YANKEE ATOMIC ELECTRIC COMPANY

49 Yankee Road, Rowe, Massachusetts 01367

November 16, 2006
BYR 2006-107

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-001

References: (a) License No. DPR-3 (Docket No. 50-29)

(b) BYR 2004-133, Submittal of Revision 1 to the Yankee Nuclear Power Station's License Termination Plan, dated November 19, 2004.

(c) Yankee Nuclear Power Station – Issuance of Amendment 158 Re: License Termination Plan

Subject: License Termination Plan Biennial Update

Yankee Atomic Electric Company (YAEC) herein encloses one paper copy and one CD-ROM copy of the updated pages of the License Termination Plan (LTP) for the Yankee Nuclear Power Station. A summary listing of the changes for each LTP section is also enclosed. YAEC is maintaining the LTP as a supplement to the FSAR, and therefore, this revision is submitted in accordance with the requirements of 10 CFR 50.71(e)(4).

We trust that this information is satisfactory. However if you should have any questions or require any additional information, please contact Alice Carson at (301) 916-3995.

Sincerely,

Wayne Norton
President & CEO

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Executed on November 16, 2006

Subscribed and sworn to before me Gerard van Noordennen, Notary Public this 16th day of November, 2006.

Signature: Gerard van Noordennen Date Commission Expires: 12-31-07

Enclosures

NMSS01

cc:

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D. Katz, CAN
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Summary Listing of November 2006 Changes to YNPS LTP

Section Number	Description of Change
Front Matter	Change to List of Effective Pages to reflect Revision 2.
Section 1	Change (LBDCR 06-02) to Figure 1-1 to identify figure as the *historical* site boundary, change to Figure 1-2 to identify figure as *historical* site design, addition of Figure 1-3 to show new site boundary as allowed by approved partial site release, and addition of page 1-16 because of new figure.
Section 2	No change to this section.
Section 3	No change to this section.
Section 4, including Appendix 4A	No change to these sections.
Section 5	Change (LBDCR 06-03) to revise criteria used to determine when resurveys, post-FSS, are required. Change (LBDCR 06-11) to acknowledge that survey area limits are "suggested" rather than being rigid limits.
Section 6	Change (LBDCR 06-04) to correct typographical and printing errors.
Appendix 6A	Change (LBDCR 06-04) to correct typographical and printing errors.
Appendices 6B through 6D	No change to these sections.
Appendix 6E	Change (LBDCR 06-04) to correct typographical and printing errors.
Appendix 6F through 6I	No change to these sections.
Appendix 6J	Change (LBDCR 06-04) to correct typographical and printing errors.
Appendices 6K through 6S	No change to these sections.
Section 7	No change to this section.
Section 8	No change to this section.

List of Effective Pages

Page	Revision	Date
Front Matter		
i through ix	1	November 2004
x through xv	2	November 2006

Page	Revision	Date
1 General Information		
1-1 through 1-12	1	November 2004
1-13 through 1-16	2	November 2006

Page	Revision	Date
2 Site Characterization		
all	1	November 2004

Page	Revision	Date
Appendix 2A		
all	1	November 2004

Page	Revision	Date
Appendix 2B		
all	1	November 2004

Page	Revision	Date
Appendix 2C		
all	1	November 2004

Page	Revision	Date
3 Identification of Remaining Site Dismantlement Activities		
all	1	November 2004

Page	Revision	Date
4 Site Remediation Plans		
all	1	November 2004

Page	Revision	Date
Appendix 4A ALARA Evaluations		
all	1	November 2004

Page	Revision	Date
5 Final Status Survey (FSS) Plan		
5-1 through 5-6	1	November 2004
5-7 through 5-8	2	November 2006
5-9 through 5-11	1	November 2004
5-12	2	November 2006
5-13 through 5-62	1	November 2004

Page	Revision	Date
6 Compliance with the Radiological Criteria for License Termination		
6-1 through 6-3	1	November 2004
6-4	2	November 2006
6-5 through 6-13	1	November 2004
6-14	2	November 2006
6-15 through 6-20	1	November 2004

Page	Revision	Date
Appendix 6A		
6A-1 through 6A-8	1	November 2004
6A-9	2	November 2006
6A-10 through 6A-16	1	November 2004

Page	Revision	Date
Appendix 6B through 6D		
all	1	November 2004

Page	Revision	Date
Appendix 6E		
all	2	November 2006

Page	Revision	Date
Appendix 6F through 6I		
all	1	November 2004

Page	Revision	Date
Appendix 6J		
all	2	November 2006
Page	**Revision**	**Date**
Appendix 6K through Appendix 6S		
all	1	November 2004
Page	**Revision**	**Date**
7 Updates of the Site-Specific Decommissioning Costs		
All	1	November 2004
8 Supplement to the Environmental Report		
All	1	November 2004

