State of Wisconsin

2014

La Crosse Boiling Water Reactor

Environmental Radioactivity Survey

Wisconsin Department of Health Services
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State of Wisconsin, Department of Health Services

2014

La Crosse Boiling Water Reactor Environmental Monitoring Survey

Executive Summary

Wisconsin Stat. § 254.41 mandates the State of Wisconsin, Department of Health Services to conduct environmental radiation monitoring around the nuclear power facilities that affect Wisconsin. This environmental monitoring report is for the La Crosse Boiling Water Reactor (LACBWR) nuclear generating plant for the calendar year January - December 2014. It provides a description and results of this environmental monitoring program.

The Wisconsin Department of Health Services' environmental monitoring program consists of the collection of various types of samples from the air, water and terrestrial exposure pathways, sample analysis and interpretation of the data. The sampling program included samples of ambient gamma radiation, surface water, fish, soil and vegetation that are collected from selected locations at planned sampling intervals.

Program Summary

For 2014, all sample results from the LACBWR environmental monitoring area were less than state and federal standards or guidelines.

The Wisconsin Department of Health Services' environmental monitoring programs provide an ongoing baseline of radioactivity measurements to assess any Wisconsin health concerns from the operation of nuclear power generating facilities in or near Wisconsin or other radiological incidents that may occur within Wisconsin or worldwide. These monitoring programs show the following:

- Environmental radioactivity levels have been trending downward in the time period since the 1950s-1960s atmospheric nuclear testing and such radiological incidents as the Chernobyl nuclear reactor incident.
- There were no incidents during 2014, such as the 2011 Japan Fukushima Daiichi incident, that required additional environmental monitoring.
- There is no radioactive problem in types of food consumed in Wisconsin and no health problem related to radioactivity for Wisconsin citizens.

The Department's ongoing environmental monitoring programs will continue to provide assurances to the citizens of Wisconsin that the environment surrounding the LACBWR nuclear power facility and other monitoring areas will continue to be evaluated.

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Introduction

Wisconsin Stat. § 254.41 mandates the Wisconsin Department of Health Services (DHS) to conduct environmental radiation monitoring around the nuclear power facilities that affect Wisconsin. This environmental monitoring report is for the La Crosse Boiling Water Reactor (LACBWR) for the calendar year January - December 2014. It provides a description and results of this environmental monitoring program.

Wisconsin DHS LACBWR Environmental Monitoring Sampling Program

The Wisconsin DHS environmental monitoring program consists of the collection of various types of samples from the air, water and terrestrial exposure pathways. The sampling program included samples of ambient gamma radiation as measured by thermoluminescent dosimeters (TLD), surface water, fish, soil and vegetation that are collected from selected locations at planned sampling intervals.

Table 1 is a listing of sampling sites and includes a description, direction and distance from the monitored power plant. Table 2 provides a listing of the types of samples collected, sites where samples are collected, number of samples collected, number of samples that were missed or had noted problems and a listing of the required analyses. Table 3 provides an explanation of missing samples or non-routine sample analyses. Figure 1 is a map showing the location of each environmental sampling site.

Program Modifications

On April 30, 1987, Dairyland Power Cooperative permanently shut down the LACBWR facility. Their USNRC (United States Nuclear Regulatory Commission) licensee was amended to a possess-but-not-operate status on August 4, 1987, and they are now in the process of decommissioning the LACBWR facility. Since any severe accident involving the stored spent fuel will have little offsite consequences, the Wisconsin DHS environmental radioactivity monitoring program was modified in June 1988. These modifications included the elimination of precipitation, shoreline sediment, and well water samples as well as a reduction in vegetation, soil, and some surface water sampling.

In response to decommissioning and funding restrictions, the LACBWR environmental monitoring program was reviewed and modified in 1998, 1999, 2000, and 2013. The 2013 program modifications were made due to funding and the relocation of the spent nuclear fuel to the Independent Spend Fuel Storage Installation (ISFSI) in 2012. Table 1 shows current sample sites and discontinued sites in the third quarter of 2013.

