SAFETY EVALUATION

OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

RELATED TO AMENDMENT NO. 158 TO FACILITY OPERATING LICENSE NO. DPR-3

YANKEE ATOMIC ELECTRIC COMPANY

YANKEE NUCLEAR POWER STATION

DOCKET NO. 50-029

1.0 INTRODUCTION

By letter dated November 24, 2003 (Ref. 1), and supplemented by letters dated December 10, 2003 (Ref. 2), December 16, 2003 (Ref. 3), January 19, 2004 (Ref. 4), January 21, 2004 (Ref. 6), February 10, 2004 (Ref. 8), March 4, 2004 (Ref. 9), April 27, 2004 (Ref. 11), August 3, 2004 (Ref. 12), September 2, 2004 (Ref. 13), September 2, 2004 (Ref. 14), September 30, 2004 (Ref. 17), November 19, 2004 (Ref. 18), December 10, 2004 (Ref. 19), and April 7, 2005 (Ref 43), Yankee Atomic Electric Company (YAEC or the licensee) submitted a request to amend Facility Operating License No. DPR-3 for the Yankee Nuclear Power Station (YNPS or the facility). The supplemental letters provided additional clarifying information, did not expand the scope of the application as originally noticed, and did not change the staff's original proposed no significant hazards consideration determination published in the Federal Register on June 22, 2004. In accordance with the requirements of Title 10, U.S. Code of Federal Regulations (10 CFR 50.82(a)(9)) (Ref. 2) the licensee submitted a license termination plan for its facility. Under the provisions of 10 CFR 50.82(a)(10), the U.S. Nuclear Regulatory Commission (NRC) approves license termination plans by license amendment. Thus, the licensee has requested the addition of a new License Condition to the YNPS License. The new license condition would incorporate the NRC approved License Termination Plan (LTP) into the YNPS license, and allow the licensee to make certain changes to this approved LTP without prior NRC review or approval. The new License Condition would appear as follows:

C. (11) License Termination Plan (LTP)

The License Termination Plan dated November 19, 2004, as supplemented April 7, 2005, is approved by NRC License Amendment No. 158.

In addition to those criteria specified in 10 CFR 50.59 and 10 CFR 50.82(a)(6), a change to the LTP requires NRC approval prior to being implemented if the change:

(k) Increase the probability of making a Type I decision error above the level stated in the LTP;

(l) Increase the radionuclide-specific derived concentration guideline levels (DCGLs) and related minimum detectable concentrations;

(m) Increase the radioactivity level, relative to the applicable DCGL, at which investigation occurs;

(n) Change the statistical test applied to one other than the Sign Test or Wilcoxon Rank Sum Test.

(e) Prior to license termination, if the concentrations of site-generated radionuclides other than tritium are reported in the groundwater in excess of the individual concentrations listed below, or if a sum of the fractions formed by dividing the reported concentrations by these values is greater than 2.0, the licensee shall evaluate the need for site-specific groundwater DCGLs for these radionuclides. New groundwater DCGLs will require that a license amendment request be submitted to NRC for approval.

Radionuclide	Individual Concentration Limit, pCi/L	Radionuclide	Individual Concentration Limit, pCi/L
Ag-108m	50	Fe-55	25
Am-241	0.5	Nb-94	50
C-14	200	Ni-63	15
Cm-243/244	0.50	Pu-238	0.50
Co-60	25	Pu-239/240	0.50
Cs-134	14	U-241	15
Cs-137	15	Sb-125	50
Eu-152	50	Sr-90	3
Eu-154	50	Tc-99	15
Eu-155	50		

Re-classification of survey areas from a less to a more restrictive classification (e.g., from a Class 3 to a Class 2 area) may be done without prior NRC notification; however, re-classification to a less restrictive classification (e.g., Class 1 to a Class 2 area) will require NRC notification at least 14 days prior to implementation.

2.0 EVALUATION

The licensee submitted its LTP on November 24, 2003 (Ref. 1), with a supplemental revision dated November 19, 2004, (Ref. 18), in accordance with 10 CFR 50.82(a)(9). Section 50.82(a)(9) requires the LTP to contain the following information: (1) site characterization information; (2) identification of remaining dismantlement activities; (3) plans for site remediation; (4) detailed plans for conducting a final radiation survey; (5) a description of the end use of the site, if a restricted option is selected; (6) an updated site-specific estimate of remaining decommissioning costs; and (7) a supplement to the environmental report, pursuant to 10 CFR 51.53 (Ref. 3), describing any new information or significant environmental changes associated with the licensee's proposed termination activities. In addition, the licensee requested the authority to make certain changes to the LTP, once approved by NRC.

The LTP describes YAEC's approach for demonstrating compliance with radiological criteria, for unrestricted use. As stated in 10 CFR 20.1402, the annual dose limit is 0.25 mSv (25 mrem) per year Total Effective Dose Equivalent (TEDE) above background from all pathways to an average member of the critical group, including ground water. YAEC must also reduce residual radioactivity to "as low as is reasonably achievable" (ALARA) levels.

2.1 Site Characterization

Site characterization surveys are conducted to determine the nature and extent of radioactive contamination in buildings, plant systems and components, site grounds, and surface and ground water. The major objectives of characterization activities are to: 1) permit the planning and conduct of remediation activities; 2) confirm the effectiveness of previously conducted remediation methods; 3) provide information to develop specifications for Final Status Surveys (FSSs); 4) define site and building areas as survey units and assign survey unit classifications; and 5) provide information for dose modeling.

On June 29, 2005, the Commission issued CLI-05-15 providing guidance concerning the type of information that should be included in a site characterization. Specifically, the Commission stated that:

> At a minimum, the site characterization and remediation plans must provide sufficient information to allow the NRC to determine the extent and range of expected contamination, to determine whether estimates for remaining decommissioning costs are reasonable, to determine the likely schedule for remaining activities, and to support the final site survey to verify compliance with Part 20 release limits.... With respect to an adequate site characterization, it seems reasonable to interpret the regulations [50.82] as requiring LTP submissions to contain the type of information discussed in the NUREG-1700 [Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plan, Rev.1] acceptance criteria, including a reasonably bounded discussion of future activities to refine site characterization information. (CLI-05-15 at 12-13)

Site characterization activities are summarized in the Historical Site Assessment (HSA) (Ref. 6 & 17). Site characterization survey activities included the review of various types of sample results, including those from soil, sediment, water, concrete, and metal. Surveys and sampling conducted during site characterization are biased and judgmental measurements based on process knowledge and operational history. In accordance with 10 CFR 50.82(a)(9)(ii)(A), YAEC provides radiological conditions of the site in Chapter 2 of the LTP. The results of sample analyses, and the use of the results in identifying the significant radionuclides expected to be present after remediation, are described in Technical Basis Document YA-REPT-00-001-03, Radionuclide Selection for DCGL Determination, dated November 5, 2003.

In support of characterization efforts, the licensee conducted an HSA. The HSA used information from decommissioning records, historical records, plant and radiological incident files, operational survey records, and annual environmental reports to the NRC. Personnel interviews were conducted with present and former plant employees and contractors to obtain additional information regarding operational events that caused contamination in areas or systems not designed to contain radioactive or hazardous materials.

The HSA process identified events, during the operational life of the plant, with known or potential radiological impacts on the environment. These events are summarized in Appendix 2A of the LTP. The results of the HSA are used to guide remediation activities; and to confirm the appropriateness of the radiological source terms used for the dose model, as more site information is being collected. Assessments of subsurface soil and groundwater are ongoing. Subsurface soils will be evaluated as the site structures are demolished and removed. Groundwater characterization will continue to confirm spacial and radiological characteristics of the groundwater contamination is adequately bounded.

The licensee has conducted a series of sample analyses using site media which represent the distribution of radionuclide contaminants, and their decay-corrected distribution based on process knowledge, over the operational history of the plant. Table 2-6 of the LTP identifies 22 radionuclides of potential concern at the site:: ^{3}H, ^{14}C, ^{55}Fe, ^{60}Co, ^{63}Ni, ^{90}Sr, ^{94}Nb, ^{99}Tc, ^{108m}Ag ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{241}Am, ^{243}Cm, and ^{244}Cm. These radionuclides include fission and activation products, which are typical of those found in pressurized-water reactor plants and are those radionuclides described in NUREG/CR-0130, "Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station," (Ref. 39); and NUREG/CR-3474, "Long-Lived Activation Products in Reactor Materials," (Ref. 22) Accordingly, these radionuclides will form the basis for planning and conducting all FSSs, and demonstrating compliance with the site release criteria. The licensee has identified radionuclides of primary concern by survey area in the HSA and Appendices 2B and 2C of the LTP. The LTP does not rule out the possibility of taking and analyzing additional samples as decommissioning activities warrant.

Site-specific measurements resulting from radiological surveys and hydrogeological assessments provided the information necessary to develop finalized DCGL values and radionuclide fractions. The methods and findings for development of final DCGL values are detailed in Chapter 6, Compliance with the Radiological Criteria for License Termination.

The types of surveys and sampling methods described for the survey efforts are consistent with industry standard methodologies and are, therefore, acceptable. The staff will evaluate survey implementation activities during routine, in-process, inspections to confirm that the methodology is adequate to meet the technical objectives of the LTP, and the results confirm that YAEC has remediated the site and meets the cleanup criteria.

Quality assurance (QA) and quality control (QC) measures for characterization surveys included requirements for ensuring compliance with 10 CFR Part 50, Appendix B. The QA/QC measures address organization, program controls including personnel training and qualifications, instrumentation use and control, procedures, records and document control, audits and surveillance, and data collection and verification.

The radionuclides considered important in modeling doses are presented in Table 2-6 of the LTP. The dose limit and dose model, and corresponding DCGLs are presented in Section 6.1.1 and Table 6-1 of the LTP.

The licensee has transferred spent fuel to concrete dry storage casks located in the newly constructed Independent Spent Fuel Storage Installation (ISFSI). The ISFSI is a secured facility with restricted access. Both the ISFSI and its Security Operations Building will remain active until all the spent fuel is transferred to the U.S. Department of Energy (DOE), projected by the licensee to occur in calendar year 2020. At that time, the ISFSI and Security Operations Building will be demolished, and the areas and facilities will be surveyed and released in accordance with NRC regulations.

In the approach outlined in the LTP, the licensee proposes to demolish all major above-ground structures, but may leave some subsurface footings and structures. The resulting concrete demolition debris will be shipped off the site for appropriate disposal, or used to fill the remaining subsurface structures. All areas will be contoured to local grade elevation.

Based on both the YAEC HSA and additional characterization surveys, a large portion of the site located outside the industrial area was determined to be non-impacted, as documented in Section 2.5 of the LTP. The classification of the area as non-impacted, according to Multi-Agency Radiation Survey And Site Investigation Manual (MARSSIM) criteria, is based upon historical photographs, results of Radiological Environmental Monitoring Program (REMP) surveys, particulate gaseous effluent deposition modeling, and a statistical analysis of Cs-137 soil concentrations relative to a set of background reference areas.

