ENCLOSURE

LOW-LEVEL RADIOACTIVE WASTE

STORAGE FACILITY

BROWNS FERRY NUCLEAR PLANT

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1.0 INTRODUCTION

1.1 PURPOSE

This document is provided as supporting information for a proposed amendment to the operating license for each unit of the Browns Ferry Nuclear Plant. The proposed amendment is to allow onsite storage of low-level radioactive waste at Browns Ferry. This document is intended to be fully adequate for the staff of the U.S. Nuclear Regulatory Commission to make a decision regarding the acceptability of the action authorized by the proposed amendment.

1.2 BACKGROUND

The Tennessee Valley Authority (TVA) owns and operates the three-unit Browns Ferry Nuclear Plant located in Limestone County, Alabama. Each unit is licensed for a thermal power level of 3,293 megawatts. Commercial operation of units 1, 2, and 3 began on August 1, 1974, March 1, 1975, and March 1, 1977, respectively.

Operation of Browns Ferry results in planned and controlled generation of low-level radioactive waste. This waste consists of ion exchange and condensate demineralizer resins and miscellaneous trash as described in Table 1.2-1. At the present time, TVA is shipping the waste offsite to a licensed radioactive waste burial facility. However, for the reasons outlined in section 1.3 Need TVA is seeking authorization by way of amendment to the existing facility operating licenses, to store the low-level radioactive waste onsite at Browns Ferry for five years.

Storage on-site has a number of distinct benefits. It can provide a management method for low-level radioactive waste in lieu of using increasingly scarce and uncertain space at commercial disposal facilities. These facilities are subject to unexpected shutdowns for indefinite periods for reasons such as commercial or regulatory concerns. Because of the long lead times TVA's proposed action will prevent undesirable impacts on plant operation. This action will also allow time for the Federal government or commercial firms to open new disposal facilities for low-level radioactive waste.

Another benefit of storage comes as a result of the dramatic decrease in the amount of radiation emitted from containers at the time of disposal because of the radioactive decay. Much of the radioactive waste contains radionuclides with half-lives of one year or less. For storage times of five or more years, radioactive decay removes essentially all radionuclides except cesium-137, strontium-90, and cobalt-60 (all of which are minor contributors to the initial overall activity and container dose rate). Retaining the waste onsite for this period of decay will result in lower exposure of individuals in unrestricted areas during transportation of waste for ultimate offsite disposal. Lower curie contents could result in less radiological impact on disposal facilities and possibly the use of less restrictive disposal areas. Risk from a transportation accident will be reduced because of the lower curie content.

1.3 NEED

Since the startup of Browns Ferry Nuclear Plant unit 1, TVA has packaged and shipped low-level radioactive waste (LLRW) generated at Browns Ferry to Chem-Nuclear Systems, Inc.'s (CNSI) commercial radioactive waste disposal site in Barnwell, South Carolina. In the past months, however, significant restrictions have been placed on the amount of packaged LLRW that Barnwell will accept for burial.

CNSI has announced a policy that will result in further restrictions on the volume that TVA can send to Barnwell in the very near future, and it now appears that acceptable disposal space will become increasingly scarce and uncertain within the next 10 years. The problem of the lack of sufficient available disposal space at Barnwell for the LLRW generated at Browns Ferry will progressively intensify as other TVA nuclear plants come on line, because the announced burial restrictions are being applied to each utility as opposed to each plant. This situation could worsen over the next two years because of cutbacks in TVA's monthly allocation of disposal space and the startup of Sequoyah units 1 and 2. Even without these restrictions it is likely that additional disposal options would be needed because no other waste disposal facilities are being planned in the southeast or midwest regions of the nation.

Historical data on TVA's volume allocation and the total volumes shipped is enclosed as Table 1.3-1.

Historically, Browns Ferry has produced about 90,000 ft^3 of LLRW annually, but this number can vary depending on outage and modification activities. The design basis values for the Sequoyah, Watts Bar, and Bellefonte Nuclear Plants are approximately 56,000 ft^3 per year each. This number, however, assumes periodic steam generator tube leakage and annual refueling outages for each unit. As a result, the LLRW production rate during the initial years of operation at these plants should be significantly lower. Current schedules provide for fuel load in the first unit at Watts Bar Nuclear Plant in late 1982, and at Bellefonte in early

1983. Therefore, total volume to be disposed of over the next five years (January 1982-December 1986) is less than 1.1 million ft³.

The need to develop alternatives to disposing of LLRW at CNSI's Barnwell facility is immediate. The intent of the proposed action is to ensure that the uncertain availability of commercial disposal space will not adversely affect future electric power generation at Browns Ferry. Browns Ferry is a major contributor to the TVA electric power system and adds significantly to the reliability of the system. Operation of Browns Ferry increases TVA's ability to comply with the Nation's policy of attaining energy indepedence and could continue to minimize future dependence on foreign oil. Implementation of the proposed action will make TVA's operations at Browns Ferry essentially immune from outside restrictions on disposal of LLRW for the immediate future.

The need for immediate action requires an LLRW management plan that can be initiated promptly. The continuing nature of the problem requires a solution that will extend into the foreseeable future. Therefore, the proposed action combines immediate administrative actions with design changes and plant additions as they become available.

TVA's future use of the volume allocation at Barnwell is under continuing review. Because of uncertainty in TVA being able to obtain sufficient disposal allocations at Barnwell, our present plans are to store radioactive material onsite when our storage facility is licensed. We will evaluate continued offsite disposal during the five-year storage period, if commercial burial space remains available. Based on allocations for offsite disposal and rate of production of waste in all TVA plants, it will be necessary for TVA to begin using the onsite storage modules immediately upon receipt of authorization. Therefore, use of the modules will be required independent of continued use of the present disposal site. This use will ensure that TVA's long-term waste management plans are flexible enough to provide for the protection of the health and safety of the public while considering the best interest of TVA ratepayers.

Delaying action at this time would offer TVA no advantages in resolving the present and future LLRW storage needs at Browns Ferry. Delaying action now would only make the situation more difficult when action is mandatory. There are no foreseeable occurrences which would help alleviate the situation in the short term that could justify TVA's waiting before taking any action. Therefore, delaying action would have the same effect as taking no action.

TVA's assessment indicates that taking no action or delaying action could severely curtail electric power generating capability at Browns Ferry during a period in which use of domestic energy sources must be maximized.

1.4 SCOPE

The scope of this document is limited to the waste storage 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 Browns Ferry low-level radioactive waste storage facility as given in this document is based on USNRC Regulatory Guide 1.143. 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 facilities, although it was not specifically prepared and issued for this purpose. The actual design parameters employed by TVA in the facilities' design are in some cases more conservative than those documented. This is done in order to facilitate the development of a standardized design acceptable for use at all TVA nuclear power plants.

TABLE 1.2-1
Composition of Low-Level Radioactive Waste

Scintillation Liquids
Scintillation Vials
Oil/Water mix from lubrication and diesel oil
PVC's
Polyethylene Boots
Rubber Shoe Covers
Ion Exchange Resins
Rubber Hose
Plastic Hose (Nalgene)
Cotton Gloves, Inserts, Coveralls, and
Surgical Masks
Paper Coveralls
Pine Crates
Oak Crates
Plywood Crates
Scrap Iron and Steel
Copper Wire
Small Hand Tools
Chains
Cables
Mops
Brooms
Wood used for scaffolding and ladders
Cable Insulation
Laboratory Equipment (vials, glassware, plastic bottles)
HEPA Filters
Other wood and small metal objects

Table 1.3-1

Historical Data - TVA Allocations and Total Volumes Shipped (ft^3)

Month	Allocation	First-Come First-Served Pool	Total Shipped BFNP	Total Shipped SQNP
October 1979	-	-	7,506	-
November 1979	-	-	5,936	-
December 1979	-	-	4,434	-
January 1980	4,102	-	4,095	-
February 1980	3,293	-	3,286	-
March 1980	3,293	924	4,217	-
April 1980	2,828	15,839	18,667	-
May 1980	2,827	2,732	5,559	-
June 1980	2,827	4,967	7,794	-
July 1980	6,607	-	5,294	240
August 1980	5,948	3,310	8,858	400
September 1980	5,948	-	5,606	-
October 1980	5,463	5,914	11,377	-
November 1980	5,463	1,707	7,170	-
December 1980	5,463	1,076	6,539	-
January 1981	4,999	1,055	6,054	-
February 1981	4,999	921	5,920	-
March 1981	4,999	1,480	6,479	-
April 1981	4,535	3,266	7,481	320
May 1981	4,535	2,272	5,430	1,377
June 1981	4,535	962	5,497	-
July 1981	4,050	3,580	5,510	2,120
August 1981	4,050	1,615	5,665	-

2.0 FACILITY DESIGN DESCRIPTION

2.1 STRUCTURAL DESIGN

2.1.1 General

An evaluation was performed pursuant to 10 CFR Part 50.59, in which it was concluded that construction of the storage facility did not constitute an unreviewed safety question. Therefore, NRC's approval was not needed before initiation of construction activities. Initial phases of construction began in June 1980.

Four modules have been constructed at Browns Ferry, representing over 1 year of storage of as-produced waste. Additional modules can be built as needed.

The maximum number of storage modules to be constructed at Browns Ferry is 22. This includes a minimum of 5 resin storage modules (25 compartments) and a minimum of 9 trash storage modules (45 compartments).

The resin storage modules and trash storage modules will be above-ground, safety-related structures constructed of reinforced concrete.

All storage modules will be designed to withstand the design basis events specified in 2.1.2 and will be designed and constructed for the normal loads, severe environmental loads, and extreme environmental loads specified in 2.1.3.

Details of the site facility layout, the storage modules, and the gatehouse are provided in Figures 1 through 4.

2.1.2 Design Basis Events

2.1.2.1 Design Basis Earthquake

Each storage module will be designed to withstand the design basis earthquake (DBE). The DBE is defined as a top-of-ground motion with three statistically independent orthogonal components. The peak acceleration will be a minimum of 0.1G. Response spectrum for this event will be taken in accordance with Regulatory Guide 1.60.

2.1.2.2 Design Basis Flood

Each storage module will be located above the design basis flood elevation. The design basis flood elevation will be above the 500-year flood elevation at the site.

2.1.2.3 Design Basis Wind

Each storage module will be designed to withstand the forces exerted by a wind having a maximum speed of 95 mi/h and a recurrence interval of 100 years.

2.1.2.4 Design Basis Precipitation

Normal rainfall of 4 inches/hour has a precipitation frequency value of once every 100 years. Grading for the facility will be such that buildup of water around the structure during and after precipitation will be minimized.

2.1.2.5 Design Basis Tornado

Each storage module is 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 and translational velocity of 70 miles per hour. The storage modules are also designed for a tornado depressurization load of three pounds per square inch.

In addition to the design parameters noted above, the storage modules are constructed of thick reinforced concrete due to shielding considerations and will be capable of resisting tornado missile penetrations.

2.1.3 Loads, Definition, Nomenclature

2.1.3.1 Definition of Load Terms for Safety-Related Structure

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

Normal Loads - those loads to be encountered during normal facility operation and include:

Dead loads or their related internal moment and forces including any permanent equipment loads.

