

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

License Nos. DPR-3 and SFGL-13

**ANNUAL RADIOLOGICAL ENVIRONMENTAL  
OPERATING REPORT**

January - December 2014



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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 2014 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 2014 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 REMF design. Included is a summary of the ODCM requirements for REMF 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 Radiological Environmental Monitoring Program (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 REMF 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 2014 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 Independent Spent Fuel Storage Installation (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. The sample locations do not appear in Table 3.1 or 3.2 of this report. For this monitoring period, no special samples were collected as part of the YNPS ISFSI Radiological Environmental Monitoring Program.



**Table 3.1**  
**Radiological Environmental Monitoring Program**

<b>Exposure Pathway and/or Sample Media</b>	<b>Collection</b>			<b>Analysis</b>	
	<b>Number of Sample Locations</b>	<b>Routine Sampling Mode</b>	<b>Collection Frequency</b>	<b>Analysis Type</b>	<b>Analysis Frequency</b>
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**

<b>Station Code</b>	<b>Station Description</b>	<b>Zone *</b>	<b>Distance From ISFSI (km)</b>	<b>Direction From ISFSI</b>
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

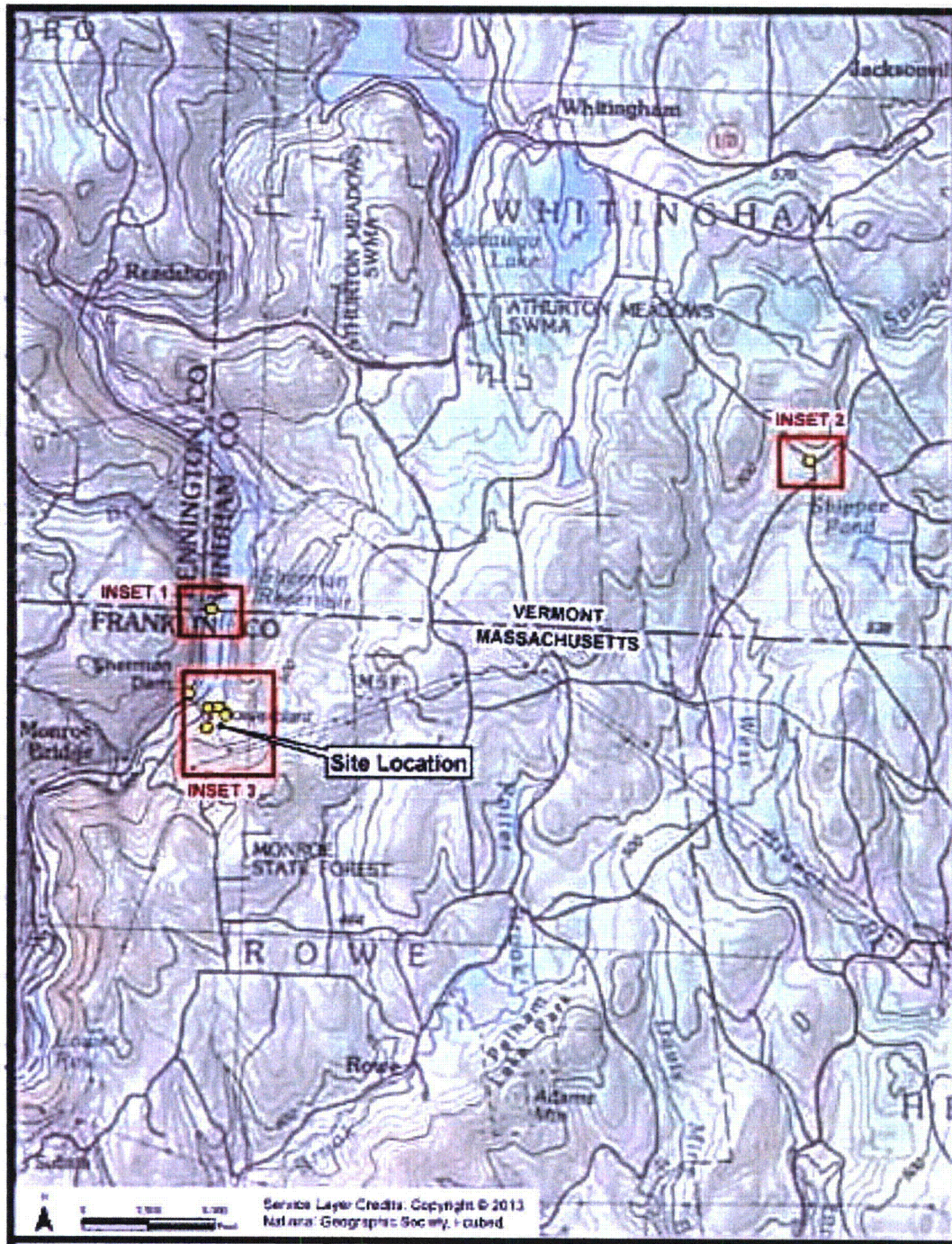




Figure 3.2  
Onsite Direct Radiation Monitoring Locations

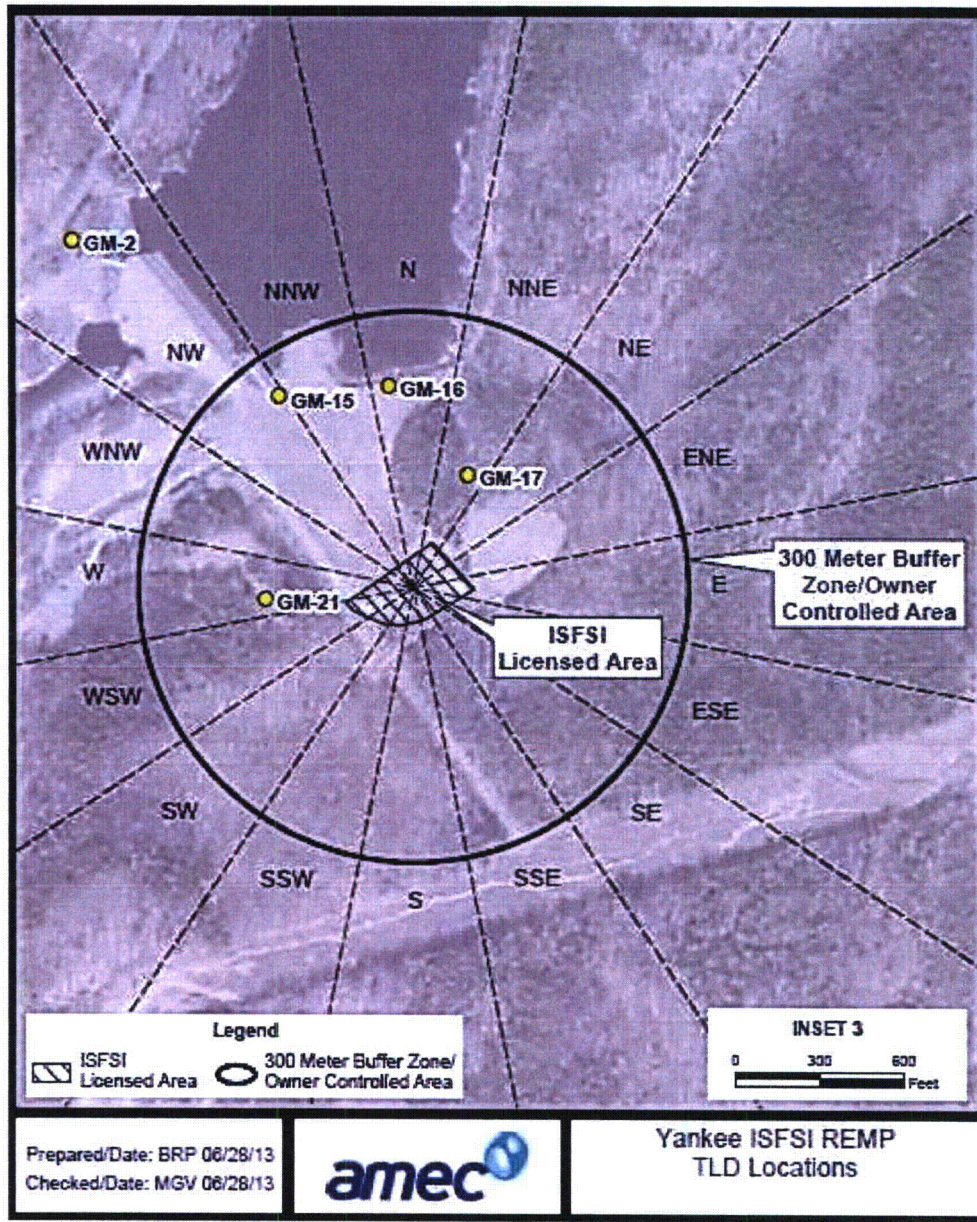


Figure 3.3  
Direct Radiation Monitoring Locations (Within 1 mile)

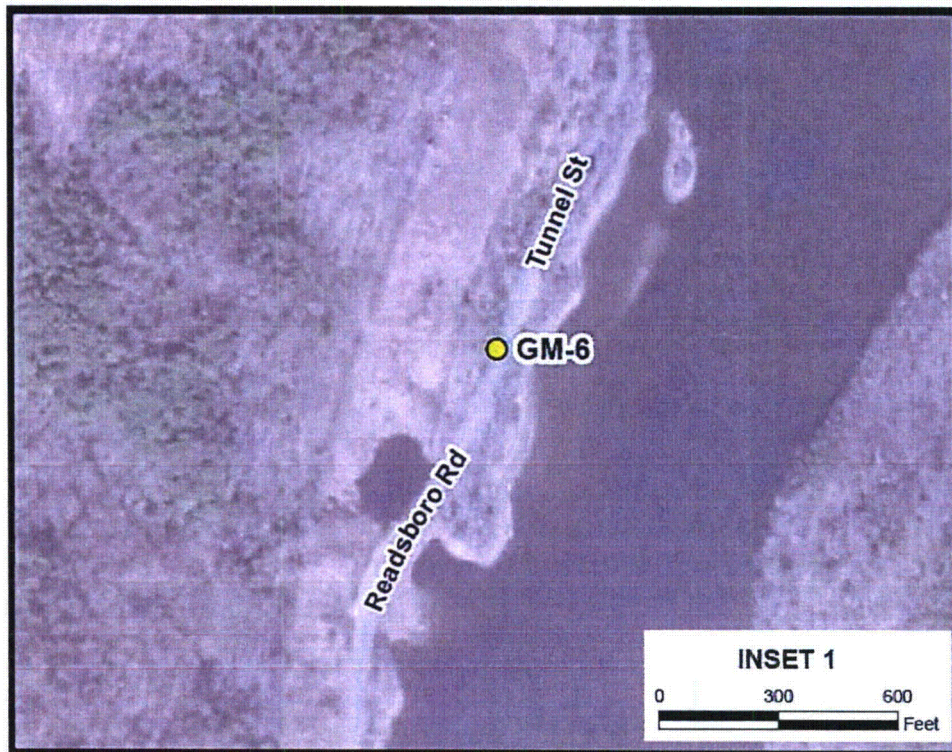
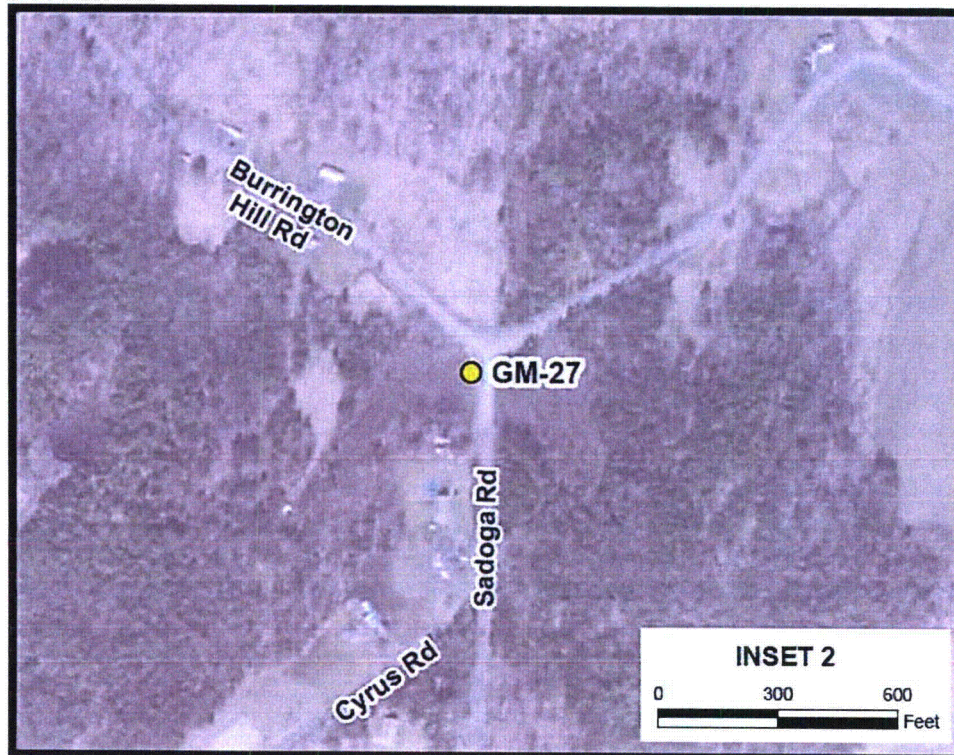




