UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DAIRYLAND POWER COOPERATIVE	)	Docket No. 50-409
	)	(FTOL Proceeding)
(La Crosse Boiling Water Reactor)	)	

AFFIDAVIT OF EDWARD F. BRANAGAN, JR.
REGARDING INTERVENORS' CONTENTIONS 2A AND 8

My name is Edward F. Branagan, Jr. I am employed by the Nuclear Regulatory Commission in the Radiological Assessment Branch of the Division of Systems Integration. I have been employed in this position since 1979. My professional qualifications are attached as Enclosure 1 to this affidavit. This affidavit was prepared by me.

The purpose of this affidavit is to present written testimony addressing Contentions 2A and 8 admitted for litigation in this proceeding.

Contention 2A reads as follows:

> CREC contends that the excessive off-gas emissions from LACBWR are inimical to public health and safety, and fail to comply with the restrictions set forth in 10 C.F.R. Part 50, Appendix I.

Response

The regulations in 10 C.F.R. 50 Appendix I set numerical design objectives for limiting the doses to offsite individuals to as low as reasonably achievable (ALARA) levels. There are three categories of radioactive effluents from light water reactors such as the La Crosse reactor: (1) all liquid effluents;

8006090213
G

(2) noble gas effluents released to the atmosphere; and (3) radioiodines and particulates released to the atmosphere. It is the NRC Staff's view that compliance with these design objectives is sufficient to protect the public health and safety. I will discuss, in turn, the estimated dose and the applicable design objective(s) for each category of radioactive effluent.

For liquid effluents, Appendix I sets a design objective for annual doses of 3 millirem to the total body, and 10 millirem to any organ from all pathways. Based on the liquid effluent source terms (i.e., Table 3.6-2), and the dilution factors and transit times (i.e., Table 5.5-6) in the Final Environmental Statement (NUREG-0191), the calculated dose to the total body and the highest dose to any organ (i.e., 0.7 millirem, and 0.8 millirem, respectively) are estimated to be less than one-fourth of the design objective values (see Table 5.5-4). Consequently, the quantity of liquid effluents that are estimated to be released in the future should result in doses within the design objectives of 10 C.F.R. 50 Appendix I for liquid effluents.

For noble gases, Appendix I sets four design objectives for annual doses: (1) 10 millirad for the gamma ray air dose; (2) 20 millirad for the beta ray air dose; (3) 5 millirem to the total body of an individual and (4) 15 millirem to the skin of an individual. The estimated noble gas source term for future releases is contained in Table 3.6-3 of the FES. Based on the noble gas source term and the maximum atmospheric dispersion (X/Q) value (i.e., FES Table 5.5-2), the estimated annual doses (5.6 mrad for the gamma air dose, 3.8 mrad for the beta air dose, 3.7 mrem to the total body of an individual, and 7.4 mrem to the skin of an individual are less than 75% of the design objectives. Consequently, the quantity of noble gases that are estimated to be released in the future, comply with the design objectives of 10 C.F.R. 50 Appendix I.

For radioiodines and particulates released to the atmosphere, Appendix I sets a design objective of 15 mrem to any organ from all pathways. The estimated radioiodine and particulate source term for future releases is contained in Table 3.6-3 of the FES. Based on the radioiodine and particulate source terms, and the relative deposition (D/Q) and the atmospheric dispersion (X/Q) values for nearby offsite locations, the highest dose to any organ (2.2 mrem to the thyroid) was estimated to be less than one-fifth of the design objective (see FES Table 5.5-4). Consequently, the quantity of radioiodines and particulates that are estimated to be released in the future, comply with the design objectives of 10 C.F.R. 50 Appendix I.

Contention 8 reads as follows:

> CREC contends that LACBWR's radiological environmental monitoring program is inadequate in terms of
> a) the methodology of the testing
> b) the size and distribution of the sample, and
> c) the frequency of the sampling, in light of the off-gas levels, the geography of the area to the east of the plant, and the fact that the area is primarily a dairy region.

