NUCLEAR REGULATORY COMMISSION STAFF'S

SAFETY EVALUATION REPORT

OF

LOW-LEVEL RADIOACTIVE WASTE STORAGE

AT

TENNESSEE VALLEY AUTHORITY

SEQUOYAH NUCLEAR PLANT

DOCKET NO. 30-19101

SEPTEMBER 1982

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NMS LIC30
41-08165-14 PDR

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1. INTRODUCTION AND GENERAL DESCRIPTION OF THE FACILITY

By letter dated November 24, 1980, the Tennessee Valley Authority (TVA or licensee) applied for an amendment to facility operating license DPR-77 for the Sequoyah Nuclear Plant (SNP) Unit 1 pursuant to 10 CFR Parts 50.59 and 50.90. The request was for authorization to store low-level radioactive waste (LLRW), generated from operation of SNP, onsite for five years. In its Federal Register notice of receipt of application (46 FR 15390), the Nuclear Regulatory Commission (NRC or Commission) stated that storage of LLRW would apply for the yet-to-be licensed Unit 2 as well as for Unit 1. In accordance with NRC policy (Ref. 1) and for the administrative convenience of the Commission, the application was reviewed under the provisions of 10 CFR Part 30. In accordance with 10 CFR Part 51 the environmental aspects of the license have been assessed separately and are addressed in the NRC staff's (the staff) Environmental Impact Appraisal (Ref. 2).

This report documents the staff's review and evaluation of the safety of onsite storage of LLRW, generated at SNP, for the five-year term. Our technical review of radiological safety matters with respect to the issuance of a byproduct material license pursuant to 10 CFR Part 30 was based on TVA's application and amendments thereto. The application is available for public inspection at the NRC's Public Document Room at 1717 H. Street, N.W., Washington, D.C. and in the NRC Dockets 50-327 and 50-328 for the SNP at the Local Public Document Room at the Chattanooga-Hamilton County Bicentennial Library, 1001 Broad Street, Chattanooga, Tennessee 34702.

We have reviewed the design and operation of the LLRW Storage Facility to determine whether NRC's safety requirements have been met. Many procedures to be used in the operation of the LLRW Storage Facility are in use at the SNP and have been previously reviewed by the staff for the reactor operating licenses. Therefore, these procedures were not reviewed again for this report. References to these procedures are specifically noted where they are made throughout this evaluation. If a byproduct material license is granted, the facility must be operated in accordance with the terms of the license and NRC's regulations and will be subject to the NRC's inspection program.

1.1 Background

TVA owns and operates the two-unit Sequoyah Nuclear Plant. Each pressurized water reactor (PWR) is licensed for a thermal power level of 3,411 megawatts. Commercial operation of the units 1 and 2 began on September 17, 1980 and September 15, 1981, respectively.

Operation of these reactors results in the generation of LLRW. This waste consists of ion exchange resins, evaporator concentrates, spent regenerates, and miscellaneous trash. Presently, TVA ships these wastes to Chem-Nuclear Systems, Inc's (CNSI) commercial radioactive waste disposal site in Barnwell, South Carolina. Recently, there have been significant restrictions on the amount of LLRW that this site will accept for disposal. CNSI has announced a policy that further restricts the volume of waste TVA can send to the Barnwell site. Because disposal allocations at the Barnwell site are issued to each utility company rather than to individual reactors, this problem of insufficient disposal allocations for Sequoyah waste will worsen as other TVA nuclear plants start operating and producing LLRW. Also, it will be several years before additional LLRW disposal sites, established as a result of the Low-Level Radioactive Waste Policy Act (Public Law 96-573), will be available. In view of these facts about the uncertainty of available commercial disposal space, TVA has submitted a proposal for contingency storage onsite of the LLRW generated at the SNP.

1.2 General Description of the Facility

The onsite LLRW Storage Facility area consists of about 8 ha (20 acres) in the east-central edge of the SNP property outside the SNP reactor restricted area, but within the protected area of the site boundry. The location is about 610 m (2000 ft) east of the reactors along the western shore of the Chickamauga Lake formed on the Tennessee River.

The LLRW will be stored in independent buildings (storage modules) for trash and resins. Eight resin storage modules and five trash modules are being considered now, with provisions for a maximum of eighteen modules. Each module contains four compartments, with five cells per compartment.

The resin and trash storage modules will be above-ground structures constructed of reinforced concrete. The modules are nearly the same size with concrete floor slabs 90 cm thick (39.5 in), an outside width of 10.4 m (34 ft), an outside lengths of 58.6-59.6 m (192-195 ft), a height of 5.9 m (19.5 ft), and compartment caps and cap support beams 61 cm (24 in) thick. The walls of the trash modules are 61 cm (24 in) thick while those at the resin storage module are 107 cm (42 in). Curbed concrete runways are provided along the length of the modules for crane operations.

Each compartment contains a liquid drainage system which is routed to an external sampling collection point. A collection point consists of a drainage valve and sampling valve which are surrounded by a covered concrete sump. Any radioactive liquids that are collected can be removed to the SNP for processing by the radwaste system.

The interior surfaces of each module (excluding the caps) are provided with a decontaminable coating.

The LLRW Storage Facility will have a 6.1 m (20 ft) wide perimeter road which will pass no closer than 15.2 m (50 ft) from any module. A chain-link fence topped by barbed wire will enclose the entire LLRW Storage Facility providing a restricted area.

Presently there are four completed storage modules located at the south end of the LLRW Storage Facility. Since TVA has stated that the modules can be built as needed (Ref. 3), an interim fence has been erected approximately 8 m (26 ft) north of the nearest completed modules and separates them from modules under construction. As modules are finished and before they are used, the interim fence will be progressively moved to encompass completed storage modules until the final design configuration has been attained.

