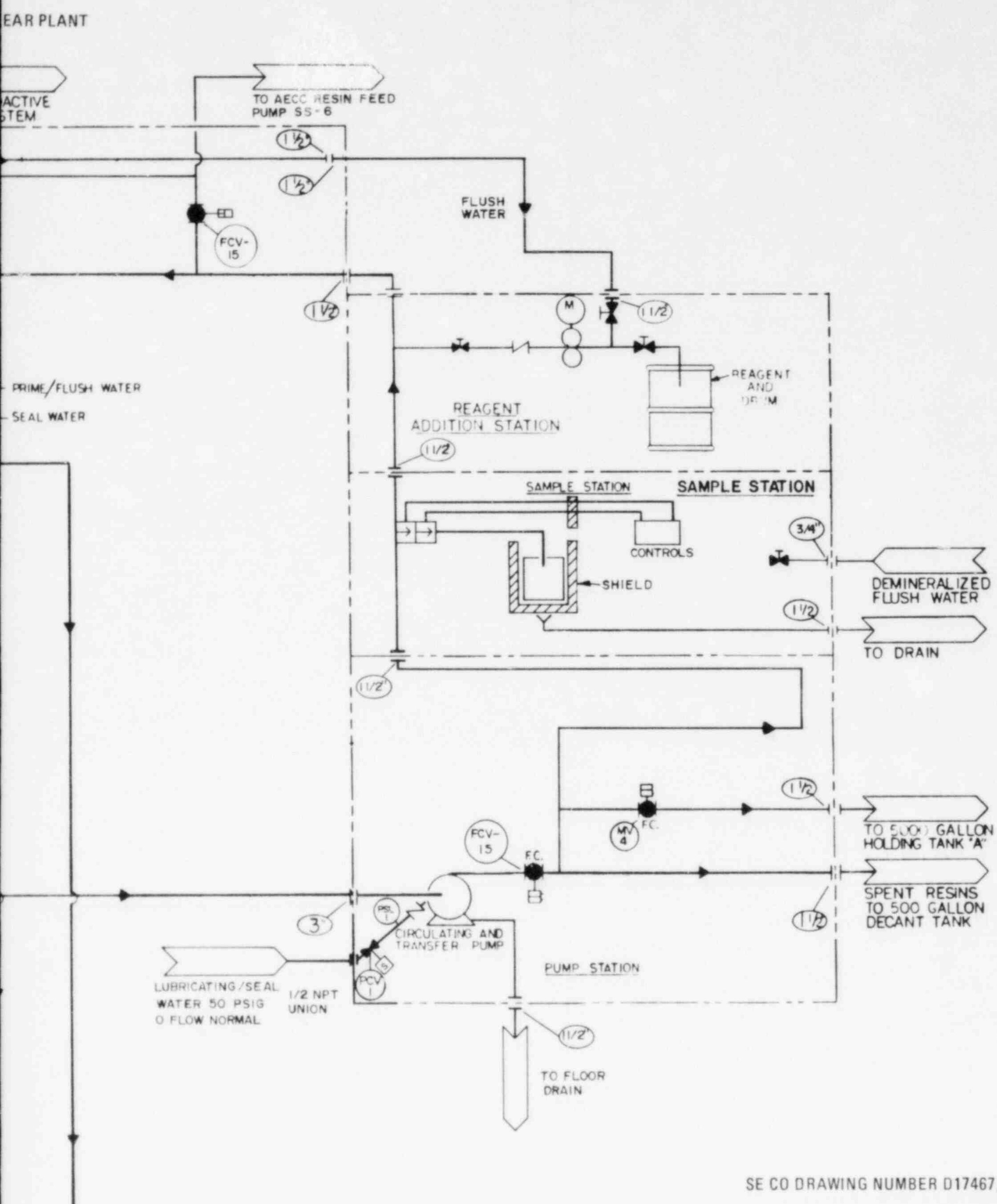


SE Co Drawing Number D17467, Sheet 2

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION
AND SOLIDIFICATION SYSTEM

SOLIDIFICATION SYSTEM
P & ID'S
FIGURE 2.1-23


TO RADIO
VENT SY
2"
1½"
F.C.
F.C.
FROM 5000 GALLON
HOLDING TANK "A"
SPENT RESINS
F3 FILTER BACKFLUSH
MAN-
HOLE
TANK
WASHDOWN
OVER
FLOW
DECANT PUMP
WATER LEVEL
SOLIDS LEVEL
AGITATOR
SEAL WATER DRAIN
5000 GALLON
STORAGE
STATION
B
F.C.
FCV-
18
FCV-
15
FLUSH WATER
F.C.
FLUSH WATER
STORAGE TANK "A"
1½"
STORAGE TANK
OVERFLOW TO
LIQUID RADIOACTIVE
WASTE SUBSYSTEM
DRAIN
2½"
DECANTED WATER
TO LIQUID RADIOACTIVE
WASTE SUBSYSTEM
DRAIN
1"



SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM

SOLIDIFICATION SYSTEM
P & ID'S
FIGURE 2.1-24

This figure corresponds to SECo drawing number LD18183 Sheet 3. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by SECo. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
SOLIDIFICATION SYSTEM P & ID'S FIGURE 2.1-25

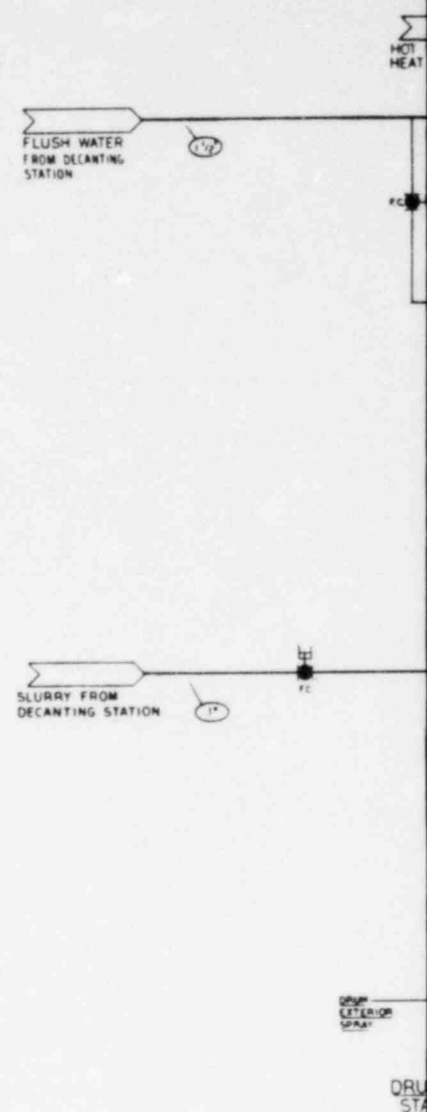
This figure corresponds to SECo drawing number 17467 Sheet 5.
In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by SECo. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM

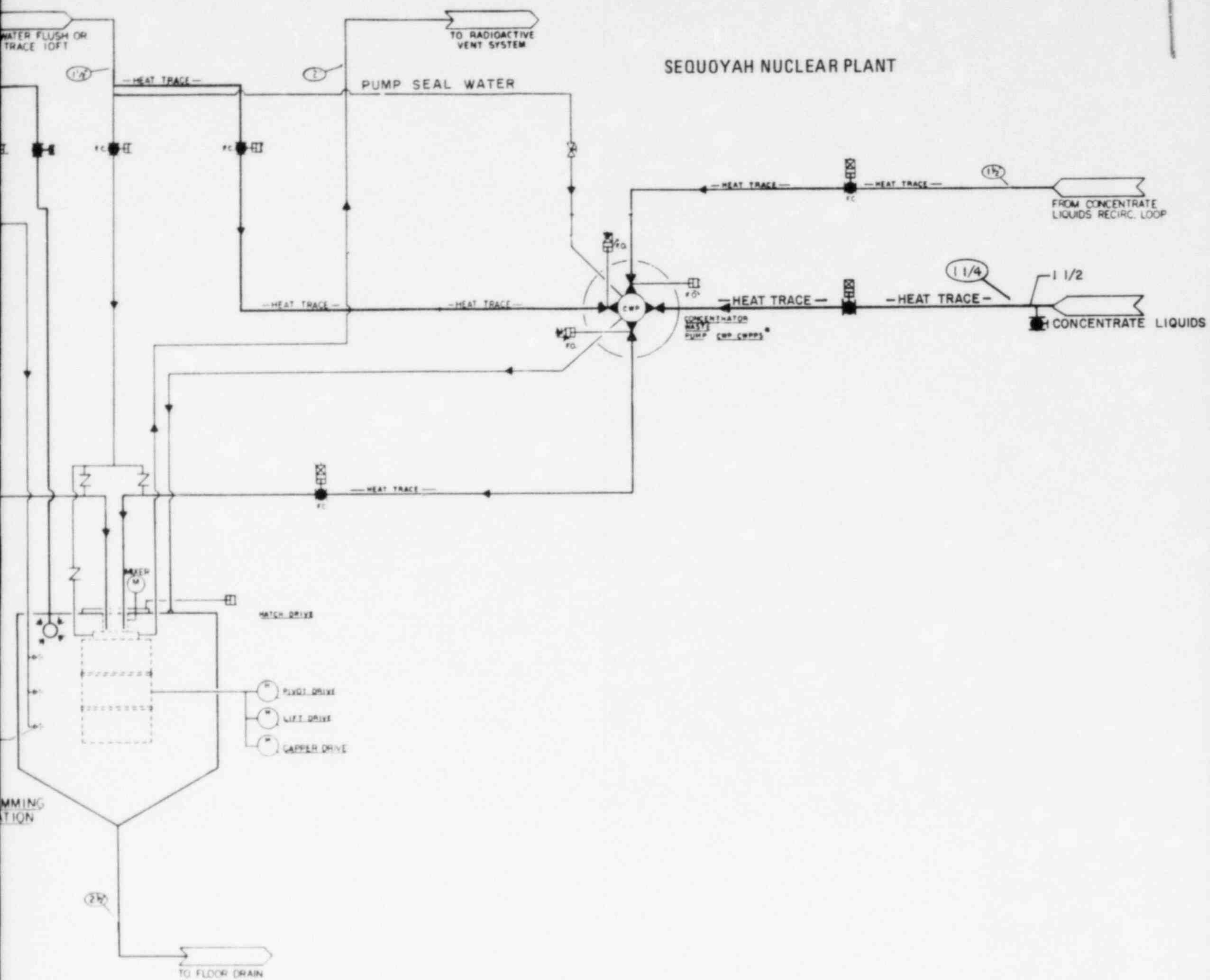
SOLIDIFICATION SYSTEM
P & ID'S
FIGURE 2.1-26

This figure corresponds to SECo drawing number LD18183 Sheet 2. In accordance with 10 CFR 2.790 paragraph (b), the information contained in this drawing is judged to be proprietary by SECo. This figure has been submitted by separate letter.