Live loads or their related internal moment and forces including any movable equipment loads.

Thermal effect loads during normal operating conditions based on the most critical transient or steady-state condition.

Severe Environmental Loads include:

Loads generated by the design basis wind specified for the facility.

Extreme Environmental Loads include:

Load generated by design basis earthquake specified for the facility.

Other Loads

Construction live loads.

2.1.3.2 Minimum Live Loads

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

2.1.3.3 Precipitation Loads

The maximum snow load and glaze ice load for the facility is less than the minimum roof live load specified. No rainfall buildup on the roof is anticipated since there will be no parapets and the roof will be sloped and free draining.

2.1.4 Load Combination

2.1.4.1 Methodology

For these concrete structures, the required section strength used in design is the maximum value among the several values determined for the required loading combinations of ACI 318-77, 'Building Code Requirements for Reinforced Concrete.' Situations occur where one or more loads in a loading combination have opposite signs from the other loads in the same combination. The following situations will be investigated for possible reversal of net effects and for determination of maximum moments and forces:

A. Area distribution for live load.

B. Maximum value for live load.

C. Zero value for live load.

Other loads will be combined with these live load situations.

2.1.4.2 Load Combinations for Concrete Structures

For service load conditions, the strength design method will be used. The required section strength will be at least equal to the greatest of the load combinations given in ACI 318-77. All storage modules will meet the requirements for watertight structures.

2.1.5 Foundation

2.1.5.1 Foundation Design

Each storage module foundation will be a structure composed of concrete base slab and walls placed on either in situ soil or compacted fill. The foundation of the module will be designed to withstand normal, severe, and extreme environmental loading conditions.

2.1.5.2 Soil Properties

The ultimate bearing capacity for the storage module foundation will be determined by standard methods. The maximum allowable bearing capacity will have a factor of safety of 2.5 with respect to the ultimate capacity. The minimum factor of safety for sliding and overturning for the storage modules will be 1.3 for normal conditions but may be reduced to 1.1 for severe and extreme environmental conditions.

2.1.5.3 Settlement

The storage modules will be designed for the anticipated total and differential settlement.

2.1.6 Concrete

2.1.6.1 Structural Concrete

All structural cast-in-place concrete and precast concrete beams and caps will have a specified minimum compressive strength of 3000 lb/in^2.

2.1.7 Steel

2.1.7.1 Reinforcing Steel

Reinforcing steel will be grade 60 deformed bars per specification ASTM A 615.

2.1.7.2 Structural Steel

Rolled shapes, plates, and bars will be per ASTM specification A 36.

2.1.8 Drainage and Sampling

Each of the compartments of a storage module will be provided with internal liquid collection and drainage capability routed to an external sampling collection point. The collection point consists of a stainless steel 2-inch drain valve and a smaller sampling valve at the low point of the drain. The external collection point is surrounded by a covered concrete sump connected to the module. The concrete sump will be utilized to collect any liquid and provided with decontaminable coating on the interior surface.

2.1.9 Decontaminable Coatings

The interior surfaces of each storage module (excluding the cap) will be coated with an approved decontaminable coating system in accordance with TVA's General Construction Specification G-14, Part No. N-935.

2.1.10 Wall Thickness and Radiation Shielding

The storage modules will be shielded using concrete. The outer walls of each resin storage module will be a minimum of 42-inches thick while the outer walls of each trash storage module will be a minimum of 24 inches thick. The concrete caps for resin and trash storage modules will be 24 inches thick. The resin storage modules (including foundations, walls, beams, and 24-inch caps) will be designed to support an additional 18-inch (maximum) concrete cap for additional shielding if needed. The concrete beams which shield the joint between the concrete caps will be a minimum of 24 inches thick (vertically).

2.2 Container Integrity

2.2.1 Steel Drums

All miscellaneous trash will be stored in steel drums. In general, these containers will meet the DOT specification 17H (or equivalent), and will have a capacity of 55 gallons. As an alternative, metal boxes meeting DOT specifications may be used for storage. These containers will be constructed of at least 18-gauge steel and shall be externally coated to reduce container corrosion. No wooden or cardboard packages will be stored in the storage facility.

Most of the radioactive waste stored in these containers will be dry and inactive. On occasion, moist material (with no free-standing water) may be packaged for storage. All moist material will be packaged in a sealed polyethylene bag before it is placed in the steel container. Double bags will be used when necessary. Therefore, no corrosion of the inside of the steel container is expected, and no coating will be applied to the inside of the container. Without a mechanism for internal or external corrosion, it is expected that 5-year storage of miscellaneous trash in steel drums or boxes can be accomplished without loss of container integrity.

2.2.2 Steel Liners

2.2.2.1 Waste Form

2.2.2.1.1 Physical Properties

Ion exchange waste will be stored in steel liners in the storage modules. This material consists of the following: anion and cation resin in both powdered and bead form (the majority is powdered), cellulose filtration material, radioactive crud, and water contained within the other materials (about 60 to 70 percent by weight). There is no free water, i.e., the resin has been dewatered to meet the State of South Carolina's 0.5-percent free-standing water criterion. The resin consists of a plastic material (copolymerized styrene crosslinked with divinyl benzene) with strong acid cation (hydrogen form) ion-change capacity and strong base anion (hydroxide form) capacity. It should be noted that the resins will be fully or partially exhausted after being used in plant systems. A fiberous filtering material (under various trade names) is used as an overlay material on a demineralizer precoat and consists of a cellulose-like filtration material. This fiberous material makes up approximately 30 percent of the precoat volume utilized by the condensate cleanup system and is sometimes used in the radwaste and reactor waste cleanup systems. Radioactive crud (consisting mostly of activated corrosion products) is filtered from water within the nuclear plant and has been estimated to make up about 2 percent of the total weight of the waste.

2.2.2.1.2 Chemical Properties

The pH of unexhausted cation resins is approximately 6.8. The pH of typical mixture of anion and cation resins ranges from 5.0 to 5.3 in locations of collected water. As the resins are depleted, pH values will approach 7.0 (neutral pH). Condensate cleanup resins are rarely fully exhausted, but reactor water cleanup and radwaste filter resins are usually exhausted before disposal or storage. Resin conductivity ranges from 0.5 to 2 umbos. The above conditions could be corrosive to carbon steel, and internal coating of the liner will be required.

2.2.2.1.3 Radiological Properties

The activity of ion-exchange resin varies depending on plant operating conditions and the source of the water that is demineralized by the resin. Currently, condensate cleanup resins range in activity from about 0.2 to 10 uCi/cc with liner contact dose rates from 100 mrads/hr to 7 rads/hr. Reactor cleanup resin activities range from about 2 to 230 uCi/cc with liner contact dose rates from 500 mrads/hr to 45 rads/hr. The design source terms provided in Table 4.1-1 are applicable for nonvolume-reduced waste as well as for volume-reduced waste. Based on these source terms, we have determined the maximum absorbed doses to nonvolume-reduced resins during five years of storage. We have also determined the maximum absorbed doses that these resins will have received prior to the storage period. The absorbed doses are as follows:

	Absorbed Dose		
	Gamma Dose (rads)	Beta Dose (rads)	Total Dose (rads)
Prior to Storage	1.5×10^6	7.2×10^5	2.2×10^6
During 5 Yrs. Storage	5.9×10^6	2.4×10^6	8.4×10^6
Total	7.4×10^6	3.1×10^6	1.1×10^7

2.2.2.2 Changes in Waste During 5-Year Storage

2.2.2.2.1 Physical

No physical changes are expected in the radwaste itself. There is a possibility of resin densification (packing) during the storage period with a resultant increase in free water. This increase is expected to be minor and will probably not exceed the State of South Carolina's free-water limitation in TVA's liner design. Before offsite shipment of a previously stored liner, an attempt will be made to dewater the liner to remove any accumulated water.

2.2.2.2.2 Chemical

There are several mechanisms that can produce chemical changes in the resin during storage.[1] These include resin degradation through:

a. direct irradiation of the resin

b. formation of hydrogen peroxide through radiolysis of water

c. thermal heating from decay of Sr-90 and Cs-137

d. nitric acid production through oxidation of nitrogen compounds in the resin and air in the liner (secondary reaction)

e. sulfuric acid production from cation resin degradation (secondary reaction)

f. formation of amines from anion resin degradation (secondary reaction)

g. carbonic acid production from the equilibruim reaction of water with carbon dioxide (secondary reaction)

h. bacterial decay of cellulose material or other organics

These reactions can produce acids (sulfuric, sulfonic, nitric, carbonic, and nitrous), various gases (hydrogen, oxygen, carbon dioxide, nitrous oxide, nitric oxide, sulfur dioxide, methane, carbon monoxide, and nitrogen) as well as amines, hydrogen peroxide, and sodium acid sulfate. These constituents (with the exception of methane and carbon dioxide from bacterial decay)[2] result from irradiation of the waste over a long period of time and do not become significant until the total absorbed exposure to the resin exceeds 10^7 to 10^8 rads.[2,3] As previously stated, the maximum expected integrated dose to the resins based on design basis source terms during the 5-year storage is about 1.3 x 10^7 rads. Therefore it can be seen that Browns Ferry waste will not exceed the radiation levels that will produce significant resin degradation during the storage period.

One mechanism which may produce a chemical reaction in the waste container during storage is bacterial decay. Decomposition of cellulose or other organics can release methane and carbon dioxide if microorganisms are present in the waste. Recent studies have shown that bacterial growth is retarded at a radionuclide concentration of 2.7 x 10^4 pCi/ml and completely inhibited at a concentration of 2.7 x 10^5 pCi/ml. For a 186 ft^3 TVA liner of waste, bacterial growth would be completely inhibited if the liner contains 1.4 curies of waste (1.2 curies for a 156 ft^3 liner). All of the ion-exchange resin shipped from Browns Ferry since March 1978 has contained in excess of these activities as did the large majority of the waste shipped before that time. All future shipments are expected to contain at least these amounts of activity. Because of radioactive decay, the specific activity of some of the waste stored may fall below 2.7×10^4 pCi/ml during storage. While retardation of bacterial growth should occur to a level of 2.7×10^4 pCi/ml, a biocide can be added to the waste to prevent bacterial decay during storage. This biocide will be compatible with the container and waste form. Before offsite shipment of a previously stored liner, each liner will be vented under controlled conditions inside the nuclear plant to relieve potential gas buildup.

2.2.2.2.3 Radiological

Radiological changes will occur only due to decay of the original radioactive isotopes. After five years of storage, most of the short-lived isotopes will have decayed and the remaining radioactivity will be primarily Cs-137, Co-60, and Ba-137m. The activity levels will, of course, be dependent on the initial level and the time in storage.

2.2.3 Container Description

2.2.3.1 Physical

TVA's resin liner is constructed of 0.25 inch A-36 carbon steel in the shape of a cylinder. These liners are constructed for TVA by the TVA Power Operations Service Shops in Muscle Shoals, Alabama, in accordance with TVA drawings. All welding is performed utilizing welders and procedures qualified to the requirements of TVA Division Procedure Manual (DPM) No. N73M2 (construction procedure G29M).