1.3 Summary of Principal Review Matters

Our review and evaluation of the information submitted by the licensee considered the principal review matters summarized below:

- Since the facility is on the SNP site and site characteristics were previously reviewed by NRC for the reactor licenses, we only evaluated any new information concerning population density, geology, seismic potential and flood potential applicable to the LLRW Storage Facility.

- We evaluated the licensee's principal design criteria as compared with Commission guidance issued on November 10, 1981 (Ref. 4). We evaluated the licensee's compliance with the stated criteria.

- We evaluated the licensee's proposed conduct of operations and program for radiation protection at the LLRW Storage Facility. Since the facility is on the reactor site and operated by the same personnel, many programs and procedures already instituted at the SNP will be incorporated into the operation of the LLRW Storage Facility; and therefore no additional review was performed. Those programs, procedures and items previously reviewed by NRC include: the health physics program; the environmental monitoring program; the security procedures; the emergency procedures; the TVA organizational structure; the technical and financial qualifications of TVA; the training and experience of its personnel; and the quality assurance program.

. We evaluated the licensee's information on the potential for accidents during operation of the LLRW Storage Facility and their likely maximum radiological consequences.

2. SITE CHARACTERISTICS

2.1 Introduction

The staff review and evaluation regarding site characteristics were provided in the Safety Evaluation of the Tennessee Valley Authority Sequoyah Nuclear Plant Units 1 and 2 (Ref. 5). The Safety Evaluation is available for public inspection at the NRC's Public Document Room at 1717 H. Street, N. W., Washington, D.C. and at the Local Public Document Room at the Chattanooga-Hamilton County Bicentenial Library, 1001 Broad Street, Chattanooga, Tennessee 34702. The staff has evaluated new information relating to the site since the original evaluation. The staff's evaluation of new information is discussed in this section together with some descriptive information.

2.2 Description

The SNP is located in Hamilton County in southeastern Tennessee approximately 30 km (18 mi) northeast of Chattanooga and six miles east of the town of Soddy-Daisy. The plant site occupies a 212 ha (525-acre) tract of land on a peninsula on the western shore of Chickamauga Lake, a reservoir formed by the Chickamauga Dam on the Tennessee River. The peninsula site extends 610 m (2,000 ft) north and 914 m (3,000 ft) south of Tennessee River miles 485 and 484, respectively. The LLRW Storage Facility is located along the eastern edge of the plant site bordered by Chickamauga Lake and occupies approximately 8 ha (20 acres).

2.3 Demography

The area in immediate proximity to the SNP and the LLRW Storage Facility is sparsely populated. There are three residences within one mile to the west northwest and west. The nearest residence is approximately 1.3 km (4,275 ft) west northwest of the LLRW Storage Facility. There are also about 25 more residences within a mile of the LLRW Storage Facility which are located across Lake Chickamauga along the eastern shore of Lake Chickamauga. There is a total population of 9203 persons living within eight kilometers (5 mi) of the LLRW Storage Facility. The total population within a 80 km (50 mi) radius of the LLRW Storage Facility is 796,497 (Ref. 2). Chattanooga and immediate environs comprise about 25% of the total population within the 80 km (50 mi) radius.

2.4 Climate

There have been no significant deviations in weather patterns since climate conditions were described in the Final Environmental Statement and Safety Evaluation for SNP. Therefore the staff's original evaluation is applicable.

2.5 Hydrology

The Tennessee River - Chickamauga Lake is the principal hydrological feature in the SNP area. The water level varies due to flow control activities upstream at the Watts Bar Dam and downstream at the Chickamauga Dam. The normal minimum pool elevation is 208 m (683 ft) above mean sea level (msl). The average level of the LLRW Storage Facility is 229 m (750 ft) above msl. The maximum probable flood level of 222 m (727.8 ft) above msl, previously evaluated by the staff, would not threaten the integrity or operation of the LLRW Storage Facility.

Ground water in the area is derived from precipitation which has averaged 147 cm/yr (58 in./yr) over the past 20 years of record. There is no distinct aquifer in the SNP area and ground water moves through the terrace material overlying the bedrock. Test holes have shown that the water table stands about 6 m (20 ft) above the bedrock, i.e., at an elevation of about 208 m (675 ft) msl with the distance below the surface varying with the variance in surface elevations. Discharge from the ground water system is toward the northeast and southwest into Chickamauga Lake at a rate of about 1 m (3.3 ft) per day.

2.6 Geology and Seismology

The regional and local geological features of the southeastern Tennessee have been previously described in the SNP EIS and evaluated by the staff (Ref. 5). These basic features have remained unchanged with the exception of the LLRW Storage Facility site which has been leveled to a mean evaluation of 229 m (750 ft) msl.

3. PRINCIPAL DESIGN CRITERIA AND COMPLIANCE

3.1 Introduction

The Commission, based on its Policy Paper SECY-81-383, issued Radiological Safety Guidance for Onsite Contingency Storage Capacity (Ref. 4). This guidance sets forth general criteria applicable to the design and operation of such waste storage facilities. In this section we discuss the applicability of the guidance to the licensee's design criteria and their compliance with that criteria. The staff's review and evaluation of TVA's design criteria and compliance with that criteria is described below.

3.2 Facility Design Criteria

Prior to the issuance of SECY-81-383 guidance, TVA stated in its application that the minimum design basis for the BFNP LLRW Storage Facility was based on the requirements of USNRC Regulatory Guide 1.143, "Design Guidance For Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants." Although this regulatory guide was not specifically prepared for an independent low-level waste storage facility such as this, TVA deemed it to be the most applicable to the nature of the facility.

In Section 2.1 of the application TVA has presented its design basis events for protection against natural phenomena. In assuming the modules to be safety-related structures, TVA designed them to meet class I (seismic) structural design criteria. These criteria are based on withstanding the same design basis tornado and earthquake loadings as the SNP reactors. Similarly, TVA has described protection against the maximum effects of flooding and winds, and precipitation described in Section 2 of this report.