<u>Response</u>

The NRC requires two types of radiological monitoring at nuclear power reactors to ensure that radioactive effluents are within acceptable limits: (1) radiological effluent monitoring; and (2) radiological environmental monitoring. Radiological effluent monitors are required to monitor and control, as applicable, the releases of radioactive materials in liquid and gaseous effluents during actual or potential releases. In addition, the NRC requires that the operator of a nuclear power reactor conduct radiological environmental monitoring to confirm that measured releases of radioactivity (i.e. radiological effluent monitoring) from the plant do not result in unanticipated build-ups in the environment. The requirements for an acceptable radiological monitoring program for nuclear power reactors are contained in the NRC's "Branch Technical Position" (Revision 1, Nov. 1979, see Enclosure 2). Since Contention 8 alleges that the radiological environmental monitoring program is inadequate, the discussion that follows is limited to the radiological environmental monitoring program rather than radiological effluent monitoring.

The Branch Technical Position requires that the licensee monitor the principal pathways of exposure to radioactivity. Table 1 contains a summary of the exposure pathways, sample locations, frequency of sampling, and types of analysis in the La Crosse radiological environmental monitoring program. These pathways and types of analysis include monitoring of: (1) radioiodines in air for I-131; (2) particulates in air for gross beta activity and gamma isotopic analysis; (3) direct radiation for gamma dose; (4) surface and ground water for tritium and gamma isotopic analysis; (5) drinking water for gross beta, tritium and gamma isotopic analysis; (6) shoreline sediment for gamma isotopic analysis; (7) milk for I-131 and gamma isotopic analysis, (8) fish and invertebrates for gamma isotopic analysis, and (9) food for gamma isotopic analysis. Consequently, the methodology of the radiological environmental monitoring program at the La Crosse nuclear power plant is adequate to ensure that the principal pathways of exposure are monitored.

The size (number of sample locations) and distribution (sample locations) of samples collected and analyzed are given in Table 1. Comparison of the number and distribution of samples in Table 1 with the requirements of the "Branch Technical Position" (see Table 1 of Enclosure 2) indicates that the size and distribution of samples is adequate to monitor the principal pathways of exposure.*/

The lower limits of detection of radioactivity in various types of samples are listed in Table 2. These limits conform to the basic requirements of the "Branch Technical Position" (see Table 2 of Enclosure 2). In addition, Dairyland Power Cooperative is required to participate in an Interlaboratory Comparison Program to ensure the precision and accuracy of the measurements of radioactive material in environmental samples. The lower limits of detection of radioactivity in the La Crosse program, in combination with the requirements for participation in an Interlaboratory Comparison Program, ensure that the size (i.e., volume or weight) or samples is adequate to meet the basic requirements of the Branch Technical Position.

---

*/ After the licensee applied for conversion of Provisional Operating License No. 45 to a full-term operating license, the Branch Technical Position was updated to increase the number of direct radiation monitors to 40. The licensee will be required to meet this new requirement and to update the technical specifications in the near future.

The frequency of radiological environmental sampling of the La Crosse nuclear plant ranges from at least weekly to annual sampling, depending on the type of sample (see Table 1). Milk samples are collected biweekly during the grazing season, and monthly at other times. Water samples are collected on either a monthly or a quarterly basis (depending on the type of sample), and dosimeters are collected on a quarterly basis. Sediment from the shoreline, and fish and invertebrate samples are collected at least semi-annually if not seasonally. Vegetation samples are collected at the time of harvest. Comparison of the frequency of sampling at the La Crosse nuclear plant with the requirements of the "Branch Technical Position" (see Table 1 in Enclosure 2), indicates that the sampling frequency is adequate to monitor the principal pathways of exposure.