SEQUOYAH NUCLEAR PLANT RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM
SOLIDIFICATION SYSTEM P & ID'S FIGURE 2.1-27


HOT
HEAT
FLUSH WATER
FROM DECANTING
STATION
1 1/2"
FC
SLURRY FROM
DECANTING STATION
1"
FC
DRUM
EXTERIOR
SPRAY

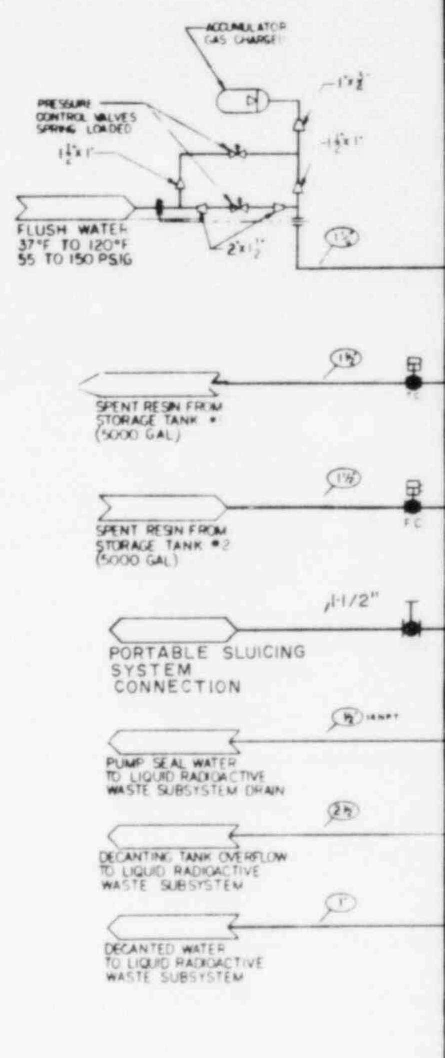
SEQUOYAH NUCLEAR PLANT

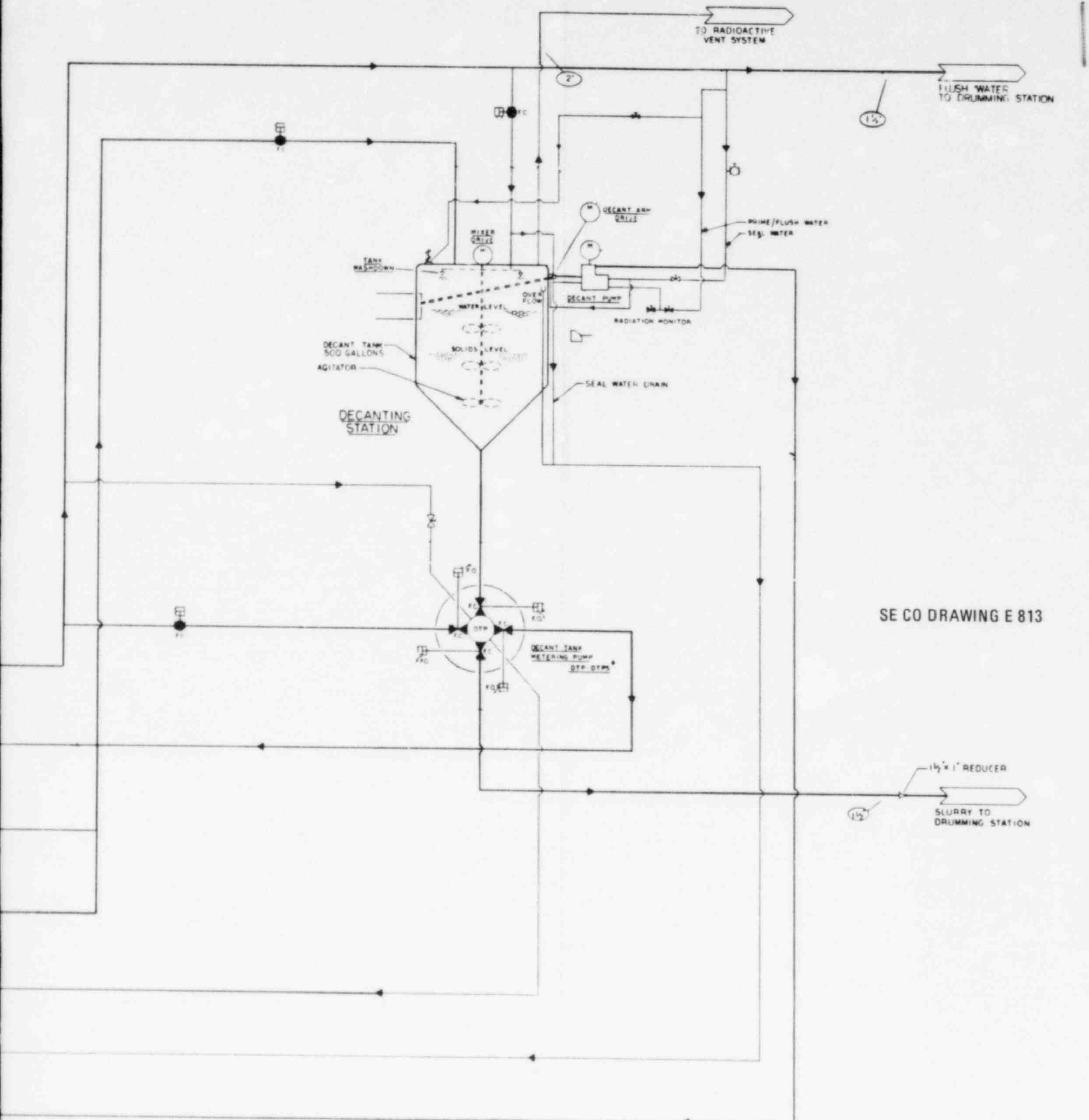


SE CO DRAWING E 812

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION
AND SOLIDIFICATION SYSTEM

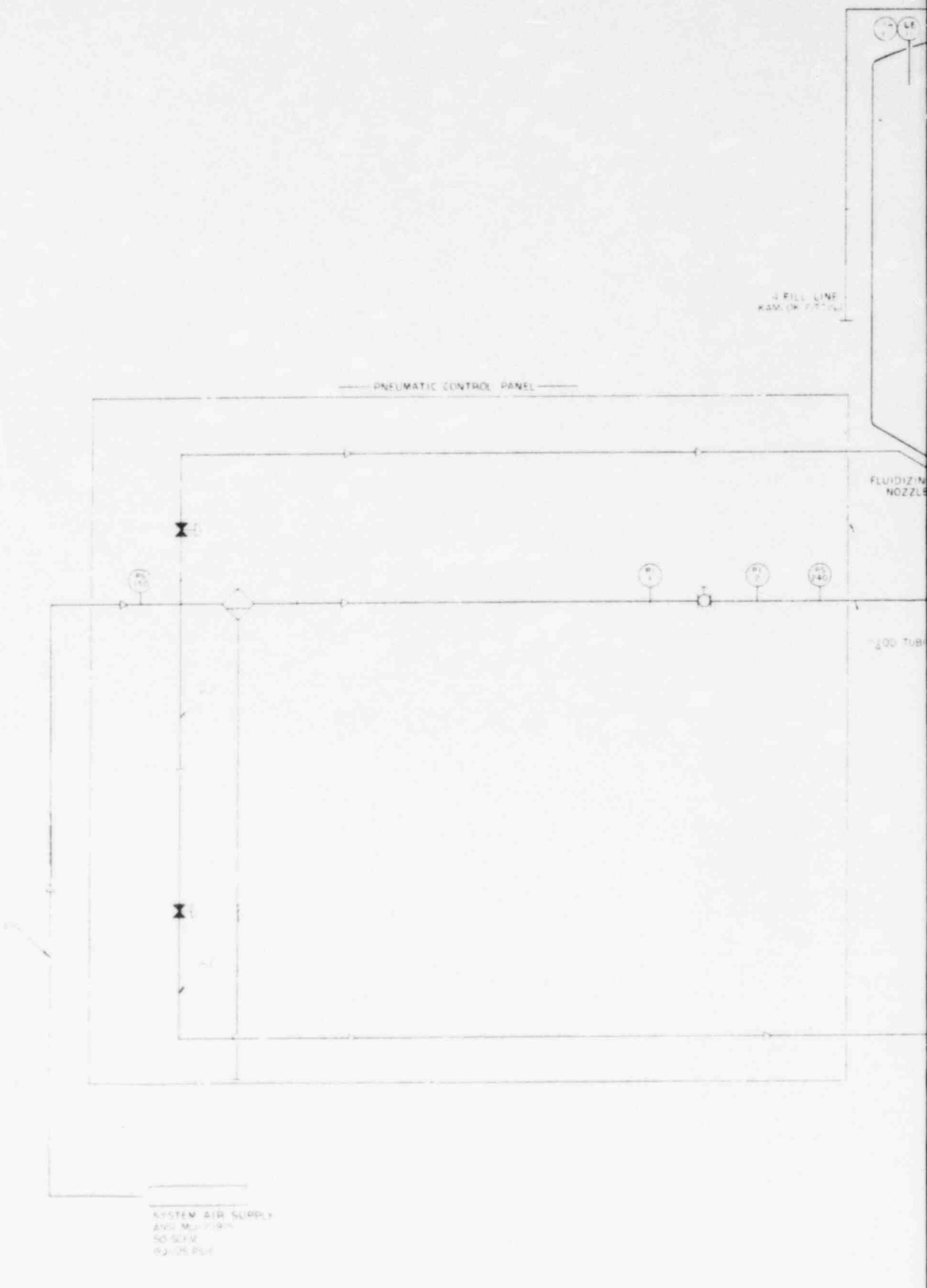
SOLIDIFICATION SYSTEM
P & ID'S
FIGURE 2.1-28

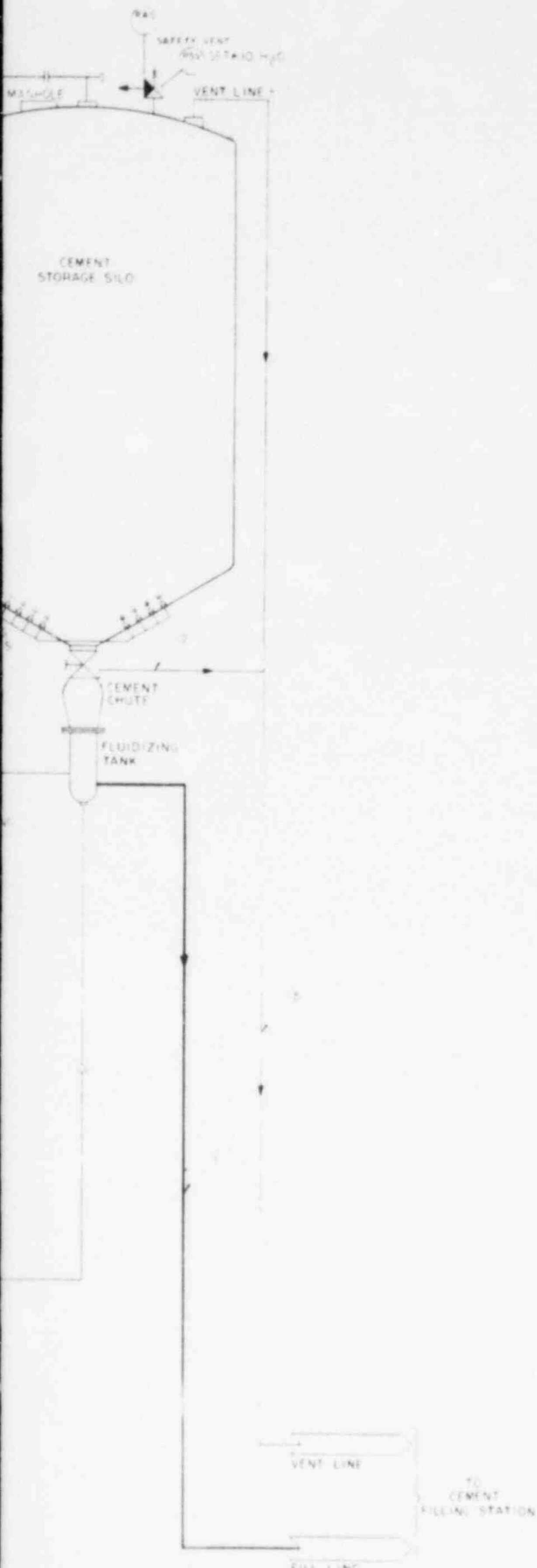

ACCUMULATOR GAS CHARGED
PRESSURE CONTROL VALVES SPRING LOADED
FLUSH WATER 37°F TO 120°F 55 TO 150 PSIG
SPENT RESIN FROM STORAGE TANK #1 (5000 GAL)
SPENT RESIN FROM STORAGE TANK #2 (5000 GAL)
1-1/2"
PORTABLE SLUICING SYSTEM CONNECTION
PUMP SEAL WATER TO LIQUID RADIOACTIVE WASTE SUBSYSTEM DRAIN
DECANTING TANK OVERFLOW TO LIQUID RADIOACTIVE WASTE SUBSYSTEM
DECANTED WATER TO LIQUID RADIOACTIVE WASTE SUBSYSTEM



SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION
AND SOLIDIFICATION SYSTEM

