

BYR 2017-014

ENCLOSURE 2

YANKEE NUCLEAR POWER STATION
INDEPENDENT SPENT FUEL STORAGE INSTALLATION
ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT
JANUARY – DECEMBER 2016

**YANKEE NUCLEAR POWER STATION
INDEPENDENT SPENT FUEL STORAGE INSTALLATION**

License Nos. DPR-3 and SFGL-13

**ANNUAL RADIOLOGICAL ENVIRONMENTAL
OPERATING REPORT**

January - December 2016



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EXECUTIVE SUMMARY

Yankee Nuclear Power Station was permanently shutdown in 1991. All fuel has been transferred into dry storage casks and placed at the Independent Spent Fuel Storage Installation. The Radiological Environmental Monitoring Program (REMP) for the Yankee Nuclear Power Station (YNPS) Independent Spent Fuel Storage Installation (ISFSI) located in Rowe, MA was continued for the period January through December 2016 in compliance with the YNPS Offsite Dose Calculation Manual (ODCM).

By design, there are no liquid or gaseous effluents associated with the operation of the ISFSI. Therefore, the ODCM only requires monitoring of direct exposure from the facility. TLDs were used to measure direct gamma exposure at six locations in the vicinity of the ISFSI and one control location 7.6 kilometers away. The results of these measurements showed no significant change in exposure rates and potential doses to members of the public during the monitoring period. The results of the monitoring performed in 2016 also show that operating the YNPS ISFSI results in only a small fraction of the 40 CFR Part 190 and 10 CFR Part 72.104 direct radiation dose limit of 25 mrem/year to members of the public.

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1.0 INTRODUCTION

This report summarizes the findings of the Radiological Environmental Monitoring Program (REMP) conducted by Yankee in the vicinity of the Independent Spent Fuel Storage Installation in Rowe, Massachusetts during the calendar year. It is submitted annually in compliance with the Offsite Dose Calculation Manual (ODCM). The remainder of this report is organized as follows:

- Section 2: Provides a brief description of the Yankee site and its environs.
- Section 3: Provides a description of the overall REMP design. Included is a summary of the ODCM requirements for REMP sampling, tables listing TLD monitoring locations with compass sectors and distances from the ISFSI, and maps showing the location of each of the TLD monitoring locations.
- Section 4: Provides a complete set of TLD data showing measured results (mR) and calculated doses (mrem per year). This section also provides the summarized TLD data in the format specified by the NRC Branch Technical Position on Environmental Monitoring (Reference 1).
- Section 5: Provides the results of the calendar year monitoring program. The performance of the program in meeting ODCM requirements is discussed, and the data acquired during the year is analyzed.
- Section 6: References

2.0 GENERAL ISFSI AND SITE INFORMATION

The Yankee Nuclear Power Station site is located on over 1800 acres in a predominantly rural area of northwestern Massachusetts, three-quarters of a mile south of the Vermont border. The site resides in the town of Rowe, Massachusetts, approximately 9 air miles east-northeast of North Adams, Massachusetts. The surrounding area is heavily forested and lightly populated. Hills bounding the river valley rise 500 to 1000 feet above the site, reaching elevations of 2100 feet.

The Deerfield River is used extensively for hydroelectric power generation both upstream and downstream of YNPS. The Sherman Dam, immediately adjacent to the site, operates as a hydroelectric generating station. Sherman Pond, the impoundment behind this dam, had been used as a source of cooling water for the former power plant.

The former nuclear power plant was voluntarily shut down on October 1, 1991 after 31 years of operation. The site was involved in the process of decommissioning over the years which involved the disassembly and removal of the plant components and structures and was completed in 2006. This process took place in strict conformance with USNRC regulations. Oversight of the site closure process also took place from the U.S. Environmental Protection Agency, the Massachusetts Department of Environmental Protection, and Massachusetts Department of Public Health.

3.0 PROGRAM DESIGN

The REMP for the Yankee Nuclear Power Station ISFSI was designed to provide assurance to regulatory agencies and the public that the station's environmental impact is known and within anticipated limits. The direct dose limit for members of the public from operation of the ISFSI is 25 mrem per year (References 3 and 4).

The detailed sampling requirements of the REMP are given in the ODCM. The sampling requirements specified in the ODCM are summarized in Table 3.1 of this report. Details of the monitored locations are shown in Table 3.2, as well as Figures 3.1 through 3.4 of this report.