Based on the class I (seismic) design of the modules, a staff evaluation of identical storage module compartments at Browns Ferry (Ref. 6) and our review of the application, we conclude that the licensee has provided adequate criteria for protection against environmental conditions and natural phenomena. We further conclude that the criteria satisfy Commission guidance relating to the design basis flooding, tornado and seismic events. Based on inspection (Ref. 7), we conclude that the licensee has adequately complied with those criteria in design and construction of four modules of the onsite LLRW Storage Facility.

3.3 Waste Handling System

In Sections 2.4 and 3.1 of the application, TVA has described the design and operation of the crane used to handle the LLRW containers, support grating and the storage module caps. The crane is a rubber-tired, diesel-powered, mobile gantry crane. It has two cross beams: a 15-ton capacity trolley on the front beam for lifting the waste containers and two 30-ton capacity trolleys on the rear beam for lifting module cell caps. The largest resin liner, if filled with concrete, would not exceed the capacity of the 15-ton crane. Similarly, a module cell cap would not exceed the total capacity of both the 30-ton cranes. The crane is equipped with eight 500-watt lights and a closed circuit TV monitoring system designed to allow remote handling of the waste containers. The crane has the capability of manual operation to lower waste containers to a safe position should the lifting cables lock due to motor or electrical power failure.

There is no requirement for the crane to be designed to withstand the effects of a tornado or an earthquake. LLRW handling operations will not be performed during inclement weather. This obviates the necessity for design against the effects of tornados. Also, the worst result from the effects of an earthquake on the crane would be the dropping of a resin liner. Since the radiological impacts of such an accident are assessed in Section 6 and are found to be within Commission guidance, there is no necessity for the crane to be seismically qualified.

Based on its review and evaluation of this information, the staff concludes that the mobile gantry crane is adequately designed to assure safe operation in transferring waste containers in and out of the storage modules.

3.4 Fire Protection System

Pursuant to Commission guidance (Ref. 4), the licensee's design should incorporate good engineering features and capabilities for early detection, prevention and mitigation of accidents, such as fires.

Spontaneous combustion of packaged trash is unlikely. Resins, dewatered to disposal site criteria, and resins, spent regenerates, and evaporator concentrates solidified in concrete are not considered combustible. All LLRW is packaged in noncombustible steel containers. The wastes are then stored in sealed modules which are constructed of noncombustible materials. It is for the above reasons that the staff regards a fire in a storage module to be extremely unlikely. Any fire occurring in an open trash module would be detected by workers involved in waste handling operations.

It is TVA's position that the significant potential for fire at the LLRW Storage Facility is from an external exposure fire. TVA has considered external exposure fires in its design and addressed them in its application. TVA has followed the practice of using noncombustible materials in construction of the modules. The modules are designed to provide a three-hour fire resistance rating from exposure to fires. In addition to multiple barriers of protection against fire, the perimeter of the LLRW Storage Facility has hydrants in accordance with NFPA

Standard No. 24. Also, the LLRW Storage Facility will be provided with multi-purpose dry chemical fire extinguishers. Any fires at the LLRW Storage Facility would be detected by workers involved with waste handling operations or by SNP security patrols. Any fires will be fought by specially assigned personnel of the existing SNP fire brigade.

Based on the evaluation of the above information, the staff concludes that TVA's fire protection measures for the LLRW Storage Facility are acceptable.

3.5 Industrial Security System

Commission guidance for storage facilities not inside the reactor plant protected area calls for both a physical security program (fence, locked and alarmed gates/doors, periodic patrols) and a restricted area for radiation protection purposes in accordance with 10 CFR Part 20.

The LLRW Storage Facility is surrounded by a 2.4 m (8 ft) high mesh and barbed wire security fence. Points of access will have positive control of personnel and vehicles. All personnel entering and exiting the storage facility will be positively identified and physical or electronic monitoring will be conducted while on site. The LLRW Storage Facility will not contain amounts of special nuclear material that require safeguards physical protection. However, the design of the modules is such that the LLRW will be adequately protected from sabotage. The industrial security program for the onsite LLRW Storage Facility is an extension of the program in place for the SNP which has been previously reviewed by the staff and found suitable.

3.6 Container Integrity

Commission guidance addresses several items that should be considered to ensure that integrity of the waste containers is sufficient to allow handling during transportation and disposal without container breach. In Section 2.2 of the application TVA considered the physical, chemical and radiological properties of the waste form and container material, evaluated their compatibility and incorporated into the container design measures to minimize corrosive conditions to ensure container integrity.

All miscellaneous trash will be stored in 18-gauge (minimum) steel drums (that meet DOT specification 17H) or steel boxes. The containers will have an external protective coating to reduce container corrosion. Moist material will be packaged in a sealed polyethylene bag before being placed in the container. Double bagging will be performed if appropriate. Ion exchange wastes will be stored in 0.64 cm (.25 in) thick A-36 carbon steel cylindrical liners. The liners will be coated on the exterior surfaces with one coat of primer and two coats of alkyd gloss enamel and on the interior surfaces with one coat of a two-part epoxy coating, eight-mils thick minimum. The design of the liners is such that accumulated free water resulting from densification during the five-year storage period can be drained. TVA stated that this will be done to meet disposal site criteria. The design also allows for venting to relieve potential gas buildup as a result of decomposition of the waste from radiation exposure or microbial action. TVA has stated that if conditions warrant they will take measures to vent the liners in the nuclear plant.