During and following construction of the liners, a number of tests and inspections are performed to ensure that the liner is properly built. These include a hydrostatic or pneumatic pressure test at a minimum pressure of two psig for 10 minutes to ensure container integrity, visual inspection of interior and exterior welds in accordance with procedure 3.M.5.1 (d) of DPM N73M2, visual inspection of internal dewatering elements and pipe fittings, and a final inspection check to ensure that the liner meets all tolerances. Upon receipt at Browns Ferry, the liner will be inspected to ensure that exterior coatings are properly applied, that the liner and the coating have not been damaged during transportation, and that there are no obvious defects in fabrication.

Radwaste liners may be lifted using either a permanently attached sling or an air-actuated remote lifting device. Closure of liner penetrations (countersunk pipe plugs) is accomplished using a TVA-approved thread sealant (such as Teflon tape or Loctite) before storage of the waste. All lifting devices and closures are visually inspected to ensure proper fabrication and installation before liner use.

2.2.3.2 Chemical

Liners currently used for offsite disposal are coated on the exterior surfaces with one coat of primer and two coats of alkyd gloss enamel. Liners to be used for onsite storage are coated on both the interior and exterior surfaces with one coat of primer and one coat of of a 2-part epoxy coating to a minimum thickness of 8 mils. This coating is applied with sufficient quality control to ensure that uniformity and minimum thickness requirements are met and, when possible, will be checked for pin hole defects. The coatings preclude chemical attack on the liner material during waste storage.

2.2.4 Compatibility

The epoxy coating protects the interior of the liner from chemical attack from the liner contents and precludes corrosion of the exterior surface from high humidity, rain, temperature extremes, and other expected corrosion-producing mechanisms. The coatings are selected to provide corrosion protection for periods exceeding the 5-year storage period.

2.2.5 Range of Compositions

The storage liners allow the storage of any mixture of depleted or partially depleted anion and cation ion-exchange resins, cellulose, and other waste constituents. Although only material with a pH of 5.0 to 7.0 is expected to be stored, the protective coating will allow storage of waste with a pH range of 2 to 13 during the 5-year storage period. Free-standing water content ranges from nondetectable levels to less than 0.5 percent of the container volume (from 5.8 to 6.9 gallons depending on the container). Experience has shown that free-standing water is not detectable in TVA liners.

2.3 SECURITY

The storage facility will be surrounded by a wire fabric fence with three strands of barbed wire, totaling eight feet in height. All individuals and vehicles, while on the facility site, will be monitored--either physically or electronically. Communication equipment is located at each nuclear plant to contact local, State, and Federal law enforcement agencies and emergency services. The fence will be provided with one or more points of access and access will be positively controlled while individuals and vehicles enter and exit the OSF. All individuals entering and exiting the OSF will be positively identified. TVA will conduct a yearly audit of the OSF security system.

2.4 CRANE

The crane to be used at the LLRW facility will be a rubber-tired, diesel-powered, mobile gantry crane. It will have two cross beams, a 15-ton capacity trolley on the front beam and two 30-ton capacity trolleys on the rear beam. The 15-ton hoist will be used to handle the LLRW containers and the 30-ton hoists will be used to handle the storage module caps. In order to facilitate movement from one module to another, the crane will be driven and steered by the same wheels and these wheels will be capable of turning 90° in either direction. In addition to its standard features, the crane will be equipped with an ac generator, an air compressor, eight 500-watt lights, a cable reel and a hose reel to provide air and electric power to the 15-ton hook, and a CCTV monitoring system. The CCTV monitoring system will be designed to allow remote handling of the LLRW containers beyond the line of sight of the operator. The CCTV monitors, the CCTV controls, and all crane controls will be mounted in a cab. Three special lifting devices will be furnished. Handling of the resin liners will be accomplished using a rigid frame with air-actuated lifting lugs. The 55-gallon drums will be handled using a standard gravity-actuated barrel grapple. A magnetic lifting system will be provided to handle the support grating that is to be used for stability between levels of drums or liners.

2.5 FIRE PROTECTION

The only significant potential for fire at the storage facility is an external exposure fire. The facility is of noncombustible construction and designed to provide a three-hour fire resistance rating from external exposure fires.

Potential fires within the storage modules have been assessed. TVA has performed an analysis that establishes that the potential spontaneous combustion of packaged trash is not a concern and dewatered resins when placed in sealed liners are not considered to be flammable.

The Browns Ferry OSF will have a remotely located 150,000-gallon bladder-type storage tank serviced by a diesel-driven fire pump. Hydrants and hydrant houses are provided around the perimeter of the storage facility in accordance with NFPA Standard No. 24. The storage tank will be supplied by a water line branching from a local water utility main servicing Browns Ferry Nuclear Plant. This water line will also serve as a second source of fire hydrant water in the event the storage tank is not available. A portable fire pumper will be stationed at the OSF as an interim measure until the storage tank, which is currently under construction, is available. Two points of entry are provided through the security fence to accommodate a standard fire department pumper.

Each storage module compartment has been sized to collect and contain that quantity of water used for manual fire fighting from two 2-1/2-inch hose streams simultaneously for a duration of at least one hour. The storage facility will also be provided with multipurpose dry chemical fire extinguishers in accordance with NFPA Standard No. 10. All fires will be fought by specially assigned personnel with support from the BFNP fire brigade.

2.6 RADIATION MONITORING AND PROTECTION

2.6.1 Radiation Monitoring

Radiation monitors will be permanently installed only at the security gatehouse. All other necessary radiation monitoring will be performed by the plant Health Physics Staff using portable equipment.

Monitoring wells in clusters will be provided and placed outside the security fence. The initial well of the cluster was core drilled under the supervision of a geologist. Representative ground water samples will be collected before waste is stored in the modules. The water table under the waste storage site is between elevation 552 and 572 feet (i.e., 28 to 8 feet, respectively, below the grade of the storage area which is 580 feet). The design and number of additional wells in the cluster should be determined on the basis of the initial core. All wells will be fully developed, grouted, sealed, and capped to prevent the introduction of any extraneous material. Monitoring well identification markers will be erected above ground.

2.6.2 Radiation Protection

Except for trash, the design basis radioactivity levels of the LLRW will be based on plant operation with expected radioactivity concentrations in the reactor coolant. The design basis radioactivity levels for trash will conservatively assumed be a factor of 10 higher than average levels measured at Browns Ferry Nuclear Plant through June 30, 1979.

The facility will be designed for implementation of the control measures for radiation and high radiation areas as defined in 10 CFR 20. The facility will also be designed such that the probability is small that any person would receive a dose equivalent greater than 500 mrem during any calendar year in unrestricted areas from storage facility operation (which includes handling operations). As part of the provisions to implement this restriction on dose equivalent in 2-7 unrestricted area, the dose equivalent rate at the storage facility security fence will not exceed 0.6 mrem per hour. During handling operations this dose rate may be temporarily exceeded.

2.7 QUALITY ASSURANCE

To ensure the storage module structures will perform as intended, a quality assurance program will be established and documented. As a minimum, this program shall conform to the requirements of Regulatory Position 6 of USNRC Regulatory Guide 1.143.

2.8 ELECTRICAL REQUIREMENTS

The OSF will be provided with electrical power from offsite by the local utility.

2.9 EQUIPMENT CODES

All storage facility equipment shall be designed, procured, constructed, and inspected in accordance with the codes and standards identified below:

EQUIPMENT CODES

COMPONENT	DESIGN & FABRICATION	MATERIALS	WELDING	INSPECTION & TESTING
PIPING AND VALVES				
a. Storage Module Drains	ANSI B31.1 (QA shall be in accordance with attachment RW of MEB E.P.23.5.5)	304-L or 316-L	ANSI B31.1	ANSI B31.1
b. Storm Drains	AASHTO	AASHTO	-	-
c. Potable water and sewers	National Plumbing Code	National Plumbing Code	National Plumbing Code	National Plumbing Code
d. Fire Protection	NFPA Code Standard 24	NFPA Code Standard 24	NFPA Code Standard 24	NFPA Code Standard 24
CRANE	Joint Industrial Council & AISC	ASTM	AWS	AISC, ASTM, & AWS
Decontaminable Coatings	TVA Spec. G-14	ANSI N512	-	TVA Spec. G-55
Electrical, Security, and Radiation Monitoring Equipment	IPCEA Standards Industry Standards NEMA Standards RDT Standards RDTC1-1T	ASTM Industry Standards	AWS Industry Standards	Industry Standards ANSI-N13.1-1969 ANSI-N13.10-1974
FIRE PROTECTION				
a. Extinguishers	NFPA Code Standard 10	NFPA Code Standard 10	-	NFPA Code Standard 10
b. Hydrants, Houses, Hoses, etc.	NFPA Code Standard 24	NFPA Code Standard 24	NFPA Code Standard 24	NFPA Code Standard 24

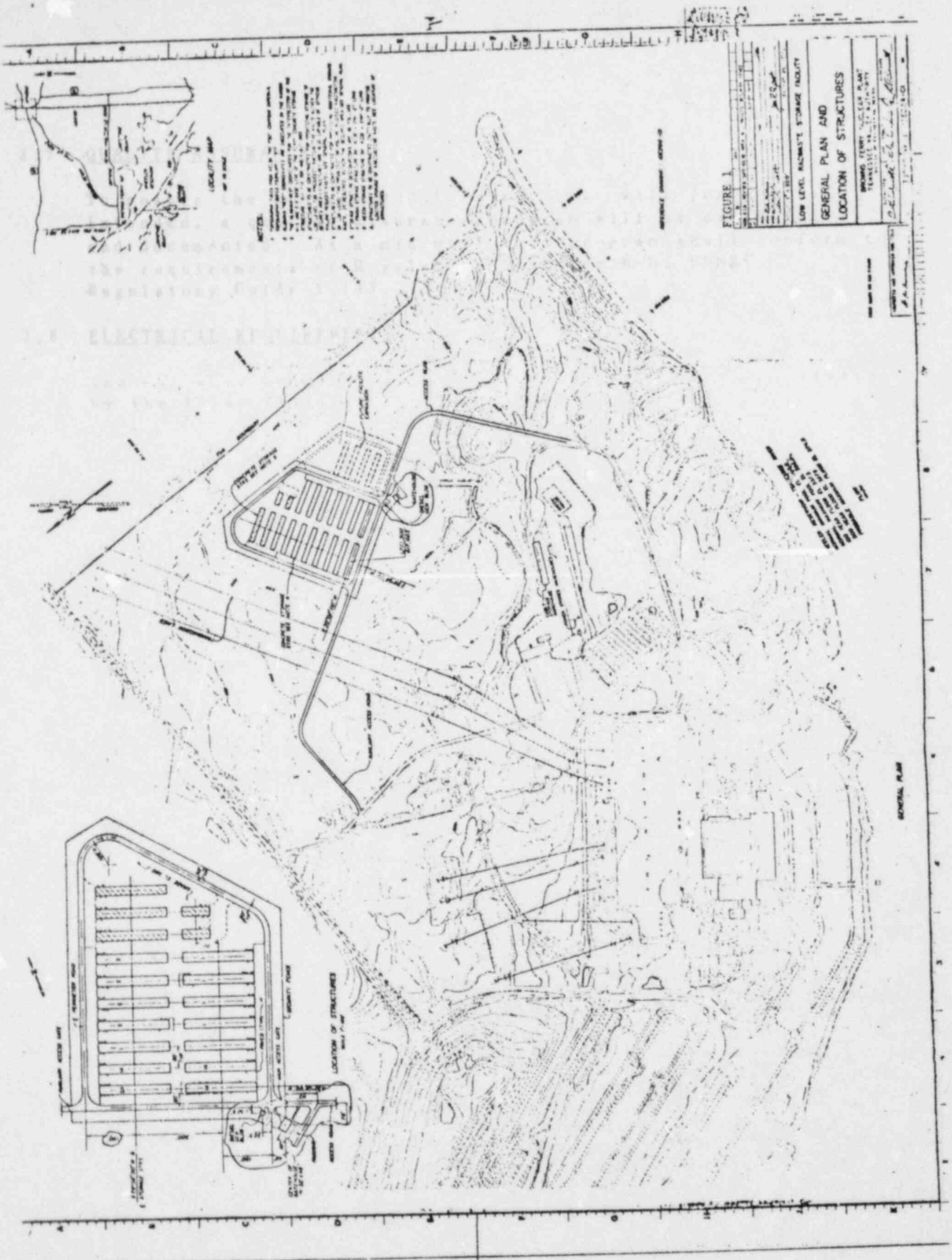
FIGURE 1
LOW LEVEL RADWASTE STORAGE FACILITY
GENERAL PLAN AND
LOCATION OF STRUCTURES
LOCATION OF STRUCTURES
GENERAL PLAN