List of Acronyms

ALARA	As Low As Reasonably Achievable
AMDA	Alternate Method of Disposal Authorization
AOR	Abnormal Operating Report
ASWS	Auxiliary Service Water System
CFR	Code of Federal Regulations
cpm	Counts per minute
CR	Condition Report
DCGL	Derived Concentration Guideline Level
$DCGL_w$	DCGL for average concentration over a wide area, used with statistical tests
$DCGL_{EMC}$	DCLGS for small areas of elevated activity
DEP	[Massachusetts] Department of Environmental Protection
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DPH	[Massachusetts] Department of Public Health
dpm	Disintegrations per minute
DQO	Data quality objective
EMC	Elevated Measurement Comparison
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FGEIS	Final Generic Environmental Impact Statement
FSS	Final Status Survey
FSAR	Final Safety Analysis Report
GPS	Global positioning system
GTCC	Greater than Class C [Waste]
HEPA	High Efficiency Particulate Air
HSA	Historical Site Assessment
ISFSI	Independent Spent Fuel Storage Installation
LBGR	Lower Bound Grey Region
LER	License Event Report
LLW	Low Level Waste
LTP	Licence Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MDCR	Minimum Detectable Count Rate
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
ODCM	Offsite Dose Calculation Manual
PAB	Plant Auxiliary Building
PIR	Plant Investigation Report
PSDAR	Post-Shutdown Decommissioning Activities Report
QA	Quality Assurance
QAP	Quality Assurance Program
QAPP	Quality Assurance Program Plan
QC	Quality Control
RCA	Radiologically Controlled Area
RESRAD	RESidual RADioactivity [Computer Code]
REMP	Radiological Environmental Monitoring Program

List of Acronyms

RETS	Radiological Environmental Technical Specifications
RIR	Radiological Incident Report
SSCs	Structures, Systems, and Components
SFP	Spent Fuel Pit
TEDE	Total Effective Dose Equivalent
TRU	Trans-Uranics
WRS	Wilcoxon Rank Sum [test]
YAEC	Yankee Atomic Electric Company
YNPS	Yankee Nuclear Power Station