Due to LACBWR's limited sampling and assistance to the Radiation Protection Section, additional modifications to the program were implemented beginning with the first quarter of 2014.

TLD: The two (2) TLDs on the inside of the outer fence were moved to the outside of the outer fence. The TLD sites were renumbered to better reflect their present positioning. Quarterly monitoring will be continued at the remaining four (4) sites.

Surface water: Surface water sampling at the two (2) sites—LAC-2 and LAC-3—was discontinued. One surface water site sample at LAC-4 will be collected on an annual basis.

Fish: Fish sampling was changed from semi-annual to annual.

Bottom Sediment: Bottom sediments were discontinued in June of 2014.

Laboratory Services and Quality Assurance

Analysis of the samples is performed under contract with the Wisconsin State Laboratory of Hygiene (WSLH). WSLH maintains a quality assurance program. Analytical procedures provide for routine replicate analyses to verify methods and instrument operation. Traceable sources are used daily to regularly calibrate instrumentation and conduct performance checks. Instrumentation quality control charts are maintained and available upon written request.

WSLH participates in the Environmental Resource Associates' Proficiency Testing program and has performed satisfactorily over the report period. In addition, WSLH participates in the Multi Analytical Performance Evaluation Program (MAPER) for environmental matrix analysis. Proficiency testing results are available from the Wisconsin State Laboratory of Hygiene.

Detection Limits

Detection limits, required by Wisconsin DHS, will be expressed as a lower limit of detection (LLD). The required DHS LLD, as indicated in Table 4 under the heading "LLD," is an "a priori" estimate of the capability for detecting an activity concentration by a given measurement system, procedure, and type of sample. Counting statistics of the appropriate instrument background are used to compute the LLD for each specific analysis. Using 4.66 times the standard deviation (s_b) of the instrument background, the LLD for each specific analysis is defined at the 95% Confidence Level.

The LLD for each radioisotope listed in Table 4 has been calculated from the following equation:

$$LLD = \frac{4.66\, s_b}{E * V * 2.22 * Y * S * \exp(-dt)}$$

Where:

LLD	is the "a priori" lower limit of detection as defined above, as picocuries per unit mass or volume,
s_b	is the standard deviation of the background counting rate or of the counting rate of blank sample as appropriate, as counts per minute,
E	is the counting efficiency, as counts per disintegration,
V	is the sample size in units of mass or volume,
2.22	is the number of disintegrations per minute per picocurie,
Y	is the fractional radiochemical yield, when applicable,
S	is the self-absorption correction factor,
d	is the radioactive decay constant for the particular radionuclide, and
t	for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting.

Typical values for E, V, Y and dt have been used to calculate the LLD.

Reporting of Sample Analysis Results

Results for specific analyses will be reported as either a "less than" (<) value or an actual activity value The reporting of results in Table 4 under the heading "Range" and in Tables 5-8 is an "a posteriori" calculation based on the actual analysis performed using the actual sample values for E, V, Y and dt. Typically the reported "less than" (<) results are lower than the required Wisconsin DHS LLD, indicating that the required DHS LLD has been met.

An actual activity value will be accompanied by an uncertainty term for that analysis. The uncertainty term is a plus or minus counting uncertainty term at the 2 sigma (95%) confidence interval and is printed as (+- or $\pm$). Examples and explanations of data reporting are:

Example	**Nuclide**	**Activity reported**
1	^{137}Cs	< 10 pCi/liter
2	^{137}Cs	15 $\pm$ 3 pCi/liter

In example 1 we can be 95% confident that the sample activity, if any, is less than the LLD of 10 pCi/liter. In example 2 we can be 95% confident that the actual sample activity is greater than the LLD for that analysis and is between 12 and 18 pCi/liter.

Table 1. Wisconsin DHS LACBWR environmental monitoring sampling sites.