This portion of the site located outside the industrial area is open land consisting of approximately 2170 acres. The non-impacted land surrounds the industrial area and all other routinely utilized areas. The non-impacted area is bounded on the east and south by Monroe State Forest, on the southeast by USGen property, on the west by Readsboro Road (with the exception of an 89 acre plot on Kingsley Hill Road), and on the north by the Massachusetts/Vermont state line. The non-impacted area was not involved in plant operations and consists mostly of rugged terrain which is forested and undisturbed. Power lines traverse the area in a northeast by east direction.

Impacted areas of the site include the industrial area and surrounding open land areas extending out approximately 1000 feet from the Vapor Container (VC). The characterization summaries provided in Appendices 2B and 2C of Section 2 of the LTP include a description, key elements of the history, contaminated media and an evaluation of the principal radionuclides expected to be present in the area. The summary also includes a current decommissioning status and a description of the work remaining to be done to attain the anticipated end-state. A survey area classification statement is provided at the end of each assessment. None of the impacted areas were classified based only on the results of scoping or preliminary characterization data. The classifications assigned, based on historical activities performed in these survey areas, are substantiated by the large quantity of scoping data available in the form of soil sample analyses and survey data. Summaries of the sampling data as shown on Tables 2-4 and 2-5 of the LTP are compiled from information detailed in the YNPS HSA. More detailed descriptions, histories and the radiological status of each of these survey areas are also contained within the YNPS HSA.

As part of the MARSSIM methodology, classification determines the level of survey effort based on the potential for contamination. Class 1 areas, prior to remediation, are impacted areas with concentrations of residual radioactivity that exceed the $DCGL_w$. Class 2 areas are impacted areas where concentrations of residual activity that exceed the $DCGL_w$ are not expected. Class 3 areas are impacted areas that have a low probability of containing areas with residual radioactivity.

In general, the impacted areas immediately outside the confines of the historical Radiologically Controlled Area (RCA) have been assigned a NUREG-1575 Class 2 status. These buffer zones are areas where radionuclides may have migrated beyond the RCA boundary due to environmental or other translocation vectors. The exceptions are Survey Areas OOL-12 and OOL-13 where radionuclides are known to have migrated beyond the RCA boundary due to the combination of a recorded contaminating event (PIR 81-09) and a significant rain event. Surface run-off from the RCA yard not channeled into the storm drain system migrated down grade along the rail spur in these areas toward Sherman Reservoir. Although the surfaces of these areas were quickly decontaminated and cleared for general access, some of the contamination carried by the run-off filtered into the crevices of the rails and rail bed remain embedded. These areas have been assigned a Class 1 status. Survey Area OOL-07 has been assigned a Class 2 status as it contains soils removed from other Class 2 areas and soils that have only been evaluated by composite sampling techniques. The remaining impacted areas are assigned a Class 3 status. These areas were designated as impacted areas for a wide variety of reasons. None of these areas are expected to contain radioactivity in excess of a small fraction of the appropriate DCGL.

Section 5.4.2 of the LTP, particularly Table 5-1, provides a process and description for defining impacted area classifications (Classes 1, 2, and 3) that is consistent with MARSSIM and is acceptable. LTP Sections 5.4 to 5.6 present the process and criteria that will be used to plan, design, and implement FSSs taking into account the various types (surface and/or volumetric) of DCGLs that will be applied to open land areas (surface and deep soils), subsurface partial structures, concrete debris, sediments, and ground water to demonstrate compliance with the release criteria. LTP Sections 6.3 to 6.5 present a method for calculating site-specific DCGLs for various media. The final site surveys will be conducted using guidance from MARSSIM. The licensee will use NRC guidance to develop survey procedures to demonstrate compliance with the site-specific criteria for unrestricted release.

The staff finds the site characterization program provides sufficient information to determine the extent and range of expected contamination, to determine whether the estimates for remaining decommissioning costs are reasonable, to determine the likely schedule for remaining activities, and to support the final site survey to verify compliance with Part 20 release limits acceptable, and is therefore, acceptable. NRC will continue to monitor, by future in-process inspections, the licensee's activities and how this information will be used in implementing the FSS.

2.1.1 Facility Radiological Status

As described in Section 1.3 of the LTP, the plant started operating in 1960, and was shut down in 1992. On August 5, 1992, NRC issued a license amendment approving a change to reflect the permanently defueled conditions of the plant and operating conditions, and to ensure the long-term safety of the spent fuel.

Significant radiological events are summarized in Appendices 2B and 2C of Section 2 of the LTP. Events reported range from spills both in and at outdoor locations, soil and sediment contamination from system leaks, and inadvertent relocation of contaminated materials in previously clean areas. Significant events included leaks from the Spent Fuel Pit/Ion Exchange Pit that resulted in contamination (primarily tritium) of subsurface soils. Table 2-3 of the LTP presents a summary of unplanned liquid releases. More detailed information is provided in the HSA, Volumes 1 and 2.

Spent fuel from the reactor was transferred to the ISFSI by June 2003. The fuel pool has been drained and cleaned.

The staff finds that the facility radiological status presented in the LTP provides sufficient information to allow the NRC to determine the extent and range of expected contamination and to support the final site survey to verify compliance with 10 Part 20, Subpart E release limits and is, therefore, acceptable.

2.1.1.1 Structures

The only structures expected to remain onsite will be those supporting ISFSI operations. Although no buildings utilized during power operation are expected to remain on the site at the time of the FSS, it is recognized a contingency might arise for a specific structure to be in use at the time of the FSS. If so, any such building would be surveyed in accordance with NUREG-1575 guidelines, and would be included in the FSS results provided to the NRC. Contaminated materials will be transferred to a licensed Low Level Waste (LLW) “broker” or radioactive waste disposal site for packaging and disposal in accordance with its license.

The staff has determined that the approach used by the licensee to characterize demolition debris provides sufficient information to determine whether estimates for remaining decommissioning costs are reasonable and to determine the likely schedule for remaining activities, and is acceptable.

2.1.1.2 Systems

Each plant system was evaluated for potentially removable and fixed contamination by various methods, including surveys and sample analyses. As expected, radioactivity levels in affected plant systems were noted to be elevated where contamination levels and associated exposure rates were equally high. The licensee is removing all systems and components pursuant to the Post Shutdown Decommissioning Activities Report. At this time, the fuel pool has been drained and cleaned. Because all of this equipment is being removed and disposed of as radioactive waste, their removal will not contribute to residual contamination levels at the time that FSSs will be conducted. Accordingly, the associated radiological properties of plant systems are not discussed here, but this information can be found in LTP Section 2.

The staff has determined that the approach used by the licensee to characterize affected and unaffected systems provides sufficient information to allow the NRC to determine the extent and range of expected contamination, to determine whether the estimates for remaining decommissioning costs are reasonable, and to determine the likely schedule for remaining activities and is acceptable.

2.1.1.3 Activation

Neutron-activated material is only found in the immediate vicinity of the reactor, as the nuclear reactor is the only significant source of neutrons during operation. The removal and shipment of neutron-activated reactor components and concrete are expected to eliminate the majority of the associated radioactivity from the site. Some concrete debris that has been activated at very low levels may be used as backfill for subsurface structures.

The staff has determined that the licensee's characterization of neutron-activated material provides sufficient information to allow the NRC to determine the extent and range of expected contamination and to support the final site survey to verify compliance with 10 Part 20, Subpart E release limits and is acceptable. The NRC staff will confirm, during in-process inspections and
confirmatory surveys, that residual contamination levels from activated materials remaining on site meet the release criteria.

2.1.1.4 Surface and Deep Soils

Surveys were conducted to assess the presence, and extent, of contamination in surface and deep soils, and to identify the scope of remediation necessary to meet the release criteria for unrestricted site use. The Non-Impacted Area was sampled in August 1998, to determine the standard background concentration of gamma emitting radionuclides in soil, as summarized in Section 2.5.6.2 of the LTP. Cs-137 concentrations in the Non-Impacted Area are less than or equal to those found in a reference area two miles east-southeast of the plant. The Cs-137 in the Non-Impacted Area is attributable to atmospheric weapons testing and is not of plant origin.

Sampling of impacted open land areas was performed to characterize the radiological condition of soils. Results of radiological samples are summarized by survey area in Appendices 2B and 2C of Section 2 of the LTP.

Additional sampling will be performed to support planning for the FSS. Some of the soils to be characterized are located beneath the concrete floors and asphalt. Sub-grade structures that are not part of a designated structural survey area (e.g., concrete support structures) will be evaluated within the overlying open land survey area or subsurface survey area when they are potentially impacted by the migration of sub-surface contamination.

In order to address the potential for contamination with difficult-to-detect radionuclides for gross surface contamination measurements, one of two processes will be employed: (1) the use of a surrogate relationship to contamination or (2) direct measurement of alpha contamination. The licensee has proposed a process to determine the need to use surrogate ratios for hard-to-detect (HTD) radionuclides. First, it will be determined whether HTD radionuclides (e.g., Transuranics (TRU), Sr-90, H-3) are likely to be present in the survey unit based on process knowledge and historical data or characterization. When HTD radionuclides are likely to be present, a relationship will be established using a representative number of samples (typically six or more). The samples may come from another survey unit if the source of the contamination and expected concentrations are reasonably the same. These samples will be analyzed for easy-to-detect and HTD radionuclides using gross alpha, alpha spectroscopy, gross beta analysis, or gamma spectroscopy techniques.

The staff has determined that the approach used by the licensee to characterize both Impacted and Non-Impacted areas, and the process to identify areas that might require further soil remediation are consistent with staff guidance and previously approved methodologies and are, therefore, acceptable. In addition, the licensee has committed to remove contaminated surface and subsurface soils and evaluate radionuclide distributions and fractions to confirm that the assumptions used to develop the site dose model and cleanup criteria are still in agreement with site conditions. The NRC staff will also confirm, during in-process inspections and confirmatory surveys, that residual soil contamination levels in affected and unaffected areas meet the release criteria.

2.1.1.5 Groundwater

The NRC staff has evaluated the following: (1) the extent that groundwater at the YNPS site contains site-generated radionuclides and (2) whether groundwater contaminated with site-generated radionuclides has migrated offsite. This evaluation is based upon YNPS's LTP and supporting documents and upon NRC's independent assessment.

YNPS's groundwater characterization of this site has evolved as additional hydrogeologic data have been compiled (i.e., installation of additional monitoring wells, collection and analysis of more radiological groundwater samples). It is apparent that this evolution will continue as the licensee's pursues additional groundwater sampling at the site. As documented by license condition 2. C. (11) (e), if radionuclides other than the known tritium contamination are identified in the groundwater in excess of the specified concentrations, new DCGLs would have to be submitted to the NRC for approval as part of a license amendment.

Geology, Hydrology, and Stratigraphy

The hydrogeologic system at YNPS site is a product of the stratigraphy and hydraulic conductivity of the rocks and unconsolidated materials; the geomorphology, including the glacial history; and the hydrology of this area. The YNPS site is located on the east side of the Berkshire Mountains predominantly on a terrace of the Deerfield River. The terrace is recessed into the east side of a 2 mile wide glacially-derived river valley where the valley rises to over 1,000 feet above the river elevation. The YNPS plant is adjacent to a dammed portion of the Deerfield River, Sherman Pond, which is about 2 miles long, a quarter mile wide, and up to 75 feet deep along its central channel. The local gradient for this portion of the Deerfield River is 28.4 feet/mile over a river distance of about 33 miles from the Vermont border at the Sherman Pond to the West Deerfield, Massachuset gauging station (Framatome ANP DE&S, 2003).