LBDCR
06-02

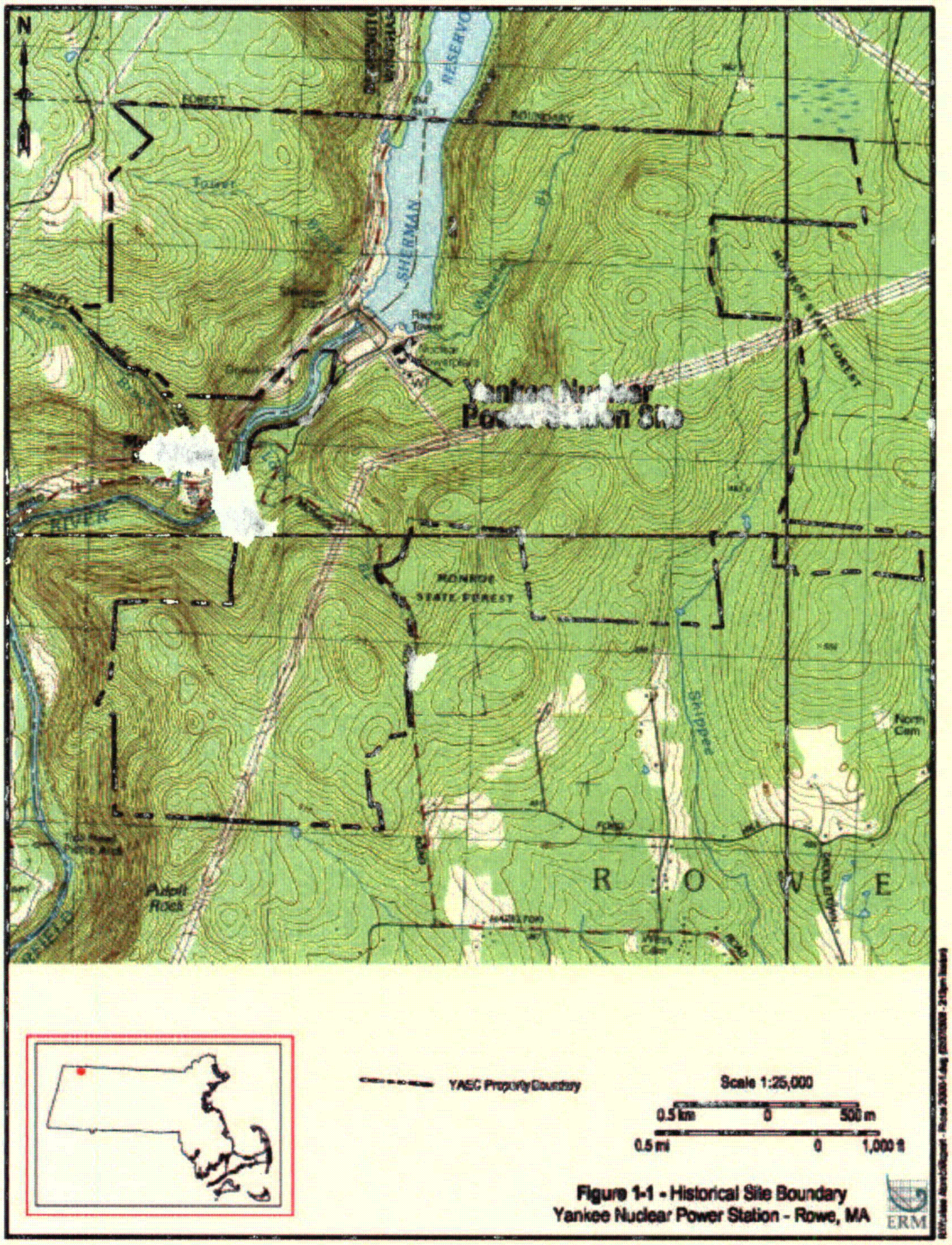
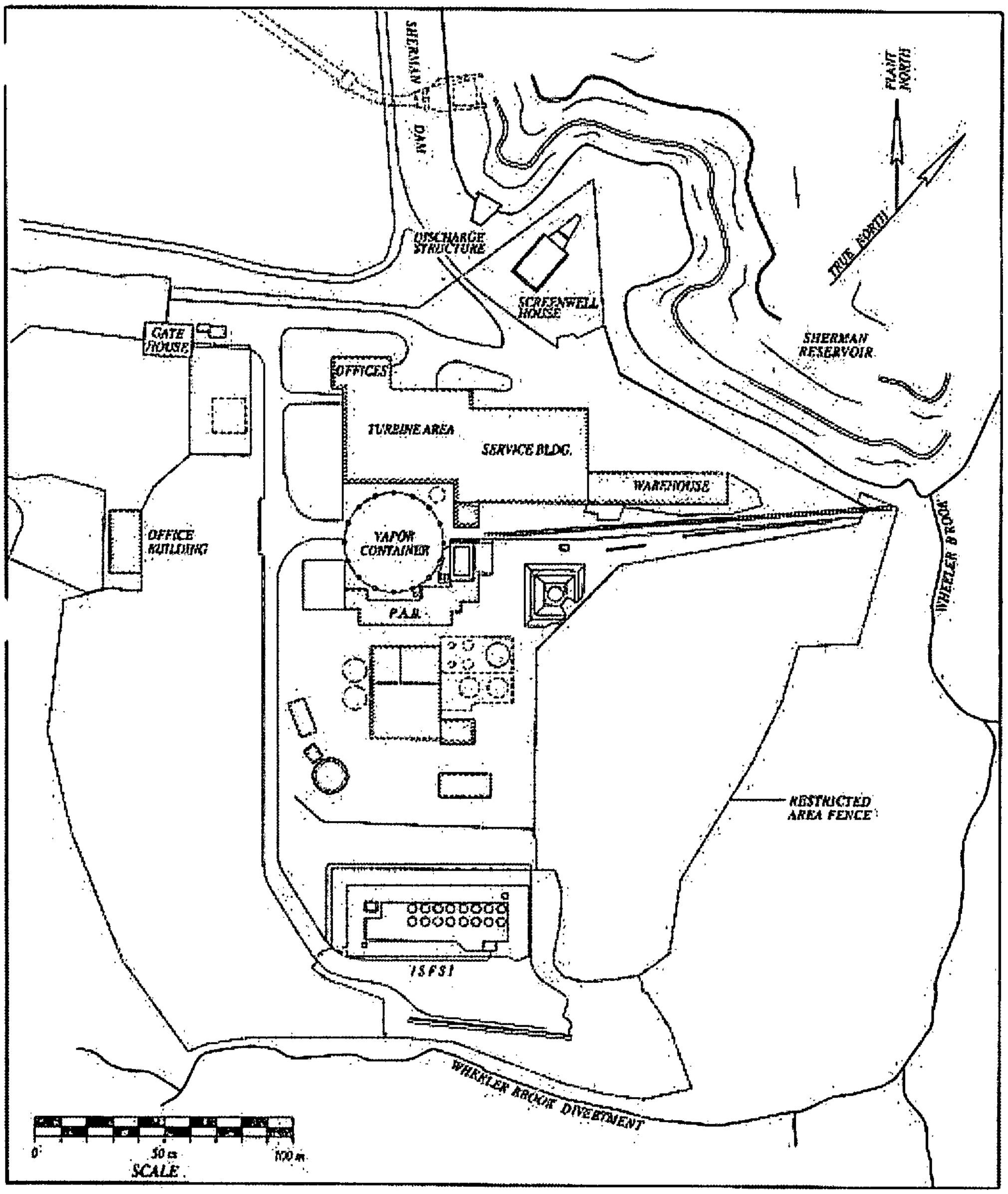