Because of recent changes in requirements for LLRW disposal instituted at the Barnwell site and because of NRC's Proposed Rule; "Licensing Requirements for LLRW disposal of Radioactive Waste," (10 CFR Part 61), TVA may want to use alternate types of containers for LLRW disposal other than described and evaluated in its application. In order to ensure that any such container is also acceptable as a storage container, TVA has established an evaluation plan (Ref. 8) to review the design of any new container for suitability before being used in the LLRW Storage Facility. This plan includes criteria against which the design of new containers will be evaluated. The results of these evaluations will be documented and maintained in TVA's record management system.

In order to minimize waste container contact with moisture, unnecessary introduction of water into the modules will be prevented by keeping them closed during inclement weather.

Based on its review of the above information and our discussions in Section 4.4.2 of this report, the staff concludes that the licensee has adequately addressed the Commission guidance and provided for container integrity for the period of storage.

For periods beyond the license term, no expected conditions are known that would cause degradation of container integrity that could not be identified in a timely manner by the container and module monitoring programs (See Section 4.4.2). Should preventive actions be necessary, TVA has the capability to repackage the LLRW at the SNP.

3.7 Quality Assurance

TVA has in effect a quality assurance (QA) program plan for the SNP that is in conformance with Appendix B of 10 CFR Part 50. To ensure the storage module structures are constructed as intended, the licensee will incorporate into the existing SNP QA plan a program for the onsite LLRW Storage Facility that conforms to Regulatory Position 6 of NRC Regulatory Guide 1.143. Since all applicable practices and procedures in use at the SNP will apply to the operation of the LLRW Storage Facility, so too will the existing operational QA program.

4. FACILITY OPERATIONS

4.1 Organizational Structure and Staff Qualifications

The operation of the onsite LLRW Storage Facility will be an integral part of the SNP operations. As such, all personnel required for storage activities will be furnished by the plant with no reorganization of the management and operating staff. There are no special personnel qualification requirements for the operation of the LLWR Storage Facility other than those already imposed for operation of the SNP. The NRC staff has previously reviewed TVA and SNP organizational structure and staff qualifications and found them satisfactory to provide a staff and engineering support capable of operating the SNP. Based on the above information and the licensee's experience, the staff concludes that the licensee's organization is adequate to conduct LLRW storage operations in accordance with regulatory requirements and license conditions.

4.2 Training and Experience

Pursuant to 10 CFR 30.33(a)(3), the licensee must be qualified by reason of training and experience to safely handle the byproduct material. The licensee under the requirements of 10 CFR Part 50.57 has been found technically qualified to engage in activities authorized by the SNP operating licenses. The health physicist is the onsite supervisor responsible for direction of radiological hygiene surveillance for operations involving potential radiation hazards. The training and experience of the plant health physicist meets the requirements set forth in Regulatory Guide 1.8. The staff has previously reviewed TVA's SNP management and operating staff qualifications and found them satisfactory. Based on the above information, we conclude that the training and experience of personnel is adequate to conduct LLRW storage operations in accordance with regulatory requirements and license conditions.

4.3 Normal Operating Procedures

4.3.1 Waste Handling Operations

Waste will be containerized and transported by truck from the reactor radwaste building to the LLRW Storage Facility in compliance with 10 CFR Part 71 and Department of Transportation regulations. The waste will be taken to the appropriate resin or trash module where the gantry crane, positioned over the module cell, will remove and set aside the cell cap. The truck will then park under the gantry crane for the transfer of the waste to the storage cell. Metal gratings will be used as an interface between the module floor and the first layer of containers and successive layers of containers. When all the containers in the shipment have been stored, the cell cap will be replaced and the vehicle returned to the plant after being monitored for contamination. To prevent introduction of water into the storage modules, storage operations will not be conducted during inclement weather.

One resin liner at a time will be transported in a shielded cask and stored. When the cask arrives at the resin storage module, the cask cover bolts will be removed using an air wrench and the cover removed and set aside using the gantry crane. An air-activated remote lifting device hooked to the crane will be used to remove the steel resin liner from the cask and transfer it to a predetermined space in the modules. The licensee plans to store liners in two layers. Waste solidified in concrete would be placed on the bottom layer and dewatered resins, that require quarterly inspection, would be placed on the top layer. Then, the lifting device will be unhooked, the cask cover replaced and the cask returned to the plant.

Fifty-five gallon steel drums containing trash will be transported to a trash storage module by van-type trucks. For trucks with removable tops, the drums will be unloaded directly from the truck. However, for trucks with rear doors, a movable ramp and fork lift will be used to unload the drums before storage. The gantry crane will be equipped with a remote drum handling device to lift the drums of trash one at a time into the storage module. These drums will be stored in lots of 140 to 160 and will be stacked up to four layers high.

At the end of storage, when containers are removed for further disposition, these procedures will be reversed.

4.3.2 Monitoring Operations

Several monitoring operations will be performed in connection with the LLRW Storage Facility to ensure public health and safety. Considering the characteristics of the waste to be stored, only intermittent surveillance would be needed. Waste containers will be monitored to ensure integrity, to identify any conditions that may result in container breach and to prevent release of radioactive material. Also, the storage modules will be monitored to ensure early detection of unexpected conditions and to prevent release of airborne radioactivity. Radiation monitoring will be performed by the plant health physics staff to ensure worker protection during storage operations. If conditions warrant, radiological environmental monitoring can be conducted to detect leakage and any possible contamination.