TABLE 1≠

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations**	Sampling and Collection Frequency	Type of Frequency of Analysis
1. AIRBORNE			
a. Radioiodine and Particulates	Locations #4, #6, #15, #16, #17, #18, and #22	Continuous operation of sampler with sample collection as required by dust loading but at least once per 7 days.	Radioiodine canister. Analyze at least once per 7 days for I-131. Particulate sampler. Analyze for gross beta radioactivity ≥ 24 hours following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is > 10 times the mean of control sample. Perform gamma isotopic analysis on composite (by location) sample at least once per 92 days.
2. DIRECT RADIATION	Locations #1-#21 ≥ 2 dosimeters at each location.	At least once per 92 days.	Gamma dose. At least once per 92 days.

**Sample locations are shown on Figure 1 in Enclosure 3.

≠ This table was taken from Proposed Changes to Technical Specifications in a letter from Frank Linder, General Manager of Dairyland Power Cooperative, to Dennis L. Ziemann dated August 4, 1979.

TABLE 1 - (Cont'd)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations**	Sampling and Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE			
a. Surface	Locations #15, #27 and #30	Composite* sample collected over a period of ≤ 31 days.	Gamma isotopic analysis of each composite sample. Tritium analysis of composite sample at least once per 92 days.
b. Ground	Locations #6 and #29	At least once per 92 days.	Gamma isotopic and tritium analyses of each sample.
c. Drinking	Locations #24 and #31	Sample collected at least every 31 days.	Gross beta and gamma isotopic analysis of each sample. Tritium analysis of composite sample at least once per 92 days.
d. Sediment from Shoreline	Locations #22, #27, and #30	At least twice per year.	Gamma isotopic analysis of each sample.

*Composite samples shall be collected by collecting an aliquot during at least three batch effluent discharges.

**Sample locations are shown on Figure 1 of Enclosure 3.

TABLE 1 - (Cont'd)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations**	Sampling and Collection Frequency	Type and Frequency of Analysis
4. INGESTION			
a. Milk	Locations #17, #18, and #23	At least once per 15 days when animals are on pasture; at least once per 31 days at other times.	Gamma isotopic and I-131 analysis of each sample.
b. Fish and Invertebrates	Locations #15 or #26 and #30 or #27 or #28	One sample in season, or at least once per 184 days if not seasonal. One sample of each of the following species at two locations: 1. Carp 2. Catfish	Gamma isotopic analysis on edible portions.
c. Food Products	Locations #17, #16 or #23, and #18	At time of harvest. One sample of each of the following classes of food products: 1. Legumes 2. Feed Grains 3. Garden Vegetables	Gamma isotopic analysis on edible portion.
	Location #17	At time of harvest. One sample of broad leaf vegetation.	Gamma isotopic analysis.

**Sample locations are shown on Figure 1 of Enclosure 3.

TABLE 2

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)[a]

Analysis	Water (pCi/l)	Airborne Particulate or Gas (pCi/m^3)	Fish (pCi/kg,wet)	Milk (pCi/l)	Food Products (pCi/kg,wet)	Sediment (pCi/kg,dry)
gross beta	4[b]	1×10^{-2}				
^{3}H	2000(1000[b])					
^{54}Mn	15		130			
^{59}Fe	30		260			
$^{58,60}Co$	15		130			
^{65}Zn	30		260			
$^{95}Zr\text{-}Nb$	15					
^{131}I	1	7×10^{-2}		1	60[c]	
$^{134,137}Cs$	15(10[b]), 18	1×10^{-2}	130	15	80	150
$^{140}Ba\text{-}La$	15			15		

*This table was taken from Proposed Changes to Technical Specifications in a letter from Frank Linder, General Manager of Dairyland Power Cooperative, to Dennis L. Ziemann (NRC/NRR) dated August 14, 1979.

TABLE 2
(Cont'd)

TABLE NOTATION

a - The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radio-chemical separation):

$$LLD = \frac{4.66\ s_b}{E \times V \times 2.22 \times Y \times \exp(-\lambda \Delta t)}$$

WHERE:

LLD is the lower limit of detection as defined above (as pCi per unit mass or volume)

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E is the counting efficiency (as counts per transformation)

V is the sample size (in units of mass or volume)

2.22 is the number of transformation per minute per picocurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting

The value of s_b used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma-ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples (e.g., potassium-40 in milk samples.