Figure 3.4  
Offsite Control Location



## **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)**

<b>Station ID</b>	<b>Location</b>	<b>1<sup>st</sup> Half-Year</b>	<b>2<sup>nd</sup> Half-Year</b>
GM-02	Observation Stand	48	37
GM-06	Tunnel Road Readsboro Town Line	49	42
GM-15	On-site perimeter	58	51
GM-16	On-site perimeter	51	46
GM-17	On-site perimeter	45	43
GM-21	On-site perimeter	45	43
GM-27	Control	36	38
GM-27a	Control Backup	45	37

**Note:** the TLD at location GM-16 was not present for retrieval at the end of the year. The value listed is the average of the year 2013 measurements.



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

Indicator TLDs	Control TLDs	Station With Highest Mean	
		Station #	Mean (Range) (No. Measurements)*
Mean (Range) (No. Measurements)*	Mean (Range) (No. Measurements)*		
46	39	GM-15	55
(37 – 58)	(36 – 45)		(51 – 58)
(11)	(4)		(2)

**Note:** the TLD at location GM-16 was not present for retrieval at the end of the year. The values listed in the Indicator TLDs column include the 2013 average GM-16 value substituted for the missing measurement.

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

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

Station ID	1 <sup>st</sup> Half-Year		2 <sup>nd</sup> Half-Year		Annual Dose
	Net TLD Result	Calculated Dose	Net TLD Result	Calculated Dose	
GM-02	7.50	0.43	0.00	0.00	0.43
GM-06	8.50	0.48	4.50	0.26	0.74
GM-15	17.50	1.00	13.50	0.77	1.77
GM-16	10.50	0.60	8.00*	0.46	1.06
GM-17	4.50	0.26	5.50	0.31	0.57
GM-21	4.50	0.26	5.50	0.31	0.57
			<b>Max Dose =&gt;</b>		<b>1.77</b>