The stratigraphy of the hydrogeologic system at YNPS is complex with three units that are sometimes saturated: the stratified drift, glaciolacustrine, and bedrock. The stratified drift unit contains surficial sands and gravels,10 to 20 feet thick, that are water-laid ice-contact deposits derived from a melting glacier. The glaciolacustine unit contains sediments about 260 feet thick of glaciolacustrine origin with multiple, relatively thin water-bearing units of fine to medium-grained sand that is moderately to well sorted. The bedrock unit is a gray, medium-grained, moderately foliated metamorphic rock that contains significant amounts of megacrystals of plagioclase feldspar albite. This bedrock is the upper member of the Lower Cambrian Hoosac Formation, which is relatively competent with few fractures (Yankee Nuclear Power Station, 2004a).

Groundwater Regime and Hydrogeology

As discussed above, three groundwater-bearing units (stratified drift, glaciolacustrine, and bedrock) comprise the hydrogeologic system at this site. The horizontal and vertical extent of these water-bearing units varies throughout the site based primarily upon glacial action and fluvial deposition and/or erosion. The licensee in the LTP refers to these three units, sequentially from the land surface, as shallow, intermediate, and bedrock.

The stratified drift unit, whose combined unsaturated and saturated thickness ranges from 10 to 20 feet, has a variable saturated thickness based upon climatic conditions and location within the Deerfield River valley. Most of the monitoring wells installed prior to 2003 were screened within this shallow unit. The stratified drift unit is not used as a drinking water source at or nearby the site (Framatome ANP DE&S, 2003).

The glaciolacustrine unit, which ranges in thickness from 0 to 260 feet across the river valley, is undergoing additional characterization by the licensee. The multiple water-bearing sand layers within this unit are a few feet thick and are interbedded within a matrix of silt; fine to medium-grained gravel and cobbles; and varve materials, clay, silt and fine sand. The matrix materials, which have much lower hydraulic conductivity than the water-bearing sand layers, are usually dry and sometimes moist. The degree of continuity between the water-bearing sand layers across the site is not clearly understood; therefore YAEC has installed data-logging pressure transducers in selected monitoring wells to evaluate the connectivity of subsurface units at available monitoring wells (Yankee Nuclear Power Station, 2005a). However, it is clear that there is some interconnection and also a net downgradient flow of groundwater within all materials in this unit (Yankee Nuclear Power Station, 2004a). The glaciolacustrine unit is not used as a drinking water source on site.

The bedrock unit is a potable drinking water source, and YNPS's water supply well is screened in this unit. The water supply well, which has an approximate yield of 50 gallons/minute and a maximum depth of 280 feet, is located about 450 feet southwest of the main plant buildings. The depth to the bedrock unit varies across the site from a few feet to about 280 feet below the land surface (Framatome ANP DE&S, 2003)

Radiological Spills, Leaks, and Releases

The licensee in its LTP and HSA has acknowledged that spills, leaks, and releases of site-generated radionuclides have occurred at the YNPS site. The licensee has responded to the radiological contamination of the soils and groundwater with remediation activities and additional characterization. The primary source of tritium in the groundwater appears to have been one or more leaks in the Ion Exchange Pit (IX Pit) and the Spent Fuel Pit (SFP) that occurred in the 1960's and 1960's - 1970's, respectively. The IX Pit and SFP share a common wall. The Primary Auxiliary Building was another source of tritium contamination. Details on these spills, leaks, and releases can be found in LTP Section 2.2.3 and Appendix 2A.

Licensee's Response to the Groundwater RAIs

The NRC staff generated a request for additional information (RAI) to clarify groundwater issues at this site based upon the licensee's LTP, Rev. 0. Areas of concern included; mapping of groundwater flows, bounding of the tritium plume, the potential for transport of groundwater contaminates offsite, and the examination of groundwater for all site-generated radionuclides. Hydrogeologic characterization issues, particularly within the glaciolacustrine unit at the site, will require further monitoring. The licensee responded to the RAIs by discussing existing hydrogeologic studies pertaining to the site and by performing additional characterization of the groundwater emphasizing potential site-generated radionuclide contamination.

The licensee's revised LTP and response to the RAIs have addressed the NRC staff's groundwater issues by providing additional information or committing to further monitoring. The licensee's commitment to additional hydrogeologic characterization, in particular continued monitoring of the distribution and contaminate level of the tritium plume, and to the inclusion of a groundwater license condition to the LTP, to continue monitoring the groundwater for additional radionuclides, addresses the NRC staff's groundwater concerns.

Radiological Monitoring Wells

The radiological groundwater monitoring at the YNPS, excluding monitoring for the REMP, began after the plant shut down in 1992 and has continued during the last 11 years. Monitoring wells at YNPS have been installed in stages as follows: two in the late 1970's, 15 in 1993-94, 21 from 1997 through 2001, 17 during the summer of 2003 (Yankee Nuclear Power Station, 2004a), and 10 during the summer of 2004 (Yankee Nuclear Power Station, 2004b). Most of these wells that were installed prior to 2003 are located in the RCA; however, a few of the wells are either downgradient or upgradient of the RCA. All of the wells that were installed before 2003 except one well are shallow wells, that range in depth from 7 to 31 feet below the land surface. The one exception is a 49 feet deep bedrock monitoring well in the RCA. Most of the monitoring wells installed during the summers of 2003 and 2004 are screened in either the glaciolacustrine or the bedrock units. After the summer of 2004, 60 monitoring wells existed at the YNPS site because 11 wells installed prior to 2003 had been abandoned.

Groundwater samples have been collected for radiological analysis from the existing monitoring wells since 1993. Before 2003, the licensee analyzed the groundwater for tritium, gross alpha, gross beta, and gamma spectroscopy. The analytical results for these samples (i.e., groundwater samples from monitoring wells primarily screened in the stratified drift unit) indicated that only tritium was observed above the minimum detection concentration (MDC). Also, the largest tritium concentrations were observed in wells located near the SFP and IX Pit.

After a review of the YNPS groundwater monitoring program, the licensee made several changes in its monitoring program to improve the characterization of the site and to improve the sampling and analytical procedures. During the summers of 2003 and 2004, the licensee installed 27 monitoring wells, as mentioned above, to characterize the stratified drift, glaciolacustrine, and bedrock units more adequately. The licensee has committed to installing additional monitoring wells in the future to improve its characterization of the groundwater-bearing units. In 2003, the licensee began quarterly sampling, and in 2004 the licensee improved its sampling procedures by measuring the groundwater levels in all monitoring wells within a few hours before any water samples were collected. The licensee has also committed to collecting the water samples from the monitoring wells over a shorter time period.

Groundwater Potentiometric Surfaces and Groundwater Flow Directions

The groundwater potentiometric maps for the stratified drift unit, the glaciolacustrine unit, and the bedrock unit for July and November 2003 are delineated in Figures 2-11 through 2-16 from the LTP. The characterization provided by these groundwater potentiometric maps will need further confirmation because the measurement of the groundwater levels was extended over several weeks. The licensee has also obtained additional data for the glaciolacustrine unit that indicates that one of the groundwater potentiometric maps for entire unit will need further characterization (Figures 2-13 and 2-14). Recent 2004 data indicates that the water-bearing sand layers have unique groundwater potentiometric surfaces.

The groundwater flow patterns within the YNPS site are based upon the groundwater potentiometric surfaces, the hydraulic gradients of the groundwater surfaces, and the hydraulic conductivities of the different rock types. The groundwater flow directions for the stratified drift and the bedrock units are both north to northwest during the July 2003 groundwater measurements. However, 2004 data indicate that the groundwater flow directions for the thin water-bearing sand layers in the glaciolacustrine unit are variable by layer. The licensee has committed to perform additional characterization prior to license termination to ensure that all groundwater flow paths have been identified.

Recharge and Discharge

The average precipitation at the YNPS site is 47 inches/year; however, only a portion of this precipitation is recharged to the groundwater system. Infiltration of precipitation through the soils and cover materials and recharge to the shallow stratified drift unit are extremely variable throughout the site. This variability is caused by changes in the cover materials' vertical permeabilities and in preferential flow. Generally, fill materials and areas with extensive preferential flow will have the largest infiltration and recharge rate; and areas with extensive amount of impermeable surfaces will have the smallest infiltration and recharge rate. However, the infiltration and recharge within the RCA is complicated by the drainage systems, impermeable surfaces from buildings and paving, and preferential flow along cracks in the impermeable surface.

Groundwater discharge from the site is to Deerfield River, Wheeler Brook, Sherman Pond, and springs. The volume of groundwater discharge fluctuates as the amount of precipitation increases or decreases. During periods of greater precipitation, groundwater discharge will increase.

Aquifer Parameters

The licensee has limited information on the hydraulic conductivity (K) for the three water-bearing units at the YNPS site. The licensee has computed the K and effective porosity (θ) for 12 samples collected from the stratified drift unit based upon geotechnical laboratory analyses (grain-size distribution). The licensee has estimated the K and θ values as 3.11 feet/day and .3, respectively.

The NRC staff evaluated whether the lithology (medium sand) of the water-bearing materials from the logs of the monitoring wells screened in the stratified drift unit [*Hydrogeologic Report of 2003 Supplemental Investigation* (Yankee Nuclear Power Station, 2004a)] matched the K value obtained from the grain-size analysis. The staff believes that the K values are more representative of a silty fine sand rather than medium sand. However, the staff considers the licensee's characterization of the aquifer parameters to be adequate because the staff will monitor the licensee's continued characterization of the groundwater to evaluated the need for any adjustments.

Groundwater Sampling and Analysis for Radionuclides

In 2003, the licensee improved and expanded its analysis of the groundwater samples by analyzing for the radionuclides of concern at the YNPS. Table 2-6 in the LTP lists the radionuclides of concern as H-3, C-14, Fe-55, Co-60, Ni-63, Sr-90, Nb-94, Tc-99, Ag-108m, Sb-125, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Pu-238, Pu-239/240, Pu-241, Am-241, and Cm-243/244. The licensee, in its July and November 2003 sampling events, analyzed for these radionuclides of concern and for Mn-54. Tritium was the only site-generated radionuclide that was detected in the July and November 2003 sampling events.

The largest tritium concentration observed at YNPS site has been in groundwater flowing from Sherman Spring, which is downgradient from the Sherman Dam and Sherman Pond near the Deerfield River. Groundwater from Sherman Spring had a tritium concentration of 7,195,000 pCi/L in December 1965. The tritium was apparently caused by a leakage from the IX Pit, which was repaired in May 1965.

Tritium concentrations from the July and November 2003 sampling events are variable by space and time throughout the water-bearing units at the site. The maximum tritium concentrations were approximately 2,000 pCi/L in the stratified drift unit, 45,000 pCi/L in the glaciolacustrine unit, and 6,000 pCi/L in the bedrock unit.