SOLIDIFICATION SYSTEM
P & ID'S
FIGURE 2.1-29

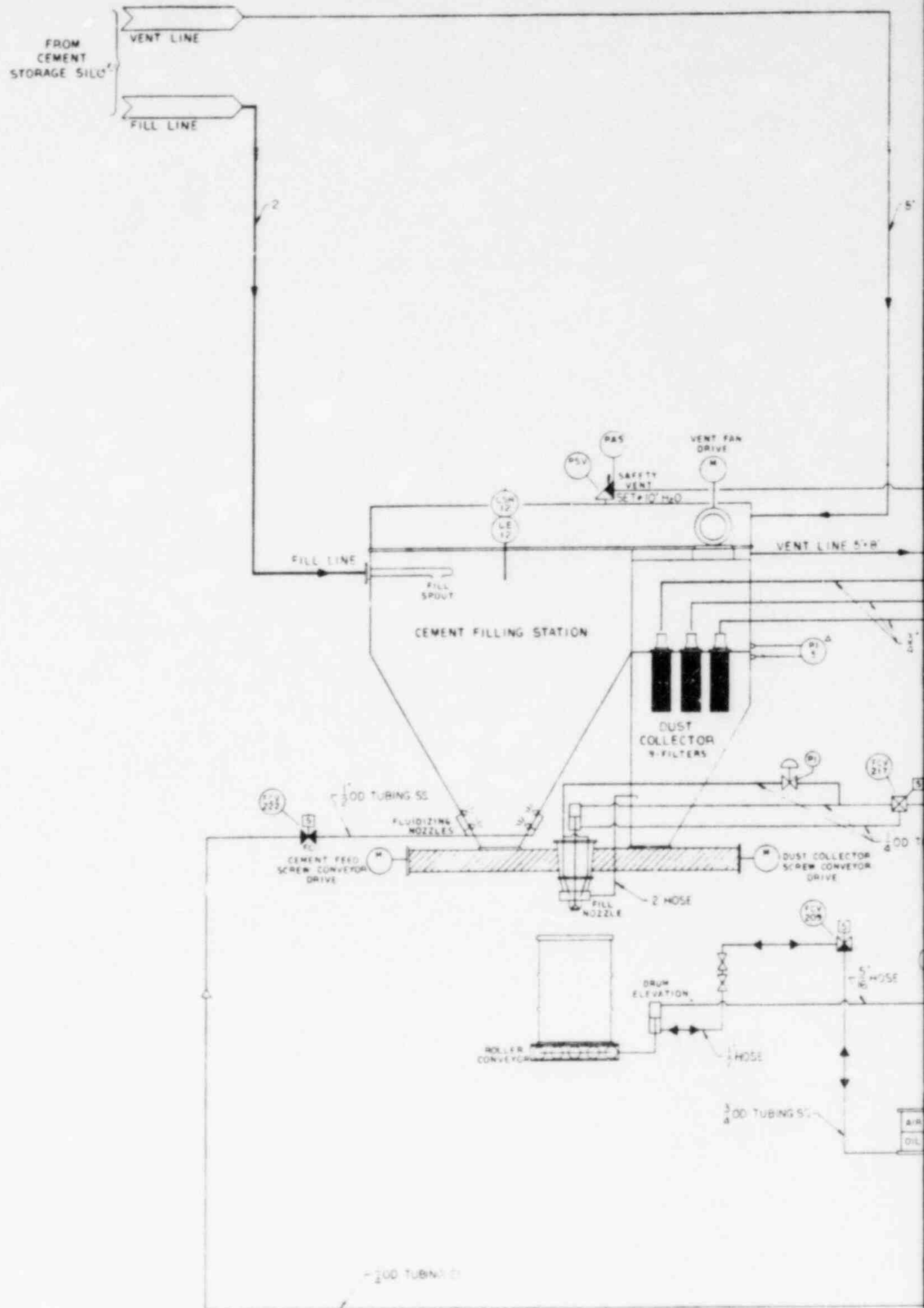

PNEUMATIC CONTROL PANEL
FLUIDIZING
NOZZLE
SYSTEM AIR SUPPLY
50 SCFM

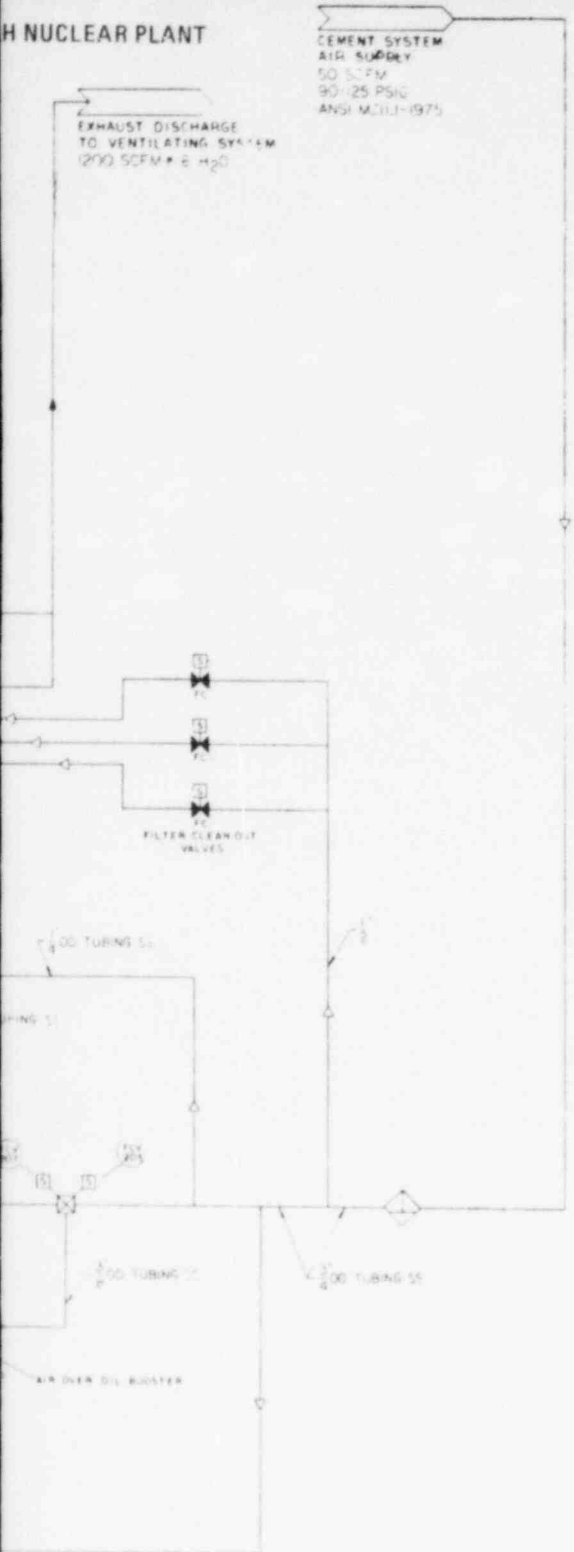


SE CO DRAWING E 1005, Sheet 1

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION
AND SOLIDIFICATION SYSTEM

SOLIDIFICATION SYSTEM
P & ID'S
FIGURE 2.1-30

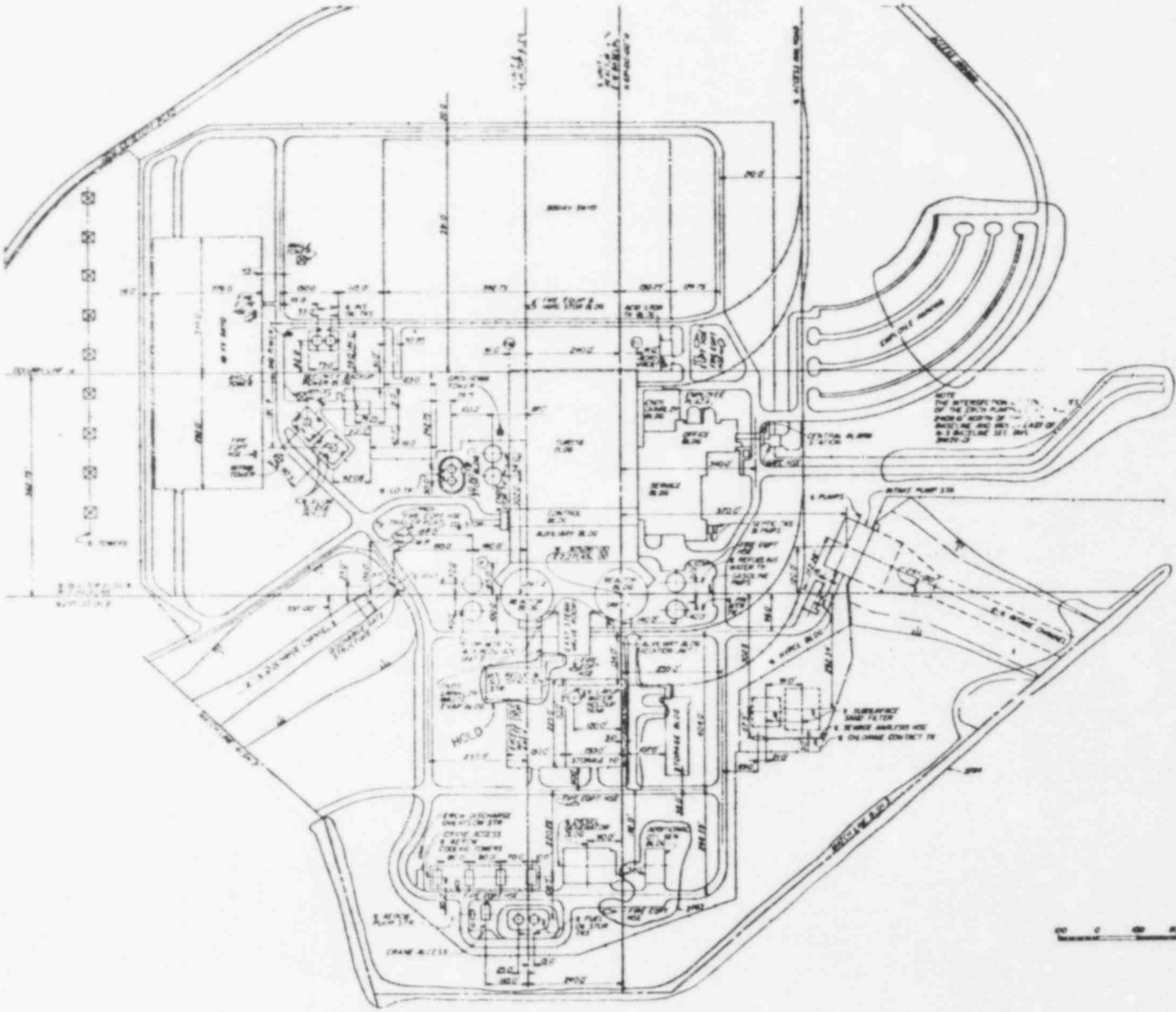

FROM
CEMENT
STORAGE SILO
VENT LINE
FILL LINE
FILL LINE
FILL SPOUT
CEMENT FILLING STATION
SAFETY VENT
VENT FAN DRIVE
VENT LINE
DUST COLLECTOR
FLUIDIZING NOZZLES
CEMENT FEED SCREW CONVEYOR DRIVE
DUST COLLECTOR SCREW CONVEYOR DRIVE
2 HOSE
FILL NOZZLE
DRUM ELEVATION
ROLLER CONVEYOR
HOSE
OD TUBING SS
AIR
OIL



SE CO DRAWING E 1005, Sheet 2

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION
AND SOLIDIFICATION SYSTEM

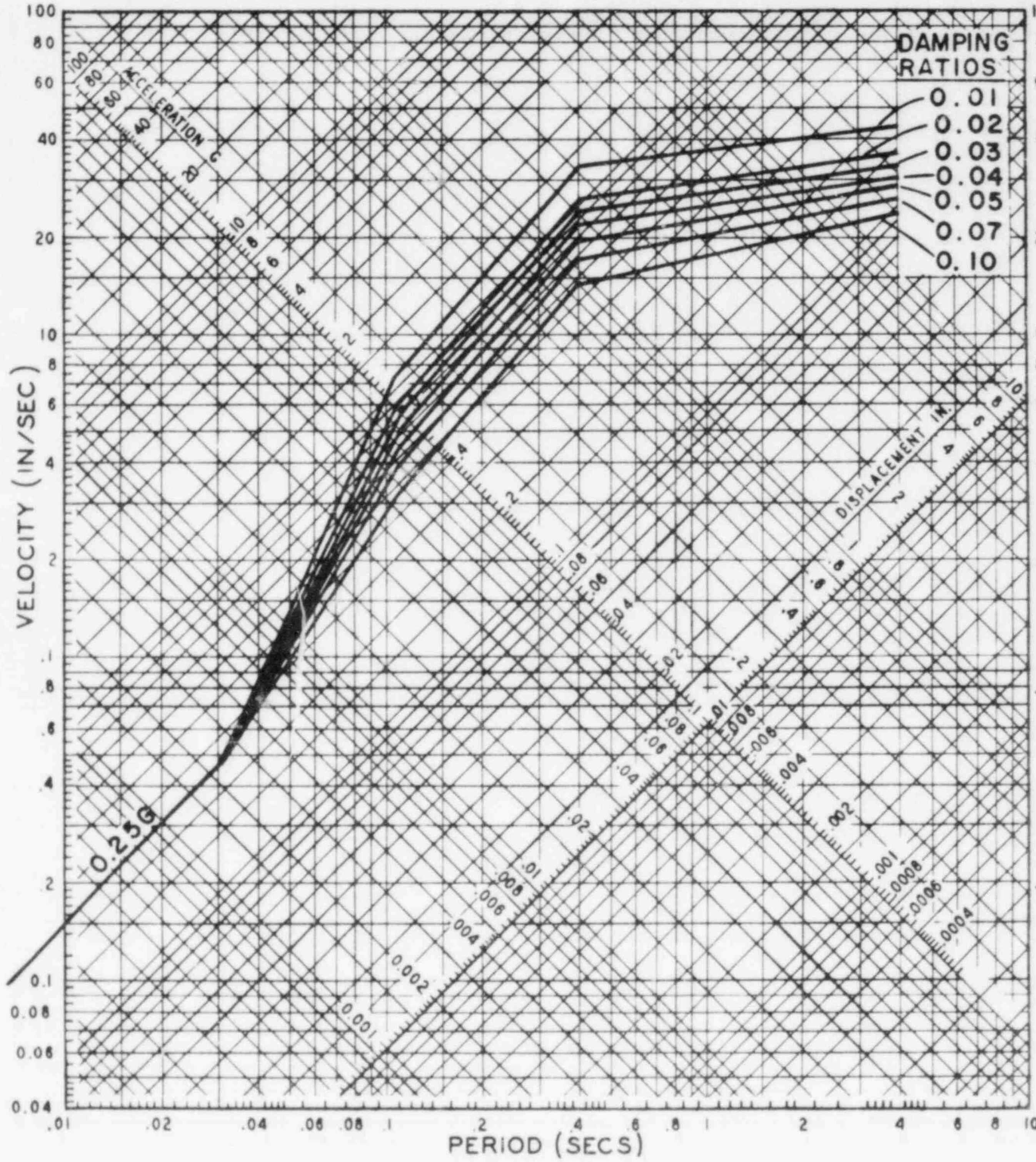
SOLIDIFICATION SYSTEM
P & ID'S
FIGURE 2.1- 31