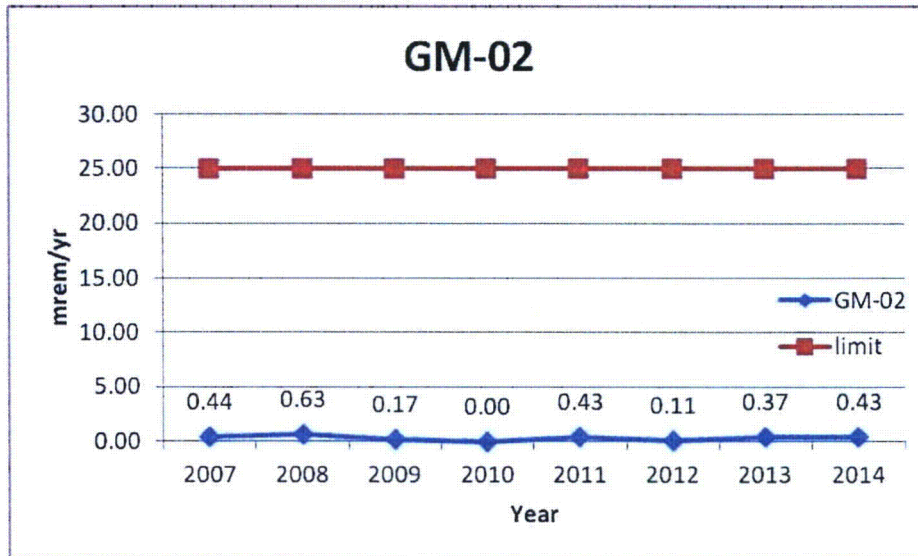
**Note:** the TLD at location GM-16 was not present for retrieval at the end of the year. The value shown in the Net TLD result column in the 2<sup>nd</sup> Half-Year was based upon the average of the year 2013 measurements.

**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. The analysis and trending of the REMP TLD data in this report has changed from the previous years. Previously, the net TLD results were converted to exposure rates, summarized and then plotted for trending purposes. Starting with this report, only the uncorrected TLD results will be summarized and the annual doses, calculated for “real members of the public” based upon guidance in the ODCM, will be plotted for trending.

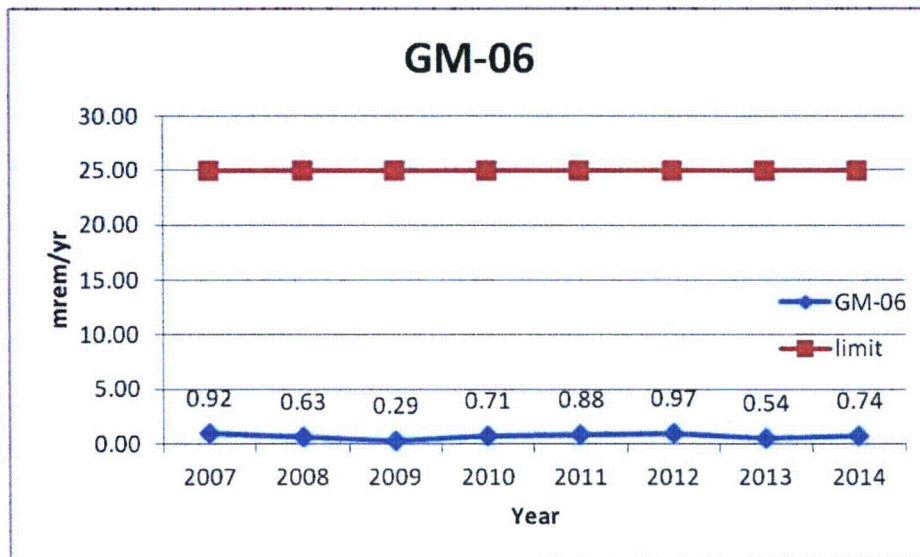
Figure 4.1 Annual Dose Trend at GM-02



Annual Doses (mrem/yr)