Sample site	Distance and direction (miles)	Location description
LAC-1	15.0 N	La Crosse State Office Building (discontinued July 2010)
LAC-2	0.6 N	Lock & Dam #8 (discontinued January 2014)
LAC-3	0.1 WSW	Discharge channel (discontinued January 2014)
LAC-4	0.7 SSW	Boat launch area
LAC-5	0.6 NNE	Hwy 35 parking lot
LAC-6	0.7 S	Boat launch access road
LAC-7	0.8 ENE	Philip Malin farm (discontinued January 2001)
LAC-T1	0.6 N	Lock & Dam #8
LAC-T2	0.5 SSE	Edgewood Trailer Court, Hwy 35
LAC-T3	0.2 S	ISFSI outer fence (outside on fence)
LAC-T4	0.2 W	ISFSI outer fence (outside on fence)

Table 2. Sample collection summary and required analyses.

Sample Type	Collection and Frequency	LAC Site locations	Number of Samples Collected	Number of Sample Deviations	Required Analyses
air particulate	C/BW	discontinued			
TLD	G/Q	LAC T1-T4	15	1	direct exposure
surface water	G/A	LAC 2,3	2	0	GA, GB, GI, Sr, H
bottom sediment	G/A	discontinued			
fish	G/A	LAC 3	2	0	GI
vegetation	G/A	LAC 5, 6	2	0	GA, GB, GI
soil	G/A	LAC 5, 6	2	0	GA, GB, GI

Collection type: C/ = continuous; G/ = grab

Frequency: /W = weekly; /M = monthly; /Q = quarterly; /A = annually; /BW = bi-weekly; /SA = semi-annually

Required analyses: GA = gross alpha; GB = gross beta; GI = gamma isotopic; Sr = strontium; H = tritium

Table 3. Wisconsin DHS missing sample or non-routine analysis report for 2014.

Sample type	Date	Site	Explanation
TLD	07-15-14	LAC –T1	TLD was lost in the field

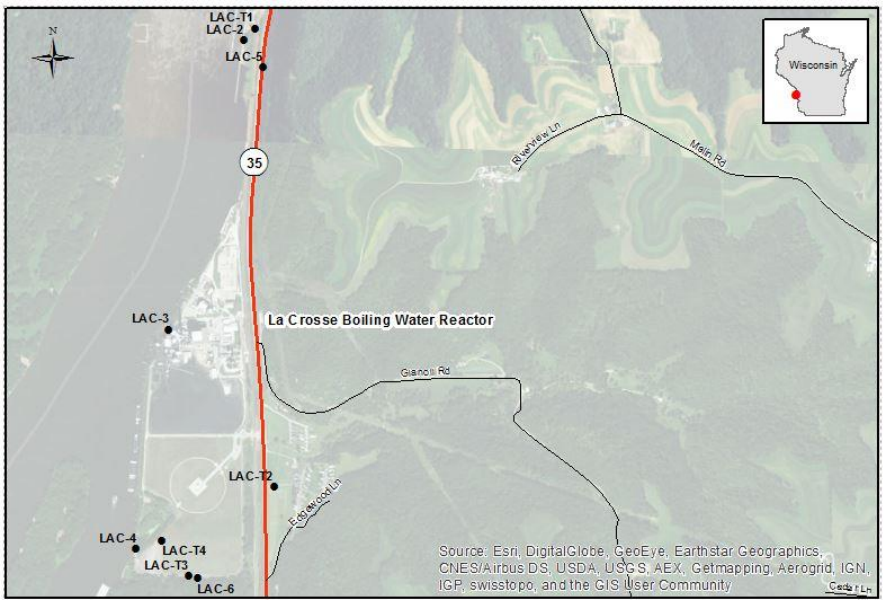

Figure 1. Wisconsin DHS environmental monitoring sampling sites for the LACBWR monitoring program.

Results and Discussion for the LACBWR Environmental Monitoring Program

Ambient Gamma Radiation - Thermoluminescent Dosimeters (TLDs)

A summary of reported activities by Wisconsin DHS for ambient gamma radiation is included in Table 4. Results from the individual sample analyses are listed in Table .