TABLE 2
(Cont'd)

TABLE NOTATION

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

b - LLD for drinking water.

c - LLD for leafy vegetables.

In summary, the methodology of testing; size, distribution and frequency of sampling in the La Crosse radiological environmental monitoring program meets the basic requirements of the NRC "Branch Technical Position," and are adequate to confirm that measured releases of radioactivity do not result in unacceptable doses to the public.

I have read the foregoing affidavit and swear that it is true and correct to the best of my knowledge and belief.

Edward F. Branagan, Jr.

Edward F. Branagan, Jr.

Subscribed and sworn to before me
this 20th day of May, 1980

Notary Public

My Commission Expires: July 1, 1980.

Professional Qualifications

My name is Edward F. Branagan, Jr. I am an Environmental Scientist with the Radiological Assessment Branch in the Office of Nuclear Reactor Regulation. Presently, I am responsible for evaluating the environmental radiological impacts from nuclear power reactors. In particular, I am responsible for evaluating radioecological models and health effect models for use in reactor licensing. I have been with the Radiological Assessment Branch for about 1 year.

I received a B.A. in Physics from Catholic University in 1969, an M.A. in Science Teaching from Catholic University in 1970, and a Ph.D. in Radiation Biophysics from Kansas University in 1976. While completing my course work for my Ph.D., I was an instructor of Radiation Technology at Haskell Junior College. My research work was in the area of DNA base damage, and was supported by a U.S. Public Health Service tranineeship. My dissertation was entitled "Nuclear Magnetic Resonance Spectroscopy of Gamma-Irradiated DNA Bases."

Since joining the NRC in 1976, I have been with both the Office of Nuclear Material Safety and Safeguards (NMSS), and with the Office of Nuclear Reactor Regulation (NRR). In NMSS I was involved in project management and technical work. I was the project manager for two contracts that the NRC had with Oak Ridge National Laboratory. These contracts were concerned with estimating radiation doses from radon-222 and radium-226 releases from uranium mills. As part of my work on NRC's Draft Generic Environmental Impact Statement on Uranium Milling (DGEIS), I calculated health effects from uranium mill tailings. Upon publication of the DGEIS, I presented a paper entitled "Health Effects of Uranium Mining and Milling for Commercial Nuclear Power" at a Conference on Health Implications of New Energy Technologies. Since joining NRR, I have worked on several projects: (1) analyzed the radioecological models in the "Heidelberg Report," and (2) served as a technical contact on an NRC contract with Argonne National Laboratory involving development of a computer program to calculate health effects from radiation.

Presently, I am a member of the Health Physics Society and the American Association for the Advancement of Science.

Revision 1
November 1979

Branch Technical Position

Background

Regulatory Guide 4.8, Environmental Technical Specifications for Nuclear Power Plants, issued for comment in December 1975, is being revised based on comments received. The Radiological Assessment Branch issued a Branch Position on the radiological portion of the environmental monitoring program in March, 1978. The position was formulated by an NRC working group which considered comments received after the issuance of the Regulatory Guide 4.8. This is Revision 1 of that Branch Position paper. The changes are marked by a vertical line in the right margin. The most significant change is the increase in direct radiation measurement stations.

10 CFR Parts 20 and 50 require that radiological environmental monitoring programs be established to provide data on measurable levels of radiation and radioactive materials in the site environs. In addition, Appendix I to 10 CFR Part 50 requires that the relationship between quantities of radioactive material released in effluents during normal operation, including anticipated operational occurrences, and resultant radiation doses to individuals from principals pathways of exposure be evaluated. These programs should be conducted to verify the effectiveness of in-plant measures used for controlling the release of radioactive materials. Surveillance should be established to identify changes in the use of unrestricted areas (e.g., for agricultrual purposes) to provide a basis for modifications in the monitoring programs for evaluating doses to individuals from principal pathways of exposure. NRC Regulatory Guide 4.1, Rev. 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," provides an acceptable basis for the design of programs to monitor levels of radiation and radioactivity in the station environs.