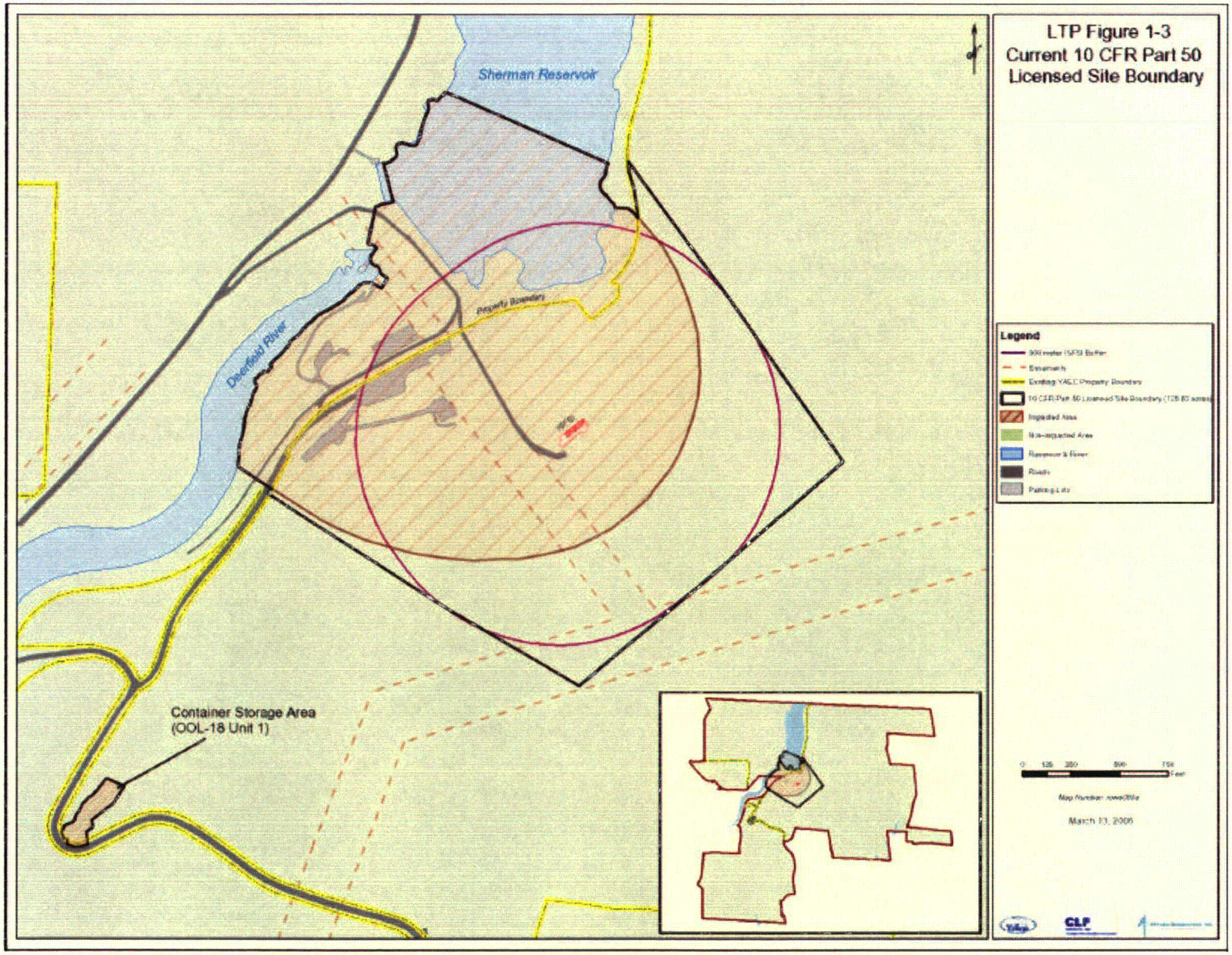
Figure 1-1 - Historical Site Boundary
Yankee Nuclear Power Station - Rowe, MA

Figure 1-2

Historical Site Design

LBDCR 06-02




LTP Figure 1-3
Current 10 CFR Part 50
Licensed Site Boundary
Sherman Reservoir
Deerfield River
Property Boundary
Container Storage Area
(OOL-18 Unit 1)
Legend
March 13, 2006

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- **Optimize the Design for Obtaining Data**

  The first six steps are the DQOs that develop the performance goals of the survey. This final step in the DQO process leads to the development of an adequate survey design.

5.4.2 Classification of Survey Areas and Units

The adequacy of the FSS process rests upon partitioning the site into properly classified survey units of appropriate physical area. Section 2 of the LTP discusses in detail the HSA for the YNPS site and the classifications assigned to all of the site structures and grounds. Because characterization is an ongoing effort throughout the decommissioning process, and survey unit classifications may be modified on the basis of new characterization information or impacts from decommissioning activities. The process described in LTP Section 1.6 will be used to evaluate such modifications in order to determine whether prior notification to the NRC is required. Survey areas have been determined as described in Section 2.1.1 of this LTP.

A survey area may consist of one or more survey units. A survey unit is a physical area consisting of structures or land areas of a specified size and shape which will be subject to a FSS. Compliance with the applicable criteria will be demonstrated for each survey unit.

Survey units are limited in size based on classification, exposure pathway modeling assumptions, and site-specific conditions. Surface area limits, used in establishing the initial set of survey units for the YNPS FSS Plan, are provided in Table 5-1 for structures and land areas. The area limits for structures refer to floor area, and not the total surface area, which would include the walls and ceiling. This is consistent with the guidance in Table A.1 of Appendix A to NUREG-1757) and MARSSIM. LBDCR 06-11

The values in Table 5-1 are suggested values. These limits on survey unit size for Class 1 and Class 2 areas were suggested in MARSSIM because they give a reasonable sampling density. However, the size and shape of a particular survey area may be adjusted to conform to the existing features of the particular site area and other constraints. Special considerations may be necessary for survey units with structure surface area less than 10 m^2 or land areas less than 100 m^2. IN these cases, the number of data points obtained from the statistical tests is unnecessarily large and not appropriate for small survey unit areas. If this situation should arise, the basis for selection of this size of survey unit will be documented, and this basis will be provided to and discussed with the NRC prior to proceeding. LBDCR 06-11

The floor area limits given in Table 5-1 were also used to establish survey unit sizes for structures such as roofs or exterior walls of buildings. The limits given in Table 5-1 will also be used should the need arise to establish any new survey units beyond the initial set given in this plan.