Container Integrity

Pursuant to NRC guidance concerning container integrity, the licensee has established a monitoring program to ensure container integrity and to identify any conditions that may result in container breach and to prevent release of waste within the module or to the environment. The monitoring of dewatered resin liners is a two part program. First, liners will be visually inspected by means of remote television monitors. This inspection will be performed at least quarterly, after a storage cell has been filled, to check for any swelling, exterior corrosion or breach of the containers. The second part of the program is a system to check on the contents of the resin liners to identify any changes that may occur during storage and to be able to take measures to minimize potential problems. Two worst-case control liners will be set aside in the radwaste packaging bay at the Browns Ferry Nuclear Plant. One liner will be filled with 50% ion-exchange resin and 50% cellulose filtration material and will be monitored for excessive pressurization from possible gas evolution. Gases will be collected to determine whether they are radioactive or explosive. The liners will also be sampled quarterly to monitor pH, free water, activity, and signs of resin degradation. Also, samples of coated liner material will be suspended in the liner and checked for signs of degradation. Because TVA's most radioactive PWR and BWR resins are similar in physical, chemical and radiological characteristics, a second control liner will be filled with high-activity resin from Browns Ferry. This liner will be equipped with a pressure gauge, which can be monitored remotely to determine if significant quantities of gas are generated. If significant potential problems are indicated by the monitoring, the licensee will take measures to vent stored liners in the nuclear plant or stabilize stored wastes in order to ensure safe storage.

Because of the precautions outlined in Sections 3.6 and 4.4.1 to minimize moisture contact with the trash containers, the nature of the material placed in the containers, and the container protective outer coating, corrosion is expected to be minimized. With reduced mechanisms for corrosion, there is no reason to believe that this type of waste in the steel containers cannot be adequately stored for the five-year license term and longer without loss of container integrity. At the time of removal and before shipment offsite, inspections of the containers will be performed to determine if they are acceptable for transportation and receipt at the disposal site. If problems exist, TVA has the capability to repackage the waste at the SNP. Therefore, an integrity monitoring program for the trash containers is deemed not to be necessary.

Module Monitoring

The storage modules will be monitored to ensure early detection of unexpected conditions. Routine patrols through the area, by workers during operations or by security personnel when work is not being conducted, will provide for detection of external fires.

Additional module monitoring consists of sampling for radioactive releases in the module. The sump in each module will be sampled periodically to detect the presence of water. Although no gaseous releases are expected from the sealed containers, if a compartment has been sealed for two months or longer, an air sample will be taken from the compartment and analyzed for explosive gases and airborne radioactivity before the cell cap is removed. If potential problems are detected, appropriate corrective actions will be initiated.

Radiological and Environmental Monitoring

In addition to the radiation and environmental monitoring programs existing at SNP, the LLRW Storage Facility will have a personnel radiation monitor and thermoluminescent dosimeters permanently installed at the security gatehouse. All other necessary radiation monitoring for compliance with 10 CFR Part 20 will be performed by SNP health physics staff using portable instruments. Also, monitoring wells, drilled in clusters outside the security fence, could be sampled to detect if any radioactive contamination has reached the underlying aquifer.

4.4 Emergency Plans

TVA has emergency plans in effect for the SNP which will cover any situation arising at the LLRW Storage Facility as well.

4.5 Records

Pursuant to 10 CFR Part 30, the licensee must keep records showing receipt and transfer of byproduct material. These records are being maintained as part of the SNP operating licenses. In addition to the requirements of 10 CFR 30.51, TVA's records will indicate the date of placement, location in the storage module, identification number, curie content, dose rate and type of waste stored for each container. Documented results of the container evaluation plan (See Section 3.6) will also be maintained in TVA's record management system.

Based on the above, we conclude that the licensee's records will be sufficient to meet regulatory requirements.

4.6 Conclusion

Based on the above information, we conclude that the licensee's procedures for operations at the LLRW Storage Facility are adequate to conduct LLRW storage operations in accordance with regulatory requirements and license conditions to ensure public health and safety and minimize danger to life or property.

5. RADIATION PROTECTION

TVA has described its radiation protection program in Sections 2.6 and 4.1 of its application. We have reviewed and evaluated the information on radiation protection to assure that it meets the requirements of 10 CFR Part 20 and 40 CFR Part 190. A discussion of our review and evaluation follows.

5.1 Design Basis

The radiation protection design of the LLRW Storage Facility is based on the radioactivity levels of LLRW generated by SNP operations. The resin storage modules are designed with respect to the expected annual radioactivity produced if both units are operated continuously with approximately .12 percent failed fuel. Design of the trash storage modules is based on annual radioactivity inventory ten times higher than inventories experienced at Browns Ferry. The staff finds these radiological design basis assumptions to be more than adequate.

Radiological assessments were based on LLRW generation rates of PWRs of similar design to Sequoyah. Although some fluctuation in annual rates may occur, use of these values is not expected to cause significant under-estimations for assessment purposes. The source term used by TVA for design and assessment purposes is 17,744 curies per year (17,700 Ci/yr, resins regenerates and evaporator concentrates and 44 Ci/yr, trash). TVA assumed the trash to be an equivalent activity of Co-60 for exposure rate calculations. The following isotopic breakdown for resin waste was assumed by TVA for assessments:

Radionuclide	Percent of Activity
Co-58	2%
Co-60	1%
Cs-134	7%
Cs-137/Ba-137m	89%
Other fission, activation and corrosion products	1%

5.2 Health Physics Program

The health physics program for the LLRW Storage Facility is the same one employed at the SNP. The administration of the radiation protection program is the responsibility of the Radiological Hygiene Branch. The health physicist is the onsite supervisor representing the Radiological Hygiene Branch and he is responsible for the direction of the radiation protection and monitoring program for all operations involving radiation hazards. All operations at the LLRW Storage Facility will be performed under the coverage of Special Work Permits (SWP's) which specify all necessary protection and monitoring requirements.

The occupational radiation monitoring program for waste storage operations will be governed by Radiological Control Instructions. In general, the program consists of health physics surveys, use of self-reading pocket dosimeters and use of Thermoluminescent Dosimeter (TLD) badges. Health physics surveys will be performed by technicians using portable survey instruments. The self-reading pocket dosimeters worn by workers will allow them to keep track of their accumulated exposures. The TLD badges worn by workers will be the official means of dose accounting as required by 10 CFR Part 20.