3.1 Monitoring Zones

The REMP is designed to allow comparison of levels of radioactivity in samples from the area possibly influenced by the ISFSI to levels found in areas not influenced by the ISFSI. The first area is called "indicator stations". The second area is called "control stations". The distinction between the two is based on relative direction from the facility and distance. Analysis of survey data from the two zones aids in determining if there is a significant difference between the two areas. It can also help in differentiating between radioactivity or radiation due to releases and that due to other fluctuations in the environment, such as seasonal variations in the natural background.

3.2 Pathways Monitored

Based on the design of the ISFSI, only the direct radiation exposure pathway is monitored by the REMP. This pathway is monitored by the collection of thermoluminescent dosimeters (TLDs) which are described in more detail below.

3.3 Description of Monitoring Program

3.3.1 Direct Radiation

Direct gamma radiation exposure was continuously monitored during 2016 with the use of thermoluminescent dosimeters (TLDs). At each monitoring location, these TLDs are sealed in plastic bags and attached to an object such as a tree, fence or utility pole. The TLDs are posted and retrieved on a semi-annual basis. All TLDs are provided and processed by a National Voluntary Laboratory Accreditation Program (NVLAP) certified vendor. The TLDs are placed at various locations around the ISFSI. Table 3.2 lists the Station ID Codes, distances and direction of the TLDs from the ISFSI.

3.3.2 Special Monitoring

Special samples can be taken that are not required in the ODCM. No special samples were collected in 2016.

**Table 3.1
Radiological Environmental Monitoring Program**

Exposure Pathway and/or Sample Media	Collection			Analysis	
	Number of Sample Locations	Routine Sampling Mode	Collection Frequency	Analysis Type	Analysis Frequency
Direct Radiation (TLD)	Total Locations: 7 (6 around perimeter of the site and 1 offsite control location)	Continuous	Semi-annual	Gamma dose	Semi-annual

**Table 3.2
Radiological Environmental Monitoring Locations**

Station Code	Station Description	Zone*	Distance From ISFSI (km)	Direction From ISFSI
GM-15	Onsite Perimeter (I)**	1	0.24	NW
GM-16	Onsite Perimeter (I)**	1	0.22	NNW
GM-17	Onsite Perimeter (I)**	1	0.13	NNE
GM-21	Onsite Perimeter (I)**	1	0.17	WSW
GM-02	Observation Stand (O)**	1	0.50	NW
GM-06	Tunnel Road Readsboro Town Line (O)**	1	1.30	N
GM-27	Number Nine Road (O)*	2	7.60	ENE