Based upon the tritium sampling of the borehole materials during well drilling within the glaciolacustrine unit, the licensee may need to conduct additional monitoring in water-bearing sand layers that have large tritium concentrations. The licensee has committed to additional monitoring, including additional wells if needed, to provide additional characterization of the glaciolacustrine unit. The licensee's commitment to additional hydrogeologic characterization and the inclusion of a groundwater license condition to the LTP adequately address groundwater radionuclides.

Groundwater Movement and Radionuclide (Tritium) Transport

The travel times of site-generated radionuclides dissolved in the groundwater at this site are limited to tritium movement because tritium has been the only radionuclide observed in groundwater above minimum detection concentrations (MDC). Tritium is not absorbed by the soils or rock materials; therefore, it acts as a tracer for groundwater movement. The average velocity for groundwater flow can be calculated using the formula:

$$v = Ki / \theta.$$

Where v = average velocity (units - length per time),
K = hydraulic conductivity (units - length per time),
I = change in hydraulic gradient or head (units - length per length), and
θ = effective porosity of the flow medium (no units).

The licensee has calculated the average velocity of the groundwater for the stratified drift unit from the SFP/IX Pit complex to the Sherman Spring (Figure 5 from the LTP) as approximately 1.0 feet/day. The NRC staff has confirmed this calculation based upon licensee's input parameters (K= 3.1 feet/day, θ =.3, and I = .091 feet/feet from Figure 5). The staff also computed an independent groundwater velocity of 1.4 feet/day from the tritium plumes in Figures 2-9a and 2-9b in the LTP. These results are within a margin of error given the different methodologies used, therefore the staff agrees that the average velocity of the groundwater or the velocity of the tritium plume movement is approximately 1.0 feet/day.

The licensee has estimated the travel time for tritium flow within the stratified drift unit from the SFP/IX Pit complex to the Deerfield River as 2.3 years. The staff independently calculated the travel time as 2.6 years. These results are within a margin of error given the different methodologies used, therefore the NRC staff finds the licensee's travel time estimate acceptable.

The estimated travel time agrees with the actual data observed for the IX Pit tritium leak in 1963 and compared in 1965 with tritium values observed at Sherman Spring (maximum concentration of 7,195,000 pCi/L in December 1965). With a velocity of approximately 1.0 feet/day, tritium would have reached the Deerfield River in 1966 (Yankee Nuclear Power Station , 2004c). Thus, tritium has moved offsite in the stratified drift unit. After tritium in the groundwater reaches the much larger surface water volume, it will be diluted significantly to levels below the Environmental Protection Agency (EPA) Maximum Concentration Level (MCL) of 20,000 pCi/L.

Because hydraulic conductivity data does not exist for the other two water-bearing units, groundwater velocities cannot be estimated for these units.

Groundwater Monitoring During and After Decommissioning

The licensee has agreed to continue the groundwater monitoring program during the decommissioning of the YNPS site. This will include quarterly sampling of tritium and other radionuclides as appropriate. In addition, the licensee will also continue to monitor the site for tritium and other radionuclides as appropriate after decommissioning is completed but before license termination. The licensee will need to replace critical monitoring wells that are abandoned because of their location either within or near the decommissioning areas or become nonfunctional during these monitoring periods.

Conclusion

The NRC staff has determined that the licensee's groundwater characterization at the YNPS site with respect to site-generated radionuclide provides sufficient information to allow the NRC to determine the extent and range of expected contamination and to support the final site survey to verify compliance with Part 20 release limits, and is acceptable. The licensee has committed to continue groundwater characterization prior to license termination, particularly with respect to the glaciolacustrine unit. Also, a groundwater license condition will be added to the LTP that will address the impact on the approved DCGLs if site-generated radionuclides, other than tritium, are identified in the groundwater above background concentrations. Based on the licensee's commitment to request license termination only if the tritium levels are below the EPA MCL of 20,000 pCi/L, no remediation is expected to be necessary (see 2.5.5.3).

2.1.1.6 Surface Water

The surface water at the YNPS site includes the Deerfield River, Sherman Pond, the Discharge Canal, and Wheeler Brook. The Deerfield River and its associated flood plain and terraces were developed, in part, by glaciation within the Berkshire Mountains. The local gradient for this portion of the Deerfield River is 28.4 feet/mile over a river distance of about 33 miles from the Vermont border at the Sherman Pond to the West Deerfield, Massachusetts gauging station. Sherman Pond was formed by damming (Sherman Dam) the Deerfield River. Sherman Pond is approximately 2 miles long, a quarter mile wide, and up to 75 feet deep along its central channel (Framatome ANP DE&S, 2003). The Discharge Canal, which discharges into the Sherman Pond, was built to handle return water from the plant's cooling water processes. Wheeler Brook handles surface water runoff from the RCA and nearby areas upgradient from the RCA. Wheeler Brook and its tributaries flow about 400 to 500 feet outside the RCA around the south and east sides of the site before Wheeler Brook discharges into Sherman Pond (Framatome ANP DE&S, 2003).

The licensee samples three surface water sites for its REMP at the YNPS site. The Deerfield River is sampled downstream from the YNPS site at Bear Swamp Lower Reservoir with an automatic sampler every two hours. These samples are composited for each month. The licensee also collects monthly grab samples from Sherman Pond and from an upstream Deerfield River site at the Harriman Reservoir. Samples from all three sites are analyzed for gamma emitting radionuclides, tritium, and gross beta. The tritium and gamma spectroscopy results for 2003 indicated that no surface water samples contained detectable levels of site-generated radionuclides. Also, the gross beta averages for 2003 were slightly greater at the upstream Deerfield River site than at the downstream site (Yankee Atomic Electric Company, 2004).

The NRC staff has reviewed the licensee's sampling and analysis of surface water on and near the site and found it to be consistent with staff guidance and prior industry experience. Therefore, the NRC staff has determined that the licensee's surface water characterization is acceptable. Based upon these recent data, the staff agrees with the licensee that the surface waters at the YNPS site do not require remediation with respect to site-generated radionuclides.

2.1.1.7 Sediment

The presence of radioactive contamination in sediment was assessed using the process designed for soils. Portions of the site with sediments were included in characterization surveys. These areas include Sherman Pond and shorelines along Sherman Pond and the Deerfield River. The licensee analyzed sediment samples for the presence of radioactivity and radionuclide distributions, using the same characterization process described for soils.

Sediment sampling and analysis revealed varying contamination levels, depending on whether or not portions of these areas had been affected by plant operations, including permitted discharges, spills, and leaks. The contaminants were mainly Sr-90, Co-60 and Cs-137.

The staff has determined that the approach used by the licensee to characterize sediments provides sufficient information to allow the NRC to determine the extent and range of expected contamination and to support the final site survey to verify compliance with Part 20 release limits and is acceptable. The staff will confirm, during in-process inspections and confirmatory surveys, that residual contamination levels in sediments meet the release criteria.

2.1.1.8 Pavement

As with sediments, the presence of radioactive contamination under paved areas was assessed using the process designed for soils. Characterization surveys included portions of the site where they expected pavement and underlying soils to be contaminated. The LTP has identified that some paved areas and covered soils are suspected of being contaminated; however, these areas are yet to be fully characterized and evaluated by the licensee.

The staff has determined that the approach used by the licensee for the initial characterization of contamination levels of paved areas is acceptable, while recognizing that further efforts will be necessary to complete the decommissioning prior to FSSs. This information will be used to identify areas that might require remediation, as described under continuing characterization activities. The staff will confirm, during in-process inspections and confirmatory surveys, that residual contamination levels in paved areas have appropriately been evaluated and meet the release criteria for surface or deep soils.

2.1.2 Site Characterization - Summary Finding

The staff has reviewed the information in the LTP for the YNPS, according to Section B.2 of NUREG-1700 (Ref. 30). The site characterization provides sufficient information to allow the NRC to determine the extent and range of expected contamination, to determine whether estimates for remaining decommissioning costs are reasonable, to determine the likely schedule for remaining activities, and to support the final site survey to verify compliance with Part 20 release limits. Based on this review, the staff has determined that the licensee has met the objectives of providing an adequate site characterization as required by 10 CFR 50.82(a)(9)(ii)(A).

2.2 Remaining Site Dismantlement Activities

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(B), the licensee provided the status of dismantlement and decontamination activities for the YNPS major systems, structures, and components, as of November 2003. Also, in accordance with the guidance provided in NUREG-1700, and Regulatory Guide 1.179 (Ref. 25), the licensee provided the following: a radioactive waste characterization; an estimate of the quantity of radioactive material that they will ship for offsite burial; an estimate of personnel exposures; and the methods that will be used to control the spread of contamination while performing dismantlement activities. In addition, descriptions of the remaining dismantlement activities were sufficiently detailed to allow the staff to plan inspections during dismantlement.

Decommissioning activities are divided into three phases: (1) mechanically/electrically isolate the Spent Fuel Pool, remove systems not supporting fuel storage, and remove fuel and greater than Class C waste from the Spent Fuel Pool; (2) dismantlement and disposition of remaining systems, structures, and components; and (3) termination of the Part 50 license. The first phase is described in Chapter 3 of the YNPS LTP and was completed in June of 2003. Many of the major decommissioning activities in Phase 2 have already been completed. Chapter 3,

Table 3-2, provides the status of plant systems, structures, and components as of July 2003; Table 3-1 lists the remaining contaminated plant systems and Figure 3-1 provides a summary schedule. Chapter 4 describes site remediation, and Chapter 5 describes the FSSs. Phase 3 will occur after all spent fuel and greater than Class C waste have been removed from the site.

Total volume of waste projected for YNPS decommissioning is 13,586 cubic meters (480,512 cubic feet). The licensee also has estimated the total worker exposure during decommissioning to be 5.8 person-sievert (580 person-rem), which is less than the 12.15 person-sievert (1215 person-rem) found acceptable in NUREG-0586, Supplement 1, Table 4-1(Ref. 32). The licensee will continue to implement the existing YNPS Radiation Protection Program and the Radioactive Waste Management Program, including the existing program used to control the spread of contamination while conducting dismantlement activities, consistent with NRC regulatory requirements.

The staff has reviewed the LTP against the information in Section B.3 of NUREG-1700. Based on this review, the staff has determined that the licensee has identified, in sufficient detail, the remaining dismantlement activities necessary to complete decommissioning of the facility, as required by 10 CFR 50.82(a)(9)(ii)(B) and 10 CFR 50.82(a)(11)(I). Further, the staff has determined that the remaining dismantlement activities can be completed in accordance with 10 CFR 50.59.

2.3 Plans for Site Remediation

In accordance with the requirement of 10 CFR 50.82(a)(9)(ii)(C), the licensee provided its plans for completing radiological remediation of the site. The licensee plans to remediate the site, including structures and systems that remain on the site, to the criteria of 0.25 mSv/yr (25 mrem/yr) for all pathways, which is the unrestricted use criteria specified in 10 CFR Part 20, Subpart E. To meet this criterion, the licensee is using typical remediation methods, including chemical decontamination, wiping, washing, vacuuming, scabbling, chipping, and abrasive blasting. All structures and systems will be sent for disposal to a LLW facility, an approved landfill (if not radioactive waste), or used as backfill onsite if it meets the “no detectable” criteria or passes a FSS.