The radiological environmental monitoring program required as part of the SNP reactor operating licenses will encompass the LLRW Storage Facility. The requirements for the Radiological Environmental Monitoring Program are contained in the technical specifications of the SNP reactor operating licenses. In the event that conditions warrant, the licensee has the capability to sample water in the underlying aquifer through the use of monitoring wells placed in clusters outside the LLRW Storage Facility security fence.

Based on this information and the administrative control procedures established as part of the SNP reactor operating licenses, the staff concludes that the licensee has an adequate health physics program.

5.3 Occupational Exposure

Storing LLRW onsite at SNP necessarily results in some exposure of personnel to external ionizing radiation. This exposure may occur at various times and locations within the storage area.

The highest exposure rate in which a person will work will be about 200 mR/hr. This rate will be encountered during quarterly sampling of the control liner filled with reactor water cleanup resins at the Browns Ferry Nuclear Plant. Sampling by Browns Ferry personnel in conjunction with LLRW Storage at Browns Ferry, is not expected to exceed two hours per year.

The next highest radiation exposure rate a worker will encounter occurs during storage operations when the sling assembly of the resin liner shield cask cover is connected to the crane hook and the cover unbolted. The exposure rate is expected to be about 10 mR/hr and the work is estimated to take only about ten minutes.

The highest doses are received by personnel operating the crane. The crane operator is adjacent to the module wall and receives direct and skyshine* radiation from the waste in the facility during placement operations. The licensee has estimated collective dose to crane operators could be as high as 14.6 person-rem/yr.

*Skyshine radiation is that radiation which exists through the roof of the modules and is scattered back down to the receptor.

Personnel exposures will vary from operation to operation, depending on the amount and type of waste to be handled. Based on an annual storage requirement of about 178 resin liners and 3348 drums of trash, and the container and module monitoring programs previously described, the applicant has estimated the collective occupational dose to be about 25 person-rem/yr.

All workers involved in LLRW Storage Facility operations will come under same radiation protection and monitoring requirements that govern SNP operations. These procedures or standard practices for personnel radiation protection are consistent with 10 CFR Part 20, include provisions for maintaining exposures as low as reasonably achievable (ALARA) and have been previously approved as requirements for the SNP reactor operating licenses.

There is the possibility that for short periods of time during certain waste handling operations, a radiation area (as defined in 10 CFR 20.202 (b)(2)) could exist which extends beyond the LLRW Storage Facility security fence. When such a situation occurs, the licensee is required to take appropriate measures in accordance with 10 CFR 20.203 (b) to protect workers constructing adjacent modules and other individuals not associated with waste handling operations that may be located in the vicinity of the LLRW Storage Facility.

Based on the TVA's application of engineered safeguards and adherence to administrative control procedures involving personnel radiation exposure, the staff concludes that the licensee will be able to ensure that all exposures are maintained within the requirements of 10 CFR Part 20 and at levels which are as ALARA.

5.4 Environmental Radiological Assessment

Storage of LLRW onsite will necessarily result in increased levels of radiation in the nearby area. Under the terms and conditions of a Part 30 license, the licensee must abide by the radiation protection provisions of 10 CFR Part 20. Since the management of LLRW is being considered as an integral part of the operations involved in the generation of electricity under the uranium fuel cycle (as defined in 40 CFR Part 190), the licensee must also conform to EPA's Environmental Radiation Protection Standards for Nuclear Power Operations, 40 CFR Part 190.

Because of the proximity of the LLRW Storage Facility to the Chickamauga Reservoir (91 m to the nearest shoreline), the maximum calculated radiation levels at the nearest shoreline under certain circumstances could, for a short period of time, exceed the radiation level provision of 10 CFR 20.105 (b)(1), of two millirems in any one hour. In accordance with 10 CFR 20.105 (a), the licensee has proposed a radiation level of ten millirems in any one hour. Because of the location and brief duration of these radiation levels it is not likely to cause any individual to receive such a dose. Additionally, the licensee will establish administrative controls to ensure that no individuals are present to receive such a radiation dose. All other requirements of 10 CFR 20.105 will be satisfied.

The staff recommends that a license condition be granted approving the licensee's proposed limit of ten millirems in any one hour, at the near shoreline, in lieu of the requirement of 10 CFR 20.105 (b)(1) only during LLRW placement, retrieval, and inspection operations. The license condition should also require the licensee to establish and implement administrative controls to ensure that no unauthorized individuals are present to receive this radiation dose.

A detailed assessment of radiation doses is contained in the Environmental Impact Appraisal of Low-Level Waste Storage at TVA Sequoyah Nuclear Plant (Ref. 2). This assessment shows the estimated doses in unrestricted area to be in conformance with the requirements of 10 CFR Part 20, as exempted, and that the annual dose to the nearest resident from normal operation of the LLRW Storage Facility will not exceed one millirem. The assessment also shows that when the dose from storage operations is combined with the dose from SNP operations the total annual dose will be well within the requirements of 40 CFR Part 190.

Based on this information, the licensee's application and adherence to the administrative control requirements of the technical specifications to the SNP reactor operating licenses, the staff concludes that the licensee will be able to ensure storage of LLRW are maintained within the requirements of 10 CFR Part 20 and 40 CFR Part 190.

5.5 Conclusion

Based on the staff's review and evaluation as described above, we conclude that the licensee will provide an adequate radiation protection program that meets the requirements of 10 CFR Part 20 and 40 CFR Part 190.

6. ACCIDENT ANALYSIS

As part of its safety review for storage of LLRW onsite at BFNP, the staff reviewed those accidents TVA evaluated in its application and performed independent evaluations which considered the following postulated types of accidents and their possible radiological consequences: (1) fire in a trash module; (2) leach of radioactive material to ground water; (3) effect of earthquake; (4) effect of tornado; and (5) dropping of a cell cap or waste container.