*2 = Control TLD; 1 = Indicator TLD

**I = Inner Ring TLD; O = Outer Ring TLD

Figure 3.1
All Radiation Monitoring Locations

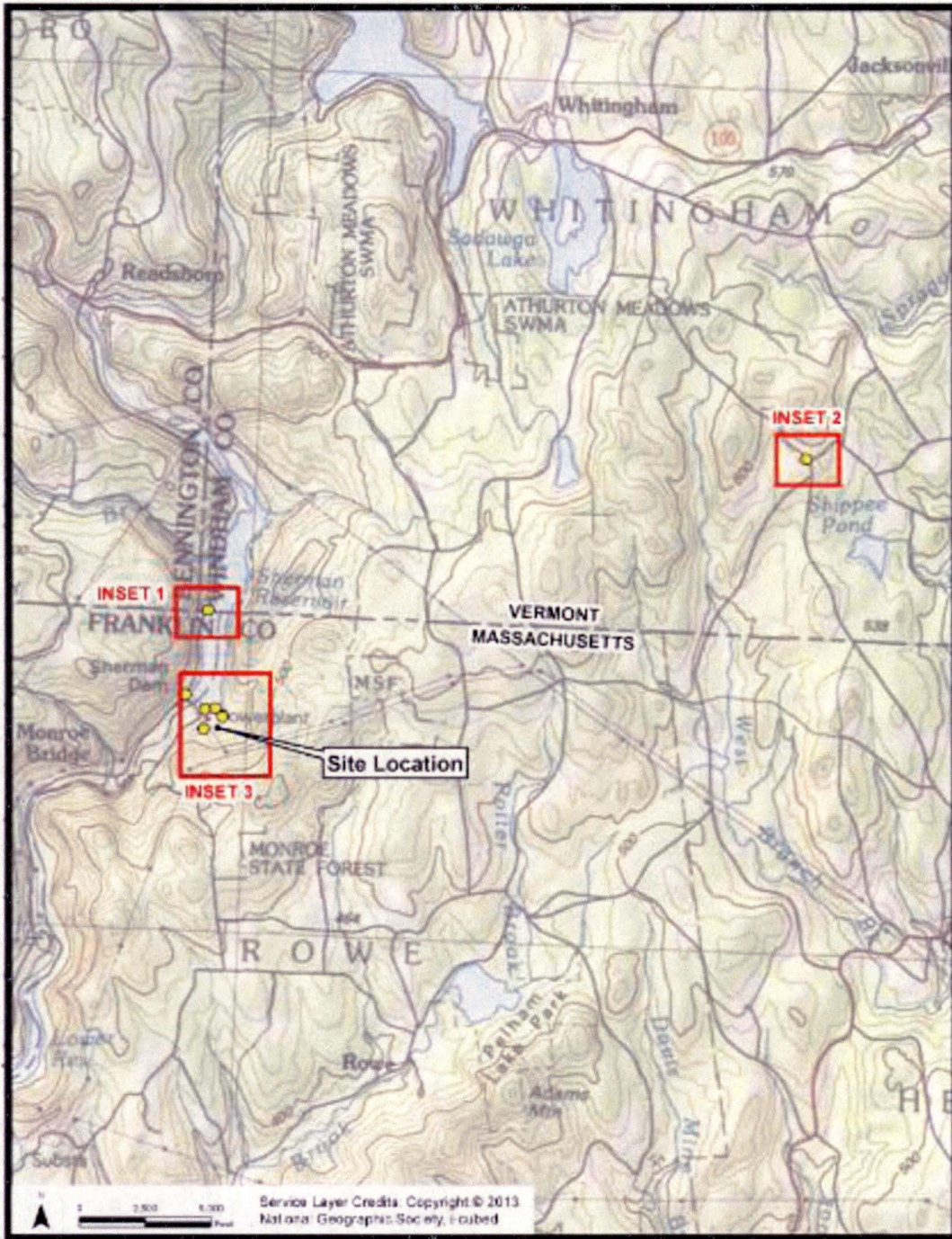