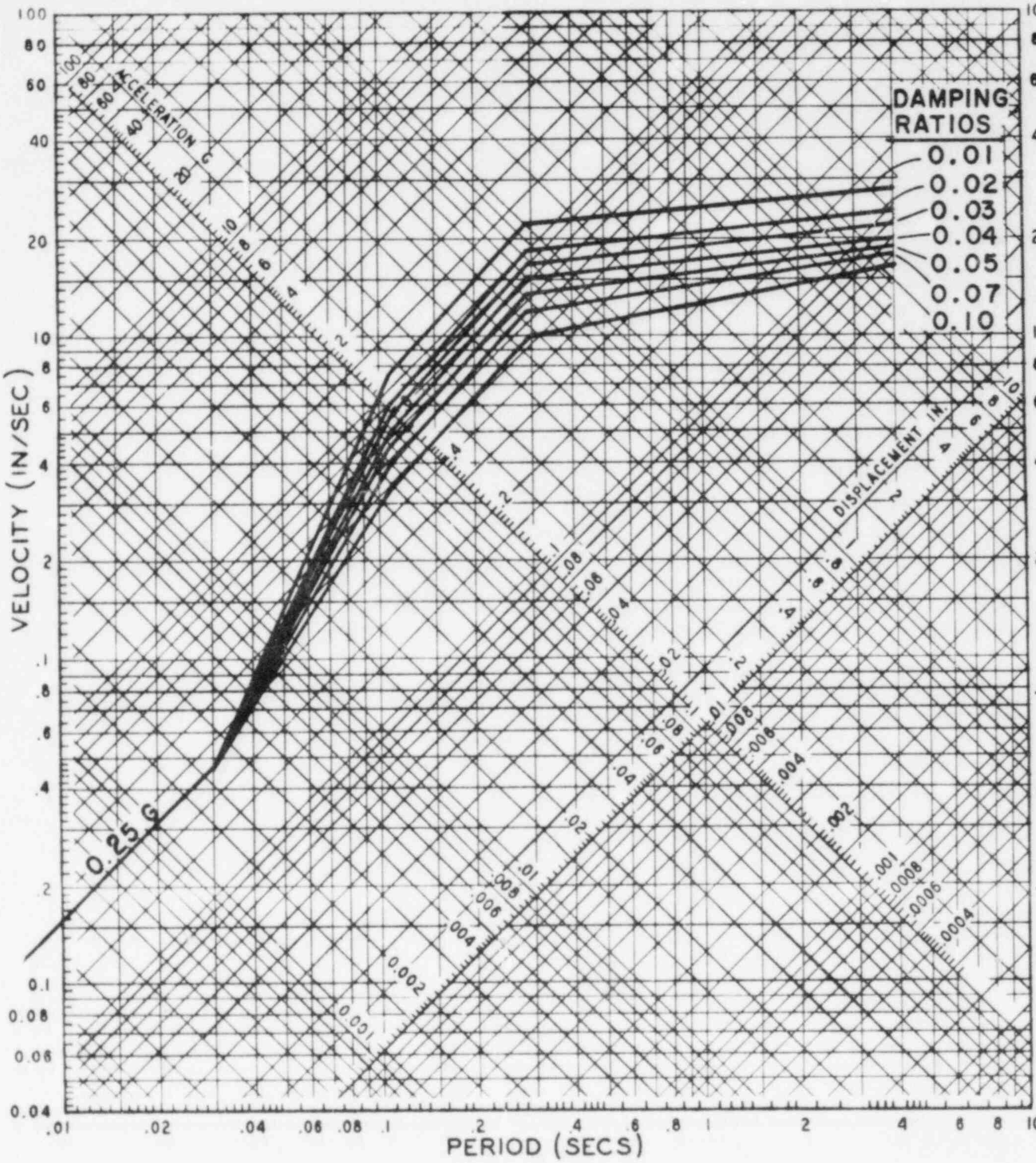
NOTES
1. COORDINATES AT THE INTERSECTION OF THE N-S AND T-4 BASELINES ARE TENNESSEE LAMBERT COORDINATES

SEQUOYAH NUCLEAR PLANT
RADIOACTIVE WASTE VOLUME REDUCTION AND SOLIDIFICATION SYSTEM

MAIN PLANT
LOCATION OF STRUCTURES
TVA DWG NO. 10N201-81 R14
FIGURE 2.2-1



SAFE SHUTDOWN EARTHQUAKE
DESIGN RESPONSE SPECTRA
HORIZONTAL MOTION
FIGURE 2.2-2



SAFE SHUTDOWN EARTHQUAKE
DESIGN RESPONSE SPECTRA
VERTICAL MOTION
FIGURE 2.2-3

3.0 FACILITY OPERATIONS

3.1 Volume Reduction System

After sufficient waste has been collected, the operator will determine which mode of operation he wishes to use. These are: (1) drying of evaporator concentrates and/or spent regenerates; (2) simultaneous drying of evaporator concentrates and/or spent regenerates and incineration of dry active waste and/or contaminated oils; (3) incineration of the dry active waste and/or contaminated oils only; or (4) bypass of the entire VR system.

The first operational mode consists of fluid bed drying of liquid wastes. The evaporator concentrates and spent regenerates which contain typically 7- to 25-weight percent dissolved solids are pumped from the concentrated liquid waste storage tanks to the venturi scrubber-preconcentrator (S-2) by the waste pump (P-4) as shown in figure 2.1-13. The feedrate to the dryer is automatically controlled by temperature-sensing devices which control the speed of the feed pump. The heat from the drying process will be used to preconcentrate the feed to 25- to 28-weight percent. The liquid feed to the dryer will be used as the S-2 off-gas scrub solution.

The dry granular bed particles from the dryer are pneumatically transferred from the fluidized bed to a product storage hopper. In addition, the over-head gas passes through the gas/solids cyclone where the fines are removed and mixed with those from the incinerator (R-3) and discharged to a product storage hopper.

The optimum operating mode is for the dryer and incinerator to operate simultaneously. In this mode, the waste heat contained in the incinerator off-gas stream is utilized in the preconcentrator, therefore increasing the liquid input flowrate from the concentrate liquid waste storage tanks to the fluid bed dryer system. The scrub solution used to scrub the process off-gas also consists of the incoming liquid wastes. After preconcentration, these wastes are then processed in the fluid bed dryer to anhydrous, free-flowing salts. If this is an initial system startup or startup after maintenance has been performed, inert nonradioactive bed material will be fed into the dryer and incinerator vessels. If used bed material is available, then it will be reintroduced into the vessels as needed. The operator then turns on the electric heating system and blower for both volume reduction subsystems and stabilizes the temperature profile over the system. He then initiates combustible feed to the incinerator and liquid feed to the dryer.

Bags of dry active waste are passed through a metal detector to prevent metal objects from accidentally entering the shredder.

If metal objects are detected, the bags are either set aside for compaction or are hand sorted before placing them in the shredder. Acceptable bags of dry active waste are then fed into the shredder and conveyed by way of a trash elevator (G-1) to trash hoppers (H-3A and H-3B).

All incinerator feedrates are manually determined by the operator. The feedrate is then set into the controller for continuous metering in the predetermined flow of contaminated oil when processing this type of waste. The dry active waste is pneumatically fed at a controlled rate to maintain process temperatures.

After cooling, the off-gas from the incinerator is ducted to the gas/solids separator (S-1) where essentially all of the ash is removed from the gas stream and dropped into a product storage hopper. The remainder of the ash is removed from the off-gas stream by the scrub solution in the venturi scrubber and then is sent to the fluid bed dryer for processing. The remaining off-gas passes through a second scrubber and HEPA/charcoal filter before it is discharged to the building ventilation system.

The process will be similar when only the dryer portion or incinerator portion is used individually. In this mode, either the evaporator concentrate and/or spent regenerate waste in the concentrated liquid waste storage tanks can be used as the incoming liquid waste stream to the venturi scrubber-preconcentrator for the purpose of scrubbing the off-gas from the gas/solids separator. The concentrated liquor produced in the venturi scrubber-preconcentrator is pumped back to the concentrate liquid waste storage tank for future processing by the fluid bed dryer.

3.2 Solidification System

The solid waste products produced in the volume reduction process are collected in the product storage hopper and solidified in accordance with the process control program. The operator initiates the filling process of 55-gallon drums with the binder, an internal mixer, and any additives to be used in accordance with the process control program. The prefilled drums containing binder are then transferred from the polymer filling station to the dry product drumming station with a crane. The drum is loaded into the process chamber with the aid of remote television monitoring and a grid location system. After the drum is inside the processing station, the operator initiates the automatic uncapping, filling, mixing, and recapping process. The drum containing waste is then removed from the processing station by the operator with the overhead crane. The drum is positioned on the radiation monitoring and weighing station. The weight and dose rate of the drum are recorded by the operator and registered in the radwaste log book and on the storage tag. The tag is then placed on the storage board to indicate the location where the drum is to be stored. The drum can then be picked up and placed in the drum inspection station if deemed necessary or placed directly into the proper storage location in the VR/SS building.

When a load of solidified 55-gallon drums has been produced, they may remain in the VR/SS storage location for decay or be transported either to a licensed nuclear waste disposal facility or stored temporarily on site. In either case, when transport is necessary, the operator will load the shipping vehicle by use of the television monitor and guidance grid. After all necessary shipping papers and radiation surveys are completed, the shipment will be allowed to leave the VR/SS building.

The resin waste will be fed into 5,000-gallon resin tanks where samples can be taken and pH adjustments are made. Then the waste will be transferred to the 500-gallon decant tank and waste-to-cement ratio verified. When the proper ratio has been verified, the waste will be metered into a 55-gallon drum containing the proper amount of cement and any additives deemed necessary by the process control program. The 55-gallon drum will then be prepared in the same manner as the drum containing volume reduced waste except cement will be used as a binding agent. After processing, the drum will be removed from the processing unit and placed in storage in a similar manner as that described for volume reduced solidified waste. Evaporator concentrates and spent regenerates can be processed in a similar manner.

3.3 Bulk Resin Processing

The capability will be provided to package and dewater bulk quantities of all radioactive spent resins for eventual storage or removal from the plant. Resin slurry will be sluiced from the spent resin storage tank to a licensed shipping container consisting of an inner disposable liner with an outer reuseable shield. When the container is nearly full, automatic level control valves are closed and the water is removed through internal filters. The fill-and-dewater process is repeated until the desired amount of resin is transferred. The water is sent to a collection tank. A pump is used as required in the dewatering process to meet free-standing water limits at licensed disposal facilities. Flush connections will be provided to flush lines when resin transfer is complete.

4.0 RADIOLOGICAL ASSESSMENT

4.1 Radiological Considerations

A radiological assessment has been performed for the SQNP site to estimate potential impacts from the operation of a VR/SS. The major medium for potential radiological exposure is via the offgas effluents. No direct liquid effluent discharges to the environment are planned from the VR/SS system. The following potential pathways to man were analyzed for individual and population exposure to gaseous effluents: (1) external radiation from radioactivity in the air and on the ground; (2) inhalation; and (3) ingestion of beef, vegetables, and milk. The estimated routine gaseous effluent releases contained in Table 4.1-1 were used to calculate radiological exposures to individuals at points of potential maximum exposure. Locations for potential maximum exposure are contained in Table 4.1-2 for the SQNP site. The dose to the population is based on population estimates in the 16 compass sectors for ten downwind distances out to fifty miles.