6.1 Fire in a Trash Module

As was previously discussed in Section 3.4, the staff has found the resin to be nonflammable and the possibility of a fire in the trash storage modules to be extremely unlikely. However, a trash fire would be the accident that could result in a significant airborne radioactive release.

The radiological consequence of a postulated fire that could result in offsite radioactive releases was evaluated as follows. Waste in one open compartment of a trash module (11 Ci, about 1/4 of one year's trash waste) is assumed to catch fire due to an unspecified cause. The waste is assumed to consist of 57%, H-3; 28%, Mo-99/Tc-99m; 9%, I-131; 2%, Co-58; and 4% other. The airborne release is assumed to be 1.5% of the waste in the compartment, and occurs over a one-hour period. Our calculations assume ground level releases, a windspeed of 2 m/s, and Pasquill diffusion stability category G. The atmospheric dispersion factor at the site boundary is estimated to be 3.0 E-4 s/m^3 (Ref. 9). Doses for the one hour duration of the accident are estimated using dose conversion factors for inhalation from Regulatory Guide 1.109 (Ref. 10) and for immersion from NUREG/CR-1918 (Ref. 11). The assumed breathing rate used in the calculation is 1.25 m^3/h (Ref. 12).

An individual occupying the the nearest land on the eastern shore of Chickamauga Lake for the duration of the postulated fire would receive a whole-body dose of about .01 mrem and 2.31 mrem to the thyroid.

TVA in its application evaluated the consequences of an accidental fire in a storage module. TVA estimated the consequences to be .11 mrem to the whole-body and 5.5 mrem to the thyroid. These doses differ from those estimated above principally because of differences in assumptions. The staff assumed more conservative values for source term, breathing rate, and release fraction which would result in doses a factor of two greater than those calculated by TVA. However, TVA assumed an atmospheric dispersion factor which was more conservative by a factor of about 5. It is these combinations of differences in assumptions that result in the differences between the dose rates calculated by the staff and TVA.

6.2 Leach to Ground Water

As previously discussed, operations at the LLRW Storage Facility are designed to prevent any unnecessary introduction of water into the module. Should some water enter a storage module it would be detected by the module monitoring program and removed. If the water contained radioactivity it would be treated as radioactive liquid waste at the SNP.

Although it is very unlikely that a significant amount of water with leached contamination could be released and enter the ground water, for purposes of this safety evaluation, potential leaching of radioactivity from the waste to the ground water is assessed. The assessment is based on the following assumptions.

Maximum stored Activity (5 yrs)	- 7.8E+4 Ci (essentially all Cs-137)
Annual Leach Fraction	- 1% per yr (of Max. Stored Activity)
Travel Distance to River	- 91 m (300 ft)
Ground Water Velocity	- 1.0 m/d (4 ft/d)
Effective Soil Porosity	- 50%
Bulk Soil Density	- 1.6 g/cm^3
Distribution Coefficient (K_d)	- 500 cm^3/g (Cs)
	- 50 cm^3/g (Sr)
River Dilution	- 3.0E+15 cm^3/yr (0.1 avg. yearly flow)
Dose Calculation Assumptions	- USNRC Regulatory Guide 1.109, potable water and aquatic food pathways

Because of the slow ground water velocity, the distance to the river and retardation factors, only the longer-lived radionuclides, Cs-137 (half-life = 30 yrs) and Sr-90 (half-life = 29 yrs) would be of concern. It is expected that it would take on the order of 400 yrs for cesium to reach the river. By then, the activity reaching the river would be about 1.7 Ci/yr. Because the distribution coefficient for strontium is an order of magnitude greater than for cesium, the strontium would be expected to reach the river in about 40 yrs. Because only a very small fraction of the waste is strontium (2.2E-4; about 17.2 Ci), only about 6.6E-2 Ci/yr would reach the river. After 40 years, leached Sr-90 would result in a maximum whole body dose of about .06 mrem/yr and a maximum organ dose of .23 mrem/yr to the bone. After 400 years, leached Cs-137 would result in a maximum whole body dose of about .08 mrem/yr and a maximum organ dose of .13 mrem/yr to the liver.

6.3 Earthquake

The LLRW storage modules, although not defined as Class I (seismic) structures, meet Class I (seismic) structural design criteria (as previously described in Section 3.2) under tornado or earthquake loading. Therefore we conclude that the modules will satisfactorily perform their functions in the event of an earthquake and no further assessment of an earthquake accident has been performed.

6.4 Tornado

As described in Section 3.2, TVA designed the storage modules to meet Class I structural design criteria under tornado loading although there is no requirement to do so. Because TVA received comments from members of the public about the ability of identical module compartments at Browns Ferry Nuclear Plant to withstand tornados and because of the potential tornados have for damaging structures and dispersing the contents to the environment, the staff performed a separate analysis of the capability of the LLRW storage modules to resist tornado wind loading. The staff, using the guidance outlined in NRC's Standard Review Plan, Section 3.3.2, concluded that the modules would withstand the design basis tornado for Region I under Regulatory Guide 1.76 (Ref. 6). Based on the above discussion, the staff concludes that there would be no significant radiological releases to the environment from the effects of a tornado.

6.5 Dropping of Storage Module Caps and LLRW Container

TVA in Section 6 of its application analyzed several accidents which involved the dropping of storage module caps into, onto and outside a module. Also, damage to waste containers from accidental dropping was analysed.

The worst result would be from a resin liner rupture. If rupture occurred in the module, the spilled resin would be contained within the module and not released to the environment. The dewatered resin could then be removed through the drainage connections to a new liner and cask assembly and the storage module would be decontaminated. If the rupture occurred outside the module, only one liner would be involved and the spillage would be in a localized area within the LLRW Storage Facility grounds. The spilled LLRW could then be collected along with any contaminated soil and repackaged for storage or disposal. The local area would then be decontaminated.