As specified in 10 CFR Part 20, Subpart E, a site is acceptable for unrestricted use if the remaining residual radioactivity results in a TEDE less than or equal to 0.25 mSv (25 mrem) per year above background, and the remaining residual radioactivity is reduced to levels that are ALARA. The licensee provided its ALARA analysis process. The ALARA analysis is described in Section 4.3 of the YNPS LTP. The licensee’s formulas for calculating the remediation levels conform to the guidance provided in NUREG-1727 (Ref. 27). (See ALARA Determination in section 2.5.8 of this SE.)

The staff compared the information in the LTP against Section B.4 of NUREG-1700 (Ref. 30) and against similar decommissioning activities conducted at other plants. Based on this review, the staff determined that the licensee has met the requirements of 10 CFR 50.82(a)(9)(ii)(C) by providing a detailed discussion of the remediation plans for the remaining decommissioning activities.

2.4 Final Status Survey

A FSS is performed after an area has been fully characterized, remediation has been completed, and the licensee believes that the area is ready to be released for unrestricted use. The purpose of the FSS is to demonstrate that each area, as defined by survey classifications, meets the radiological criteria for license termination. The FSS design entails an iterative process that requires appropriate site classification - based on the potential residual radionuclide concentration levels relative to the DCGLs - and formal planning using data quality objectives (DQOs). DQOs are qualitative and quantitative statements that clarify study technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. An integrated design is developed that addresses selection of appropriate survey and laboratory instrumentation, well-defined survey methods and procedures, and statistically based measurement and sampling plans for collecting and evaluating the FSS data.

The FSS Plan was developed using the guidance of NUREG-1575, "The Multi-Agency Radiological Site Survey and Investigation Manual (MARSSIM)" (Reference 33); Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors" (Reference 25); NUREG-1727, "NMSS Decommissioning Standard Review Plan," (Reference 27); and NUREG-1757, Volume 2, "Consolidated NMSS Decommissioning Guidance," (Reference 35).

The FSS Plan encompasses the radiological assessment of impacted structures, systems and land areas for meeting the dose rate criterion for unrestricted release specified in 10 CFR 20.1402. In addition, Section 5.6.3.2.4 of the LTP addresses the plan for the assessment of groundwater, and Section 5.6.3.2.5 addresses the plan for the assessment of sediments.

The LTP presents the framework through which all FSSs will be planned, designed, and implemented. The following relevant sections of the LTP were evaluated: Section 5.3 - "Summary of FSS Process"; Section 5.4 - "Final Status Survey Planning"; Section 5.5 - "Final Status Survey Design"; Section 5.6 - "Final Status Survey Implementation and Data Collection"; Section 5.7 - "Final Status Survey Data Assessment"; Section 5.8 - "Final Status Survey Reports"; and Section 5.9 - "Final Status Survey Quality Assurance and Quality Control Measures".

NRC will be conducting performance-based, in-process inspections throughout the various stages of decommissioning activities. The purpose of the inspections is to review the procedures, methodology, equipment, training and qualifications, and QA and QC measures. NRC has already conducted one in-process inspection which included confirmatory surveys (Report No. 50-029/2003-002, dated February 12, 2004) at the YNPS site. The inspection identified no violations.

The licensee used HSA data, such as process knowledge and operational and routine surveillance survey records, as the principal means for initially classifying site areas as impacted or non-impacted. Tables 2-1 and 2-2 of the LTP identify site areas and structures by survey unit, and present area sizes and initial classifications (as Class 1, 2, or 3). Section 5.4.2

presents the process that will be used to classify site grounds as FSS units. The proposed survey unit sizing and classification process for site grounds were found to be consistent with NRC guidance provided in the MARSSIM and NUREG-1727 (Ref. 27).

The LTP describes information and parameters that will be applied in developing DQOs, as defined in MARSSIM. The elements of the DQOs include: the null hypothesis (i.e., the survey unit does not meet the release criteria); decision errors; selection of an appropriate statistical test; limits on decision errors; scan coverage as a function of survey unit classification; variables for calculating sample size and sampling density for each survey unit; sampling locations and reference grid system for buildings and grounds; survey design process; and establishing background radiation levels in selected reference areas. The variables used to calculate sample size are the DCGL, lower boundary of the gray region (LBGR), and estimates of the variability of the contaminants in a survey unit (commonly referred to as "sigma"). The statistical tests discussed in NUREG-1575 are the Wilcoxon Rank Sum test and the Sign test. The LTP states that the licensee will apply these tests, implemented by using the unity rule and a method using surrogate radionuclides if necessary. The LTP presents information concerning the use of reference areas for background determination.

The input parameters for sample size calculations include the DCGL; the LBGR (which generally provides an estimate of the mean concentration in the survey unit, but may be adjusted to optimize the design); and an estimate of the radionuclide variability. These parameters, together with decision errors, are used to calculate the required number of statistical samples. The estimated variabilities (sigmas) will be developed from survey data that utilize identical measurement techniques as the FSS. Default decision errors are set at 0.05 for both Type I and II errors. The principal decision error of concern to NRC, for the stated null hypothesis, is the Type I or α error. This error occurs when a survey unit is determined to meet the release criteria when in fact it does not. The default value of 0.05 for the Type I or α error used by YAEC is consistent with MARSSIM guidance and is acceptable. The LTP commits to determine sampling density using MARSSIM guidance. In addition, the number of samples will be adjusted to reflect differences between instrumentation scan minimum detectable concentrations and DCGLs. The approach and statistical survey planning discussed in the LTP are consistent with MARSSIM guidance and are, therefore, acceptable.

LTP Section 5.4.3 discusses the survey unit grid that will be used for keying all areas during the conduct of FSSs. The proposed approach in coupling survey units with a benchmark point or using site and global positioning system (GPS) coordinates to record specific locations, is deemed appropriate for the survey unit classification and the type of survey unit. Grid coordinates will then serve as the basis for the random-start systematic sample-location selection.

The selection of survey instrumentation (rate meters and detectors), calibration, and survey methods are discussed in Section 5.6.2 of the LTP. The selection process will ensure that the instrumentation used for the FSSs will respond adequately to the types of radiation being emitted by the various radionuclides of concern; is sufficiently sensitive to detect these radionuclides, or gross activity, at levels within appropriate fractions of the DCGLs; and is calibrated in a manner that accounts for the expected or known radionuclide mix, expected radiation emission energies of the mixture, surface efficiencies, and how the contaminants are physically distributed in the media. The staff has reviewed the list of instrumentation and the basis for instrumentation detection efficiencies given in Table 5-4 and determined that they are appropriate for the primary radionuclides of concern and are acceptable.

The licensee has indicated the possible use of *in situ* gamma spectrometry or other advanced technologies in certain circumstances. The licensee has stated that a technical basis document will be provided to NRC for review and approval once such a need has been identified and the appropriate survey procedure has been developed.

For volumetrically distributed contamination in soils and concrete, the licensee will account for HTD radionuclides that may be present through a modified DCGL, using direct measurements or a surrogate approach. In application, the process will consider the basis of the dose model, described in Section 6 of the LTP, DCGL for the media, and radionuclide profiles and fractions as measured or developed from historical data. In each instance, detector response and associated MDC will need to be evaluated to confirm that the survey techniques will be adequately sensitive to measure activity levels at the modified DCGL. A review of these sections of the LTP indicates that the proposed approach provides an effective manner for measuring HTD radionuclides either directly or indirectly and is acceptable.

The conduct of routine operational checks and calibration procedures is discussed in LTP Sections 5.6.2.2, and 5.6.2.3. The licensee will use National Institute of Standards and Technology (NIST) traceable calibration sources that are similar in energy to the primary radionuclides of concern. The licensee will perform instrument response checks before issue and after use. Should a response check fail the established criteria for portable survey instruments, the instrument will be removed from service, and any data collected since the last acceptable check will be evaluated and may be discarded. A review of these sections of the LTP indicates that the proposed approaches are acceptable.

The method for conducting FSSs is contained in Section 5.6 of the LTP, and supplemented with information found in Section 5.5. If subsurface contamination is suspected or known, samples will be collected or in-situ gamma spectroscopy performed. Because all buildings and structures used during nuclear plant operations are scheduled for removal, the majority of the survey units within the Industrial Area will include excavated areas. Radiation detectors of sufficient sensitivity may be utilized in a “down hole” configuration to identify the presence or absence of subsurface contamination, and the extent of such contamination. The results from subsurface sampling will be evaluated using the same tests as those described for surface soil.

Table 5-3 of the LTP presents areal scan coverages for different classes of survey units. The scan coverage for surface soils is based on survey unit classification, with Class 1 survey units receiving 100 percent scan coverage, Class 2 receiving coverages of 10 to 100 percent, and Class 3 has no set requirement.   Soil and bulk-material samples are currently proposed to be performed at locations defined using methodology from MARSSIM. The licensee has stated that measurement/sampling locations are to be determined based on a random-start systematic pattern for Classes 1 and 2 survey units, and randomly for Class 3 survey units, based on the reference grid. Additional measurements or samples may also be collected from areas of elevated radioactivity detected during scanning. In Class 2 and 3 survey units, scan coverage will vary depending on conditions and a review of the data used in developing survey design specifications. Scanning and measurement activities may be supplemented with other measurement techniques and sampling.

Section 5.6.3.1.4 describes monitoring and disposition of concrete debris. Standing concrete structures will be surveyed and survey results evaluated against ALARA constraints and ability to pass concrete debris DCGLs. Additional remediation or segregation of elevated waste for disposal will be performed as necessary. Concrete debris considered acceptable for meeting the concrete debris DCGL will be processed to appropriate sizes and loaded into containers for volumetric monitoring. Monitoring of the loaded containers will be through the use of a multiple intrinsic germanium gamma spectroscopy system (referred to as the “bulk spectroscopy monitor”) capable of detection to minor fractions of the concrete debris DCGL. Containers that indicate volumetric activity less than the concrete debris DCGL will be unloaded on site for later use as backfill. Containers that indicate greater than DCGL levels of activity will be removed from the site and disposed of in appropriately licensed facilities.

These proposed methodologies for surveys are consistent with the NRC guidance of NUREG-1575, “The Multi-Agency Radiological Site Survey and Investigation Manual (MARSSIM)” (Reference 33); NUREG-1727, “NMSS Decommissioning Standard Review Plan,” (Reference 27); and NUREG-1757, Volume 2, “Consolidated NMSS Decommissioning Guidance,” (Reference 35) and are acceptable.