Doses to critical organs were calculated using the dose factors and methodology contained in NRC Regulatory Guide 1.109, Revision 1 and NUREG/CR-1004 with certain exceptions as follows:

1. Inhalation doses are based on average individual inhalation rates[1] of 1,400; 5,500; 8,000; and 8,100 m^3/yr for infant, child, teen, and adult, respectively.

2. Doses to air are calculated using average beta and gamma energies per decay from the TVA nuclide data library.

3. The beef and milk ingestion pathway doses account for actual animal feeding factors. A feeding factor (FF) has been defined as that fraction of total feed intake an animal consumes that is from fresh forage.

4. Dose calculations for the beef ingestion pathways were made for individuals consuming meat from beef raised on their property. The normal processing route is for an individual to slaughter the beef animal, package and freeze the meat, and then consume the meat during approximately the next 3-month period. Radioactive decay during the 3-month period is calculated by:

$$\frac{1}{90} \int_0^{90} \exp(-\lambda_i t)dt = \frac{1 - \exp(-\lambda_i 90)}{90\lambda_i}$$

where

λ_i is the radiological decay constant (days^{-1})
t is time (days).

This term is multiplied into equation C-14 in Regulatory Guide 1.109. If the beef animals are sold commercially, then individuals would not be exposed continuously to meat from their farm. Consequently, radiological doses would be expected to be lower.

4.1.1 Meteorology

Calculations of atmospheric transport, dispersion, and ground deposition are based on annual-average, ground-level meteorology, consistent with the straight-line airflow model discussed in NRC Regulatory Guide 1.111 (Revision 1, July 1977). Atmospheric releases from the facility are assumed to be continuous.

Estimates of the normalized air concentrations (X/Q) and the normalized deposition rates (D/Q) are listed in Table 4.1-2 for point of interest locations, and in Tables 4.1.1-1 for population sector annuli.

All doses related to deposition pathways (ground exposure and food ingestion) are estimated using dry deposition. Calculations of wet deposition based on a washout model and recommendations of Engelmann[2] indicate that wet deposition is not a significant portion of total deposition.

4.1.2 Population Distribution

Population doses were based on the current U.S. population distribution of:

Category	Ages (A)*	Fraction
Infant	A<2	.034
Child	2≤A<13	.211
Teen	13≤A<19	.134
Adult	19≤A	.621

*e.g., someone who is 1 year, 11 months of age is an infant, while someone who is exactly two years old is a child. Population data are contained in Table 4.1.2-1.

4.1.3 Dose Estimates

Table 4.1.3-1 gives maximum estimated individual doses due to operation of a VR at SQNP and Table 4.1.3-2 gives the estimated population doses. As can be seen from these tables, the maximum calculated air dose (immersion) at the site boundary from gaseous effluents is 8.1×10^{-6} mrad/yr for SQNP. The maximum calculated individual doses were found to be for individuals with home-use gardens. These doses are 0.32 mrem/yr for SQNP. All doses are well within the applicable regulations. Further, population doses from VR operation are estimated to be 0.17 man-rem/yr for SQNP. For a population around SQNP of about 1,100,000 this dose can be compared to doses from natural background of about 1.6×10^{5} man-rem/yr for a natural background component of 145 mrem/yr.

4.1.4 Cumulative Impacts

For the purposes of determining compliance with 40 CFR 190 limits (25 mrem/yr), impacts from all nearby fuel cycle facilities must be summed. The only impacts from nearby fuel cycle facilities will be due to the operation of SQNP (FES: 5.6 mrem/yr) and possible onsite low-level radioactive waste storage modules (< 1 mrem/yr) which are predicted to result in a combined dose to the maximum individuals of about 6.6 mrem/yr. If these doses are summed with those calculated for VR operation (0.32 mrem/yr), then the cumulative doses are found to be about 7 mrem/yr for the SQNP site. These doses are below the 40 CFR 190 limits.

4.2 Incremental Occupational Exposures

4.2.1 Exposure From Routine Operations

The occupational exposure to be expected from the operation of this facility depends on the activity of the material being processed, the design of the facility, and the operational and maintenance requirements of the equipment. The facility design objectives outlined in Section 2.5, 'Radiation Protection and ALARA,' ensure that the design of the facility will be such that ALARA principles will be observed. In addition, the process equipment is designed so that components containing significant amounts of radioactive material can be remotely drained and flushed (or similarly treated) prior to performing maintenance on these components. The compartmentalization of the facility provides assurance that exposure from other components during maintenance will be minimal. Exposure due to operational requirements will be minimized by a high degree of automation of the process equipment. Manual operation of process valves and process surveillance (e.g., reading of process instrumentation) will be carried out from areas of low radioactivity whenever possible.

The measures outlined above give assurance that the occupational exposure resulting from the operation of this facility will be as low as is reasonably achievable.

Table 4.1-1

SQNP VR RELEASES FROM PROCESS
OFFGASES EXCLUDING RESINS

VR RELEASES FROM PROCESS OFFGASES EXCLUDING RESIN

	NUCLIDE	RELEASE RATE (CURIES/YEAR)
1	CR-51	7.40E-05
2	MN-54	3.50E-06
3	MN-56	1.20E-07
4	FE-59	3.00E-06
5	CO-58	7.10E-05
6	CO-60	3.60E-06
7	BR-84	8.80E-09
8	RB-88	6.30E-08
9	RB-89	1.30E-09
10	SR-89	9.20E-06
11	SR-90	4.50E-07
12	SR-91	2.40E-08
13	Y-90	4.60E-07
14	Y-91M	1.40E-08
15	Y-91	1.40E-05
16	Y-92	5.20E-10
17	ZR-95	1.80E-06
18	NB-95M	6.30E-10
19	NB-95	2.30E-06
20	MO-99	1.00E-03
21	TC-99M	9.70E-04
22	TC-99	1.60E-11
23	TE-132	5.70E-05
24	I-131	3.50E-03
25	I-132	1.50E-04
26	I-133	4.30E-04
27	I-134	3.30E-07
28	I-135	4.30E-05
29	CS-134	8.40E-04
30	CS-136	1.20E-04
31	CS-137	4.10E-03
32	CS-138	5.30E-08
33	BA-140	3.60E-06
34	LA-140	3.90E-06
35	CE-144	9.30E-07
36	PR-144	3.30E-07
		1.1E-02

Table 4.1-2

SQNP VR RELEASES--NON-RESIN WASTE
APPENDIX I TYPE EVALUATION

POINT	SECTOR	DISTANCE (M)	ELEVATION (M)	CHI-OVER-Q (S/M**3)	D-OVER-Q (1/M**2)
1 LAND SITE BOUNDARY	N	950.	-6.	6.19E-06	1.29E-08
2 LAND SITE BOUNDARY	NNE	2250.	-6.	2.19E-06	5.20E-09
3 LAND SITE BOUNDARY	NE	1910.	-6.	2.67E-06	6.33E-09
4 LAND SITE BOUNDARY	ENE	1680.	-6.	1.28E-06	2.64E-09
5 LAND SITE BOUNDARY	E	1570.	-6.	8.31E-07	1.46E-09
6 LAND SITE BOUNDARY	ESE	1450.	-6.	9.20E-07	1.58E-09
7 LAND SITE BOUNDARY	SE	1450.	-6.	1.07E-06	2.41E-09
8 LAND SITE BOUNDARY	SSE	1550.	-6.	1.55E-06	3.23E-09
9 LAND SITE BOUNDARY	S	1570.	-6.	2.81E-06	4.13E-09
10 LAND SITE BOUNDARY	SSW	1840.	-6.	5.26E-06	9.20E-09
11 LAND SITE BOUNDARY	SW	2470.	-6.	1.58E-06	2.63E-09
12 LAND SITE BOUNDARY	WSW	910.	-6.	3.56E-06	3.86E-09
13 LAND SITE BOUNDARY	W	670.	-6.	4.28E-06	3.74E-09
14 LAND SITE BOUNDARY	WNW	650.	-6.	2.93E-06	2.44E-09
15 LAND SITE BOUNDARY	NW	650.	-6.	3.42E-06	3.67E-09
16 LAND SITE BOUNDARY	NNW	730.	-6.	4.74E-06	6.59E-09
17 RESIDENT,GARDEN	N	1344.	0.	3.64E-06	7.32E-09
18 RESIDENT,GARDEN	NNE	2812.	0.	1.56E-06	3.64E-09
19 RESIDENT,GARDEN	NE	3438.	55.	1.10E-06	2.32E-09
20 RESIDENT,GARDEN,BEEF	ENE	2187.	12.	8.53E-07	1.70E-09
21 RESIDENT	E	1812.	0.	6.65E-07	1.10E-09
22 RESIDENT	ESE	1812.	43.	6.55E-07	1.11E-09
23 RESIDENT	SE	1719.	0.	8.24E-07	1.83E-09
24 RESIDENT	SSE	2250.	24.	8.68E-07	1.74E-09
25 RESIDENT,GARDEN	S	2375.	0.	1.49E-06	2.09E-09
26 RESIDENT	SSW	2250.	0.	3.88E-06	6.57E-09
27 RESIDENT	SW	2959.	0.	1.20E-06	1.93E-09
28 RESIDENT	WSW	1057.	17.	2.82E-06	2.98E-09
29 RESIDENT,GARDEN	W	938.	6.	2.65E-06	2.15E-09
30 RESIDENT,GARDEN	WNW	1812.	12.	6.70E-07	4.71E-10
31 RESIDENT,GARDEN	NW	1188.	12.	1.44E-06	1.40E-09
32 RESIDENT	NNW	781.	0.	4.30E-06	5.90E-09
33 GARDEN	E	2656.	12.	3.72E-07	6.03E-10
34 GARDEN	ESE	2031.	30.	5.51E-07	9.16E-10
35 GARDEN	SE	2052.	0.	6.23E-07	1.35E-09
36 GARDEN,BEEF	SSE	2344.	30.	8.15E-07	1.62E-09
37 GARDEN	SSW	2750.	0.	2.86E-06	4.67E-09
38 GARDEN	SW	3438.	0.	9.68E-07	1.49E-09
39 GARDEN	WSW	1057.	17.	2.82E-06	2.98E-09
40 GARDEN	NNW	1875.	15.	1.17E-06	1.41E-09
41 BEEF	NNE	2600.	2.	1.76E-06	4.16E-09
42 BEEF	NE	3438.	0.	1.10E-06	2.32E-09
43 BEEF	E	2187.	12.	5.00E-07	8.40E-10
44 BEEF	ESE	3125.	55.	2.65E-07	4.40E-10
45 BEEF	SE	2656.	65.	4.23E-07	8.86E-10
46 BEEF	S	6553.	46.	3.44E-07	3.55E-10
47 BEEF	W	700.	0.	4.03E-06	3.49E-09
48 BEEF	WSW	2052.	12.	1.06E-06	1.01E-09
49 BEEF	WNW	700.	0.	2.70E-06	2.22E-09
50 BEEF	NW	688.	0.	3.22E-06	3.43E-09
51 BEEF	NNW	1524.	2.	1.60E-06	1.99E-09
52 MILK COW ADULT	N	4219.	0.	6.50E-07	1.06E-09
53 MILK COW ADULT	NNE	4531.	6.	7.77E-07	1.57E-09
54 MILK COW ADULT	NE	5625.	61.	5.40E-07	9.75E-10
55 MILK COW ADULT	SSW	3594.	0.	1.93E-06	2.94E-09
56 MILK COW ADULT	WNW	1875.	18.	6.38E-07	4.44E-10
57 MILK COW ADULT	NW	2031.	6.	6.41E-07	5.83E-10

TABLE 4.1.1-1
SQNP - LLRW VR EFFLUENT RELEASES

AVERAGE ANNUAL CHI-OVER-Q VALUES (S/M**3)