Figure 3.2
 Onsite Direct Radiation Monitoring Locations

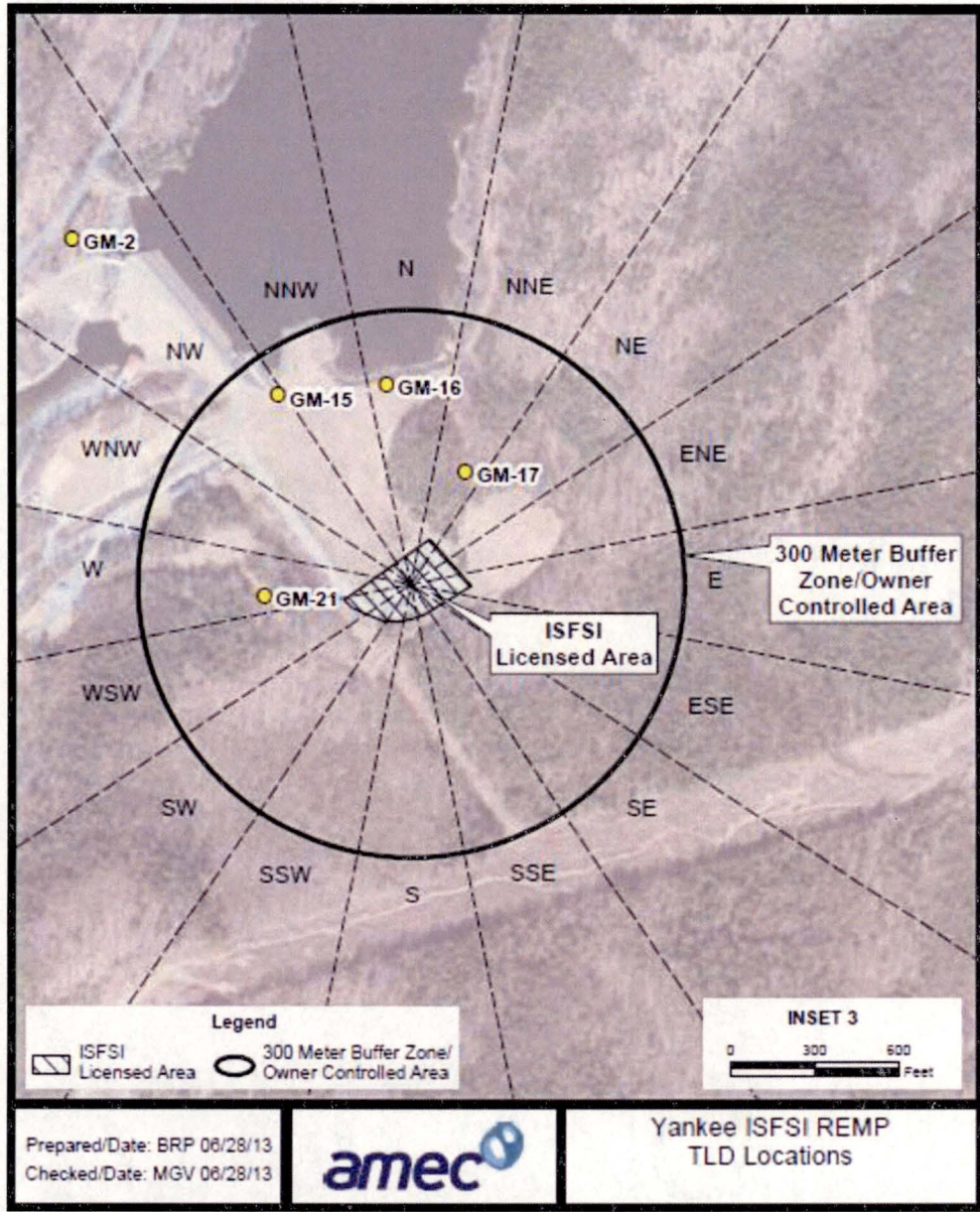


Figure 3.3
Direct Radiation Monitoring Locations (Within 1 mile)