This position sets forth an example of an acceptable minimum radiological monitoring program. Local site characteristics must be examined to determine if pathways not covered by this guide may significantly contribute to an individual's dose and should be included in the sampling program.

AN ACCEPTABLE RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Program Requirements

Environmental samples shall be collected and analyzed according to Table 1 at locations shown in Figure 1.[1] Analytical techniques used shall be such that the detection capabilities in Table 2 are achieved.

The results of the radiological environmental monitoring are intended to supplement the results of the radiological effluent monitoring by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. Thus, the specified environmental monitoring program provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of individuals resulting from the station operation. The initial radiological environmental monitoring program should be conducted for the first three years of commercial operation (or other period corresponding to a maximum burnup in the initial core cycle). Following this period, program changes may be proposed based on operational experience.

The specified detection capabilities are state-of-the-art for routine environmental measurements in industrial laboratories.

Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the annual report.

The laboratories of the licensee and licensee's contractors which perform analyses shall participate in the Environmental Protection Agency's (EPA's) Environmental Radioactivity Laboratory Intercomparisons Studies (Crosscheck) Program or equivalent program. This participation shall include all of the determinations (sample medium-radionuclide combination) that are offered by EPA and that also are included in the monitoring program. The results of analysis of these crosscheck samples shall be included in the annual report. The participants in the EPA crosscheck program may provide their EPA program code so that the NRC can review the EPA's participant data directly in lieu of submission in the annual report.

---

[1] It may be necessary to require special studies on a case-by-case and site specific basis to establish the relationship between quantities of radioactive material released in effluents, the concentrations in environmental media, and the resultant doses for important pathways.

If the results of a determination in the EPA crosscheck program (or equivalent program) are outside the specified control limits, the laboratory shall investigate the cause of the problem and take steps to correct it. The results of this investigation and corrective action shall be included in the annual report.

The requirement for the participation in the EPA crosscheck program, or similar program, is based on the need for independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid.

A census shall be conducted annually during the growing season to determine the location of the nearest milk animal and nearest garden greater than 50 square meters (500 sq. ft.) producing broad leaf vegetation in each of the 16 meteorological sectors within a distance of 8 km (5 miles).[2] For elevated releases as defined in Regulatory Guide 1.111, Rev. 1., the census shall also identify the locations of all milk animals, and gardens greater than 50 square meters producing broad leaf vegetation out to a distance of 5 km. (3 miles) for each radial sector.

If it is learned from this census that the milk animals or gardens are present at a location which yields a calculated thyroid dose greater than those previously sampled, or if the census results in changes in the location used in the radioactive effluent technical specifications for dose calculations, a written report shall be submitted to the Director of Operating Reactors, NRR (with a copy to the Director of the NRC Regional Office) within 30 days identifying the new location (distance and direction). Milk animal or garden locations resulting in higher calculated doses shall be added to the surveillance program as soon as practicable.

The sampling location (excluding the control sample location) having the lowest calculated dose may then be dropped from the surveillance program at the end of the grazing or growing season during which the census was conducted. Any location from which milk can no longer be obtained may be dropped from the surveillance program after notifying the NRC in writing that they are no longer obtainable at that location. The results of the land-use census shall be reported in the annual report.

The census of milk animals and gardens producing broad leaf vegetation is based on the requirement in Appendix I of 10 CFR Part 50 to "Identify changes in the use of unrestricted areas (e.g., for agricultural purposes) to permit modifications in monitoring programs for evaluating doses to individuals from principal pathways of exposure." The consumption of milk from animals grazing on contaminated pasture and of leafy vegetation contaminated by airborne

---

[2] Broad leaf vegetation sampling may be performed at the site boundary in a sector with the highest D/Q in lieu of the garden census.

radioiodine is a major potential source of exposure. Samples from milk animals are considered a better indicator of radioiodine in the environment than vegetation. If the census reveals milk animals are not present or are unavailable for sampling, then vegetation must be sampled.