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

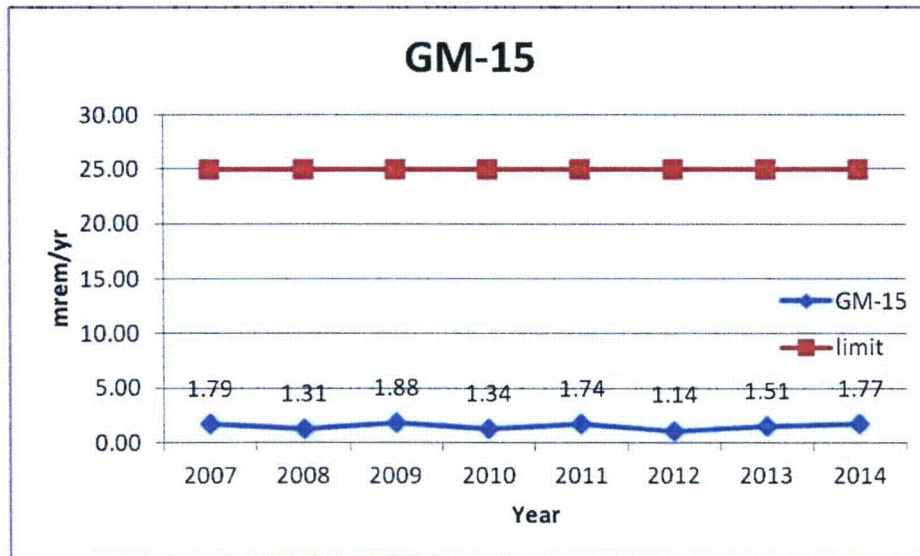
Figure 4.2 Annual Dose Trend at GM-06



Annual Doses (mrem/yr)

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

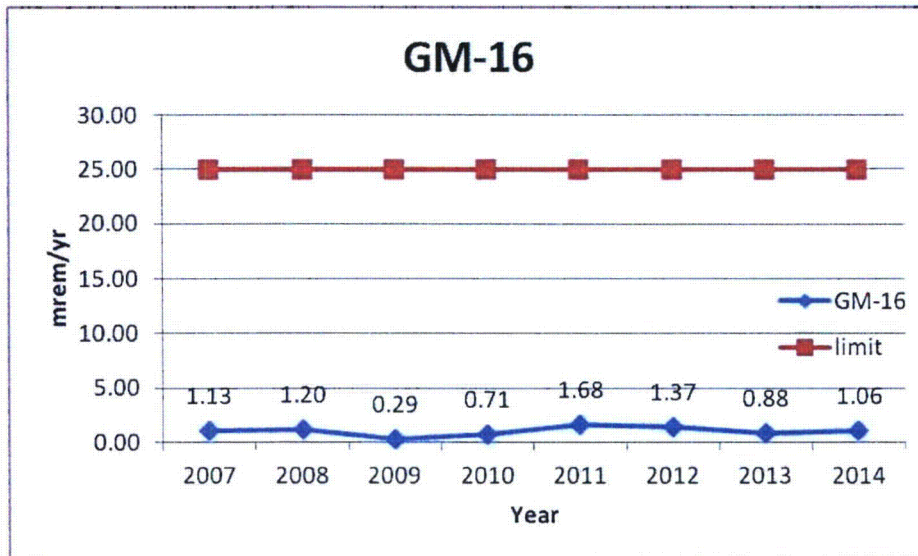
Figure 4.3 Annual Dose Trend at GM-15



Annual Doses (mrem/yr)

Location	2007	2008	2009	2010	2011	2012	2013	2014
GM-15	1.79	1.31	1.88	1.34	1.74	1.14	1.51	1.77