As indicated in LTP Section 2, impacted areas of YNPS have been divided into survey units to facilitate survey design. Each survey unit has been assigned an initial classification based on the site characterization process and the historical site assessment.

Table 5-1
Suggested YNPS Survey Unit Surface Area Limits

LBDCR 06-11

Survey Unit Classification	Surface Area Limit
Class 1:	
Structures (floor area)	≤ 100 m^2
Land areas	≤ 2,000 m^2
Class 2:	
Structures (floor area)	100 m^2 < area ≤ 1,000 m^2
Land areas	2,000 m^2 < area ≤ 10,000 m^2
Class 3:	
Structures (floor area)	no limit
Land areas	no limit

A survey unit can have only one classification. Thus, situations may arise where it is necessary to create new survey units by subdividing areas within an existing unit. For example, residual radioactivity may be found within a Class 3 survey unit, or residual radioactivity in excess of the $DCGL_W$ may be found in a Class 2 unit. In such cases, it may be appropriate to define a new survey unit within the original unit that has a lower (more restrictive) classification. Alternately, the classification of the entire unit can be made more restrictive. The NRC will be notified at least 14 days prior to subdividing and/or reclassifying a survey area.

5.4.3 Reference Coordinate Systems

Measurements and sample locations can be identified in one of two ways: using a benchmark location or a global positioning system (GPS). If benchmark is used, that benchmark (origin) will be provided on the map or plot included in the FSS package. The GPS to be used at YNPS site has sub-meter accuracy. Sub-meter accuracy is sufficient to establish a reproducible reference coordinate system and to physically locate sample points determined by the FSS plan for an area. A benchmark is being established for daily pre-operational checks of the systems.

Any coordinate systems used for surveys will typically take the form of a grid of intersecting, perpendicular lines; but other patterns (e.g., triangular and polar) may be used as convenient. Physical gridding of a survey unit will only be done in cases where it is beneficial and cost effective to do so. When physical gridding is used, benchmark locations will be designated by either marking a spot with surveyor's paint (or equivalent) for indoor areas or setting an iron pin (or equivalent) for outdoor areas. If needed, grid lines or measurement locations will be marked (e.g., with chalk lines, paint, surveyor's flags), as appropriate. Global positioning systems may also be used as practical.

are deemed not to have any reasonable potential to spread plant-related radioactive material to the area;

- tools and equipment, which are not needed for final survey activities and could interfere with final survey activities, are removed;

- equipment to be used for final survey activities is evaluated to ensure it does not pose the potential for introducing plant-related radioactive material into the area; and

- where practical, transit paths to or through the area, except those required to support final survey activities, are eliminated or re-routed.

Once the area meets the isolation and control criteria, isolation and control will be achieved through:

- a combination of personnel training, physical barriers and postings, and site notices as appropriate, to prevent unauthorized access to an isolated area;

- implementation of provisions to prevent the introduction of plant-related radioactive material by persons authorized to enter the area; and

- measures to prevent the introduction of plant-related radioactive material through the air or through other paths, such as systems or piping.

For buildings, measures to prevent against the introduction of plant-related radioactive material by persons entering an isolated area may include personnel frisking stations at the entry point, the use of "sticky pads," or other such routine methods. Isolation from airborne material may include sealing off openings, including doors and ventilation ducts. Though not likely to be encountered, if a potential for waterborne material is deemed to exist (e.g., floor drains or penetrations left by decommissioning activities), similar measures will be taken to be sure such sources are sealed off from the isolated area. In addition to these physical controls, access points to buildings will be posted with signs that include information pertaining to the proper individual to contact prior to conducting plant-related activities in the area. An administrative process will be used to evaluate, approve (or deny), and document plant related activities conducted in these open land areas during and following FSS.

For open land areas, access roads and trails will be posted with signs that include information pertaining to the proper individual to contact prior to conducting plant-related activities in the area. An administrative process will be used to evaluate, approve (or deny), and document plant related activities conducted in these open land areas during and following FSS. For land areas that do not have positive access control (i.e., areas that have passed FSS but are not surrounded by a fence), the area will be inspected annually and any material that has been deposited since the last inspection will be investigated (i.e., scanned and/or sampled).

5.4.5.2 Area Surveillance Following Final Status Surveys

Isolation and control measures will be implemented through approved plant procedures and will remain in force throughout final survey activities and until there is minimal risk of recontamination from decommissioning or the survey area has been released from the license. In the event that isolation and control measures established for a given survey unit are compromised, evaluations will be performed and documented to confirm that no radioactive material was introduced into the area that would affect the results of the FSS.

To provide additional assurance that land areas and structures that have undergone successful FSS remain unchanged until final site release, these areas will be surveyed periodically. The strategy for performing these surveys depends on the following:

- the type of area (land or building),
- the area classification of the survey areas as well as that of the adjacent survey areas,
- the potential for re-contamination of the area from remediation activities in adjacent areas,
- the proximity to operational events involving radioactive contamination.