The 50 square meter garden, considering 20% used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and a vegetation yield of 2 kg/m^2, will produce the 26 kg/yr assumed in Regulatory Guide 1.109, Rev 1., for child consumption of leafy vegetation. The option to consider the garden to be broad leaf vegetation at the site boundary in a sector with the highest D/Q should be conservative and that location may be used to calculate doses due to radioactive effluent releases in place of the actual locations which would be determined by the census. This option does not apply to plants with elevated releases as defined in Regulatory Guide 1.111, Rev. 1.

The increase in the number of direct radiation stations is to better characterize the individual exposure (mrem) and population exposure (man-rem) in accordance with Criterion 64 - Monitoring radioactivity releases, of 10 CFR Part 50, Appendix A. The NRC will place a similar amount of stations in the area between the two rings designated in Table 1.

Reporting Requirement

A. Annual Environmental Operating Report, Part B, Radiological.

A report on the radiological environmental surveillance program for the previous calendar year shall be submitted to the Director of the NRC Regional Office (with a copy to the Director, Office of Nuclear Reactor Regulation) as a separate document by May 1 of each year. The period of the first report shall begin with the date of initial criticality. The reports shall include a summary (format of Table 3), interpretations, and an analysis of trends for the results of the radiological environmental surveillance activities for the report period, including a comparison with operational controls, preoperational studies (as appropriate), and previous environmental surveillance reports and an assessment of the observed impacts of the station operation on the environment.

In the event that some results are not available the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the radiological environmental monitoring program; a map of all sampling locations keyed to a table giving distances and directions from one reactor; the results of land use censuses; and the results of licensee participation in a laboratory crosscheck program if not participating in the EPA crosscheck program.

B. Nonroutine Radiological Environmental Operating Reports

"If a confirmed[3] measured radionuclide concentration in an environmental sampling medium averaged over any quarter sampling period exceeds the reporting level given in Table 4, a written report shall be submitted to the Director of the NRC Regional Office (with a copy to the Director, Office of Nuclear Reactor Regulation) within 30 days from the end of the quarter. If it can be demonstrated that the level is not a result of plant effluents (i.e., by comparison with control station or preoperational data) a report need not be submitted, but an explanation shall be given in the annual report. When more than one of the radionuclides in Table 4 are detected in the medium, the reporting level shall have been exceeded if:

$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \ldots \geq 1$$

If radionuclides other than those in Table 4 are detected and are due from plant effluents, a reporting level is exceeded if the potential annual dose to an individual is equal to or greater than the design objective doses of 10 CFR Part 50, Appendix I. This report shall include an evaluation of any release conditions, environmental factors, or other aspects necessary to explain the anomalous result.

[3] A confirmatory reanalysis of the original, a duplicate, or a new sample may be desirable, as appropriate. The results of the confirmatory analysis shall be completed at the earliest time consistent with the analysis, but in any case within 30 days.

TABLE 1

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples[a] and Locations	Sampling and Collection Frequency[a]	Type and Frequency and Analysis
AIRBORNE			
Radioiodine and Particulates	Samples from 5 locations: 3 samples from offsite locations (in different sectors) of the highest calculated annual average groundlevel D/Q. 1 sample from the vicinity of a community having the highest calculated annual average ground-level D/Q. 1 sample from a control location 15-30 km (10-20 miles) distant and in the least prevalent wind direction[d]	Continuous sampler operation with sample collection weekly or as required by dust loading, whichever is more frequent[e]	Radioiodine Cannister: analyze weekly for I-131 Particulate Sampler: Gross beta radioactivity following filter change,[b] composite (by location) for gamma isotopic[c] quarterly
DIRECT RADIATION[f]	40 stations with two or more dosimeters or one instrument for measuring and recording dose rate continuously to be placed as follows: 1) an inner ring of stations in the general area of the site boundary and an outer ring in the 4 to 5 mile range from the site with a station in each sector of each ring (16 sectors x 2 rings = 32 stations). The balance of the stations, 8, should be place in special interest areas such as population centers, nearby residences, schools, and in 2 or 3 areas to serve as control stations.	Monthly or quarterly	Gamma dose monthly or quarterly