Ambient gamma radiation (TLD) data for 2014 from the Wisconsin DHS network was comparable for all sites. Significant differences in exposure were not noticed at different distances from the LACBWR facility. The average quarterly exposure from the four sites located within Wisconsin was 14.6 $\pm$ 1.9 milliroentgens. The average quarterly exposure for 2014 is at background levels and is comparable to other areas within Wisconsin. Influence by the LACBWR facility is not evident from air ambient gamma radiation analysis.

Fish

A summary of reported activities by Wisconsin DHS for fish samples is included in Table 4. Results from the individual sample analyses are listed in Table 6.

Fish samples showed no unusual activities. Naturally occurring potassium-40 (^{40}K) was reported in all samples. All other radioisotopes were below their respective lower limit of detection. Influence by the LACBWR facility is not evident from fish sample analysis.

Surface Water

A summary of reported activities by Wisconsin DHS for surface water samples is included in Table 4. Results from the individual sample analyses are listed in Table 8.

Surface water samples showed no unusual activities. All detected activities are at background levels and are comparable to data from previous years. The surface water samples uniformly show activities below state or federal standards. Influence by the LACBWR facility is not evident from surface water sample analysis.

Vegetation

A summary of reported activities by Wisconsin DHS for vegetation samples is included in Table 4. Results from the individual sample analyses are listed in Table 7.

Analysis of the vegetation samples showed no unusual activities. The gamma isotopic analysis detected only small amounts of naturally occurring potassium-40 (^{40}K) listed in Table 4. Influence by the LACBWR facility is not evident from vegetation sample analysis.

Soil

A summary of reported activities by Wisconsin DHS for soil samples is included in Table 4. Results from the individual sample analyses are listed in Table 7.

Analysis of the soil samples showed no unusual activities. The gamma isotopic analysis detected only small amounts of the radionuclides listed in Table 4. The naturally occurring radioisotope potassium-40 (^{40}K) was detected in all samples. The reported activities for cesium-137 (^{137}Cs) were also detected in previous years and can be attributed to residual fallout from previous atmospheric nuclear weapons tests. Naturally occurring radioisotopes from the uranium-238 (^{238}U) and thorium-232 (^{232}Th) decay series are commonly detected but have not been quantified or reported. Influence by the LACBWR facility is not evident from soil sample analysis.

Dose to an Average Individual

Federal regulations 10 CFR 20, 10 CFR 50 Appendix I and 40 CFR 190 restrict the annual exposure of the population from all parts of the nuclear fuel cycle, including nuclear power plants. Doses resulting from gaseous and liquid effluent releases from the LACBWR facility are less than the limits as stated in these Federal regulations.

The Wisconsin DHS limits for permissible levels of radiation exposure from external sources in unrestricted areas are defined in the Wis. Admin. Code § DHS 157.23. Doses resulting from gaseous and liquid effluent releases from the LACBWR facility are less than the limits as stated in Wis. Admin. Code § DHS 157.23.

References

State of Wisconsin, Wis. Admin. Code § DHS 157.23

US Environmental Protection Agency (EPA), Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, Federal Guidance Report No. 11, EPA-520/1-88-020, (Office of Radiation Programs Washington, DC), September 1988.

U.S. Environmental Protection Agency, Environmental Radiation Requirements for Normal Operations of Activities in the Uranium Fuel Cycle, EPA 520/4-76-016, 40 CFR Part 190, November 1976.

U.S. Nuclear Regulatory Commission, Title 10, Part 20.

U.S. Nuclear Regulatory Commission, Title 10, Part 50, Appendix I.

Sample Activity Summary

Table 4. Sample activity summary for the Wisconsin DHS LACBWR environmental monitoring program.