SECTOR	1305.	2414.	4023.	5633.	7242.	12070.	24140.	40234.	56327.	72420.
N	3.81E-06	1.48E-06	6.97E-07	4.31E-07	3.03E-07	1.49E-07	5.90E-08	3.02E-08	1.96E-08	1.42E-08
NNE	5.10E-06	1.98E-06	9.24E-07	5.70E-07	4.00E-07	1.97E-07	7.74E-08	3.95E-08	2.56E-08	1.85E-08
NE	4.82E-06	1.87E-06	8.74E-07	5.39E-07	3.78E-07	1.86E-07	7.31E-08	3.73E-08	2.41E-08	1.74E-08
ENE	1.90E-06	7.33E-07	3.42E-07	2.10E-07	1.48E-07	7.24E-08	2.85E-08	1.45E-08	9.40E-09	6.80E-09
E	1.11E-06	4.30E-07	2.02E-07	1.25E-07	8.76E-08	4.31E-08	1.70E-08	8.70E-09	5.64E-09	4.08E-09
ESE	1.10E-06	4.22E-07	1.97E-07	1.21E-07	8.52E-08	4.18E-08	1.65E-08	8.43E-09	5.46E-09	3.95E-09
SE	1.27E-06	4.89E-07	2.29E-07	1.41E-07	9.89E-08	4.86E-08	1.91E-08	9.77E-09	6.33E-09	4.57E-09
SSE	2.02E-06	7.79E-07	3.63E-07	2.24E-07	1.57E-07	7.71E-08	3.04E-08	1.55E-08	1.01E-08	7.28E-09
S	3.73E-06	1.46E-06	6.86E-07	4.25E-07	2.99E-07	1.48E-07	5.89E-08	3.03E-08	1.97E-08	1.43E-08
SSW	8.93E-06	3.49E-06	1.64E-06	1.01E-06	7.14E-07	3.53E-07	1.40E-07	7.17E-08	4.66E-08	3.38E-08
SW	4.18E-06	1.64E-06	7.72E-07	4.78E-07	3.37E-07	1.66E-07	6.58E-08	3.36E-08	2.19E-08	1.59E-08
WSW	2.09E-06	8.37E-07	4.00E-07	2.49E-07	1.76E-07	8.78E-08	3.50E-08	1.81E-08	1.18E-08	8.55E-09
W	1.63E-06	6.52E-07	3.11E-07	1.94E-07	1.37E-07	6.85E-08	2.74E-08	1.41E-08	9.20E-09	6.70E-09
WNW	1.10E-06	4.40E-07	2.10E-07	1.31E-07	9.28E-08	4.64E-08	1.85E-08	9.58E-09	6.25E-09	4.55E-09
NW	1.25E-06	4.95E-07	2.35E-07	1.46E-07	1.03E-07	5.13E-08	2.04E-08	1.05E-08	6.65E-09	4.98E-09
NNW	2.02E-06	8.02E-07	3.81E-07	2.37E-07	1.68E-07	8.34E-08	3.33E-08	1.71E-08	1.11E-08	6.10E-09

AVERAGE ANNUAL D-OVER-Q VALUES (1/M**2)

SECTOR	1305.	2414.	4023.	5633.	7242.	12070.	24140.	40234.	56327.	72420.
N	7.68E-09	2.77E-09	1.15E-09	5.35E-10	4.04E-10	1.66E-10	5.09E-11	2.07E-11	1.12E-11	6.02E-12
NNE	1.31E-08	4.72E-09	1.96E-09	1.08E-09	6.88E-10	2.83E-10	8.66E-11	3.53E-11	1.91E-11	1.16E-11
NE	1.18E-08	4.25E-09	1.76E-09	9.73E-10	6.19E-10	2.55E-10	7.80E-11	3.18E-11	1.72E-11	1.05E-11
ENE	3.97E-09	1.43E-09	5.94E-10	3.28E-10	2.09E-10	8.59E-11	2.63E-11	1.07E-11	5.81E-12	3.53E-12
E	1.97E-09	7.10E-10	2.94E-10	1.63E-10	1.03E-10	4.26E-11	1.30E-11	5.31E-12	2.88E-12	1.75E-12
ESE	1.89E-09	6.83E-10	2.83E-10	1.56E-10	9.95E-11	4.10E-11	1.25E-11	5.11E-12	2.77E-12	1.68E-12
SE	2.89E-09	1.04E-09	4.32E-10	2.39E-10	1.52E-10	6.25E-11	1.91E-11	7.80E-12	4.23E-12	2.57E-12
SSE	4.27E-09	1.54E-09	6.39E-10	3.53E-10	2.25E-10	9.24E-11	2.83E-11	1.15E-11	6.25E-12	3.80E-12
S	5.64E-09	2.03E-09	8.43E-10	4.66E-10	2.96E-10	1.22E-10	3.73E-11	1.52E-11	8.25E-12	5.01E-12
SSW	1.62E-08	5.83E-09	2.42E-09	1.34E-09	8.50E-10	3.50E-10	1.07E-10	4.37E-11	2.37E-11	1.44E-11
SW	7.59E-09	2.74E-09	1.14E-09	6.27E-10	3.99E-10	1.64E-10	5.02E-11	2.05E-11	1.11E-11	6.74E-12
WSW	2.15E-09	7.75E-10	3.21E-10	1.77E-10	1.13E-10	4.64E-11	1.42E-11	5.80E-12	3.14E-12	1.91E-12
W	1.26E-09	4.54E-10	1.88E-10	1.04E-10	6.61E-11	2.72E-11	8.32E-12	3.39E-12	1.84E-12	1.12E-12
WNW	8.01E-10	2.89E-10	1.20E-10	5.62E-11	4.21E-11	1.73E-11	5.30E-12	2.16E-12	1.17E-12	7.12E-13
NW	1.21E-09	4.35E-10	1.80E-10	9.96E-11	6.34E-11	2.61E-11	7.58E-12	3.25E-12	1.76E-12	1.07E-12
NNW	2.55E-09	9.21E-10	3.82E-10	2.11E-10	1.34E-10	5.52E-11	1.69E-11	6.84E-12	3.73E-12	2.27E-12

TABLE 4.1.2-1

SONP - VR EFFLUENT RELEASES POPULATION DATA

POPULATION WITHIN EACH SECTOR ELEMENT

SECTOR	1305.	2414.	4023.	5633.	7242.	12070.	24140.	40234.	56327.	72420.
N	0.	15.	35.	10.	5.	615.	4865.	2725.	2535.	10050.
NNE	0.	0.	45.	65.	35.	265.	8315.	4770.	2535.	10050.
NE	0.	0.	0.	35.	20.	235.	1220.	2765.	[illegible]	6275.
ENE	0.	10.	0.	75.	100.	335.	3715.	8470.	7000.	14370.
E	0.	20.	15.	60.	50.	330.	17245.	3425.	37275.	12635.
ESE	5.	50.	50.	100.	60.	875.	60490.	3660.	3450.	4415.
SE	5.	145.	15.	65.	65.	560.	12205.	3165.	1190.	11935.
SSE	0.	25.	85.	255.	80.	530.	10065.	9750.	1795.	2370.
S	0.	60.	5.	145.	200.	775.	12560.	10250.	64775.	3470.
SSW	0.	45.	40.	155.	85.	2260.	137250.	12170.	36795.	8350.
SW	0.	0.	35.	130.	35.	3770.	174125.	44450.	17640.	6430.
WSW	5.	50.	250.	490.	465.	7305.	33710.	5435.	10435.	5170.
W	5.	30.	85.	205.	215.	6245.	1655.	5700.	17105.	14935.
WNW	0.	20.	110.	305.	790.	4730.	3210.	3465.	4005.	3830.
NW	5.	30.	140.	160.	390.	9050.	1235.	1680.	3835.	1835.
NNW	5.	60.	10.	30.	270.	1200.	505.	2725.	870.	16320.

MAXIMUM ELEVATIONS ABOVE PLANT GRADE

SECTOR	1305.	2414.	4023.	5633.	7242.	12070.	24140.	40234.	56327.	72420.
N	0.	0.	14.	44.	44.	100.	100.	100.	100.	100.
NNE	0.	0.	6.	14.	14.	100.	100.	100.	100.	100.
NE	0.	29.	44.	6.	6.	100.	100.	100.	100.	100.
ENE	0.	44.	82.	82.	82.	100.	100.	100.	100.	100.
E	0.	60.	60.	60.	60.	100.	100.	100.	100.	100.
ESE	0.	44.	60.	82.	82.	100.	100.	100.	100.	100.
SE	0.	75.	75.	75.	75.	100.	100.	100.	100.	100.
SSE	0.	75.	75.	75.	75.	100.	100.	100.	100.	100.
S	0.	44.	60.	90.	90.	100.	100.	100.	100.	100.
SSW	14.	14.	14.	14.	14.	100.	100.	100.	100.	100.
SW	14.	14.	14.	20.	44.	100.	100.	100.	100.	100.
WSW	14.	44.	44.	44.	44.	100.	100.	100.	100.	100.
W	27.	37.	75.	75.	75.	100.	100.	100.	100.	100.
WNW	14.	44.	44.	60.	75.	100.	100.	100.	100.	100.
NW	14.	44.	52.	52.	52.	100.	100.	100.	100.	100.
NNW	14.	14.	29.	60.	60.	100.	100.	100.	100.	100.

MILK PRODUCTION FOR EACH SECTOR ELEMENT (MILLION POUNDS)

SECTOR	1305.	2414.	4023.	5633.	7242.	12070.	24140.	40234.	56327.	72420.
N	4.90E-03	1.47E-02	2.45E-02	3.43E-02	4.41E-02	3.70E-01	1.48E 00	2.27E 00	3.06E 00	4.72E 00
NNE	4.90E-03	1.47E-02	2.45E-02	3.43E-02	4.41E-02	3.70E-01	2.25E 00	2.68E 00	3.88E 00	4.20E 00
NE	5.20E-03	1.56E-02	2.60E-02	3.64E-02	4.68E-02	3.90E-01	4.38E 00	1.24E 01	1.91E 01	1.45E 01
ENE	9.50E-03	2.85E-02	4.75E-02	6.65E-02	8.55E-02	7.10E-01	8.54E 00	1.96E 01	2.71E 01	1.57E 01
E	1.56E-02	4.68E-02	7.80E-02	1.09E-01	1.40E-01	1.17E 00	7.06E 00	8.15E 00	8.52E 00	9.03E 00
ESE	1.94E-02	5.82E-02	9.70E-02	1.36E-01	1.75E-01	1.46E 00	7.79E 00	5.29E 00	4.37E 00	3.45E 00
SE	1.67E-02	5.01E-02	8.35E-02	1.17E-01	1.50E-01	1.25E 00	7.50E 00	3.86E 00	1.71E 00	1.94E 00
SSE	6.00E-03	1.80E-02	3.00E-02	4.20E-02	5.40E-02	4.50E-01	4.08E 00	3.58E 00	3.04E 00	3.62E 00
S	4.90E-03	1.47E-02	2.45E-02	3.43E-02	4.41E-02	3.70E-01	4.20E 00	9.22E 00	5.38E 00	5.55E 00
SSW	4.90E-03	1.47E-02	2.45E-02	3.43E-02	4.41E-02	3.70E-01	2.91E 00	6.14E 00	4.33E 00	4.66E 00
	4.90E-03	1.47E-02	2.45E-02	3.43E-02	4.41E-02	3.70E-01	1.50E 00	1.63E 00	1.12E 00	3.06E 00
	4.90E-03	1.47E-02	2.45E-02	3.43E-02	4.41E-02	3.70E-01	1.21E 00	8.30E-01	1.21E 00	3.24E 00

Table 4.1.3-1

SQNP VR - ANNUAL INDIVIDUAL DOSES FROM OFFGAS EFFLUENTS

EFFLUENT	PATHWAY	GUIDELINE*	POINT	DOSE
Noble Gases	γ-Air dose	10	Max. Exp.[1]	8.1×10^{-6} mrad/yr
	β-Air dose	20	Max. Exp.[1]	6.9×10^{-6} mrad/yr
	Total body[2]	5	Residence[3]	3.7×10^{-9} mrem/yr
	Skin[2]	15	Residence[3]	5.0×10^{-9} mrem/yr
Iodines/ Particulates	Liver (critical organ)	15	Real Pathway[4]	3.2×10^{-1} mrem/yr

Breakdown of Iodine/Particulate Exposures (mrem/yr)

	Child	Adult
Vegetable Ingestion	2.9×10^{-1}	1.0×10^{-1}
Beef Ingestion[5]	4.9×10^{-3}	4.6×10^{-3}
Inhalation	6.7×10^{-4}	3.5×10^{-4}
Ground Contamination	2.9×10^{-2}	2.9×10^{-2}
Total	3.2×10^{-1}	1.3×10^{-1}

*These are the annual guidelines per reactor unit for nuclear generating stations defined by Appendix I to 10 CFR 50

1. Maximum exposure point is at 950 meters in the N sector.
2. Dose from air submersion.
3. Receptor is at 2,250 meters in the SSW sector.
4. Receptor is at 1,344 meters in the N sector.
5. Beef is assumed to be obtained from location at 2,600 meters in the NNE sector.