TABLE 1 (Continued)

Exposure Pathway and/or Sample	Number of Samples[a] and Locations	Sampling and Collection Frequency[a]	Type and Frequency of Analysis
WATERBORNE			
Surface[g]	1 sample upstream 1 sample downstream	Composite sample over one-month period[h,i]	Gamma isotopic analysis monthly. Composite for tritium analyses quarterly
Ground	Samples from 1 or 2 sources only if likely to be affected[j]	Quarterly	Gamma isotopic and tritium analysis quarterly
Drinking	1 sample of each of 1 to 3 of the nearest water supplies could be affected by its discharge 1 sample from a control location	Composite sample over two-week period[i] if I-131 anlysis is performed, monthly composite otherwise	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year.[k] Composite for Gross β and gamma isotopic analyses monthly. Composite for tritium analysis quarterly
Sediment from Shoreline	1 sample from downstream area with existing or potential recreational value	Semiannually	Gamma isotopic analyses semiannually
INGESTION			
Milk	Samples from milking animals in 3 locations within 5 km distant having the highest dose potential. If there are none, then, 1 sample from milking animals in each of 3 areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year[k]	Semimonthly when animals are on pasture, monthly at other times	Gamma isotopic and I-131 analysis semimonthly when animals are on pasture; monthly at other times.

TABLE 1 (Continued)

Exposure Pathway and/or Sample	Number of Samples[a] and Locations	Sampling and Collection Frequency[a]	Type and Frequency of Analysis
Milk (cont'd)	1 sample from milking animals at a control location (15-30 km distant and in the least prevalent wind direction)		
Fish and Invertebrates	1 sample of each commercially and recreationally important species in vicinity of discharge point	Sample in season, or semianually if they are not seasonal	Gamma isotopic analysis on edible portions
	1 sample of same species in areas not influenced by plant discharge		
Food Products	1 sample of each principal class of food products from any area which is irrigated by water in which liquid plant wastes have been discharged	At time of harvest[1]	Gamma isotopic analysis on edible portion.
	3 samples of broad leaf vegetation grown nearest offsite locations of highest calculated annual average ground-level D/Q if milk sampling is not performed	Monthly when available	
	1 sample of each of the similar vegetation grown 15-30 km distant in the least prevalent wind direction if milk sampling is not performed	Monthly when available	

TABLE 1 (Continued)

[a]The number, media, frequency and location of sampling may vary from site to site. It is recognized that, at times, it may not be possible or practical to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and submitted for acceptance. Actual locations (distance and direction) from the site shall be provided. Refer to Regulatory Guide 4.1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants."

[b]Particulate sample filters should be analyzed for gross beta 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air or water is greater than ten times the yearly mean of control samples for any medium, gamma isotopic analysis should be performed on the individual samples.

[c]Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

[d]The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites which provide valid background data may be substituted.

[e]Canisters for the collection of radioiodine in air are subject to channeling. These devices should be carefully checked before operation in the field or several should be mounted in series to prevent loss of iodine.

[f]Regulatory Guide 4.13 provides minimum acceptable performance criteria for thermoluminescence dosimetry (TLD) systems used for environmental monitoring. One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter may be considered to be one phosphor and two or more phosphors in a packet may be considered as two or more dosimeters. Film badges should not be used for measuring direct radiation. The 40 stations is not an absolute number. This number may be reduced according to geographical limitations, e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly.

[g]The "upstream sample" should be taken at a distance beyond significant influence of the discharge. The "downstream" sample should be taken in an area beyond but near the mixing zone. "Upstream" samples in an estuary must be taken far enough upstream to beyond the plant influence.