For FSS areas adjacent to areas where either remediation activities (as required to meet the site release criteria) or operational events may have impacted the FSS area, a re-survey of the FSS area will be conducted. This re-survey will involve judgmental sampling of boundary and/or potential access points to the FSS area. If the results of the resurvey indicate that the mean of the resurvey measurements (DCGL fraction for land areas and static measurements for surfaces) is statistically greater than the mean (that is, greater than 3 standard deviations from the FSS mean) or if any resurvey measurements is greater that the applicable DCGLw, an investigation survey will be conducted of the area. The investigation survey will include a larger physical area than the re-survey. If the results of the investigation survey are statistically different than the FSS results, then a full FSS survey of the affected units will be performed in accordance with the LTP. The results of re-surveys and investigation surveys will be documented and maintained in the FSS files for the affected survey units. Additionally, for any area that has completed FSS activities, any soil, sediment, or equipment relocated to that area will require demonstration that the material introduced does not result in residual radioactivity that is statistically different than that in the FSS. LBDCR 06-03

Periodic surveys will be performed on a random sample basis for 5% of those survey areas for which FSS activities have been completed. If the results of these surveys exceed specific radiological contamination levels (i.e., the mean > 3 standard deviations from the initial FSS mean or any resurvey measurement > DCGLw), an investigation survey will be conducted. This investigation survey will be more extensive than the scope of the routine survey to define the magnitude and extent of the contamination. If the results of the investigation survey indicate contamination that is statistically different than the FSS survey results (as described above), then full FSS of the affected survey areas will be performed in accordance with the LTP. The results of re-surveys and investigation surveys will be documented and maintained in the FSS files for the affected LBDCR 06-03 behavior of future occupants would result in a lower dose. For example, it is more likely that the YNPS site will be reused for land conservation. The hypothetical dose from the soil to an individual in these settings would be less than for a resident farmer, since the such an individual would not ingest food grown onsite. Therefore, the use of the resident farmer as the average member of the critical group is both conservative and bounding for the calculation of soil DCGLs.

6.2.2.3 Exposure Pathways

The potential exposure pathways that apply to the resident farmer are listed below and are based upon those in NUREG/CR-5512, Volume 1:

- Direct exposure to external radiation from residual radioactivity;
- Internal dose from inhalation of airborne radionuclides; and
- Internal dose from ingestion of
    - Plant foods grown in media containing residual radioactivity and irrigated with water containing residual radioactivity,
    - Meat and milk from livestock fed with fodder grown in soil containing residual radioactivity and water containing residual radioactivity,
    - Drinking water (containing residual radioactivity) from a well,
    - Fish from a pond containing residual radioactivity, and
    - Soil containing residual radioactivity.

6.2.3 Building Occupancy Scenario

6.2.3.1 Scenario Definition

The building occupancy scenario, based upon NUREG/CR-5512, Volume 1, was selected to estimate human radiation exposure resulting from residual radioactivity in concrete from standing buildings and to determine corresponding DCGLs.

6.2.3.2 Critical Group

Given the fact that the buildings associated with the YNPS site are commercial, the average member of the critical group is an adult engaging in light industrial work within the buildings following decommissioning of the site. The person occupies a commercial facility performing standard activities that do not deliberately disturb sources of residual radioactivity. The dose from residual radioactivity in the concrete from the standing building is evaluated for the average member of the critical group as required by 10 CFR Part 20, Subpart E, and described in NUREG -1757, Appendix I.

6.2.3.3 Exposure Pathways

The potential exposure pathways, described in NUREG/CR-5512, Volume 1, are listed below:

- Direct exposure to external radiation from
  - Material deposited on the walls
  - Material deposited on the floor
  - Submersion in airborne dust
- Internal dose from inhalation of airborne radionuclides
- Internal dose from inadvertent ingestion of radionuclides

6.2.4 Code Selection

The RESRAD Family of Codes has been selected for use at YNPS. The RESRAD computer codes are pathway-analysis models developed at Argonne National Laboratory (ANL). This family of computer codes includes RESRAD, used to analyze pathways associated with soil, and RESRAD-BUILD, used to analyze pathways associated with buildings.

The RESRAD computer code (Version 6.21) was used in this analysis to consider three major exposure pathways to a resident farmer:

- Direct exposure to external radiation from soil containing residual radioactivity;
- Internal exposure from inhalation of airborne radionuclides; and
- Internal exposure from ingestion of radionuclides.

The RESRAD-BUILD computer code (Version 3.21) is used in this analysis to consider five exposure pathways to occupants of a building:

- External exposure directly from the sources;
- External exposure to material deposited on the floor;
- External exposure due to air submersion;
- Inhalation of airborne radioactive particulates; and
- Inadvertent ingestion of radioactive material directly from the sources.

Information on the use of these codes and their applications are outlined in NUREG/CRs-6676, -6692, -6697, -6755 (References 6-6, 6-7, 6-8 and 6-9) and the "Users Manual for RESRAD, Version 6.0" (Reference 6-10). LBDCR 06-04

6.2.5 Input Parameter Selection Process

The dose and conceptual models are quantified by a set of input parameters. Incorporated within RESRAD Version 6.21 and RESRAD-BUILD Version 3.21 are probabilistic modules that allow the evaluation of dose as a function of parameter distributions. A schematic flow diagram of the parameter selection process is provided in Figure 6-1. Each step of the selection process is discussed below.

6.4.4.4 DCGL Determination

The input values assigned to sensitive and non-sensitive parameters for the DCGL runs were based on Section 6.2.5.5 and the sensitivity analysis results presented in Appendix 6N. The DCGL determination was performed using RESRAD Version 6.21 analyses with the input values summarized in Appendix 6N.