TABLE 4.1.3-2

SQNP VR RELEASES FOR NON-RESIN INCINERATION

POPULATION DOSES

	Liver					Bone				
	INFANT	CHILD	TEEN	ADULT	TOTALS	INFANT	CHILD	TEEN	ADULT	TOTALS
SUBMERSION	1.20E-09	7.49E-09	4.77E-09	2.21E-08	3.55E-08	1.20E-09	7.49E-09	4.77E-09	2.21E-08	3.55E-08
GROUND	2.63E-03	1.64E-02	1.04E-02	4.83E-02	7.78E-02	2.63E-03	1.64E-02	1.04E-02	4.83E-02	7.78E-02
INHALATION	1.16E-04	1.45E-03	6.49E-04	2.24E-03	4.46E-03	9.75E-05	1.48E-03	4.73E-04	1.60E-03	3.65E-03
COW MILK	3.37E-03	1.09E-02	3.33E-03	1.14E-02	2.89E-02	2.69E-03	1.04E-02	2.29E-03	7.59E-03	2.30E-02
BEEF INGESTION	0.0	8.96E-03	4.40E-03	2.41E-02	3.75E-02	0.0	8.62E-03	3.02E-03	1.61E-02	2.77E-02
VEG INGESTION	0.0	5.39E-03	2.68E-03	1.39E-02	2.20E-02	0.0	5.24E-03	1.86E-03	9.40E-03	1.65E-02
TOTAL MAN-REM	6.12E-03	4.31E-02	2.15E-02	1.00E-01	1.71E-01	5.42E-03	4.22E-02	1.81E-02	8.30E-02	1.49E-01

5.0 ENVIRONMENTAL ASSESSMENT

5.1 Environmental Impacts of the Proposed Action

5.1.1 Construction-Related Impacts

Construction impacts associated with this project include fugitive dust, gaseous emissions, siltation, noise, socioeconomic, and potential impact on existing structures at Sequoyah Nuclear Plant.

5.1.1.1 Air Quality

The VR/SS facility construction activities will result in a temporary degradation of the local air quality. Air pollutants generated will primarily include: (1) fugitive particulate emissions from activities such as drilling and mixing concrete (in a batch plant); (2) fugitive dust from earth excavation and grading, and wind erosion of disturbed land surfaces; and (3) particulate, hydrocarbon (HC), nitrogen oxide (NO_x), and carbon monoxide (CO) emissions from fossil-fueled construction equipment and construction employee vehicles.

Disturbed land surfaces will be sprinkled with water, as necessary, to minimize fugitive dust emissions. Baghouse filters will be used to control particulate emissions at the concrete batch plant. Any open burning of debris will be done in accordance with all applicable regulations, and there will be no burning during times of an air stagnation advisory.

Overall, construction is expected to have a minor and transitory impact on air quality.

5.1.1.2 Land Use Impacts

The construction of the VR/SS facility as currently conceived will require approximately 1 acre of land, all within the SQNP reservation boundary. The proposed action involves no offsite land-use conflicts. The proposed action is compatible with the land-use plan within the SQNP reservation for the nuclear plant and its support facilities.

5.1.1.3 Siltation

During construction of this facility, runoff will be drained in a manner that will minimize erosion and the amount of sediment reaching local bodies of water. Control of construction runoff will be in accordance with practices developed by the Environmental Protection Agency (EPA) pursuant to the Clean Water Act (Guidelines for Erosion and Sediment Control Planning and Implementation), EPA Environmental Protection Technological Series - EPA-R2-72-015, (August 1972). Applicable requirements designed to prevent pollution from this construction activity will be met. The existing NPDES permit will cover any construction-related runoff from the proposed action. With these precautions, construction activities are not expected to have a significant impact on water quality.

5.1.1.4 Noise

No significant impacts are expected in either environmental or occupational noise.

5.1.1.5 Solid Waste

There will be a small amount of solid waste generated due to the construction of the VR/SS facility. Solid wastes generated during construction will be handled in accordance with applicable Federal, State and local regulations, and TVA policies and practices.

5.1.1.6 Sanitary Waste

Sanitary wastes generated during construction will be handled in accordance with applicable regulations. During the construction period, portable chemical toilets will be provided for use by construction personnel.

5.1.1.7 Cultural

On April 24, 1980 the Tennessee State Historic Preservation Officer concurred with TVA's determination that construction of this project would have no effect on any site either on or eligible for the National Register of Historic Places.

5.1.1.8 Endangered and Threatened Species

The proposed project will not contribute to the further decline of any known populations of Federally listed or proposed endangered or threatened species, or result in modification or destruction of habitat considered critical to the survival of such forms.

5.1.1.9 Floodplains and Wetlands

The site for the proposed action is not located in a floodplain, nor is it expected to directly or indirectly support or encourage floodplain development. There are no wetlands which will be affected by the project. Therefore, the proposed action is in compliance with TVA policies on floodplain management and wetlands protection.

5.1.1.10 Socioeconomic

There is now and will continue to be ongoing construction at SQNP, and there is manpower, housing, and services available in the area to fill the construction and labor skill requirements for the VR/SS facility. As a result of an adequate supply of manpower, no overall population increase is expected as a result of this construction activity, and because this plant is near an urban area (Chattanooga, Tennessee), no significant socioeconomic impacts are expected.

5.1.2 Operation of the VR/SS

5.1.2.1 Air Quality

Operation of the VR is expected to result in emissions from combustion of wastes in the incinerator/calciner subsystem. Primary pollutants expected to be emitted include SO_2, NO_x, HC, CO, and particulates. For each of these, relatively small amounts will be emitted. These will be released through a stack that is at least 10 feet higher than the building. A small quantity of other pollutants may be emitted, depending upon the composition of the waste material. Radiological releases and their impacts are discussed in chapter 4.

Tables 5.1.2-1 and 5.1.2-2 give quantitative information on nonradiological air pollutants expected to be emitted by the VR. The emission rates given in Table 5.1.2-1 were taken at a discharge to a stack during actual prototype system process runs. The particulate emission rate was estimated using 'Compilation of Air Pollutant Emission Factors' (See footnote C of Table 5.1.2-2) for industrial/commercial refuse incinerators. Planned particulate controls for the VR result in a conservative decontamination factor of 1×10^4.

TVA will obtain an air permit from the Chattanooga-Hamilton County Air Pollution Control Bureau for the release of nonradiological air pollutants expected to be released by the VR.

5.1.2.2 Water Quality

The operation of the VR/SS will generate small amounts of drainage which will be collected in sumps in the VR/SS facility. Radioactive and non-radioactive drainage will be segregated. Radioactive drainage will be pumped to the existing liquid radwaste system for treatment, and nonradioactive drainage will be pumped to the turbine building sump for any necessary treatment and discharged after meeting applicable NPDES limits. The capability to treat nonradioactive drainage as radwaste will be provided. Operation of the VR/SS will not result in an additional NPDES discharge point. The physical and chemical characteristics of the VR/SS drainage will be estimated, EPA will be notified of any changes to existing discharge streams resulting from addition of the VR/SS.

5.1.2.3 Noise

No significant environmental noise impacts are expected. Within TVA, occupational noise is controlled to meet the Occupational Safety and Health Administration (OSHA) guidelines for employee noise exposure.

5.1.2.4 Solid Waste Management

The Resource Conservation and Recovery Act of 1976 (RCRA) specifically excludes nuclear material regulated under the Atomic Energy Act of 1954, as amended (which covers LLRW). Because the operation of the VR/SS will result in no significant additional amounts of solid waste to be handled, other than LLRW, the proposed action does not have solid waste management impacts associated with it. Should solid and hazardous wastes other than LLRW be generated, they would be managed in accordance with applicable EPA regulations for solid and hazardous wastes, and TVA policies and practices.

5.2 Unavoidable Adverse Environmental Impacts

There are no significant environmental impacts associated with the construction and operation of the VR/SS. During construction some siltation may occur and the release of small amounts of gaseous and particulate pollutants can be expected. No significant cumulative impacts have been identified.

5.3 Irreversible and Irretrievable Commitments of Resources

Irreversible and irretrievable commitments of resources will include fuel oils involved in the construction of the proposed facilities along with materials used for the construction of the VR/SS facility.

TABLE 5.1.2-1

Prototype System Pollutant Concentrations[a]
Calculated Emission Rates[b] From Radioactive Waste Sources

	Contaminated Oil		Trash, Resins[c], Liquid Concentrates	
	Concentration (ppm)	Emission Rate (lb/hr)	Concentration (ppm)	Emission Rate (lb/hr)
SO_2	< 1	< 0.0137	< 1	< 0.01395
NO_x	< 10	< 0.099	< 20	< 0.1981
CO	< 100	< 0.0006	< 100	< 0.00066
HC	< 10	< 0.2064	< 100	< 0.0349

a. The pollutant concentrations for SO_2, NO_x, CO, and HC were measured at the prototype system's incinerator discharge and converted to concentrations at the system discharge by incorporating the air dilution that occurs within the system. SO_2 was measured downstream of the scrubber.

b. Emission rates are based upon discharge concentrations and a discharge flow rate of 1,360 ft^3/min.

c. These data were collected assuming spent resins would be included as a waste input. Since resins are not being incinerated, these emission rates re conservative.

TABLE 5.1.2-2

Annual Nonradioactive Emissions from Radioactive Waste Sources

	Contaminated Oil[a] (lb/yr)	Trash, Resins[b] Liquid Concentrates[c] (lb/yr)	Total Annual Emissions (lb/yr)
SO_2	7	61	68
NO_x	49	868	917
CO	<1	3	3
HC	102	153	255
Particulates[d]			negligible

a. Maximum hours needed to incinerate contaminated oil (494.5 hours), based upon system charging capacity of 4.5 gallons/hour and an estimated 300 ft^3/yr of oil wastes.

b. Since resins are not being incinerated, the annual emission values given are conservative.

c. Assumes facility operation for 4380 hours/year.

d. Emission factor for particulates (15 lbs/ton waste) taken from "Compilation of Air Pollutant Emission Factors," Third Edition, Publication No. AP-42, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, February 1980.

Tons Wastes -

Liquid Concentrates	16,000 ft^3/yr - 552 tons/yr	(assuming density of 69 lb/ft^3)
Combustible Solids	- 180 tons/yr	
Contaminated Oils	300 ft^3/yr - 9 tons/yr	(assuming 60 lb/ft^3 density)
	741 tons/yr	

Total emissions for particulates include a decontamination factor of 1×10^6 based on previous vendor information.

6.0 ACCIDENT REVIEW

6.1 General

Close evaluation of the system revealed several accidents that could result in a release of radiation to the environment. These accidents were reviewed and are discussed below.

6.2 Process Accident Postulation

The accidents given consideration were chosen after a review of the system. Little attention was placed on the mechanistic origin of the accident but rather on the result. There are several components which retain radioactive material for a significant time and the failure of which should be considered. These are as follows:

1. Resin Waste Feed - Resin slurry is held up in the storage tanks.

2. Dry Waste Feed - A volume of dry waste is present in the hoppers (H-3A, H-3B) and feed system. Each dry waste feed hopper (H-3A/B) contains 2,000 pounds of dry waste, consisting of approximately 95 percent nominal 1/2-inch particles, and 5 percent dust.

3. Bed Media Storage - Bed storage hoppers (H-4 and H-2) contain the used, contaminated, bed media. The incinerator and dryer bed materials are stored in transfer hoppers (H-4 and H-2), respectively, only when the system is shut down.

4. Product Storage Hopper - A significant amount of activity can be contained in the collected product.

5. Process Gas Filter - A small amount of particulate will be loaded on the filters and the charcoal iodine adsorber can contain iodine at any time.

6. Scrub Solution System - The scrub solution in scrubber-preconcentrator (S-2) can contain a significant amount of activity in the form of dissolved solids, particulate, and iodine.

7. Process Vessel - The dry waste processor (R-3) contains bed media which is contaminated after use and will contain a significant amount of activity. The process is designed to blow process materials overhead rather than to accumulate them in the bed. Therefore, the bed will not contain a large quantity of process solids at any point in time.

6.3 Process Accidents Considered

Three scenarios believed to result in the most severe consequences were further investigated. The product storage hopper was considered because of the potentially high radioactivity of the product; the scrub solution because of the potentially high concentration of dissolved iodine; the process gas filter train because of the long-term collection of particulate before changeout is necessary plus the iodine in the iodine adsorber.

6.3.1 Loss of Product from the Product Storage Hopper

The loss of product from the product storage hopper would result in spillage of dry salts and ash. Since a portion of the spilled material would be entrained in the air, the possibility exists for occupational as well as offsite exposure.

6.3.1.1 Detection of the Accident

If the hopper were to fail, several systems would be affected. The activity release would be detected by radiation monitors. Shutdown of the system would follow by operator action.

6.3.2 Spill of Scrub Solution

The scrubber-preconcentrator (S-2) has potentially high concentrations of dissolved iodine. The scrubber (S-4) does not contain a significant amount of activity. Although there are 120 gallons of scrubber solution in the S-3/S-4 loop, the concentration of dissolved solids is only in 100-250 ppm range, as shown in Material Balance Flow Diagram Figure 2.1-20.