Section 5.5.3 presents the approach that will be used to develop investigational levels, the process to investigate areas that have been found to contain elevated levels of activity above the DCGL of the applicable investigational levels, and the actions to be taken once it has been confirmed that an action level has been exceeded. The process outlines procedural steps regarding the initial detection, investigation process, re-surveying, comparison of results with the Elevated Measurement Comparison Test, decision process in determining the need for further remediation, and if the reclassification of the survey unit is warranted. Depending on the results of the investigation, a portion of the survey unit may be reclassified, given sufficient justification. When reclassification is to a less restrictive classification, advance notification of the NRC will be required by license condition. This evaluation process is established to avoid the unwarranted reclassification of an entire survey unit, while still requiring an assessment as to extent and reasons for the elevated area. If an individual survey measurement (scan or direct) in a Class 2 survey unit exceeds the DCGL, the survey unit or a portion of it may be reclassified, notification to NRC made if required, and the survey redesigned and reperformed accordingly. If an individual soil sample in a Class 3 survey unit exceeds 0.5 DCGL, the survey unit, or portion of a survey unit, will be evaluated, and if necessary, reclassified to a Class 2, notification to NRC made if required, and the survey redesigned and reperformed accordingly.

The LTP stipulates (Section 5.5.3.4) that the licensee may reclassify entire survey units to a more restrictive classification. It also states in Section 1.6 that reclassifying to a less restrictive classification (e.g., Class 1 to a Class 2 area) or subdividing a survey area and reclassifying a part to a more restricitive classification will require NRC notification at least 14 days prior to implementation. A license condition for this required notification is being added.

The licensee will document the reasons for reclassification and evaluate the potential for programmatic deficiencies in the survey unit classification process. The approaches proposed for investigating and reclassifying survey units are consistent with NRC and MARSSIM guidance and are acceptable.

Sections 5.7 of the LTP discuss the process for data assessment. The section describes methods for data analyses, data verification and validation, graphical review of survey data using posting plots, and application of statistical tests in demonstrating compliance. Graphical data representations will be used to identify spatial patterns and potential anomalies that would indicate additional investigation is required. Data assessment includes statistical tests, use of the unity rule, interpretation of measurements results, and use of the data to reach specific conclusions based on MARSSIM criteria. The approach proposed for evaluating measurement results, using MARSSIM statistical tests against the appropriate DCGLs, and determining compliance, is acceptable.

Section 5.8 of the LTP provides a brief description of the FSS documentation. At the completion of decommissioning, the licensee will prepare an FSS report(s) summarizing survey data results and overall conclusions, as they relate to the radiological criteria for each survey unit or groups of survey units. The planned presentation of the site's final radiological status is acceptable and generally consistent with guidance given in Section 4.5.2 of NUREG-1757. The adequacy of the site documentation process will be determined when the licensee has an opportunity to begin compiling FSS records and assembling FSS reports for NRC review.

Section 5.9 of the LTP presents FSS quality assurance and quality control measures. The LTP describes the project organization; program controls; design controls; procurement document control; instructions, procedures, and drawings; document control; control of purchased material, items, and services; control of special processes; inspections; control of measuring and test equipment; handling, storage, and shipping; control of nonconformances; corrective action program; records; and audits.

Section 5.4.5.1 presents a process that will be used for transferring survey units from the remediation activities to a phase in which FSSs can be planned and conducted without interferences that might lead to questionable survey measurements. Section 5.4.5.2 describes isolation and surveillance measures following an FSS to verify the surveyed area is not recontaminated. The approach the licensee proposed is consistent with staff guidance in NUREG-1757, Volume 2, "Consolidated NMSS Decommissioning Guidance," and is acceptable.

The staff has reviewed the information provided in the YNPS LTP according to Section B.5 of NUREG-1700. Based on this review the staff has determined that the licensee has conformed to 10 CFR 50.82(a)(9)(ii)(D). The final radiation survey plan proposed in the LTP provides assurance that the licensee's survey process will adequately determine if residual radioactive contamination levels will meet the criteria specified in Part 20, for unrestricted use. The staff will confirm, during in-process inspections, confirmatory surveys, and staff review that FSSs are planned and implemented in accordance with approved plant procedures and that residual contamination levels meet the release criteria.

2.5 Compliance with Radiological Criteria for License Termination

Chapter 6 of the LTP describes the development of residual radionuclide concentration levels that will be used to demonstrate compliance with the regulations for releasing the Yankee Rowe site for unrestricted use. YAEC has used a residential farming scenario, in combination with the RESRAD computer code, Version 6.21, and, a light industrial worker, in combination with the

RESRAD-Build computer code, Version 3.21, to develop site-specific DCGLs. The licensee has developed four separate DCGLs for the different types of media in the environment containing residual radioactivity: (1) soil, (2) concrete debris, (3) ground water, and (4) subsurface basements. In addition, they have developed DCGLs for building surfaces of buildings that will remain standing.

2.5.1 Site Release Criteria

The intent of the final decommissioning activity at the site is to reduce radiological contamination at the site to meet NRC's unrestricted release criteria. After decommissioning activities are complete, the FSSs will verify adequacy of the site meeting the radiological release criteria (i.e., DCGLs). Unrestricted use of the site is defined in 10 CFR 20.1402, as follows:

> A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE [total effective dose equivalent] to an average member of the critical group that does not exceed 25 mrem [millirem] (0.25 mSv) [milliSievert] per year, including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). . .

As required at 10 CFR 20.1402, expected TEDEs are to be evaluated for the average member of the critical group. The critical group is defined in 10 CFR 20.1003 as "... the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for an applicable set of circumstances." The concept of the average member of the critical group is an attempt to emphasize the uncertainty and assumptions needed to calculate potential future doses, while limiting boundless speculation on possible future exposure scenarios. Furthermore, the use of the average member of the critical group acknowledges that any hypothetical "individual" used in the dose assessment is based, in some manner, on the statistical results from data gathered from groups of individuals.

2.5.2 Derived Concentration Guideline Limits

One acceptable approach for the licensee to provide reasonable assurance that the final residual radionuclide concentrations will meet the dose criterion specified at 10 CFR 20.1402 for the average member of the critical group is to derive, and commit to, nuclide-specific concentration limits (i.e., DCGLs) equivalent to the dose limit or some fraction of the dose limit. The DCGL derivation can use either generic screening criteria or site-specific analyses.

As planned, the 0.25 mSv/yr (25 mrem/yr) TEDE all-pathway limit would be achieved at the site through the application of DCGLs used to measure the adequacy of remediation activities. For each of the sources of residual radioactivity, a set of appropriate radionuclide-specific DCGLs have been created. The DCGLs in use at the YNPS site were calculated by assuming unit concentrations and using dose models based on guidance provided in NUREG/CR-5512, Volumes 1, 2, and 3, NUREG/CR-6697, and the computer codes RESRAD Version 6.21 and RESRAD-BUILD Version 3.21 code for generating the DCGLs. These dose models translate residual radioactivity into potential radiation doses to the public, based on selected land-use scenarios, exposure pathways, and identified critical groups. The dose rate for a unit concentration is then divided into the dose limit to derive the maximum allowable concentrations for each radionuclide. Final compliance will be shown, after FSSs, by using a modified sum of fractions approach.

NRC staff has reviewed the dose modeling analyses for the Yankee Rowe site as part of the review of YNPS' LTP, using the Consolidated NMSS Decommissioning Guidance, Volume 2, Section 5.2 (Unrestricted Release Using Site-Specific Information). In demonstrating compliance, the licensee relies upon a reasonable combination of conceptual models, exposure scenarios, mathematical models, and input parameters to calculate DCGLs. Furthermore, the licensee has adequately considered the uncertainties inherent in the modeling analysis.

The NRC staff concludes that the dose modeling for the preferred approach is reasonable and appropriate for the exposure pathways under consideration for the resident farmer scenario. In addition, the approach provides reasonable assurance that the dose to the average member of the critical group is not expected to exceed the criterion in 10 CFR 20.1402. This conclusion is based on the modeling effort performed by the licensee and confirmatory analyses performed by the staff.

2.5.3 Source Term

YNPS performed an analysis of three sources of radionuclide data to assure that all significant nuclides associated with plant operations were identified. YNPS reviewed selected low-level waste disposal analyses representing several media types spanning a time period from pre-shutdown to the present, radionuclide distributions identified in the YNPS Decommissioning Plan and source term information from generic NRC published reports. Table 2.5.1 lists the potentially significant radionuclides for soil and concrete debris. The only radionuclide found in groundwater has been tritium (H-3).

Table 2.5.1. Radionuclides of Interest at YNPS site.

H-3	Tc-99	Eu-155
C-14	Ag-108m	Pu-238
Fe-55	Sb-125	Pu-239,240
Co-60	Cs-134	Pu-241
Ni-63	Cs-137	U-241
Sr-90	Eu-152	Am-241
Nb-94	Eu-154	Cm-243,244

There are a number of potential sources of residual radioactivity at the YNPS site. These sources include building surfaces for remaining buildings, existing ground water, basement and concrete pads that will be left in place, buried concrete debris, and soil. For each of these sources, YNPS has created DCGLs to demonstrate compliance with the dose limit. Tests for homogeneity will be done as part of the FSSs.

As it is uncertain what chemical form the radionuclides may be in at the time of exposure, YNPS has chosen to assume the chemical form that would give the highest dose.

2.5.4 Exposure Scenarios

The licensee uses the residential farming scenario to demonstrate compliance for the sources of radioactive exposure in the environment around the site. The licensee considers exposure pathways consistent with the residential farming scenario including direct exposure from residual radioactivity in soils, internal exposure from inhalation of airborne radionuclides, and internal exposure from ingestion of (1) plant foods grown in the soil with residual radioactivity and irrigated with contaminated water, (2) meat and milk from livestock fed with contaminated fodder and water, (3) drinking water from a contaminated well, (4) fish from a contaminated pond, and (5) soil with residual radioactivity. This scenario and associated pathways are consistent with the generic scenario used for development of the screening criteria published in NUREG-5512, "Residual Radioactive Contamination from Decommissioning" and NUREG-1549, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination".

For building surfaces, the licensee has used a light industrial worker scenario. The licensee considers exposure pathways consistent with light industrial work. These include direct exposure from the contaminated surfaces and internal exposure from inhalation of suspended residual radioactivity and inadvertent ingestion. This scenario and associated pathways are consistent with the generic scenario used for development of the screening criteria published in NUREG-5512, "Residual Radioactive Contamination from Decommissioning" and NUREG-1549, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination".

2.5.5 Mathematical Model

For the environmental sources, the licensee selected RESRAD Version 6.21 to develop site-specific DCGLs for the residential farming scenario. The peak of the mean results from RESRAD for a unit concentration of each of the radionuclides, in units of mrem per pCi/g, are scaled to ensure that the total from all sources will meet the 0.25 mSv/y (25 mrem/y) TEDE criterion. For the subsurface concrete structures, an additional code, DUST-MS, was used to calculate release rates from the concrete before using RESRAD to calculate the dose.

For the building surfaces, the licensee selected RESRAD-BUILD Version 3.21 to develop site-specific DCGLs for the industrial worker scenario. The peak of the mean results from RESRAD-BUILD for a unit concentration of each of the radionuclides, in units of mrem per pCi/g, are scaled to meet the 0.25 mSv/y (25 mrem/y).

Table 6-1 in Revision 1 of the LTP lists DCGLs that will be used for residual radioactivity in soil, concrete debris, subsurface concrete structures, building surfaces.

All three codes satisfy the quality assurance criteria in NUREG-1757, Volume 2. In addition, the conceptual models in the codes are consistent with the conceptual model of the site. Based on the above, the use of the selected codes is acceptable.