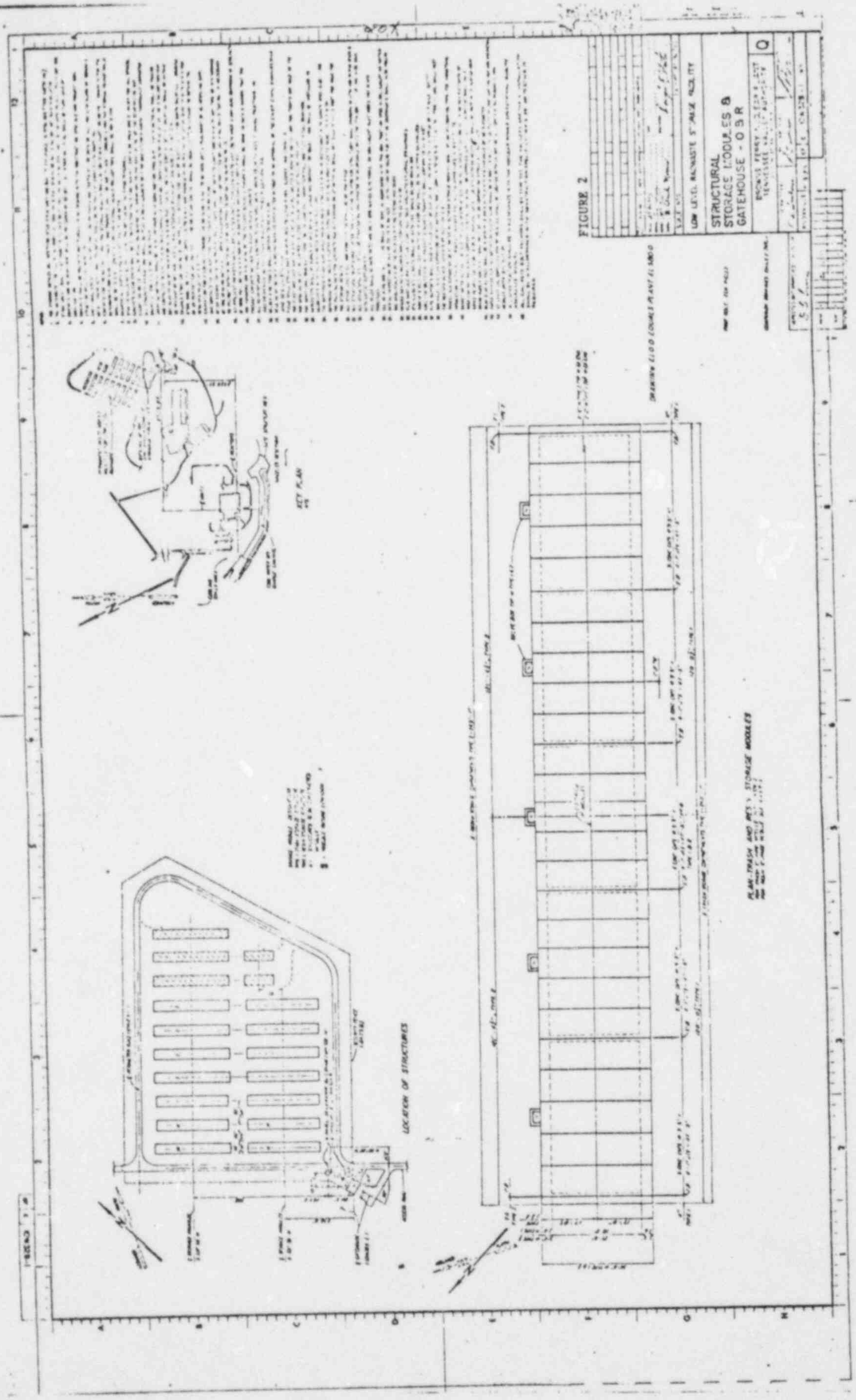
FIGURE 2
LOW LEVEL RADWASTE STORAGE FACILITY
STRUCTURAL
STORAGE MODULES &
GATEHOUSE - OBR
LOCATION OF STRUCTURES
KEY PLAN

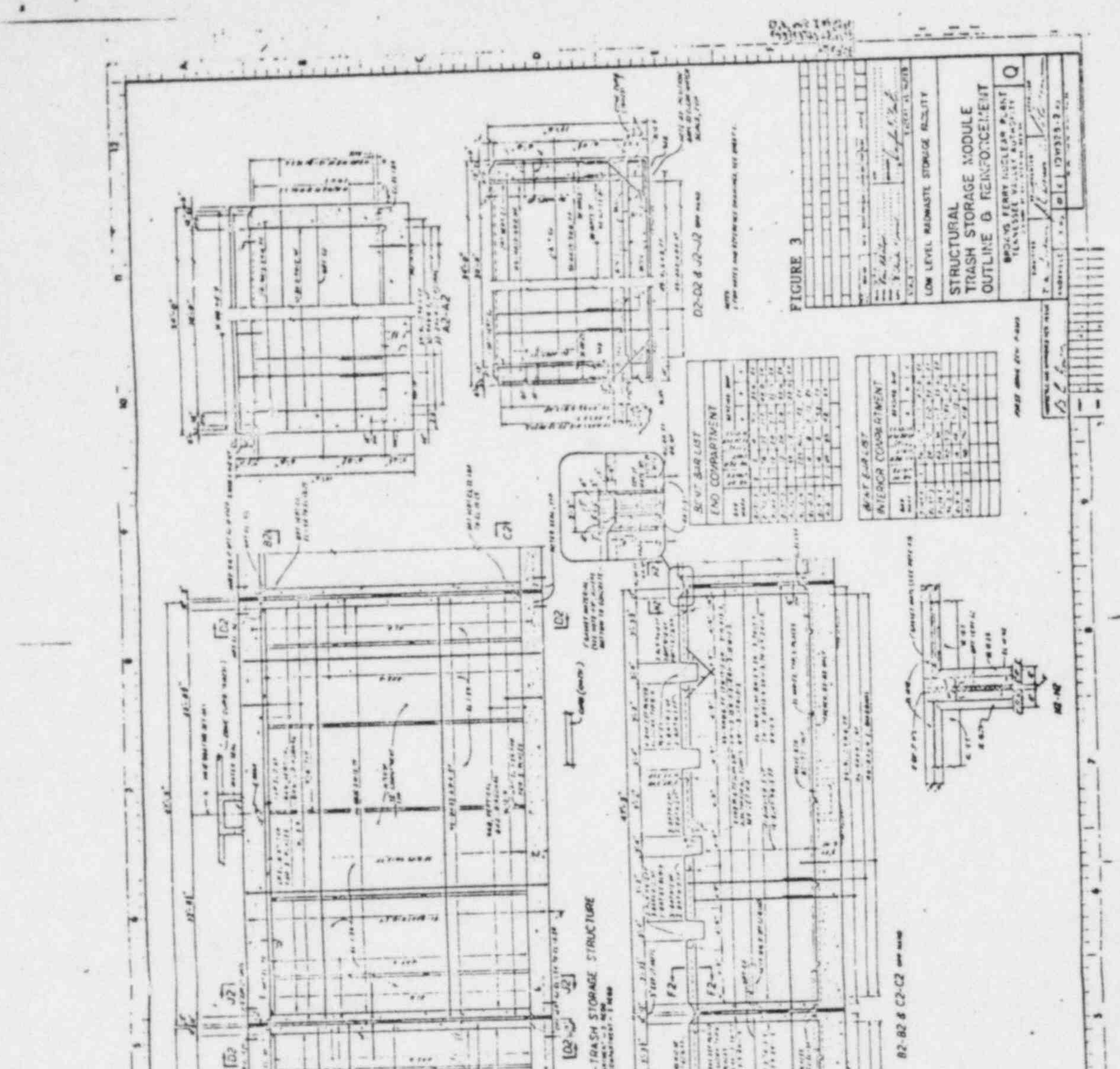
FIGURE 3
LOW LEVEL RADWASTE STORAGE FACILITY
STRUCTURAL
TRASH STORAGE MODULE
OUTLINE & REINFORCEMENT
BROWNS FERRY NUCLEAR PLANT
PLAN - TRASH STORAGE STRUCTURE
A2-A2
D2-D2 & J2-J2
B2-B2 & C2-C2
E2-E2
F2-F2
BENT BAR LIST
END COMPARTMENT
BENT BAR LIST
INTERIOR COMPARTMENT