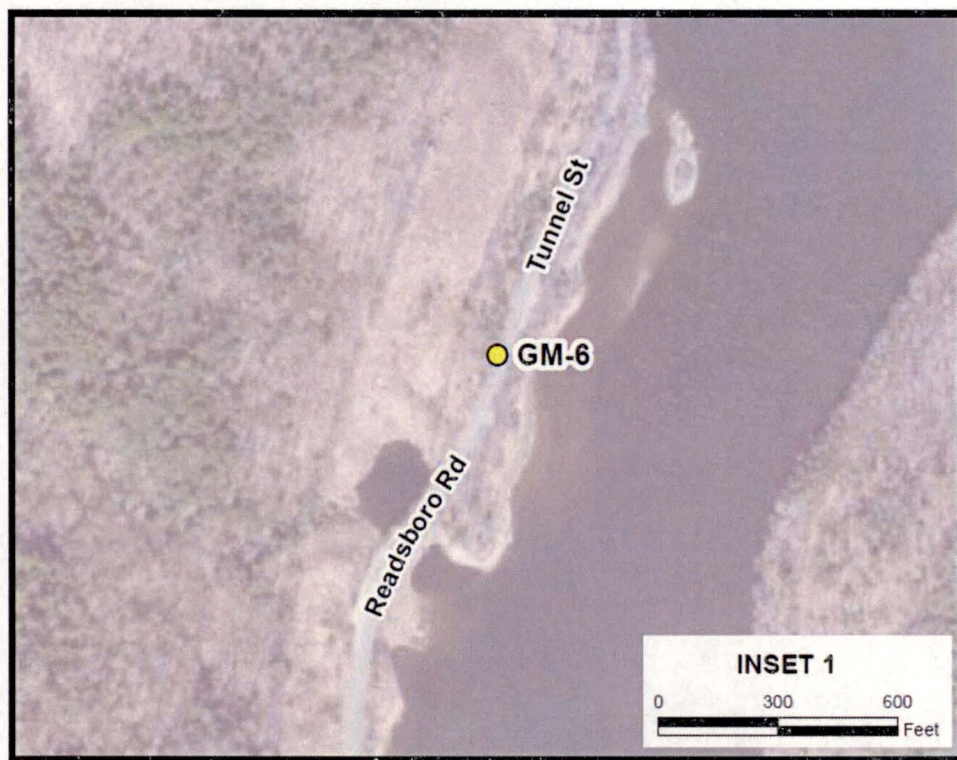
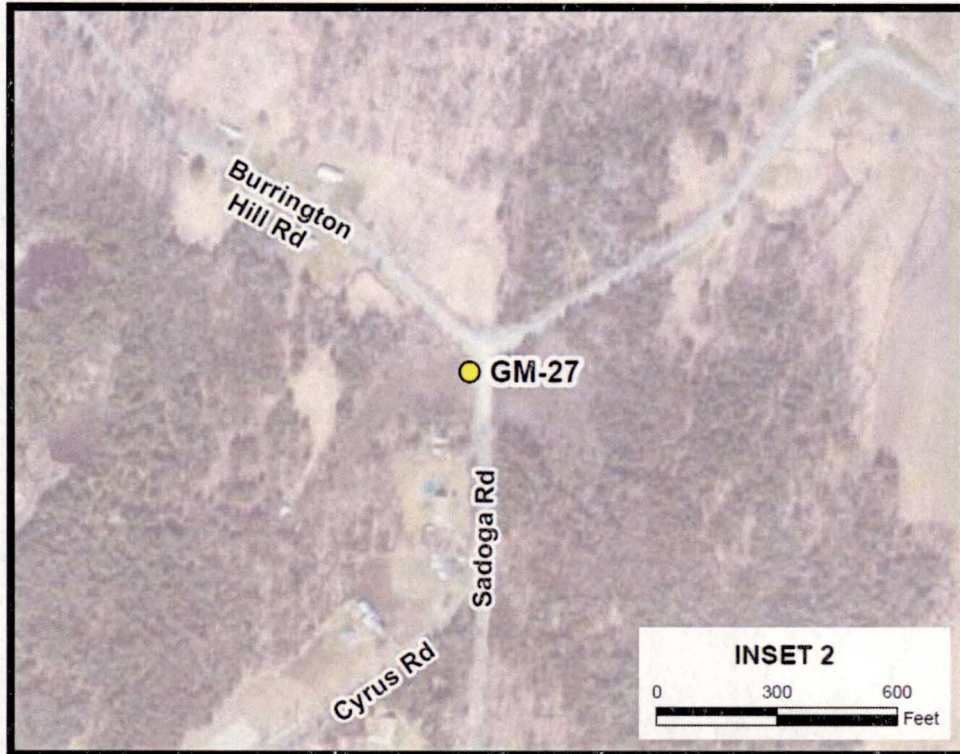


Figure 3.4
Offsite Control Location



4.0 RADIOLOGICAL DATA SUMMARY TABLES

This section summarizes the analytical results of the environmental samples, which were collected during the monitoring period.

- Data from direct radiation measurements made by TLDs are presented in Table 4.1.
- The summarized TLD measurements, shown in Table 4.2, are presented in a format similar to that prescribed in the NRC's Radiological Assessment Branch Technical Position on Environmental Monitoring (Reference 1).
- Table 4.3 presents the estimated direct dose from ISFSI operations as determined by TLD data shown in Table 4.1.

**Table 4.1 TLD Measurements by Half-Year
(mR)**

Station ID	Location	1st Half-Year	2nd Half-Year
GM-02	Observation Stand	35	44
GM-06	Tunnel Road Readsboro Town Line	39	50
GM-15	On-site perimeter	44	51
GM-16	On-site perimeter	38	51
GM-17	On-site perimeter	43	53
GM-21	On-site perimeter	36	49
GM-27	Control	31	41
GM-27a	Control Backup	32	44

**Table 4.2 TLD Data Summary
(mR)**

Indicator TLDs	Control TLDs	Indicator Station With Highest Mean	
		Station #	Mean (Range) (No. Measurements)*
Mean (Range) (No. Measurements)*	Mean (Range) (No. Measurements)*		Mean (Range) (No. Measurements)*
44.4	37.0	GM-17	48.0
(35 – 53)	(31 – 44)		(43 – 53)
(12)	(4)		(2)

* Each "measurement" is based on semi-annual readings.