Should the rupturing of a dewatered resin liner with subsequent loss of all its LLRW occur on the LLRW Storage Facility grounds be followed by a rainfall, the staff expects that no significant amounts of radioactivity would enter the Wheeler Reservoir. However, for purposes of this safety evaluation a quantitative assessment of this accident was performed assuming that a fully loaded CVCS resin liner (1300 Ci) ruptured spilling its contents onto the LLRW Storage Facility grounds. Because of the distance to the riv sorptive properties of the soil, properties of the resin waste, and mitigative ..tions (i.e., actions to minimize migration until clean-up and decontamination could take place), it is conservatively assumed that 1% of the radioactivity would reach the river within one year. Based on the same river flow and dose calculation assumptions as in Section 6.2, this accident would result in whole body dose to a maximally exposed individual of about 13 mrem and a maximum organ dose of about 20 mrem to the liver.

6.6 Conclusion

On the basis of the above discussions, the accident having the potential for the greatest offsite impact is an accidental spillage of a fully loaded CVCS resin liner outside a storage module. All other accidents have less radiological consequence. The whole-body and liver doses to a maximumly exposed individual in such a case is not expected to exceed 13 mrem, and 20 mrem, respectively. The doses from postulated accidents at the onsite LLRW Storage Facilities are only a small fraction of 10 CFR Part 100 guidelines. Accordingly, the staff concludes that the licensee has adequately considered the potential for accidents at the SNP LLRW Storage Facility and adequately analyzed their credible consequences.

The staff further concludes that since the radiological consequences of these design basis accidents are less than Commission guidance (10% of 10 CFR Part 100, i.e., no more than a few rem whole body dose) (Ref. 4), they are acceptable.

7.0 CONCLUSIONS

Based on our evaluations of the application for license amendment as set forth above, we have concluded that:

(1) The application for amendment to facility operating license DPR-77, dated November 24, 1980, and the revised application dated March 18, 1982, for both units of the Sequoyah Nuclear Plant, meets the standards and requirements of the Atomic Energy Act of 1954, as amended (Act) and the Commission's regulations set forth in 10 CFR Chapter 1 and is for a purpose authorized by the Act; and

(2) Construction of the LLRW Storage Facility at the SNP has proceeded and there is reasonable assurance that it can be completed, in conformity with the application, the provisions of the Act, and the regulations of the Commission; and

(3) The LLRW Storage Facility will be operated in conformity with the application, the provisions of the Act, and the rules of the Commission; and

(4) The licensee's proposed equipment and facilities are adequate to protect health and minimize danger to life and property; and

(5) The licensee is qualified by reason of training and experience to conduct the activities authorized by the license in accordance with regulations of the Commission set forth in 10 CFR Chapter I in such a manner as to protect health and minimize danger to life and property; and

(6) There is reasonable assurance (a) that the activities authorized by the license can be conducted without endangering the health and safety of the public, and (b) that such activities will continue to be conducted in compliance with the regulations of the Commission set forth in 10 CFR Chapter I; and

(7) The issuance of the license will not be inimical to the common defense and security or to the health and safety of the public.

8.0 REFERENCES

1. U.S. Nuclear Regulatory Commission, Policy Issue Paper: "Storage of Low-Level Radioactive Wastes at Power Reactor Sites (SECY-80-511)," SECY-81-383, June 19, 1981. Available in NRC PDR for inspection and copying for a fee.

2. U.S. Nuclear Regulatory Commission, "Environmental Impact Appraisal of Low-Level Radioactive Waste Storage at TVA Sequoyah Nuclear Plant, Docket No. 30-19101," (To Be Published).

3. Letter (with enclosure) from L. M. Mills, TVA, to L. C. Rouse, NRC, Dated March 18, 1982. Available in NRC PDR for inspection and copying for a fee.

4. Letter (with enclosure) from W. J. Dircks, NRC, to All Holders of and Applicants For Operating Licenses and Construction Permists, (Generic Letter 81-38), Dated November 10, 1981. Available in NRC PDR for inspection and copying for a fee.

5. U.S. Nuclear Regulatory Commission, "Safety Evaluation Report, related to the operation of Sequoyah Nuclear Plant Units 1 and 2, Tennessee Valley Authority, Docket No. 50-327 and 50-328," NUREG-0011, March 1979. Available in NRC PDR for inspection and copying for a fee.

6. Memorandum (with enclosure), from J. P. Knight to T. M. Novak, NRC, Subject: "Browns Ferry Unit 1, Tornado Resistance of Low-Level Radioactive Waste (LLRW) Storage Facility." Dated June 2, 1981. Available in NRC PDR for inspection and copying for a fee.

7. Letter from F. T. Long, NRC, to H. G. Parris, TVA, Subject: Reports Nos. 50-379/82-07, 328/82-06, Dated April 28, 1982.

8. Letter (with enclosure) from L. M. Mills, TVA, to L. C. Rouse, NRC Dated July 22, 1982. Available in NRC PDR for inspection and copying for a fee.

9. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Single copies are available from the U.S. NRC, Division of Technical Information and Document Control, Washington, D.C., 20555.

10. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purposes of Evaluating Compliance with 10 CFR 50, Appendix I." Single copies are available from the U.S. NRC, Division of Technical Information and Document Control, Washington, D.C., 20555.

11. D. C. Kocher, Oak Ridge National Laboratory, "Dose-Rate Conversion Factors for External Exposure to Phatons and Electrons" U.S. NRC Report NUREG/CR-1918, August 1981. Available for purchase from National Technical Information Service, Springfield, VA, 22161.

12. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors," Single copies are available from the U.S. NRC, Division of Technical Information and Document Control, Washington, D.C., 20555.