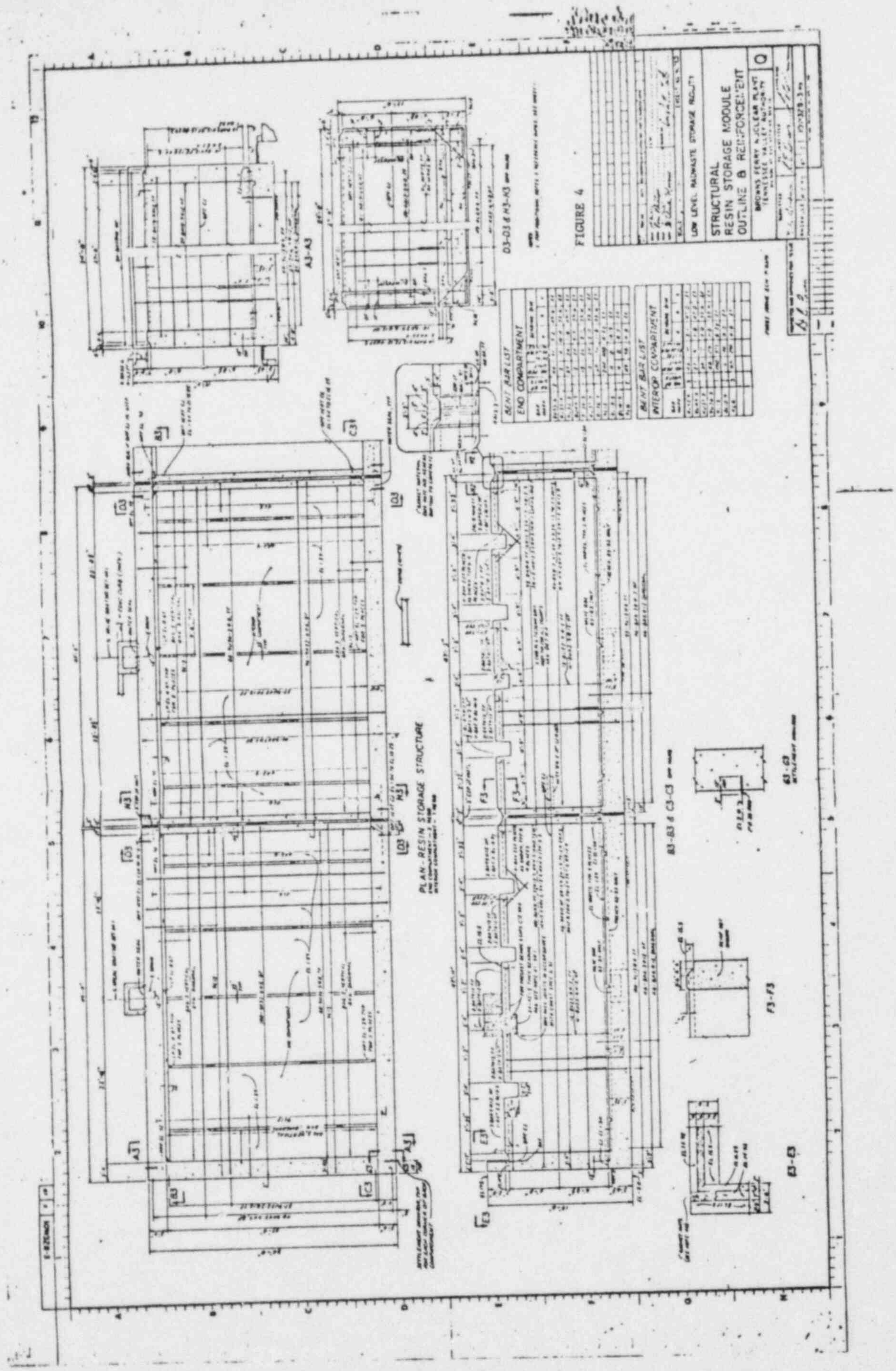

FIGURE 4
STRUCTURAL
RESIN STORAGE MODULE
OUTLINE & REINFORCEMENT
LOW LEVEL RADWASTE STORAGE FACILITY
BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY
PLAN - RESIN STORAGE STRUCTURE
BENT BAR LIST
END COMPARTMENT
BENT BAR LIST
INTERIOR COMPARTMENT
A3-A3
D3-D3 & H3-H3
B3-B3 & C3-C3
F3-F3
E3-E3

3.0 FACILITY OPERATION

3.1 HANDLING AND STORAGE OPERATIONS - DESCRIPTION

Steel liners containing dewatered resins and 55-gallon steel drums containing trash will be transported to the storage site in shielded casks or in van-type trucks depending on dose rates. All shipments will be in compliance with DOT and NRC requirements before transport. Access to the storage facility will be through the facility's main gate. The vehicle will be taken to either a resin module or a trash module depending on the type of radioactive waste to be stored. Each module will be identified by a sign denoting its intended contents and storage status. A gantry crane will then be positioned over the module cell to be loaded, and the top hatch of the module removed and set aside. The vehicle will then be parked under the gantry crane.

For resin shipments in a shielded cask, the cask cover bolts will be removed using an air wrench. The cask cover will then be removed from the cask using the gantry crane and set aside. An air-actuated remote lifting device will remove the liner from the cask and place it into a predetermined space in the module. Resin liners requiring storage will be transported and stored one at a time. All operations will be observed on closed-circuit television to reduce employee exposures. The remote lifting device will then be unhooked. The cask cover will then be replaced and bolted, and the cask returned to the plant.

For drum shipments in a truck, the truck will be parked under the gantry crane. For trucks with removable tops, the drums will be unloaded directly from the truck using a remote drum handling device and placed into the module. For trucks with rear doors, a movable ramp and forklift will be used to unload the drums to the outside of the truck. These drums will be stored in lots of 140 to 160 at a time, although only one drum will be placed in module at a time. The drums will be lifted into the module using a remote drum handling device. All vehicles will be monitored for contamination and excessive dose rates before they are returned to the plant.

TVA will utilize metal gratings as an interface medium between the storage module floor and the first layer of containers and successive layers of containers. Drums will be stored up to 3-layers high. Resin liners will be stored up to 2-layers high.

When all containers in the shipment have been stored, the top hatch will then be placed back on the module. When containers are removed for final disposition or for the contents to be volume reduced should volume reduction be installed, this procedure will be reversed.

Records kept in the plant will indicate the placement of each container. These records will also indicate the container identification number, curie content, dose rate, type of radioactive waste, and whether the contents are volume-reducible.

All laborers, crane operators, and truck drivers will be furnished by the plant. All operations at the storage facility will be monitored by plant health physics employees. Monitoring activities include vehicle and container surveys during shipment and module loading and unloading. Periodic surveys shall also be conducted in the area outside the modules as well as regular checks to determine the presence of liquid at the external sampling collection points. Sampling wells in the storage area will be checked on a regular basis to indicate if any radioactive contamination has reached the underlying aquifer.

All loading of containers into the module will be done remotely utilizing a closed circuit television monitor to observe the placement of the container in the module. The monitor will be used to ensure that a container is placed in the correct storage cell without damaging either the container, the storage module, or other containers in storage.

The CCTV system consists of two monitors and four cameras, all completely independent of each other except for their power source. Each monitor is equipped with manual control capabilities to select display from any of the four cameras. The cameras are equipped with individual pan and tilt control.

Should a camera fail, no major interruption of the system would occur. Cameras are paired and placed in such a manner that loss of a camera would not affect the operational procedure. The crane is equipped with permanent scaffolds to provide easy access to all cameras. Replacement of a camera for repair involves replacing the damaged camera with minimal exposure to personnel.

Since each monitor can survey the area through all four cameras, independent of the other monitor, the loss of one monitor would not demobilize the system. However, should a monitor fail, procedures may be slowed.

Should a total failure occur of either both monitors or all cameras (low probability but possible in the case of a total power failure), one of the following courses of action would be taken, depending on the position of the container:

(1) If CCTV capability is lost while the container is outside of the storage module, the container will be immediately returned to the truck or shipping cask from which it was removed. If repairs to the CCTV are expected to take an excessive amount of time, the truck or shipping cask shall be taken to a secure area of the site for storage until the CCTV is repaired.

(2) If CCTV capability is lost while the container is inside the module (but not in a stored position), several options exist. In any case, the crane and container will not be moved laterally. One option involves the use of a portable camera system available from the nuclear plant which can be rigged to observe the container. At the operations supervisor's option, the container can then be either retrieved and placed in temporary storage until the CCTV is repaired or lowered into place in the module under observation using the portable camera system.

At the Operations supervisor's option, container storage may be continued utilizing the portable camera.

Another option is to repair the CCTV (if possible) while the crane remains in the position where it was when the CCTV was lost. This may not be possible if the failed equipment is in a high radiation field.

The design of the mobile crane will allow storage operations at night. However, because of the decreased visibility, storage operations will normally be carried out only during daylight hours. Night operations will not be undertaken unless plant operations will be affected using only daylight storage operations. Extra lights will be used to increase visibility and to ensure that the CCTV system can be used. Low-level radioactive waste volumes are not expected to require night operations. Storage operations will not be conducted during inclement weather, such as rain or snow storms.

Should the cables of the mobile crane lock due to motor or power failure making it impossible for the trolley to transfer the container to its storage position, the container can be remotely lowered into the cask or module by manually releasing the brake. If the trolley locks in a position that is not directly above a cask or module, the container can be moved laterally by driving the crane to a safe position and the container lowered manually by releasing the brake. The crane is then moved back to an area where repairs can be done. The container would remain isolated, shielded locally, and guarded until repairs are completed and the crane could return to safely place it in its stored position. A possible alternative if the liner is not above a cask or module is to position the cask truck in an area clear of the modules such that the crane can lower the liner into the shielded cask. The truck would then be taken to a secure site for storage until repairs on the crane were completed.

Security Operations

Either the physical or electronic measures will be used to monitor individuals and vehicles while on the facility site as well as when leaving the facility. These measures will ensure that the security of the area is not compromised. Additional measures (to include security personnel) shall be utilized when necessary.

ALARA

All employee exposures will be kept as low as reasonably achievable (ALARA). When containers with excessively high radiation doses are handled, remote methods will be used. Only employees required to handle the shipment will be allowed in an area where containers are being handled. All container and vehicle dose rates and contamination levels will be within DOT limits before shipment. Employees and containers will be monitored during all operations by health physics employees to ensure that dose limits are not exceeded and that good work practices are followed. All operations will be conducted in accordance with written procedures.

3.2 MONITORING OPERATIONS

3.2.1 Integrity Monitoring

3.2.1.1 Drum Inspection

Because the waste stored in steel drums is dry, chemically inactive, and usually of very low activity, no inspection program will be set up to monitor the integrity of these containers. TVA and other industry experience has shown that drum monitoring is not necessary.

3.2.1.2 Liner Inspection

Actions taken to ensure container integrity are expected to prevent any breach of the liner and subsequent release of the waste to the module or the outside environment. To ensure this, a liner inspection program will be established to determine the status of stored resin containers.

3.2.1.2.1 Visual Inspection

Because of the high cumulative dose rate expected from stored containers within a module compartment, there will be no direct visual inspection of the liners. Instead, remote television monitors will be used during liner placement to observe liners already stored within a module cell. After a cell is filled (six liners), each cell will be opened and the liners visually inspected on at least a quarterly basis to determine swelling, corrosion of the exterior of the liner, or breach of container integrity. Television monitors will be used to ensure that occupational doses during monitoring are kept as low as reasonably achievable.

In order to provide a check on liner contents and the changes that may occur during storage, TVA will set up two worst-case control liners in empty storage module compartments or in the radwaste packaging bay at the plant. One liner will be filled with a mixture of 50-percent ion-exchange resin and 50-percent cellulose filtration material which will be used to process low-activity laundry water. This liner will be equipped with a pressure gauge to monitor possible gas evolution. If excessive pressurization of this liner takes place, TVA will take measures to vent liners in storage.