Sample type (units)	LLD	Number of samples [a]	Analysis	Range
Direct Exposure (TLD) (mR/Std Qtr)	1.0 [b]	15 / 15	direct exposure	9.7 – 23
Surface Water (pCi/liter)	3.0	2 / 0	gross alpha (sol)	1.0 – 2.1
	3.0	2 / 1	gross beta (sol)	1.7 – 3.1
	3.0	2 / 0	gross alpha (insol)	< 0.6
	3.0	2 / 0	gross beta (insol)	< 1.3
	300	2 / 0	H-3	< 220
	2.0	2 / 0	Sr-89	< 0.6
	1.0	2 / 0	Sr-90	< 0.3
			gamma isotopic	
	10	2 / 0	Mn-54	< 7
	15	2 / 0	Co-58	< 8
	30	2 / 0	Fe-59	< 15
	15	2 / 0	Co-60	< 10
	30	2 / 0	Zn-65	< 14
	15	2 / 0	Nb-95	< 7
	30	2 / 0	Zr-95	< 12
	15	2 / 0	I-131	< 16
	15	2 / 0	Cs-134	< 8
	15	2 / 0	Cs-137	< 11
	60	2 / 0	Ba-140	< 38
	15	2 / 0	La-140	< 13
Soil (pCi/kg dry)	13000	2 / 1	gross alpha	7730 – 13400
	6000	2 / 2	gross beta	11100 – 32100
			gamma isotopic	
	800	2 / 2	K-40	9600 – 30000
	60	2 / 0	Mn-54	< 26
	90	2 / 0	Co-58	< 26
	600	2 / 0	Fe-59	< 29
	90	2 / 0	Co-60	< 67
	300	2 / 0	Zn-65	< 33
	100	2 / 0	Nb-95	< 45
	250	2 / 0	Zr-95	< 48
	80	2 / 0	Cs-134	< 23
	80	2 / 0	Cs-137	< 31

Table 4. Sample activity summary for the Wisconsin DHS LACBWR environmental monitoring program, continued.

Sample type (units)	LLD	Number of samples [a]	Analysis	Range
Vegetation	5000	2 / 0	gross alpha	< 799
(pCi/kg wet)	4000	2 / 1	gross beta	2810 – 9820
			gamma isotopic	
	600	2 / 0	Be-7	417 – 520
	2000	2 / 2	K-40	3550 – 5800
	90	2 / 0	Mn-54	< 22
	100	2 / 0	Co-58	< 18
	200	2 / 0	Fe-59	< 37
	100	2 / 0	Co-60	< 28
	250	2 / 0	Zn-65	< 36
	100	2 / 0	Nb-95	< 16
	200	2 / 0	Zr-95	< 35
	80	2 / 0	I-131	< 48
	80	2 / 0	Cs-134	< 20
	90	2 / 0	Cs-137	< 21
	350	2 / 0	Ba-140	< 104
	100	2 / 0	La-140	< 38
fish			gamma isotopic	
(pCi/kg wet)	800	2 / 2	K-40	2720 – 2790
	50	2 / 0	Mn-54	< 3
	60	2 / 0	Co-58	< 5
	130	2 / 0	Fe-59	< 21
	60	2 / 0	Co-60	< 4
	130	2 / 0	Zn-65	< 8
	50	2 / 0	Nb-95	< 15
	100	2 / 0	Zr-95	< 11
	50	2 / 0	Cs-134	< 3
	60	2 / 0	Cs-137	< 3

a - Number of analysis / number of analyses detected above the Wisconsin DHS LLD.

b – 1.0 mR / TLD.

Table 5. Wisconsin DHS TLD network for the LACBWR environmental monitoring program.

	1st quarter	**2nd quarter**	**3rd quarter**	**4th quarter**
Date Placed:	01/23/14	04/24/14	07/15/14	10/15/14
Date Removed:	04/24/14	07/15/14	10/15/14	01/12/15
Days in the Field:	91	82	92	89
Individual quarterly date is reported as: mR / Standard Quarter + 2 sigma counting error.				
LAC-T1	11.7 +- 1.7	9.7 +- 1.2	ND	15.3 +- 0.7
LAC-T2	12.9 +- 1.2	13.7 +- 1.5	12.6 +- 0.8	20.5 +- 1.3
LAC-T3	14.6 +- 1.1	15.7 +- 1.2	13.8 +- 0.8	23.3 +- 0.5
LAC-T4	12.4 +- 1.3	11.8 +- 1.5	12.7 +- 1.1	20.1 +- 1.1

ND = No Data, TLD lost in the field

Table 5. Wisconsin DHS analysis results for fish samples collected for the LACBWR environmental monitoring program.