2.5.5.1 Site-Specific Parameters for RESRAD and RESRAD-BUILD

The licensee develops site-specific input parameters based on the process described in section 6.2.5 of the LTP to choose appropriate values for input parameters that have significant influence on radiation dose estimates. The selection process is consistent with guidance presented in NUREG/CR-6676, "Probabilistic Dose Analysis Using Parameter Distributions Developed for RESRAD and RESRAD-BUILD Codes", NUREG/CR-6692, "Probabilistic Modules for the RESRAD and RESRAD-BUILD Computer Codes: User Guide", and NUREG/CR-6697, "Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes".

The licensee, consistent with NUREG/CR-6697, classifies RESRAD input parameters as one of the following three types: behavioral, metabolic, or physical. Behavioral parameters depend on the behavior of the receptor and the scenario definition. Metabolic parameters represent the metabolic characteristics of the receptor and are independent of the scenario definition. Physical parameters are those that would not change if different receptors are considered.

The licensee elects to use the deterministic input values for behavioral and metabolic input parameters, based on the values in NUREG/CR-5512, Volume 3. This approach is consistent with guidance in NUREG-1757, Appendix I, when the site-specific scenarios are consistent with the generic definition of the average member of the critical group and the screening group defined in NUREG/CR-5512, Volume 3. The licensee considers a residential farming scenario for the environmental sources, and an industrial worker for buildings. These scenarios are consistent with the generic resident farming scenario and the generic industrial worker scenario. The NRC staff finds this approach reasonable, consistent with staff guidance, and acceptable.

Where site-specific data is available, the licensee incorporates direct measurements for physical and mixed-physical (parameters classified as physical and behavioral or metabolic) parameters. If a physical parameter value could not be determined by direct measurement, the licensee derived a site-specific value using a probabilistic sensitivity analysis using RESRAD Version 6.21. The licensee ranks the physical parameters for which direct measurements are not available in order of their respective importance in dose modeling according to NUREG/CR-6697, Attachment B. Three levels of priority (i.e., 1, 2, and 3) are used, where 1 represents high priority, 2 represents medium priority, and 3 represents low priority.

The licensee elects to assign deterministic values from NUREG/CR-5512, Volume 3, or national average-based parameter ranges from NUREG/CR-6697, or the default value used in RESRAD Version 6.21 for all physical parameters ranked as priority 3.

For physical parameters ranked as priority 1 and 2, the licensee assigns a generic distribution obtained from NUREG/CR-6697, Attachment C. Based on the results of the sensitivity analysis, the licensee assigns values to input parameters not previously assigned default values or site-specific direct measurements according to the following criteria:

- Priority 1 and 2 physical parameters shown to be sensitive (i.e., with absolute partial rank correlation coefficient (PRCC) values greater than 0.25) are assigned conservative values. The licensee selects the 75^{th} quantile for positive correlations and 25^{th} quantile for negative correlations.
- Priority 1 and 2 physical parameters shown to be insensitive (i.e., with absolute PRCC values less than 0.25) are assigned the median value from their generic distributions.

The threshold value for PRCC of 0.25 is consistent with the guidance in NUREG/CR-6676 for derivation of site-specific values and Draft NUREG-1757, Volume 2, "Consolidated NMSS Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria," Appendix O, for derivation of site-specific distribution coefficients for soils.

The selection process takes into account the site-specific physical environment, importance of parameters, and the receptor's behavioral pattern and metabolic characteristics. The approach is consistent with NRC guidance, should result in the derivation of conservative site-specific DCGLs and is, therefore, acceptable.

2.5.5.2 Parameter Selection for Subsurface Concrete Structures

To derive the allowable volumetric concentrations of radionuclides in subsurface concrete structures, YAEC used a combination of the DUST-MS code, to calculate diffusion rates out of the structures, and RESRAD. The parameters chosen for the DUST-MS code are upper bound estimates of diffusion rates for the important radionuclides and reasonable estimates of geometry and density. For the majority of RESRAD parameters, the subsurface contaminated concrete calculations used the same values as described previously. A few parameters needed to be modified to model appropriately the conceptual model. In addition, for priority 3 and insensitive parameters, the median value was used to allow deterministic calculations.

The staff identified no issues with the approach or the assumptions made, which are consistent with staff guidance and previously approved methodologies, and finds the analysis acceptable.

2.5.5.3 Dose Assessment for Groundwater DCGL

Instead of deriving the ground water DCGL for tritium (H-3), YAEC established a proposed limit of 20,000 pCi/L and calculated the dose associated with that ground water concentration. As the dose from this proposed DCGL was expected to be less than 10% of the dose limit and therefore provide a large margin, a detailed site calculation would be unnecessary. YAEC chose to use the DCGL calculation from Connecticut Yankee's (CY's) Haddam Neck site to estimate the dose from 20,000 pCi/L of tritium. The parameter selection process used by CY was similar to YAEC's approach. The major difference was in the selection of values for priority 3 and insensitive parameters where a deterministic value was used. However, as this difference is focused on priority 3 and insensitive parameters, significant changes in dose calculation are not expected and the staff considers the use of the CY DCGL by YAEC to be acceptable for this bounding calculation. YAEC calculated a dose of 0.0077 mSv/y (0.77 mrem/y) using this method. In addition, to further assess the reasonableness of this approach, the staff performed a site-specific analysis separately for the Big Rock Point site using its site model. That analysis resulted in a very similar dose for 20,000 pCi/L.

The licensee's proposal to address tritium contamination by setting a concentration limit for license termination would ensure that the tritium contribution to the total dose would be well below Part 20 limits. Therefore, the staff finds this approach to be acceptable.

2.5.6 Uncertainty and Variability

In developing its DCGLs, the licensee has evaluated the sensitivity of the parameters used in the RESRAD and RESRAD-BUILD dose models for the important radionuclides, and to rank sensitive parameters in the order of their sensitivity to the calculated peak mean dose. The licensee performs analyses for both uncorrelated parameters as well as correlated parameters. The parameter distributions used in the sensitivity analyses are the generic distributions from NUREG/CR-6697. Actual distributions for the YNPS site are expected to be narrower because the generic distributions are based on national data. The licensee determines sensitive parameters based on values of PRCC calculated by the RESRAD code for each individual parameter. The PRCC is a gauge of the correlation between the peak radiation dose and the parameter value. Larger absolute values of the PRCC imply greater influence of the parameter value on the estimated peak dose. Positive PRCC values imply the estimated peak dose should increase with increases in the parameter value. Conversely, negative PRCC values imply the estimated peak dose should decrease with increases in the parameter value. Previous evaluations of uncertainty analyses published in NUREG/CR-6755, NUREG/CR-6697, NUREG/CR-6692, and NUREG/CR-6697 indicate that the PRCC is the most representative among several coefficients of correlation between the estimated peak dose and the parameter value. The staff found this approach to be consistent with staff guidance and previously approved methodologies and to be acceptable.

2.5.6 Derivation of DCGLs

YAEC has chosen to use a DCGL approach for each of its sources of residual radioactivity. For each radionuclide and scenario, a concentration is derived that will result in the appropriate dose limit or fraction of the dose limit. YAEC has two fundamental scenarios: (1) industrial worker, and (2) the resident farmer.

The industrial worker scenario is for residual radioactivity that will remain in existing buildings on the surface of the walls, floors, and ceiling. No other source of radioactivity exists in this scenario. Therefore, the building surface DCGLs for each radionuclide are derived from the 0.25 mSv (25 mrem) per year dose limit. To show compliance for the industrial worker scenario, a sum of fractions calculation will be made to show that the combination of all radionuclides will result in a dose less than the limit.

The resident farmer scenario has a number of potential sources of residual radioactivity: (1) existing ground water, (2) subsurface concrete structures, and (3) either soil or a mixture of soil and concrete debris. The total dose from all these sources must be less than the 25 mrem/yr dose limit. YAEC has chosen to fractionate the dose limit between the sources. For existing ground water, the DCGL for tritium was proposed (see section 2.5.5.3) and the dose from this DCGL is calculated to be 0.0077 mSv/y (0.77 mrem/y). For the subsurface concrete structures, a dose limit of 0.005 mSv/y (0.5 mrem/y) was selected and a DCGL for each of the radionuclides was derived. For both soil and concrete debris, radionuclide-specific DCGLs were derived equal to the remaining dose [i.e., 0.2373 mSv/y (23.73 mrem/yr)]. For survey units without any concrete debris, YAEC will use the soil DCGLs for each radionuclide. For survey units with a mix of soil and concrete debris, YAEC will use the more restrictive DCGL from either the soil or concrete debris for each radionuclide. To show compliance with the dose limit, the sum of fractions will be completed for all radionuclides within the relevant source for a survey unit.

This approach will lead to a conservative estimate of the dose as it ignores the time of peak dose and it bounds the effects of mixing soil and concrete debris. The staff finds the approach to be acceptable.

2.5.7 Elevated Measurement Comparison DCGLs

In section 6.5 of the LTP, the licensee proposes the methods to be used to derive the area factors associated with surface soil and building surfaces. The licensee may use the area factors for elevated measurement comparisons to determine whether a smaller area of residual radioactivity exceeds the DCGLs during scanning. The licensee will need to adjust the number of static measurements if the sensitivity of the scanning technique is inadequate to detect levels of residual radioactivity below the DCGLs. Area factors are also necessary to identify small areas with elevated residual radioactivity that may require further investigation.

The licensee calculates area factors by using either the resident farming scenario or industrial worker, as appropriate. The licensee calculated area factors using RESRAD Version 6.21 and RESRAD-BUILD Version 3.21 repeatedly with changing areas of contamination. NRC staff's review and selected independent confirmatory calculations, using the same codes, of the licensee's calculated area factors finds no discrepancies. The staff finds the licensee's methods to be conservative and acceptable.

2.5.8 ALARA Determination

The licensee has provided a conservative dose model to meet the 25 mrem/yr limit. In addition, Appendix 4A of the LTP provides the licensees' methodology and criteria for analysis for an ALARA evaluation. This evaluation approach is consistent with the ALARA requirements of 10 CFR 20.1402.

The staff has reviewed the information in the LTP for the YNPS according to Section B.6 of NUREG-1700. Based on this review the staff has determined that the licensee has conformed to 10 CFR 50.82(a)(9)(ii)(D), and that the FSS plan in the LTP provides assurance that residual radioactivity levels will not exceed the criteria specified in Part 20, for unrestricted use.

2.6 Site End Use

Section 50.82(a)(9)(ii)(E) requires a licensee to provide a description of the planned end use of the site if the licensee proposes to have its license terminated under restricted conditions. The licensee has proposed to have its license terminated with no restrictions on the use of the site, under the provisions of 10 CFR 20.1402. Therefore, the licensee is not required to provide a description of the planned end use of the site.

The staff finds that the licensee has conformed to 10 CFR 50.82(a)(9)(ii)(E) and the description is therefore acceptable.

2.7 Cost Estimate

An updated site-specific estimate of the remaining decommissioning costs to terminate the license is required by 10 CFR 50.82(a)(9)(ii)(F). The staff reviewed Section 7, Update of Remaining Site-Specific Decommissioning Costs, of the YNPS License Termination Plan, Revision 0, dated November 24, 2003.