Direct visual examination and

manual sampling of this control liner's contents will be possible since the liner is expected to have a relatively low dose rate. Gases will be collected from the liner to determine whether radioactive or explosive gases are generated during resin storage. In addition, the liner will be monitored on a quarterly basis to check the pH, amount of free water, activity, and for signs of resin degradation. Samples of coated liner material will be suspended in the liner and checked quarterly for signs of coating degradation. Although no action is anticipated to be needed at this time, TVA will take appropriate action to vent the liners or stabilize stored waste if indicated by these tests.

The second control liner will be filled with high-activity resin. This liner will be equipped with a pressure guage which can be read remotely to minimize employee exposures during monitoring. Gas evolution will be monitored to determine if high-activity resin produces significant quantities of gas during storage. TVA will take appropriate action to vent the liners or stabilize stored waste if indicated by these measurements.

3.2.2 Module Monitoring

The only significant potential for fire at the storage facility is from an external exposure fire. Therefore, no fire detection devices will be incorporated into the module design. External fires will be detected by periodic security patrols made through the storage area or by workers during storage operations. The facility is of noncombustible construction and designed to provide a three-hour fire resistance rating from external exposure fires.

No air sampling equipment is built into the module. However, an air sample may be pulled through the compartment sump liquid sampling connection. TVA will take an air sample from a module compartment through this sampling connection before opening a module cell if the compartment has been sealed for two months or longer. The sample will be analyzed for dangerous gases and airborne radioactivity before the cell cap is removed. Detection of significant concentrations of hazardous gases will require that the compartment be cleared of these gases by pumping and filtering the compartment atmosphere before the cell is opened.

Modules will not be opened during inclement weather, such as rain or snow storms, to prevent unnecessary introduction of water into the module. Hatch sealing surfaces will be examined to ensure that they are in proper condition.

The sump in each module will be sampled periodically to detect the presence of water and/or radioactive releases in the module. Detection of water or radioactive releases in a module will require an intensive check of all containers and the inside of the module to determine the source. Corrective actions, including repackaging of a leaking container or repair of a defective hatch seal, will be undertaken. Radioactive liquids will be collected and transported to the plant for processing by the radwaste system. Nonradioactive liquids will be disposed of in accordance with established plant disposal operations.

3.2.3 Environment

Sampling wells in the storage area will be checked on a regular basis to indicate if any radioactive contamination has reached the underlying aquifer. The area outside the module walls will be checked routinely to detect leakage.

4.0 RADIOLOGICAL CONSIDERATIONS

Those organizations within TVA and BFNP having responsibility for radiological safety are discussed in Supplement 1.

4.1 RADIOLOGICAL ASSESSMENT

TVA has performed a radiological assessment of the waste storage facility, covering the operational releases expected as a result of operator error or equipment malfunction and the releases from an accidental fire for the five-year storage period. The radiological assessment is based on BFNP low-level waste generation rates for 1979. Some fluctuations in annual waste generation rates may occur with time due to radioactive 'crud' buildup and radioactive decay time allowed between waste generation and waste placement in the storage facility. However, based on current waste generation trends at BFNP, use of the 1979 values is not expected to significantly underestimate radiological impacts.

The source terms employed in the calculations of all dose equivalents are given in Table 4.1-1 as 9875 curies per year in resins and 113 curies per year in trash for a total of 9988 ci/yr. These source terms have the following bases:

1. For trash, the annual radioactivity inventory employed is 10 times annual inventories experienced at Browns Ferry Nuclear Plant through June 30, 1979. The annual inventory experienced at Browns Ferry Nuclear Plant is conservatively assumed to consist entirely of Co-60. The specific activity of Co-60 is calculated from measured exposure rates outside radioactive trash containers. Combining this specific activity with the annual trash volume produces the experienced inventory.

2. The annual inventory of resin radioactivity that can be stored in the facility is limited by the criterion that the dose equivalent to the nearest resident from facility operation not exceed 10 mrem per year. This dose equivalent is considered an appropriate allocation to the storage facility operation from the 40 CFR 190 limit of 25 mrem per year from the entire fuel cycle. The dose equivalent to offsite residents from trash storage operations is negligible. Therefore, the 10 mrem per year can be allocated entirely to resin storage operations. The corresponding resin radioactivity inventory is calculated to be 9875 curies per year. (The nuclide distribution is given in Table 4.1-1.) This annual inventory of resin radioactivity would be produced if all three units are operated continuously

with approximately .015 percent failed fuel. To date, failed fuel experience at the Browns Ferry Nuclear Plant has been considerably better than this.

The attached Tables 4.1-1 and 4.1-2 present the major assumptions used in the assessment and the results of the assessment, respectively.

4.2 OCCUPATIONAL EXPOSURE

Annual occupational personnel exposures have been estimated for the handling and placement of as-produced low-level waste in the waste storage facility for a five-year period. Dose estimates are given in Table 4.2-1 and include exposures to waste handlers, health physics monitors, crane operators, nuclear plant employees, and transport personnel. All doses are within regulatory limits.

4.3 DOSES TO UNRESTRICTED AREAS

The doses in unrestricted areas due to waste handling and storage in the OSF have been calculated and are given in Table 4.3-1. These doses include direct and skyshine radiation from the facility to the site boundary, nearest resident, and nearest onsite non-nuclear facility. All assumptions are the same as for Sections 4.1 and 4.2, except as noted in Table 4.3-1.

4.4 IMPACTS FROM RETRIEVAL

The impacts from retrival of waste from the storage modules at the conclusion of storage have been evaluated. In order to provide an estimate of how long it would take to remove the waste at the end of the five-year license term, the following assumptions have been made.

4.4.1 Assumptions

a. The waste volume to be removed consists of the total contents of 14 modules (slightly less than five years total LLRW production) and is divided as follows:

   Resins - 5 modules, 150 liners per module, 186 ft^3 per liner

   Trash - 9 modules, 3900 drums per module, 7.5 ft^3 per drum

b. Sufficient offsite disposal capacity exists for unrestricted shipment of all accumulated waste.

Table 4.1-1

BROWNS FERRY NUCLEAR PLANT - MAJOR ASSUMPTIONS FOR RADIOLOGICAL ASSESSMENT OF FIVE-YEAR

ONSITE LOW-LEVEL WASTE FACILITY

General

Type of Waste	LLW - miscellaneous non-volume reduced trash and spent resins
Activity	9,875 Ci/yr - resin 113 Ci/yr - trash
Isotopic Breakdown	About 89 percent Cs-137 and Ba 137m, 1 percent Co-60, 2 percent Co-58, 7 percent Cs-134 and 1 percent other fission, activation, and corrosion products.

OSF Operational Releases

Under normal operation, any potential leachate in the storage modules will be collected and sampled prior to release. However, it is postulated that due to operator error or equipment malfunction, a certain portion of the estimated annual leach reaches the river via ground water.

Maximum Stored Activity	Releases are assumed to occur when the activity in the OSF reaches a maximum (at 5 yrs.). The 5-year activity is estimated at about 4.2×10^4 Ci composed of essentially all Cs-137.
Annual Leach Fraction	1 percent of the 5-year activity is assumed to leach out of the storage container per year.
Travel Distance to River	700 m (2,300 ft)
Ground Water Velocity	1.5 m/d (5 ft/d)
Total Soil Porosity	50 percent
Bulk Soil Density	1.6 g/cm^3
Distribution Coefficient (K_d)	500 cm^3/g for Cs

Table 4.1-1

River Dilution	Spillage is assumed to mix with 1/10 of the average river flow ($4x10^{16} cm^3/yr$) before reaching potential receptor pathways.

OSF Accidental Fire Release

Non-volume reduced LLW trash from one section of a storage module (about 1/11 of one year's waste) as assumed to catch fire due to an unspecified incendiary event.

Activity in Module Section	About 10.7 Ci Co-60
Fractional Release from Fire	0.01 for particulates[a]
χ/Q (fifty-percentile, 1 hour, ground level	$4.7x10^{-2}$ s/m^3
Distance to Site Boundary	164 M (540 ft)

a. WASH-1238.

Table 4.1-2

BROWNS FERRY NUCLEAR PLANT - SUMMARY OF RADIOLOGICAL ASSESSMENT FOR FIVE-YEAR ONSITE LOW-LEVEL WASTE FACILITY

OSF Operational Releases	
Leach to River (10 CFR 50 Appendix I guidelines: 9 mrem/yr - whole body; 30 mrem/yr - organ)	3.0×10^{-5} mrem/yr (whole body) 9.0×10^{-6} mrem/yr (thyroid)
OSF Accidental Fire	
Air Submersion Dose at Site Boundary	2.8 mrem (whole body)
Inhalation Doses at Site Boundary (10 CFR 20 guidelines: 500 mrem/yr to whole body and 1,500 mrem/yr to individual organs other than the thyroid)	2.4 mrem (whole body) 970 mrem (lung)

Table 4.2-1

BROWNS FERRY NUCLEAR PLANT - OCCUPATIONAL DOSE ESTIMATES FOR FIVE-YEAR LLW STORAGE FACILITY

General Assumptions

1. Non-volume reduced trash is stored in 55-gallon drums; non-volume reduced resins are stored in 156 ft^3 and 186 ft^3 liners
2. About 9.6 liners of RWCU resins, 145 liners of condensate demineralizer resins, 3939 drums of combustible trash, and 4446 drums of noncombustible trash are stored per year
3. Exposure rates at 10 feet from individual containers are 2.9 R/h for RWCU resins, 6.9×10^{-1} R/h for condensate demineralizer resins, 8.3×10^{-4} R/h for combustible trash, and 3.6×10^{-5} R/h for noncombustible trash
4. Maximum number of curies in facility is about 4.2×10^{4} Ci
5. Maximum number of curies in a module cell is about 381 Ci
6. Modules have 3.5-ft concrete walls (trash modules have 2.0-ft walls) and 2.0-ft concrete cap (cap is removed for waste placement)

	Person-rem/yr
Transport Personnel	
One driver exposed to 2 mR/h, 50 h/yr	0.1
Crane Operator	
Two operators exposed to 5.3×10^{-3} R/h[a], 263 h/yr; and 4.8×10^{-3} R/h[a], 965 h/yr	12.1
Waste Handlers	
Two handlers and one health physics technician exposed to: 1.0×10^{-3} R/h[b], 427 h/yr; 0.01 R/h[c], 26 h/yr; 1.4×10^{-3} R/h[a], 263 h/yr; and 1.7×10^{-3} R/h[a], 965 h/yr	8.1
Monitoring Personnel	
One health physics staff member exposed to 3.9×10^{-3} R/h[d], 156 h/yr	0.6

a. Includes direct and skyshine radiation from facility during waste placement; crane operator is adjacent to module wall, waste handling individuals assumed to be 40 feet from the facility.
b. Average exposure rate during remote handling of drums assuming workers at 40 feet from drum.
c. Exposure during cask removal for only one worker.
d. Includes direct and skyshine radiation from facility with cap in place; individual assumed to be 10 feet from facility

Table 4.2-1 (continued)