**Table 4.3 Direct Dose from ISFSI Operations
(mrem)**

Station ID	1 st Half-Year		2 nd Half-Year		Annual Dose
	Net TLD Result	Calculated Dose	Net TLD Result	Calculated Dose	
GM-02	3.50	0.20	1.50	0.09	0.29
GM-06	7.50	0.43	7.50	0.43	0.86
GM-15	12.50	0.71	8.50	0.48	1.19
GM-16	6.50	0.37	8.50	0.48	0.85
GM-17	11.50	0.66	10.50	0.60	1.26
GM-21	4.50	0.26	6.50	0.37	0.63
			Max Dose =>		1.26

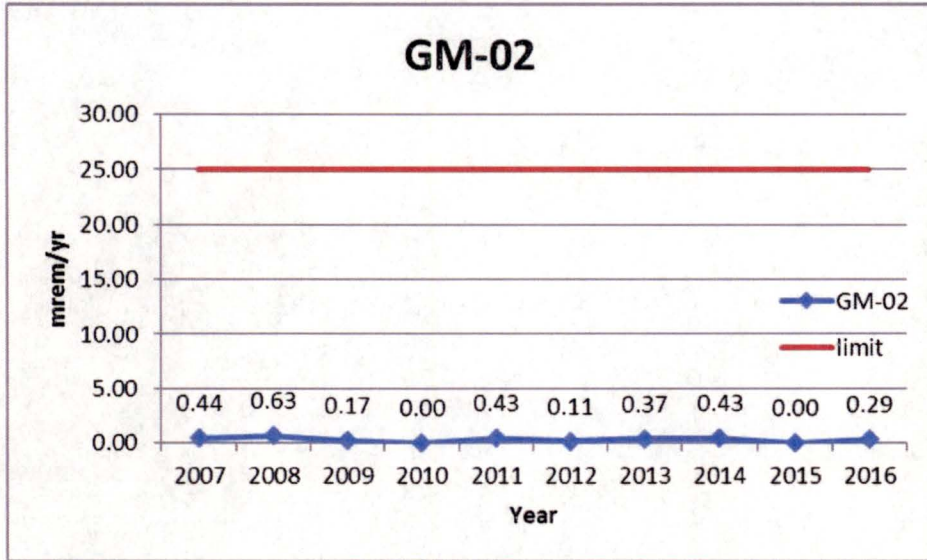
Note:

Doses based on a 250 hour occupancy in both of the first and second half-years.

Radiological Environmental Monitoring Program Trending

A series of graphs of REMP TLD data have been developed and are provided for trending purposes. The trending is developed for each of the indicator locations based on the annual historical doses. The trending is provided for the "real members of the public" based on the guidance provided in the ODCM. The analysis of the trends and associated data shows very small annual doses with minor fluctuations in the data. In this report, the uncorrected TLD results have been summarized and the annual doses, calculated for "real members of the public" based upon guidance in the ODCM, have been plotted for trending.

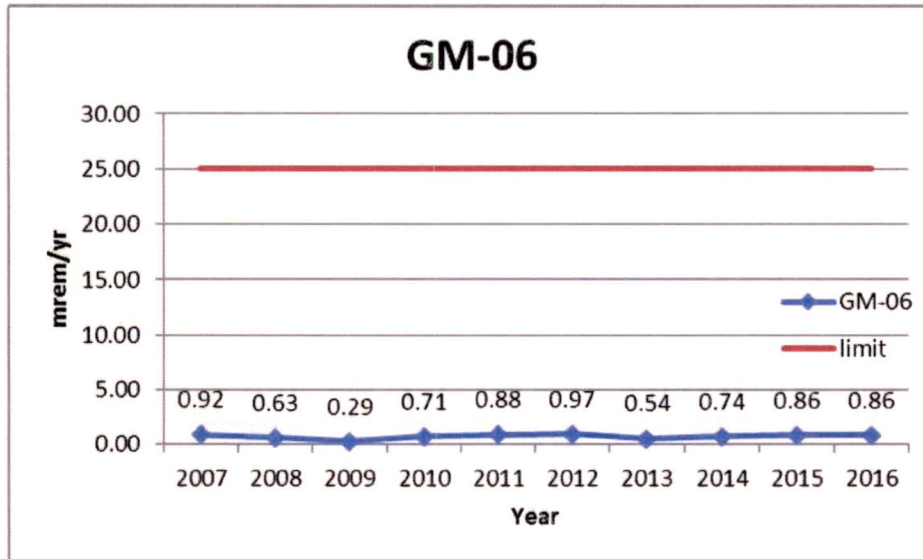
Figure 4.1 Annual Dose Trend at GM-02



Annual Doses (mrem/yr)

Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GM-02	0.44	0.63	0.17	0.00	0.43	0.11	0.37	0.43	0.00	0.29

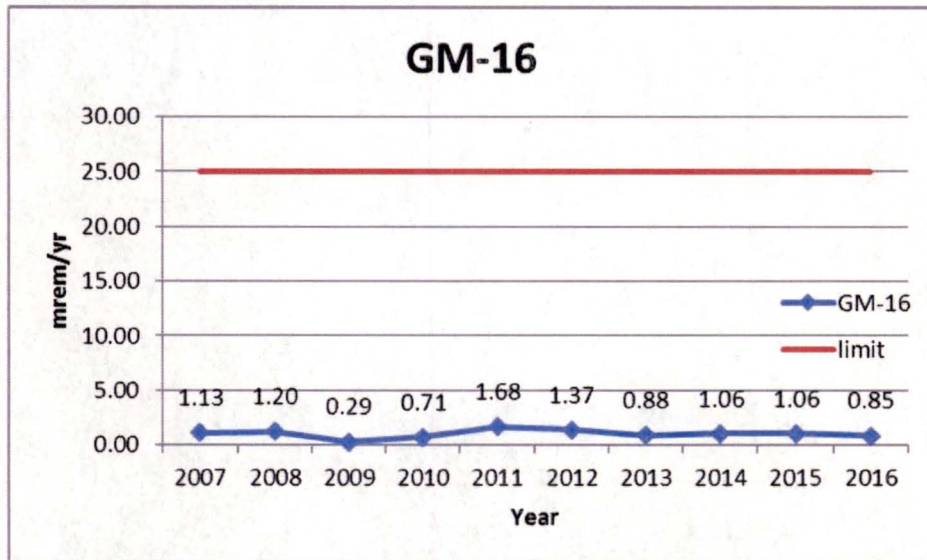
Figure 4.2 Annual Dose Trend at GM-06



Annual Doses (mrem/yr)

Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GM-06	0.92	0.63	0.29	0.71	0.88	0.97	0.54	0.74	0.86	0.86

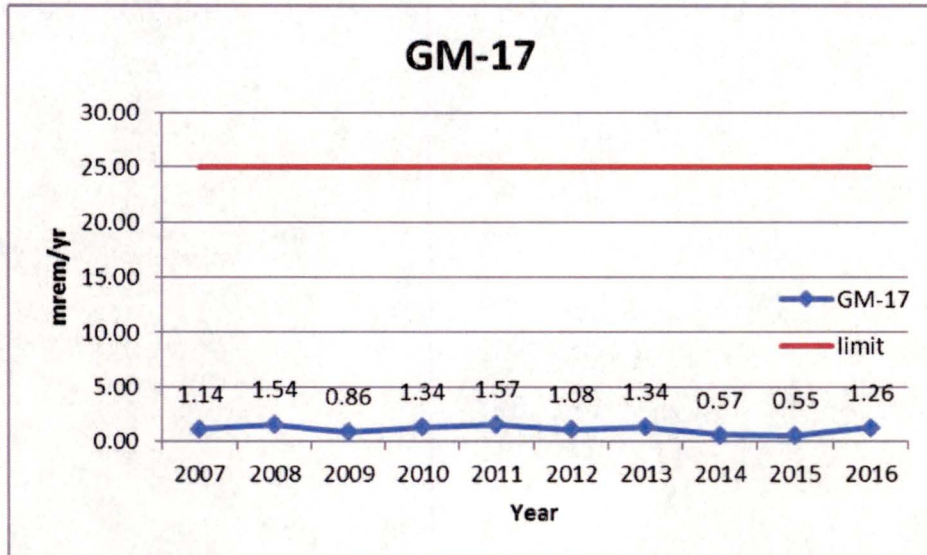
Figure 4.4 Annual Dose Trend at GM-16



Annual Doses (mrem/yr)

Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GM-16	1.13	1.20	0.29	0.71	1.68	1.37	0.88	1.06	1.06	0.85