The resulting DCFs are provided in Appendix 6O. The DCGLs, representing a dose of 25 mrem/yr, determined using Equation 6-1 are also provided in Appendix 6O.

6.5 Residual Radioactivity in Groundwater

LTP Section 5.6.3.2.4 requires that the concentration of well water available (based upon the well supply requirements assumed in Section 6 for the resident farmer) be below the EPA MCLs at the time of license termination. A calculation of the dose contribution from groundwater at the EPA MCLs was performed (Reference 6-15). This calculation used the approved groundwater DCGL from the Connecticut Yankee LTP for H-3 of 6.52E+05 pCi/l, representing a dose of 25 mrem/yr (Reference 6-16). The dose due to H-3 (the only plant-related radionuclide positively identified in groundwater) was determined to be 0.77 mrem/yr, when the concentration was at the EPA MCL for H-3 (20,000 pC/l).

6.6 Combining Dose Contributions from Different Media

YNPS considers the following media concurrently, when calculating the total dose from the site, in accordance with 10CFR20.1402:

- soils,
- subsurface partial structures,
- concrete debris, and
- groundwater.

The DCGLs for subsurface partial structures and groundwater represent a dose of 0.5 mrem/yr and 0.77 mrem/yr respectively. The sum of the dose contributions from subsurface partial structures and groundwater (1.27 mrem/yr) will be subtracted from the 25 mrem/yr total, leaving 23.73 mrem/yr for the dose contribution from soil and concrete debris.

DCGLs for soil and concrete debris, representing 23.73 mrem/yr, are provided in Table 6-1. In areas where soil and concrete debris used as backfill are present, the lower radionuclide-specific DCGL for the two media will be applied to soils and concrete debris. In areas where only soil is present (i.e., concrete debris backfill is not present), the soil radionuclide-specific DCGLs will be applied to soil.

Table 6-1

Summary of DCGLs for Different Media Types

Radionuclide	Soil (pCi/g)†	Building Surface (dpm/100 cm^2)‡	Subsurface Partial Structures (pCi/g)§	Concrete Debris† (pCi/g)
H-3	3.5E+02	3.4E+08	1.35E+02	9.5E+01 (cellar holes) 2.8E+02 (grading)
C-14	5.2E+00	1.0E+07	2.34E+03	7.2E+00
Fe-55	2.8E+04	4.0E+07	-	1.4E+02
Co-60	3.8E+00	1.8E+04	3.45E+03	4.3E+00
Ni-63	7.7E+02	3.7E+07	6.16E+04	1.0E+02
Sr-90	1.6E+00	1.4E+05	1.39E+01	7.6E-01
Nb-94	6.8E+00	2.6E+04	-	7.0E+00
Tc-99	1.3E+01	1.4E+07	-	6.1E+01
Ag-108m	6.9E+00	2.5E+04	-	7.0E+00
Sb-125	3.0E+01	1.0E+05	-	3.1E+01
Cs-134	4.7E+00	2.9E+04	-	4.7E+00
Cs-137	8.2E+00	6.3E+04	1.45E+03	6.7E+00
Eu-152	9.5E+00	3.7E+04	-	9.5E+00
Eu-154	9.0E+00	3.4E+04	-	9.1E+00
Eu-155	3.8E+02	6.5E+05	-	3.8E+02
Pu-238	3.1E+01	5.7E+03	-	9.5E+00
Pu-239, 240	2.8E+01	5.1E+03	-	8.8E+00
Pu-241	9.3E+02	2.5E+05	-	1.4E+02
Am-241	2.8E+01	5.0E+03	-	4.1E+00
Cm-243, 244	3.0E+01	7.2E+03	-	4.7E+00

LBDCR
06-04

† Represents a dose of 23.73 mrem/yr
‡ Represents a dose of 25 mrem/yr
§ Represents a dose of 0.5 mrem/yr, radionuclides based upon those found in concrete samples as discussed in Reference 6-11

6. Irrigation Rate (Evapotranspiration and Runoff Coefficients)

NUREG/CR-6697 Attachment C, Section 4.3 discusses the Irrigation Rate in terms of the Evapotranspiration Coefficient. Equation 4.3-1 of NUREG/CR-6697 expresses the Evapotranspiration Coefficient as:

$$Ce = \frac{ETr}{(1-Cr)(\mathrm{Pr}) + IRr}$$

LBDCR 06-04

Where: ETr = the Evapotranspiration Rate (m/y)
Pr = the Precipitation Rate (m/y)
IRr = the Irrigation Rate (m/y) and
Cr = the Runoff Coefficient.

Based upon this equation, the Irrigation Rate can be expressed as:

$$\mathrm{IRr} = \frac{\mathrm{ETr}}{\mathrm{Ce}} - (1-\mathrm{Cr})(\mathrm{Pr})$$

The input values for the variables in this equation:

- YA-REPT-00-002-03 (Ref. 1) cites a value for the average annual Evapotranspiration Rate, ETr, in the upper Housatonic River basin of 21.6 in/y or 0.549 m/y from 1931 to 1960.

- The Precipitation Rate, Pr, has been assigned a site-specific value of 1.2 m/y as discussed in Section 5 of this Attachment.