	Person-rem/yr
Nuclear Plant Employees	
1. Distance is approximately 975 m (3,200 feet) to plant	0.3
1. 2,500 persons exposed, assuming no shielding by building	
Exposed to 1.8×10^{-8} R/h[d], 2,000 h/yr	
Exposed to 3.5×10^{-7} R/h[a], 263 h/yr	

Table 4.3-1

BROWNS FERRY NUCLEAR PLANT - DOSES IN UNRESTRICTED AREAS

	mrem/yr
Onsite Non-Nuclear Facility	
1. Distance to nearest non-nuclear facility is 425 m (1,400 feet) from nearest module 2. Non-nuclear personnel exposed to 1.1×10^{-4} mR/h[b], 2,000 h/yr and exposed to 3.8×10^{-3} mR/h[c], 263 h/yr	1.2[a]
Site Boundary	
1. Distance to nearest site boundary is about 165 m (540 feet) from nearest module 2. Exposed to 6.1×10^{-2} mR/h[c], 263 h/yr and exposed to 8.7×10^{-4} mR/h[b], 8,766 h/yr	24
Nearest Resident	
1. Distance to nearest resident is about 400 m (1,310 feet) from nearest module 2. Exposed to 4.4×10^{-3} mR/h[c], 263 h/yr and exposed to 1.4×10^{-4} mR/h[b], 8,766 h/yr	2.4

a. 0.02 person-rem/yr for 20 employees at this location.
b. Includes direct and skyshine radiation from facility with cap in place.
c. Includes direct and skyshine radiation during waste placement.

c. Handling times are as follows:

Liner retrieval - 1.7 hours per liner, loaded 5 days per week

Drum retrieval - 18.4 hours for 144 drums, suitable weather conditions 80 percent of the time, retrieval conducted 12 hours per day, 5 days per week

d. A round trip to the disposal facility requires 16 hours and the drivers rest 8 out of each 24 hours. Two casks and unlimited trash transport equipment are assumed to be available.

4.4.2 Transportation Equipment

TVA now owns two shielded transportation casks for use in transporting resin-type waste from Browns Ferry. Additionally, at least eight other casks are available within TVA and others are on order which can be used for the Browns Ferry resin liners. TVA also maintains contracts for rental of other casks as necessary. Tractors and trailers are easily available within TVA and through common carriers for transportation of drummed trash. As a result, TVA does not anticipate that lack of transportation equipment will affect the retrieval time for the stored waste.

4.4.3 Results

Based on the above assumptions, the retrieval time has been calculated as approximately 35 months. This time is obviously directly proportional to the volume of waste stored during the five-year license period.

4.4.4 Doses

The total occupational and population doses from retrieval of stored waste are similar to those received during initial storage of the waste and would be somewhat lower due to radioactive decay during the storage period. The dose rate, however, is dependent upon the retrieval time. Using the conservative assumptions in 4.4.1 the annual dose rate to the workers and members of the public would be 1.6 times higher than the values shown in Tables 3 and 4 of Supplement 1 since the LLRW was stored for five years and removed in three years (5/3 = 1.6).

4.5 RADIATION EXPOSURES RESULTING FROM MONITORING

Using the liner and module monitoring techniques outlined in Section 3.2, occupational and pupulation radiation exposures have been estimated and are shown in Table 4.5-1. These exposures are well within regulatory limits.

Table 5.1-1

BROWNS FERRY NUCLEAR PLANT - DOSES FROM INTEGRITY MONITORING

	mrem/yr
Crane Operator	
Exposed primarily to a skyshine field of 5.2×10^{-3} R/h for 170 h/yr from the quarterly inspection of resin liners contained in 125 module cells	0.9
Manual Sampler	
Exposed to a direct radiation field of 200 mrem/h for 2 h/yr from the manual sampling of the control resin liner contents once per quarter	0.4
Air Sampler	
Doses are included under monitoring personnel in Table 3. Air sampler dose contributes about one half of the monitoring personnel dose listed	
Doses in Unrestricted Areas	
Due to skyshine during visual inspection of cell liners	
1. Non-nuclear workers - exposed to 3.8×10^{-3} mR/h, 170 h/yr	0.6
2. Site Boundary - exposed to 6.0×10^{-2} mR/h, 170 h/yr	10.2
3. Nearest Resident - exposed to 4.4×10^{-3} mR/h, 170 h/yr	0.8

5.0 ENVIRONMENTAL ASSESSMENT

5.1 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

5.1.1 Construction-Related Impacts

Construction impacts associated with this project included fugitive dust, gaseous emissions, siltation, noise, socioeconomic, and potential impact on existing structures at Browns Ferry. Construction began in June 1980. The first LLRW storage module were complete in October 1981, with additional resin and trash modules to be completed as necessary.

Air Quality

The construction activities associated with the radwaste storage facilities resulted in some temporary degradation of local air quality. Air pollutants generated from this activity primarily included: (1) fugitive particulate emissions from various activities, including cleaning of steel and concrete, drilling, and painting; (2) fugitive dust from earth excavation and grading; (3) particulate emissions from the open burning of small amounts of wood scraps; and (4) small amounts of particulates, hydrocarbons, nitrous oxides and carbon monoxide emissions from fossil-fuels construction and construction employee vehicles.

The construction site mitigation program consisted of fugitive dust suppression, by methods such as water sprinkling, which substantially reduced this problem. Periodic inspections conducted to ensure proper maintenance of construction and control equipment to minimize exhaust emissions. Open burning was conducted in accordance with all applicable Federal, State, and local regulatory requirements.

Concrete production during construction of the OSF was approximately 150 yds^3 per hour at an offsite contractor facility.

Land Use Impacts

The construction of the OSF as currently conceived may require up to approximately 30 acres of land, all within the Browns Ferry reservation boundary. The proposed action involves no offsite land use conflicts. Offsite land use in the immediate vicinity is row crop farming. The proposed action is compatible with the land use plans within the Browns Ferry reservation for the nuclear plant and its support facilities.

Siltation

Approximately 80,000 yd^3 of soil was moved for the construction of the OSF to a spoils area on the Browns Ferry reservation. During construction of this facility storm water runoff was collected, where necessary, to prevent erosion and to minimize the amount of sediment reaching local water bodies. This method is in accordance with the best management practices developed by the Environmental Protection Agency (EPA) pursuant to the Federal Water Pollution Control Act. (Guidelines for Erosion and Sediment Control Planning and Implementation EPA Environmental Protection Technological Series--EPA-R2-72-015, August 1972). Soil removal and site grading was accomplished in a manner as to eliminate reduced flooding elsewhere and contain runoff in already present low-lying drainage areas south of the OSF site which have no discharges. Grading along the NW boundary of the OSF site was accomplished so that drainage was contained within the Browns Ferry reservation. A buffer zone of approximately 1,000 feet is present between the runoff holding areas and Wheeler Reservoir. With these precautions construction activities did not have a significant impact on water quality.

Noise

The usual sources of noise associated with construction activity were present. However, these noise impacts were temporary and intermittent and were limited to the site area. The concrete batch plant noise was acceptable to the landowner leasing the site to the contractor.

Solid Waste

There was a small amount of solid waste generated due to the construction of the OSF. Solid wastes generated during construction was handled in accordance with State and Federal regulations.

Sanitary Waste

During the construction period, portable chemical toilets were provided for use by construction personnel. There was no onsite effluent from these facilities. TVA obtained the use of a contractor who disposed of the waste in State approved treatment facilities.

Cultural

Since the proposed action was constructed entirely within previously disturbed areas on the Browns Ferry reservation, the proposed action had no effect on any known archaelogical or cultural resources.

Endangered or Threatened Species

No known population of endangered, threatened, or otherwise sensitive species were adversely affected by the development of the proposed project.

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 were affected by the project. Drainage was developed to prevent induced offsite flooding.

Socioeconomic

The proposed action required a significant construction effort in view of the urgency of the situation. There is now and will continue to be significant ongoing renovations and additions to Browns Ferry, and there was manpower, housing, and services available in the area to fill the construction and labor skill requirements for the OSF. As a result of an adequate supply of manpower, no overall population increase was expected as a result of this construction activity, and because this plant is near urban areas (Huntsville and Decatur, Alabama), there were no significant socioeconomic impacts.

5.1.2 Operation of the OSF

Air Quality

Operation of the OSF storage facility will have no significant effect on air quality.

Water Quality

The operation of the OSF will not result in an unmonitored liquid release during normal or emergency conditions (i.e., fire). Liquids resulting from operation or fire fighting will be collected, monitored, and disposed of in accordance with established plant disposal operations. Sanitary facilities will be provided in the OSF gatehouse but the liquids will be piped directly to the existing sanitary system at the Browns Ferry biothermal research facility located approximately 2,000 feet southwest of the OSF. The small flows expected from the OSF sanitary facilities (normal occupancy--two people) will not hinder operation of the biothermal research facility's sanitary waste treatment system.

Noise

Noise, onsite or offsite, from the operation of the OSF will be minimal and will not have any significant effects on the site area.

Solid Waste Management

The Resource Conservation and Recovery Act of 1976 (RCRA) specifically exludes nuclear material regulated under the Atomic Energy Act of 1954, as amended (which covers LLRW). Because the operation of the OSF will result in no significant additional amounts of solid waste to be handled, other than LLRW, the proposed action for these facilities 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.

5.2 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

There were no significant environmental impacts associated with the construction and operation of the OSF.

5.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible and irretrievable commitments of resources included fuel oils involved in the construction of the proposed facilities along with materials used for the construction of the OSF.

6.0 SAFETY ANALYSIS

6.1 OSF MODULE DAMAGE

6.1.1 Dropping a Storage Module Cap Into a Module

The worst case would be a recently filled resin liner storage module about to be closed. The cap could only drop into the module if at least two of four suspension cables failed and the cap were suspended higher than approximately five feet above the open module. The cap could then conceivably fall into the open module, rupturing LLRW containers and causing abrasive damage and possible minor fracture to the walls of the modules. The cap could also be damaged. No release of resins would occur since all material would be contained within the module. Plant personnel can remove the waste through the module drainage connections, repackage, and transfer it to an undamaged module cell, leaving the damaged cell to be decontaminated and repaired as required.

A two-fold prevention of dropping a module cap into a module is employed, making this accident event highly improbable. The cap lifting heights never exceed 5 feet above an open module. TVA will restrict the lift height of a cell cap to 5 feet above an open module by setting a crane upper limit switch for a high hook position of 28 feet 7-3/4 inches. Also, at this height, the clearance between the bottom of the lifted cap and the top of an adjacent cap in place will be 2 feet 6 inches. However, a crane upper limit switch is currently not in place. Installation of a high hook limit switch will require approximately 6 months. In the interim, the lift height of a cell cap will be administratively controlled through the use of a flagman. This flagman will ensure that the clearance between the bottom of the lifted cap and the top of an adjacent cap in place is kept at approximately 1 foot. The flagman will coordinate his duties with the crane operator when the cell cap is being moved.