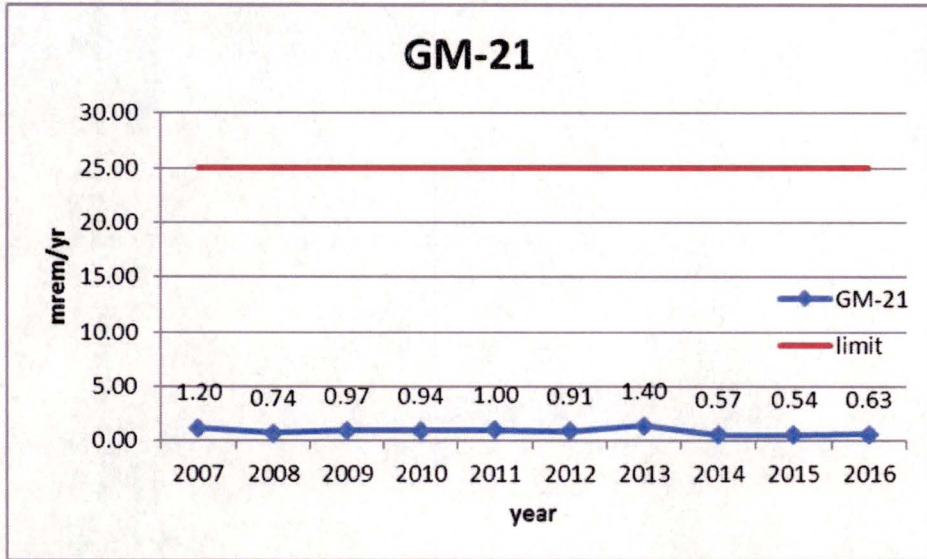
Figure 4.5 Annual Dose Trend at GM-17



Annual Doses (mrem/yr)

Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GM-17	1.14	1.54	0.86	1.34	1.57	1.08	1.34	0.57	0.55	1.26

Figure 4.6 Annual Dose Trend at GM-21



Annual Doses (mrem/yr)

Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GM-21	1.20	0.74	0.97	0.94	1.00	0.91	1.40	0.57	0.54	0.63

5.0 ANALYSIS OF ENVIRONMENTAL RESULTS

5.1 Sampling Program Deviations

A sampling program deviation is defined as samples that are unobtainable due to hazardous conditions or to malfunction of sampling equipment. Such deviations do not compromise the program's effectiveness and in fact are considered insignificant with respect to what is normally anticipated for this Radiological Environmental Monitoring Program.

There were no deviations in the sampling program in 2016.

5.2 Direct Radiation Pathway

5.2.1 Annual Dose Trends

Direct radiation is continuously measured at 6 indicator locations surrounding the YNPS ISFSI, along with 1 control location at Number Nine Road using thermoluminescent dosimeters (TLDs). These dosimeters are collected semi-annually for readout at the NVLAP certified dosimetry services vendor.

The review of Figures 4.1 through 4.6 shows no significant difference in annual doses over time at the indicator locations and their relation to the 25 mrem/yr limit.

5.2.2 Direct Doses from ISFSI Operations

The ODCM specifies that a cumulative dose estimate from direct radiation is required to be determined semi-annually. This dose estimate is the potential dose to any real member of the public that could use portions of the site or be present adjacent to the site for recreational activities throughout the year. The ODCM states that direct exposure above background can be estimated by subtracting the average TLD value of the control station from the indicator location measurements. As in previous years, the 2016 dose estimate assumes a total of 500 hours occupancy for the dose calculation; of which 250 hours are used in both the first and second half-years. The most likely location for exposure to a member of the public from the ISFSI is in Sherman Reservoir for boating and fishing; however, the time estimates are conservatively applied to all monitoring locations.

Table 4.3 presents the results of the dose calculations. The highest calculated dose is at Station ID number GM-17. The maximum calculated annual dose at this location is 1.26 mrem. This value is only 5 percent of the 25 mrem per year limit. This represents a conservative dose estimate because a member of the public would normally be situated further away in the reservoir.

6.0 REFERENCES

1. USNRC Radiological Assessment Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program," Revision 1, November 1979.
2. Yankee Nuclear Power Station Offsite Dose Calculation Manual, Revision 23.
3. 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation".
4. 10 CFR Part 72.104, "Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI or MRS".