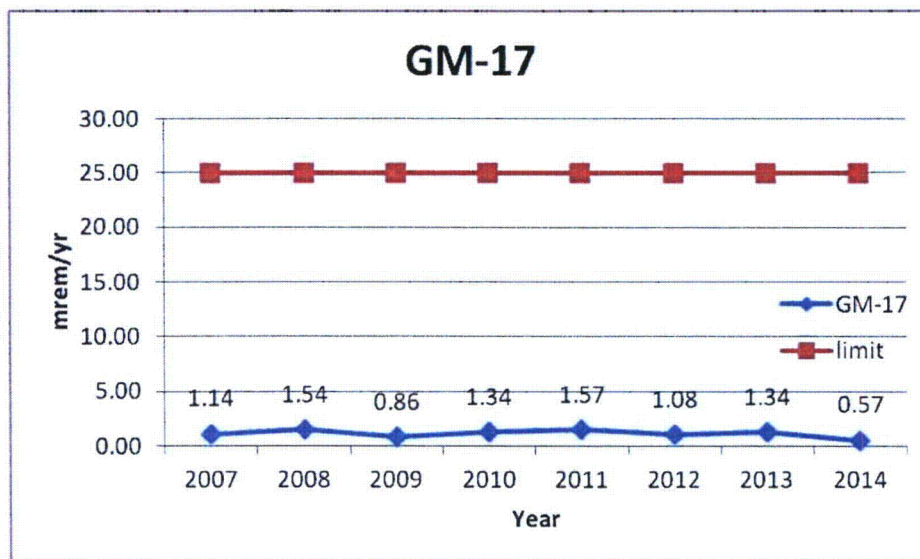
Figure 4.4 Annual Dose Trend at GM-16



Annual Doses (mrem/yr)

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

Figure 4.5 Annual Dose Trend at GM-17

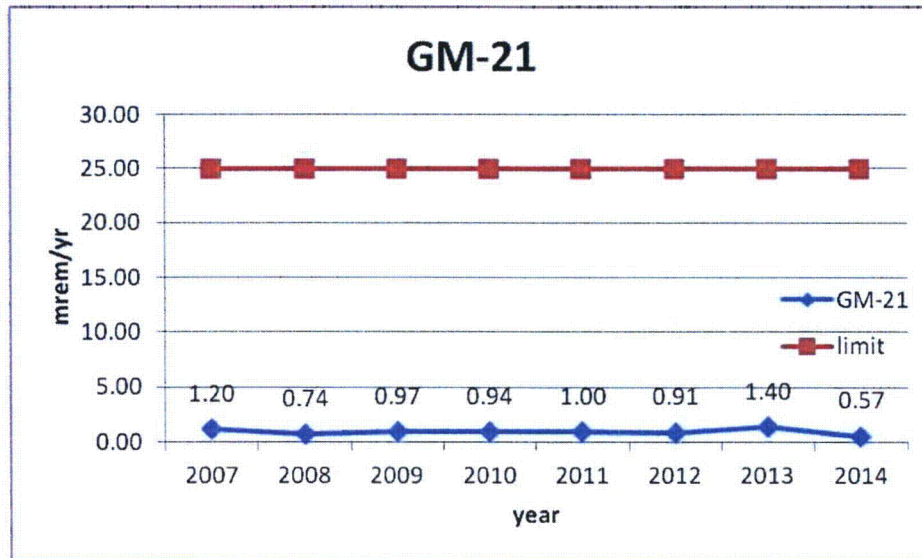


Annual Doses (mrem/yr)

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



Figure 4.6 Annual Dose Trend at GM-21



Annual Doses (mrem/yr)

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

## **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 two deviations in the sampling program in 2014.

1. The TLD at location GM-16 was not present for retrieval at the end of the year due to the tree it was mounted on was taken down by a beaver. The average of the year 2013 GM-16 readings were used as the value for the second half of 2014.
2. The incorrect TLD model was deployed at YNPS in 2014. At the time of the second quarter TLD change-out at the Connecticut Yankee and Maine Yankee ISFSI sites, it was discovered that the wrong type TLD (model BT36) was deployed instead of the requested TLD (model BT17). The model BT36 was also deployed at YNPS in 2014. A condition report was initiated and parallel testing at those two sites was initiated for the remainder of 2014. The results of the parallel testing concluded that the variation between the BT17 and BT36 TLD readings is insignificant and consistent with the variations observed in the past BT17 TLD readings.

### **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.

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 2014 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-15. The maximum calculated annual dose at this location is 1.77 mrem. This value is only 7 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 22.
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".