Crane lifting cables and lifting lugs are designed to withstand five times the maximum operating load expected. By designing the lifting cables and lugs to withstand five times the maximum operating load, failure of a cable or a lifting lug during the handling operation is highly improbable. Therefore, the dropping of a cap is also highly improbable. However, should the cables or lugs fail an additional operational measure is employed to prevent the cap from falling into the storage module. The cap is 9 feet 5 inches wide; and for it to rotate into a position from which it could conceivably fall into the module, would require it to be in excess of 5 feet higher than the upper most rim of the module. By not lifting the cap higher than 5 feet above the module, it becomes impossible for the cap to fall into the module should the cables or lugs fail. As noted previously, the failure of a cable or a lug is highly improbable; therefore, the combined probability of this accident is very low, thus, the associated risk is very low.

6.1.2 Dropping a Storage Module Cap Onto a Module

The worst case would be the dropping of a cap on a recently filled open module about to be closed. Damage could occur to both the cap and the module walls, consisting of possibly abrasive damage and fracture. We have determined that neither the module walls nor the cap would collapse into the module's interior. Because LLRW containers are spaced away from the module walls, only slight damage to the containers from falling bits of concrete would be encountered and the consequential release of radioactivity would be minimal. Plant personnel can gain access to the containers and LLRW, remove the LLRW and repackage where needed, remove the undamaged containers to an undamaged module, and leave the damaged containers to be decontaminated and/or repaired.

The opportunity for this accident event is highly improbable since the only source of the accident is the crane's lifting lugs and cables, which have been designed to withstand five times more stress than the maximum operating stresses expected.

However, to further reduce damage to the module by dropping a cap, a cap lift height of 5 feet maximum for the modules will be administratively imposed on daily crane operations. Up to this height, dropping a cap would cause only minor abrasive damage to the module and cap, leaving the integrity of the cap seals unimpaired.

6.1.3 Dropping a Storage Module Cap Onto Another Cap

See 6.1.2

6.1.4 Dropping a Storage Module Cap Onto the Ground

Should a storage module cap fall to the ground, only the cap would suffer damages. No radiation health hazard would result. The cap could be replaced with either a spare or a cap taken from an unused storage module. To eliminate the possibility of the cap falling to the ground, the overground time of transporting the cap shall be kept to a minimum.

6.1.5 Collision of the Mobile Crane or Transport Vehicle with Storage Module

Due to the slow speeds involved collision of either the mobile crane or transport vehicle with a storage module would result in only minor abrasive damage to the module wall. No release of radioactivity would be involved. In the OSF, the transport vehicle will be moving no faster than 20 mph and the mobile crane moves no faster than 5 mph. With the combined resistive forces of the 8-inch curb and the steel reinforced concrete module wall, an impact at less than 20 mph with a storage module by a fully loaded transport vehicle would result in only abrasive damage to the module wall with no significant impact on the structural integrity of the module.

6.2 LLRW CONTAINER DAMAGE

6.2.1 Dropping an LLRW Container Into a Module

The worst case would be dropping a dewatered resin liner into an open module with a resulting 100 percent spillage. Since the release would be contained within the module, plant personnel can remove the radioactive material through the module drainage connections to a new liner and cask assembly and locally decontaminate the storage module.

The potential for this accident event to occur is highly improbable due to design considerations. Lifting cables and lugs are designed to withstand five times their maximum operating stress and, therefore, are not expected to fail. Additionally, liner and 55-gallon-drum lifting devices are designed not to release unless driven to do so by a pneumatic or mechanical force delivered by the operator. The switches that deliver these forces are totally segregated from the controls that position the trolley and crane, thus reducing confusion. In the case of the liner lifting device, should the pneumatic system fail, the device is designed such that its center of gravity and configuration lets it keep a firm grip on the liner. As for the 55-gallon drum lifting device, the drum is held basically by its own downward force. The only way to release a drum is to completely remove its downward force on the lifting device by setting the drum down on the ground or other surface, and mechanically driving the gripping claws apart.

6.2.2 Dropping a LLRW Container Outside of a Storage Module

The worst case would be the dropping and the subsequent release onto the OSF grounds of the entire contents of a dewatered resin liner. Appropriately protected OSF personnel could collect and repackage all spilled LLRW and contaminated soil to locally decontaminate the area. Should the rupturing of a dewatered resin liner with a subsequent loss of all LLRW onto the OSF grounds be followed by a rainfall, no significant amounts of radioactivity would be expected to enter potential drinking water sources due to the long distance to the river and sorptive soil properties.

6.2.3 Dropping a Shield Cask Lid Onto Its Open Cask

No damage to the liner within the cask can occur, nor would there by any damage to the cask itself. Precautionary design considerations given to the crane's lifting cables are noted in 6.1.1.

6.2.4 Collision Between a Transport Vehicle and the Mobile Crane

The likelihood of a collision between a transport vehicle and the mobile crane is reduced since both machines are not in motion at the same time. The only time that such an accident has the potential to occur is when the crane straddles the module and transport vehicle. The wheel of the crane is kept from the transport vehicle by an 8-inch-high curb. Should the crane override the curb, its speed is too slow to do any damage to either the LLRW containers or to the transport vehicle.

6.2.5 Loaded Transport Vehicle Fire or Explosion

We have determined that a resin liner in its transportation cask is safe from fire or explosion through a review of the safety performance history of interstate transit of LLRW. Explosion or fire of a transport vehicle carrying the 55-gallon drums is likewise considered to be highly unlikely.

6.2.6 Sabotage of OSF

Damage to LLRW containers inside shipping casks, as well as inside the storage modules, as a result of sabotage is highly improbable, due to the high quality of the design and security measures employed.

Sabotage of the OSF is considered a highly improbable occurence for the following reasons:

1. A security fence is provided around the facility. This fence totals 8 feet tall topped with 3 strands of barbed wire and is bounded by a total of 40 linear feet of cleared land entirely around its perimeter. All locking devices for doors and gates will be key-controlled, high-security locks. The surrounding area will be patrolled on a regular basis by security employees who are in contact by radio with the nuclear plant. Communication equipment is located at each nuclear plant to contact local, State, and Federal law enforcement agencies and emergency services. Altogether, the security system provides intruder detection, penetration determent, and rapid communication and alert capabilities that make sabotage highly unlikely.

2. The wastes stored at the OSF are relatively low in radioactivity, making them unlikely targets of sabotage.

3. Storage modules and resin liner transportation casks are extremely shock resistant because of their design to withstand transportation accidents and seismic activity.

6.2.7 Liner Breech Due to Freezing of Resins

The breech of a liner by the crystallization expansion due to freezing of water mixed with resins inside the liner is improbable. Experimental results submitted to the NRC by GPU Service Corporation dated November 17, 1979, proved that resin liners, filled to capacity with dewatered resins, do not rupture when freezing of the dewatered resin contents occurs.

6.3 SUMMARY

In summary, to provide LLRW storage facility integrity and longevity, the storage modules, associated facilities, and equipment will be designed, operated, and maintained in order to minimize the consequences of, if not totally eliminate, the potential for these highly unlikely accidents to occur.

7.0 DECOMMISSIONING

At the end of the five-year license period for the proposed facility, TVA will have two options.

1. Seek an extension of the license from the NRC

2. Retrieve all radioactive waste containers and ship them offsite to a disposal facility. The modules could then be decontaminated.

If adequate offsite disposal space is available at the end of the five-year license period, TVA intends to pursue option 2. If offsite disposal space is not available, TVA will pursue option 1.

In anticipation of decommissioning the storage facility at some time in the future, TVA has developed the following guidelines for decommissioning.

1. Decontaminable coatings will be used in the onsite storage facility to facilitate decontamination.

2. Materials that cannot be decontaminated to the unrestricted levels identified in Table I of Regulatory Guide 1.86 will be disposed of by transporting to a permanent disposal site the same as for the radwaste containers.

3. Materials that meet the unrestricted levels of Regulatory Guide 1.86 will be disposed of in routine fashion.

References:

1. Final Report on Definition of Waste Forms Produced by TMI Auxiliary Building Water Cleanup with the Epicor II System - TCC # 0188 - Prepared for Sandia Laboratory by Ridihalgh, Eggers, and Associates, April 6, 1981.

2. General Electric Information Letter SIL - 54, "Pressurization of Radwaste Drums" dated January 31, 1974.

3. "Amber-hi-lites - Helpful Hints in Ion-Exchange Technology," Dr. Robert Kunin, Robin and Hass Company, March 1974.

Supplement 1

Organizational

Radiological Hygiene Branch

The Radiological Hygiene Branch is responsible for radiological hygiene activities at the plant. It develops and applies radiation standards and procedures; reviews proposed methods of plant operation; participates in development of plant documents and assists in the plant training program, providing specialized training in radiation protection. It conducts comprehensive environmental monitoring before, during, and after plant startup and provides radiological health coverage for all operations, including maintenance, fuel handling, waste disposal, and decontamination. It is responsible for personnel and in-plant radiation monitoring, and maintains continuing records of personnel exposures, plant radiation, and contamination levels.

Health Physicist

The health physicist is the onsite supervisor representing the Radiological Hygiene Branch and is responsible for direction of an adequate program of radiological hygiene surveillance for all plant operations involving potential radiation hazards. He reports to the plant superintendent for day-to-day direction for implementation of the plant radiation protection program and keeps the plant superintendent informed at all times of radiological hazards and conditions related to potential personnel exposure, contamination of plant and equipment, or contamination of site and environs. His duties include training and supervising health physics technicians; planning and scheduling monitoring and surveillance services; scheduling technicans to assure around-the-clock shift coverage as required; maintaining current data files on radiation and contamination levels, personnel, exposures, and work restriction; and ensuring that operations are carried out within the provisions of developed radiological hygiene standards and procedures. He provides monitoring assistance and technical advice to plant operations and medical staffs in emergencies where radiation and contamination hazards are involved.

The minimum qualifications of the plant health physicist comply with requirements set forth in Regulatory Guide 1.8, "Personnel Selection and Training," Revision 1, September 1975.

Division of Occupational Health and Safety

The Division of Occupational Health and Safety (OC H&S) is responsible for furnishing special services in the fields of safety, industrial hygiene, radiological protection, and other related areas. The Radiological Hygiene Branch, within the OC H&S provides administrative supervision for the Health Physics Unit at the plant. The Radiological Hygiene Branch is responsible for the preparation and review of radiological protection standards and for establishing and conducting all phases of the offsite radiological monitoring program. The Safety and Industrial Hygiene Branch performs onsite surveys of nuclear plants for the purpose of assuring compliance with TVA hazard control standards and requirements relevant to industrial hygiene. It also appraises and recommends appropriate engineering controls as required to control potential sources of occupational illnesses. The Standards and Compliance Branch develops hazard control standards and requirements which are applicable to nuclear plants. They work with the Division of Engineering Design for assurance that nuclear power plants are designed in accordance with these standards and requirements.

They also audit nuclear plants to assure that the hazards in the environment are being effectively controlled. They perform objective reviews and audits from an agency standpoint, of the occupationl compliance activities and consultation services provided to the power plants by the safety organizations within the Division of Nuclear Power, which operates the nuclear power plants in TVA.

Division of Medical Services

The Division of Medical Services is responsible for TVA's overall health program. This includes providing employee health services at the plant.