Measurements in units of pCi/kilogram (wet)		
Collection date:	3/28/2014	3/28/2014
Type	carp	northern pike
gamma isotopic		
K-40	2720 +- 440	2790 +- 450
Mn-54	< 3	3
Co-58	< 5	5
Fe-59	< 21	19
Co-60	< 3	4
Zn-65	< 7	8
Nb-95	< 15	14
Zr-95	< 11	11
Cs-134	< 3	3
Cs-137	11 +- 2	3

Radioisotopes other than those reported were not detected.

Table 6. Wisconsin DHS analysis results for vegetation and soil samples collected for the LACBWR environmental monitoring program.

Vegetation - Measurements in units of pCi/kilogram (wet)

Site:	LAC-5	LAC-6
Collection date:	6/2/2014	6/2/2014
gross alpha	< 640	< 799
gross beta	2810 +- 250	9820 +- 456
gamma isotopic		
Be-7	520 +- 110	417 +- 105
K-40	5800 +- 1000	3550 +- 672
Mn-54	< 13	< 22
Co-58	< 16	< 18
Fe-59	< 32	< 37
Co-60	< 17	< 28
Zn-65	< 28	< 36
Nb-95	< 16	< 15
Zr-95	< 24	< 35
I-131	< 28	< 48
Cs-134	< 10	< 20
Cs-137	< 14	< 21
Ba-140	< 74	< 104
La-140	< 24	< 38

Soil - Measurements in units of pCi/kilogram (dry)

Site:	LAC-5	LAC-6
Collection date:	6/12/2014	6/12/2014
gross alpha	7730 +- 3100	13400 +- 3680
gross beta	23100 +- 1530	11100 +- 1250
gamma isotopic		
K-40	30000 +- 4800	9600 +- 1600
Mn-54	< 26	20
Co-58	< 26	18
Fe-59	< 66	48
Co-60	< 29	23
Zn-65	< 67	47
Nb-95	< 33	29
Zr-95	< 45	40
Cs-134	< 23	20
Cs-137	< 31	22

Naturally occurring radioisotopes such as radium-226 (^{226}Ra), bismuth-214 (^{214}Bi), lead-214 (^{214}Pb), actinium-228 (^{228}Ac), bismuth-212 (^{212}Bi), lead-212 (^{212}Pb) from the naturally occurring uranium-238 (^{238}U) and thorium-232 (^{232}Th) decay series are commonly detected but have not been quantified or reported.

Radioisotopes other than those reported were not detected.

Table 7. Wisconsin DHS analysis results for surface water samples collected for the LACBWR environmental monitoring program.

Measurements in units of pCi/liter

LAC-2; Lock & Dam #8

Site:	LAC-2; Lock & Dam #8	LAC-3; discharge channel
Collection date:	6/2/2014	
gross alpha-sol	2.1 +- 1.0	1.0 +- 0.8
gross beta-sol	1.7 +- 1.1	3.1 +- 1.0
gross alpha-insol	< 0.5	< 0.6
gross beta-insol	< 1.1	< 1.3
H-3	< 220	< 220
Sr-89	< 0.5	< 0.6
Sr-90	< 0.2	< 0.3
gamma isotopic		
Mn-54	< 6	< 7
Co-58	< 5	< 8
Fe-59	< 15	< 15
Co-60	< 7	< 10
Zn-65	< 12	< 14
Nb-95	< 7	< 7
Zr-95	< 10	< 12
I-131	< 10	< 16
Cs-134	< 5	< 8
Cs-137	< 6	< 11
Ba-140	< 26	< 38
La-140	< 13	< 13

Radioisotopes other than those reported were not detected.