The licensee provided estimates of costs of radiological decontamination and removal of radioactive equipment and structures, waste disposal and transportation costs, FSS costs, and total costs. The cost assumptions were identified, and included an inflation factor of 2.2% per year. However, the majority of remaining decommissioning and decontamination activities will be performed under a fixed price contract, and are not subject to escalation. The licensee included a contingency factor. Although not required, the licensee reported separate line item costs for non-radiological site closure activities and management of spent fuel. The licensee projected expenses on an annual basis and identified the source of funding that will provide for the expenses. The sum of cash on hand, contributions, and earnings on cash holdings covers the amount of expenses.

The staff reviewed the YNPS LTP against Section B.7 of NUREG-1700. Based on this review, the staff determined that the licensee has met the requirements of 10 CFR 50.82(a)(9)(ii)(F) by providing an updated site-specific cost estimate for the remaining decommissioning activities.

2.8 Environmental Report

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(G), the licensee is required to provide a supplement to the environmental report, pursuant to 10 CFR 51.53, describing any new information or significant environmental changes associated with the licensee’s proposed license termination activities. Section 8 of the LTP updates the “YNPS Decommissioning Environmental Report”, dated December 1993. Therefore, Section 8 of the LTP constitutes a supplement to YNPS's Environmental Report, as required by 10 CFR 51.53(d) and 10 CFR 50.82(a)(9)(ii)(G). Based on the information in Section 8, the licensee concluded that the environmental impacts associated with changes in YNPS's decommissioning activities remain bounded by the previously issued "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0856. Under the provisions of 10 CFR 51.21, the staff prepared an environmental assessment (EA) to determine the impacts of the proposed action on the environment. In the EA, the staff found that approval of the LTP would not cause any significant impacts on the human environment and is protective of human health.

The staff has reviewed the information in the LTP for YNPS, according to Section B.8 of NUREG-1700. Based on this review and the EA prepared by the staff, the staff has determined that the licensee has met the requirements of 10 CFR 50.82(a)(9)(ii)(G) and 10 CFR 51.53.

2.9 Change Procedure

10 CFR 50.59 provides the criteria a licensee must use to evaluate if a proposed change, test or experiment requires a license amendment pursuant to 10 CFR 50.90 prior to implementation. 10 CFR 50.82(a)(6) specifies certain restrictions that a licensee must comply with in the performance of decommissioning activities. The licensee has proposed that, in addition to those criteria specified in 10 CFR 50.59 and 10 CFR 50.82(a)(6), a change to the LTP requires NRC approval prior to being implemented if the change:

(a) Increase the probability of making a Type I decision error above the level stated in the LTP;
(b) Increase the radionuclide-specific derived concentration guideline levels (DCGLs) and related minimum detectable concentrations;
(c) Increase the radioactivity level, relative to the applicable DCGL, at which investigation occurs;
(d) Change the statistical test applied to one other than the Sign Test or Wilcoxon Rank Sum Test; or
(e) Prior to license termination, if the concentrations of site-generated radionuclides other than tritium are reported in the groundwater in excess of the individual concentrations listed below, or if a sum of the fractions formed by dividing the reported concentrations by these values is greater than 2.0, the licensee shall evaluate the need for site-specific groundwater DCGLs for these radionuclides. New groundwater DCGLs will require that a license amendment request be submitted to NRC for approval.

Radionuclide	Individual Concentration Limit, pCi/L	Radionuclide	Individual Concentration Limit, pCi/L
Ag-108m	50	Fe-55	25
Am-241	0.5	Nb-94	50
C-14	200	Ni-63	15

Cm-243/244	0.50	Pu-238	0.50
Co-60	25	Pu-239/240	0.50
Cs-134	14	U-241	15
Cs-137	15	Sb-125	50
Eu-152	50	Sr-90	3
Eu-154	50	Tc-99	15
Eu-155	50		

In addition, if YAEC elects to reduce a survey unit's classification (i.e., from Class 1 to Class 2 or 3, or from Class 2 to 3), prior notification will be provided to NRC at least 14 days prior to implementation. Changes to the LTP not requiring NRC approval will be submitted as an update to the final safety analysis report, in accordance with 10 CFR 50.71(e).

The staff concludes that authorizing the licensee to make certain changes, during the final site remediation, is consistent with NRC policy as delineated in 10 CFR 50.90 and 10 CFR 50.82(a)(6). The above listed conditions, which specify changes that could impact meeting the dose limit for license termination and therefore would require NRC approval before implementation, provide appropriate restrictions and are acceptable.

3.0 STATE CONSULTATION

In accordance with NRC regulations, the State of Massachusetts was notified of the proposed issuance of the amendment. The State submitted comments on the EA on March 31, 2005 and April 14, 2005. The State's comments were incorporated into the EA prior to publication.

4.0 ENVIRONMENTAL CONSIDERATIONS

This amendment incorporates the YNPS LTP and the LTP change process, which allows the licensee to make changes to the plan without NRC review and approval. Pursuant to 10 CFR 51.21, 51.32, and 51.35, an EA and Finding of No Significant Impact were published in the *Federal Register* on June 3, 2005.

Based on the EA, the Commission has determined that issuance of this amendment will not have a significant effect on the quality of the human environment. Accordingly, it has been determined that a Finding of No Significant Impact is appropriate.

5.0 FINAL NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

The Commission's regulation at 10 CFR 50.92(c) states that the Commission may make a final determination that a license amendment involves no significant hazards consideration if operation of the facility in accordance with the proposed amendment would not: (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) result in a significant reduction in a margin of safety. The NRC staff has made a final determination that no significant hazards consideration is involved for the proposed amendment and that the amendment should be issued as allowed by the criteria contained in 10 CFR 50.91. The NRC staff's final determination is presented below:

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No.

   Currently, the bounding airborne radioactivity event given in the YNPS FSAR is the materials handling event (FSAR Section 403.5). This event considered the non-mechanistic release of the contents of the dominant plant component that could have caused the highest offsite dose as a result of the release of airborne radioactivity during handling. The dominant component was the feed and bleed heat exchanger which has since been removed from the site. The bounding analysis resulted in an offsite dose at the Exclusion Area Boundary of about 0.320 rem, significantly less than the EPA Protective Action Guidelines. Other airborne particulate radwaste or radioactive materials accidents considered in the FSAR but bounded by the materials handling event are as follows:

   * fire in a sea-land container containing combustible radioactive material,
   * dismantlement activities (i.e., cutting, segmentation) during decommissioning,
   * a gas bottle explosion inside containment,
   * an explosion of a propane tank stored onsite.

   All spent fuel is located at the ISFSI and is stored within fifteen NAC Multi-Purpose Canisters and associated vertical concrete casks. A sixteenth cask contains Greater Than Class C material. The NAC-MPC FSAR addresses the various off-normal and accident events which were postulated in support of the licensing and certification of the system. In each case, there were no radiological consequences as a result of a postulated event.

   The requested license amendment is consistent with plant activities described in the PSDAR and the YNPS FSAR. Accordingly, no systems, structures, or components that could initiate the previously evaluated accidents or are required to mitigate these accidents are adversely affected by this proposed change.

   Based on this evaluation, there is no significant increase in the probability or consequence of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different accident from any accident previously evaluated?

Response: No.

Accident analyses related to decommissioning activities are addressed in the FSAR. The requested license amendment is consistent with the plant activities described in the YNPS FSAR and the PSDAR. The proposed change does not affect plant systems, structures, or components in a way not previously evaluated. The changes do not affect any of the parameters or conditions that could contribute to the initiation of an accident. No new accident scenarios are created nor are any new failure mechanisms created by this activity.

Therefore, this proposed action does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does the proposed change involve a significant reduction in a margin of safety?

Response: No.

The LTP is a plan for demonstrating compliance with the radiological criteria for license termination as provided in 10 CFR 20.1402. The margin of safety defined in the statements of consideration for the final rule on the Radiological Criteria for License Termination is described as the margin between the 100 mrem/yr public dose limit established in 10 CFR 20.1301 for licensed operation and the 25 mrem/yr dose limit to the average member of the critical group at a site considered acceptable for unrestricted use (one of the criteria of 10 CFR 20.1402). This margin of safety accounts for the potential effect of multiple sources of radiation exposure to the critical group. Since the LTP was designed to comply with the radiological criteria for license termination for unrestricted use, the LTP supports this margin of safety.

In addition, the LTP provides the methodologies and criteria that will be used to perform remediation activities of residual radioactivity to demonstrate compliance with the ALARA criterion of 10CFR20.1402.

Also, as previously discussed, the bounding accident for decommissioning is the materials handling event. Since the bounding decommissioning accident results in more airborne radioactivity than can be released from other decommissioning events, the margin of safety associated with the consequences of decommissioning accidents is not reduced by this activity.

Therefore, the proposed change does not involve a significant reduction in the margin of safety.

6.0 CONCLUSIONS

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner; (2) such activities will be conducted in compliance with the Commission's regulations; and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

7.0 LIST OF CONTRIBUTORS

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8.0 LIST OF ACRONYMS

ALARA	As Low As Is Reasonable Achievable
Bq/g	Becquerel per gram
Bq/L	Becquerel per liter
CFR	Code of Federal Regulations
DCGL	Derived Concentration Guideline Limit
DOE	U.S. Department of Energy
dpm/100cm^2	disintegrations per minute per 100 square centimeters
DQO	Data Quality Objective
EA	Environmental Assessment
FR	Federal Register
FSS	Final Status Survey
HSA	Historical Site Assessment
HTD	Hard to Detect
ISFSI	Independent Spent Fuel Storage Installation
kV	kilovolt
LBGR	Lower Boundary of the Gray Region
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey And Site Investigation Manual
MDC	Minimum Detectable Concentration
mrem/hr	millirem per hour
mrem/yr	millirem per year
mSv/yr	milliSievert per year
nC/Kg-hr	nanocoulomb per kilogram per hour
NIST	National Institute of Standards and Technology
NMSS	Office of Nuclear Material Safety and Safeguards
NRC	Nuclear Regulatory Commission
pCi/g	picocurie per gram
pCi/L	picocurie per Liter

QA Quality Assurance
QC Quality Control
RAI Request for Additional Information
RCA Radiologically Controlled Area
RCRA Resource Conservation and Recovery Act
REMP Radiological Environmental Monitoring Program
SER Safety Evaluation Report
Sv/hr Sievert per hour
TEDE Total Effective Dose Equivalent
TRU Transuranic
uR/hr microroentgen per hour
YAEC Yankee Atomic Electric Company
YNPS Yankee Nuclear Power Station

9.0 REFERENCES

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2. Yankee Atomic Electric Company, “RESRAD-BUILD Calculation for LTP,” December 10, 1003. (BYR 2003-102 incl. YA-CALC-00-003-03) ADAMS Accession No.: ML033530147.

3. Yankee Atomic Electric Company, “RESRAD Calculation for LTP,” December 16, 2003. (BYR 2003-105 incl: YA-CALC-01-001-03) ADAMS Accession No.: ML041110261.

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