During previous radioiodine tracer tests discussed in AECC Topical No. AECC-1-A, it was determined that iodine compounds are present in the system. The amount of iodine held by organic compounds was found to be related to the quantity of oil in the dryer feed; and could therefore vary with time depending on non-VR conditions. Essentially all iodine would be collected in the first scrubber-preconcentrator; the final scrubber would be expected to collect almost no iodine. The remaining amount will pass on to be absorbed on to the charcoal adsorber. A scrubber-preconcentrator and the scrubber vessel could rupture or a pipe transferring high activity and possible volatile solutions could break, dumping the contents onto the floor. This pipe could be on the scrub pump (P-3) discharge side and could pump the entire inventory of the scrub vessels onto the floor.

6.3.2.1 Detection of the Accident

Any loss of liquid in significant quantity from the scrubber-preconcentrator vessel or scrubber vessel would be detected with the tank level indicator and/or alarm, and the operator would shut down the system. Loss of scrub flow to the venturi in the event the operator does not respond will result in automatic shutdown of the system.

6.3.3 Blowout of the Process Gas Filter

The process gas filter train provides long-term collection of particulate, plus holdup of iodine in the charcoal adsorber.

A postulated accident, involving a pressure excursion of undetermined cause and subsequent rupture of the filter housing, could occur and result in the discharge of the contents of the HEPA filters and of the iodine adsorber.

6.3.3.1 Detection of the Accident

This accident would result in a loss of pressure drop across the HEPA filters that would be detected by the operator. This accident would also initiate automatic shutdown due to a high radiation level in the exhaust gas flow.

6.4 Process Accidents Analyzed

The three assumed accident scenarios discussed in Section 6.3 were investigated using conservative assumptions to determine the one which posed the most significant radiological consequence. This analysis revealed that the accident scenario of loss of product from the product storage hopper could produce the most severe consequences to in-plant personnel, and blowout of the process gas filters could produce the most severe consequences in unrestricted areas. These consequences are discussed below.

6.4.1 Exposure as a Consequence of an Accident

The release of radioactive material to the facility as the result of a failure of one or more system components could result in unintended exposure of the operating personnel. Of a number of possibilities considered, the most severe consequences would result from the rupture of the product hopper; the assumed scenario for and the consequences of such an accident are described below.

It is assumed that the product storage hopper has accumulated process product which represents one year's radioactivity input (Table 6.4-1). Radioactive decay during the collection time is taken into account. The resulting activity in the product storage hopper is also shown in Table 6.4-1.

Following the failure of the product storage hopper, it is assumed that 25 percent of the material in the hopper spills into the cubicle. This material is in the form of small particles; it is assumed that the size distribution of the particles is such that 10 percent of them will remain suspended in the air rather than settling out, i.e., 2.5 percent of the radioactivity is airborne. It is further assumed that the building ventilation system would be operating. The ventilation effluent is discharged through a HEPA filter, hence, the activity will collect on this filter. A 100-percent collection was conservatively assumed. The resulting dose rate at a distance of two feet from the face of the filter was calculated to be 57 rem/h.

The HEPA filters will be located behind shield walls. Radiation monitors will be provided which will sound a local alarm on high radiation level. This will permit personnel who may be performing routine maintenance in this area to exit, thus avoiding an excessive dose. Assuming two minutes as the egress time, total body doses received by any individual would be less than 2 rem.

6.4.2 Doses to Unrestricted Areas Following an Accident

The release of radioactive material to unrestricted areas as a result of the failure of a VR/SS component could result in exposure of the general public. The most severe consequences would result from the destruction of the process gas filters. The material released from these filters can be carried directly from the building without having to pass through the filters of the building HVAC system.

The radioisotope inventory on the process gas filters, corresponding to one year's radioactivity input, is given in Table 6.4-1 together with the annual input activity. It is assumed that the full filter inventory is released directly to the environment.

The radioactive material is transported to the unrestricted area, taking account of the prevalent meteorological conditions. For conservatism, the 5th percentile X/Q values used in the accident evaluations in the SQNP FSAR, Chapter 15, 'Environmental Consequences of Accidents,' are used here. These values are 1.64 x 10^{-3} s/m^3 for the site boundary and 1.96 x 10^{-4} s/m^3 for the low population zone boundary.

Using the assumptions outlined above, the total body dose to an individual at the site boundary, a distance of 556 m, would be 0.01 rem, with the corresponding inhalation dose to the thyroid of 60 rem. The dose received by an individual at the edge of the low population zone (4828 m) would be 0.001 rem total body and

7.1 rem thyroid.

Maximum exposure limits to the general public as the result of an accident at a nuclear power plant are set forth in 10 CFR 100 and are 25 rem whole body or 300 rem thyroid. The exposures calculated above are well below these limits.

6.5 Handling Accidents

6.5.1 Dropping of a Recently Filled Product Drum

The only operation in the VR/SS facility which would have possible radiological consequence is the transfer of recently filled drums using the overhead crane.

The postulated accident would be the dropping of a drum just filled with product and solidification agent as it is being transferred by crane to either the drum inspection station or the drum storage area. Since the drum will be capped prior to lifting, the drum container should not be breached by a drop. However if it were breached, plant personnel could remove the waste, repackage it, and decontaminate the area as required. Therefore, the radiological consequences of a dropped drum are considered to be small.

The design of the facility's crane makes this accident event highly improbable. The drum grab is rated at one ton and utilizes four clamping jaws designed to clamp on the upper drum flange at equally spaced locations and to provide equal clamping pressure. A redundant motor operated clamp actuator and load sensing limit switches provide positive load release control and preclude releasing drums unless firmly supported. Also, a television camera allows the operator to visually verify the drum grab orientation and gripping. Therefore, the probability of a drum being dropped is very low.

6.6 System Design Safety Features to Preclude Accidents

6.6.1 Volume Reduction System

Automatic process shutdown interlocks as discussed below are provided in the VR to preclude damage to the process equipment and provide safety to plant personnel in the event of a process upset. Process shutdowns are automatically initiated by the following conditions and preclude startup until the malfunction has been corrected:

1. The entire gas train system pressure is affected by various malfunction conditions such as; high or low fluidizing airflow, high or low pressure drops across the scrubber-preconcentrator, plugged ductwork or leaks. Any of these failures activate shutdown and individually set alarms

facilitating location of trouble spots.

2. High temperature on the Scrubber-Preconcentrator (S-2).

3. Low discharge pressure on the Condenser Pump (P-5).

4. Failure of the Air Blower (C-1).

An automatic process shutdown results in immediate shutdown of the following equipment:

1. Air Blower (C-1)
2. Air Heater (E-1)
3. Gas Heater (E-2)
4 Bed Heater (E-3)
5. Startup Heater (E-4)
6. Dryer Feed Pump (P-2)
7. Waste Feed Pump (P-4)
8. Dry Waste Feeder (H-3A & B)

6.6.2 Solidification System

In addition to normal process status indications, additional alarms and indications are provided. Should any of these indications be annunciated, they will alarm and cause an audible signal to be turned on. System functions monitored with these indications include: flush water pressure, machinery air pressure, decant tank high level, select decant tank feed, motor overload trip, drum process cycle complete, no cap in drum, no fill selection, drum overfill, and drum process fault.

Flush Water Pressure is alarmed if water pressure drops below or rises above recommended pressure. Should either of these conditions occur, a pressure transmitter located in the system line will initiate alarm circuitry. In addition, this fault will cause drumming station operations and decanting station operations except decant tank filling to be stopped. Once the alarm condition has been corrected, operations can then be reinitiated.

Machinery Air Pressure is monitored with a pressure transmitter located near an air regulator used for controlling air pressure for operation of the valve actuators and metering pumps. This transmitter has been set to energize alarm circuitry should air pressure supplying the equipment exceed 100 psig or drop below 60 psig.

The Decant Tank High Level alarm indicates high level waste conditions within the decant tank. This alarm is controlled by a sonic sensor mounted at the top of the decant tank which is preset to annunciate a high level condition prior to waste being spilled over into the overflow pipe. Instrumentation supplied with this sensor allows for two high-level set points in order to provide advance annunciation to the operator of the approach of an overfilling condition, and to automatically close valves to stop filling. In addition, contact initiations are provided which may be incorporated into control circuits for liquid system pumps feeding the decant tank.

Select Decant Tank Feed annunciations are alarmed should the operator fail to select a feed stream for filling the decant tank.

Motor Overload Trip alarms are annunciated should any of the following motors have an overload trip: decant mixer drive motor, decant arm drive motor, decant pump motor, pivot drive motor, lift drive motor, clamp drive motor, capper drive motor, and tumble drive motor. In addition to the console alarm display, each motor has been provided with status indications on the electrical cabinet doors where their respective motor starters are located. These status indications display whether a run, stop, or motor overload condition exists. This allows the operator to quickly and positively identify which motor has tripped.

Drum Process Cycle Complete is annunciated when the drum is ready to be removed from the drumming station.

No Cap In Drum is annunciated whenever the drumming process has gone through the uncapping sequence and no cap has been detected by the capper. Should this condition exist, the automatic process sequence will stop and not advance to the next operation.

No Fill Selection is annunciated should the operator fail to select the amount of waste to be pumped into the drum with metering pump control switches. Should this condition occur, the automatic processing sequence will stop until the alarm condition has been corrected.

Drum Overfill is annunciated whenever drum pumping operations approach an overfill condition. A sonic sensor mounted in the fill nozzle for the concentrated waste and the decant tank slurries at the drumming station is used to detect drum content levels and is preset to initiate alarm circuitry prior to spillage conditions. Circuitry automatically stops pumping before overfilling occurs.

Drum Process Fault is annunciated whenever a problem in the drum processing program exists. This alarm is given in coincidence with all other alarms. Timing relays and interlocks are used in conjunction with the automatic sequence program for drumming operation to verify that operations automatically advance as programmed.

The alarm circuitry is interlocked with station controls to stop drumming station and decanting station operations except decant tank filling. Once the alarm condition has been corrected, station operations can then be reinitiated.

TABLE 6.4-1

MAXIMUM RADIOACTIVITY ACCUMULATION IN EQUIPMENT

Isotope	Total Annual Input[1] Activity (Ci/yr)	Maximum Activity in[1] Product Hopper (Ci)	Accumulation in[1] Process HEPA Filters (Ci)
I-131	1.4(3)	1.1(3)	7.0(1)
I-132	6.0(1)	3.1(1)	3.1(-3)
I-133	1.7(2)	3.1(1)	2.1(0)
I-134	1.3(-1)	9.9(-4)	6.6(-5)
I-135	1.7(1)	9.8(-1)	6.6(-2)
Cs-134	8.4(2)	8.4(2)	1.9(-1)
Cs-136	1.2(2)	1.0(2)	8.1(-3)
Cs-137	4.1(3)	4.2(3)	4.2(-1)
Cr-51	7.4(1)	6.8(1)	6.8(-3)
Mn-54	3.5(0)	2.6(0)	2.6(-4)
Mn-56	1.2(-1)	2.7(-3)	2.7(-7)
Fe-59	3.0(0)	2.8(0)	2.8(-4)
Co-58	7.1(1)	7.2(1)	7.2(-3)
Co-60	3.6(0)	4.8(0)	4.8(-4)
Sr-89	9.2(0)	8.5(0)	8.5(-4)
SR-90	4.5(-1)	4.9(-1)	4.9(-5)
Y-90	4.6(-1)	4.9(-1)	4.9(-5)
Y-91	1.4(1)	1.3(1)	1.3(-3)
Zr-95	1.8(0)	1.7(0)	1.7(-4)
Nb-95m	6.3(-4)	3.8(-4)	3.8(-8)
Nb-95	2.3(0)	2.2(0)	2.2(-4)
Mo-99	1.0(3)	4.6(2)	4.6(-2)
Tc-99m	9.7(2)	4.4(2)	4.3(-2)
Te-132	5.7(1)	3.0(1)	3.0(-3)
Ba-137m	3.9(3)	3.9(3)	3.9(-1)
Ba-140	3.6(0)	3.0(0)	3.0(-4)
La-140	3.9(0)	3.5(0)	3.2(-4)
CE-144	9.2(-1)	8.7(-1)	8.6(-5)
PR-144	9.2(-1)	8.7(-1)	8.6(-5)

[1] $1.4(3) = 1.4 \times 10^3$

7.0 DECOMMISSIONING

It is planned to begin use of the LLRW VR/SS facility as soon as it is licensed, and to operate it for the remainder of the life of SQNP. Near the end of SQNP, a decommissioning plan will be submitted to NRC which addresses all phases of decommissioning for the facility. This plan may be incorporated into the decommissioning plan for the entire nuclear plant.

8.0 REFERENCES

1. 'Report of the Task Group on Reference Man,' ICRP Publication 23, Pergamon Press, New York, 1975.

2. R. J. Engelmann, 'The Calculation of Precipitation Scavenging,' Meteorology and Atomic Energy, TID-24190, USAEC, 1968.