- Appendix E, Table E.1 of Ref. 2 provides the equation below to calculate the Runoff Coefficient, C_r, for an agricultural environment. Table E.1, Runoff Coefficient Values, also lists values for c_1, c_2 and c_3 for various environments:

$$C_r = 1 - c_1 - c_2 - c_3$$

c_1 = 0.1 for hilly land with an average slopes of 46 m/mi (Refer to section 2 of this Attachment for the site slope determination- 20' drop per 700' run or 46 m/mi).
c_2 = 0.2 for intermediate combinations of clay and loam as identified at the site in Ref. 3.
c_3 = 0.1 for cultivated lands which also fits the scenario for the site.

$$\mathrm{Cr} = 1 - 0.1 - 0.2 - 0.1 = 0.6$$

- NUREG/CR-6697, Attachment C, Section 4.3-Evapotranspiration Coefficient, Ce, defines this parameter as the ratio of the total volume of water (a combination of evaporation from soil surfaces and transpiration from vegetation) transferred to the atmosphere to the total volume of water available within the root zone of the soil. The NUREG/CR recommends the use of a uniform distribution with minimum and maximum values of 0.5 and 0.75, respectively and with 0.625 as median. Any selected value for the irrigation rate should satisfy the Ce minimum to maximum range.

Substituting the minimum and maximum values of Ce into Equation 4.3-1 results in the following range for the Irrigation Rate, IRr:

Table 6- 1 Irrigation Rate

Variable	"Min" Value	"Max" Value	Units
ETr	0.549	0.549	m/y
Pr	1.2	1.2	m/y
Cr	0.6	0.6	--
Ce	0.5	0.75	--
IRr	0.252	0.618	m/y

Based on the calculated minimum and maximum IRr values, the median value is 0.435 m/y. A uniform distribution was assigned to this parameter and a positive input correlation to the Well Pumping Rate was assigned based upon guidance in NUREG/CR-6697 and NUREG/CR-6676.

7. Field Capacity: Contaminated Zone, Unsaturated Zone and Saturated Zone

The "Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil," (Ref. 3) defines the relationship of field capacity (residual water content) to effective porosity. The field capacity is the ratio of the volume of water retained in the soil sample, after all drainage has ceased, to the total volume of the soil sample. Equation 4.4 of Ref. 3 relates Total and Effective Porosity to Field Capacity as follows:

Effective Porosity = Total Porosity - Field Capacity

Thus,

Field Capacity = Total Porosity - Effective Porosity

Appendix 6E

Soil DCGL Results

Soil DCGL Results

Nuclide	Dose Conversion Factor (DCF) (mrem/y per pCi/g)	DCGL (pCi/g)
H-3	6.79E-02	3.7E+02
C-14	4.52E+00	5.5E+00
Fe-55	8.57E-04	2.9E+04
Co-60	6.21E+00	4.0E+00
Ni-63	3.07E-02	8.1E+02
Sr-90	1.45E+01	1.7E+00
Nb-94	3.46E+00	7.2E+00
Tc-99	1.76E+00	1.4E+01
Ag-108m	3.44E+00	7.3E+00
Sb-125	7.82E-01	3.2E+01
Cs-134	5.02E+00	5.0E+00
Cs-137	2.92E+00	8.6E+00
Eu-152	2.43E+00	1.0E+01
Eu-154	2.63E+00	9.5E+00
Eu-155	6.29E-02	4.0E+02
Pu-238	7.48E-01	3.3E+01
Pu-239/-240	8.30E-01	3.0E+01
Pu-241	2.54E-02	9.8E+02
Am-241	8.59E-01	2.9E+01
Cm-243/-244	7.85E-01	3.2E+01

LBDCR 06-04

Appendix 6J

Building Surface Area DCGL Results

Building Surface DCGL Results

Nuclide	Dose Conversion Factor (DCF) (mrem/yr per pCi/m^2)	DCGL (pCi/m^2)	DCGL (dpm/100cm^2)
H-3	1.6E-09	1.5E+10	3.4E+08
C-14	5.4E-08	4.6E+08	1.0E+07
Fe-55	1.4E-08	1.8E+09	4.0E+07
Co-60	3.1E-05	8.1E+05	1.8E+04
Ni-63	1.5E-08	1.7E+09	3.7E+07
Sr-90	4.0E-06	6.3E+06	1.4E+05
Nb-94	2.1E-05	1.2E+06	2.6E+04
Tc-99	3.9E-08	6.5E+08	1.4E+07
Ag-108m	2.2E-05	1.1E+06	2.5E+04
Sb-125	5.5E-06	4.5E+06	1.0E+05
Cs-134	1.9E-05	1.3E+06	2.9E+04
Cs-137	8.8E-06	2.8E+06	6.3E+04
Eu-152	1.5E-05	1.7E+06	3.7E+04
Eu-154	1.6E-05	1.6E+06	3.4E+04
Eu-155	8.5E-07	2.9E+07	6.5E+05
Pu-238	9.7E-05	2.6E+05	5.7E+03
Pu-239/-240	1.1E-04	2.3E+05	5.1E+03
Pu-241	2.3E-06	1.1E+07	2.5E+05
Am-241	1.1E-04	2.2E+05	5.0E+03
Cm-243/-244	7.7E-05	3.2E+05	7.2E+03

LBDCR 06-04