[h]Generally, salt water is not sampled except when the receiving water is utilized for recreational activities.

[i]Composite samples should be collected with equipment (or equivalent) which is capable of collecting an aliquot at time intervals which are very short (e.g., hourly) relative to the compositing period (e.g., monthly).

[j]Groundwater samples should be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

[k]The dose shall be calculated for the maximum organ and age group, using the methodology contained in Regulatory Guide 1.109, Rev. 1., and the actual parameters particular to the site.

[l]If harvest occurs more than once a year, sampling should be performed during each discrete harvest. If harvest occurs continuously, sampling should be monthly. Attention should be paid to including samples of tuborous and root food products.

TABLE 1 (Continued)

Note: In addition to the above guidance for operational monitoring, the following material is supplied for guidance on preoperational programs.

Preoperational Environmental Surveillance Program

A Preoperational Environmental Surveillance Program should be instituted two years prior to the institution of station plant operation.

The purposes of this program are:

1. To measure background levels and their variations along the anticipated critical pathways in the area surrounding the station.

2. To train personnel

3. To evaluate procedures, equipment and techniques

The elements (sampling media and type of analysis) of both preoperational and operational programs should be essentially the same. The duration of the preoperational program, for specific media, presented in the following table, should be followed:

Duration of Preoperational Sampling Program for Specific Media

6 months	1 year	2 years
. airborne iodine	. airborne particulates	. direct radiation
. iodine in milk (while animals are in pasture)	. milk (remaining analyses)	. fish and invertebrates
	. surface water	. food products
	. groundwater	. sediment from shoreline
	. drinking water	

<u>TABLE 2</u>

Detection Capabilities for Environmental Sample Analysis[a]

		Lower Limit of Detection (LLD)[b]				
Anaysis	Water (pCi/l)	Airborne Particulate or Gas (pCi/m3)	Fish (pCi/kg,wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
gross beta	4	1×10^{-2}				
^{3}H	2000					
^{54}Mn	15		130			
^{59}Fe	30		260			
$^{58,60}Co$	15		130			
^{65}Zn	30		260			
^{95}Zr	30					
^{95}Nb	15					
^{131}I	1[c]	7×10^{-2}		1	60	
^{134}Cs	15	5×10^{-2}	130	15	60	150
^{137}Cs	18	6×10^{-2}	150	18	80	180
^{140}Ba	60			60		
^{140}La	15			15		

Note: This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

TABLE 2

NOTES

[a]Acceptable detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

[b]Table 2 indicates acceptable detection capabilities for radioactive materials in environmental samples. These detection capabilities are tabulated in terms of the lower limits of detection (LLDs). The LLD is defined, for purposes of this guide, as the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\, s_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

where

LLD is the "a priori" lower limit of detection as defined above (as pCi per unit mass or volume). (Current literature defines the LLD as the detection capability for the instrumentation only, and the MDC, minimum detectable concentration, as the detection capability for a given instrument, procedure, and type of sample.)

s_b is the standard deviation of the background counting rate or of the counting rate of a 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)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elasped time between sample collection (or end of the sample collection period) and time of counting

The value of S_b used in the calculation of the LLD for a particular measurement system should be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicated variance.

In calculating the LLD for a radionuclide determined by gamma-ray spectrometry, the background should include the typical contributions of other radionuclides normally present in the samples (e.g., potassium-40 in milk samples). Typical values of E, V, Y and Δt should be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as a posteriori (after the fact) limit for a particular measurement.*

[c]LLD for drinking water samples.

---

* For a more complete discussion of the LLD, and other detection limits, see the following:
  (1) HASL Procedures Manual, HASL-300 (revised annually).
  (2) Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry" Anal. Chem. 40, 586-93 (1968).
  (3) Hartwell, J. K., "Detection Limits for Radioisotopic Counting Techniques," Atlantic Richfield Hanford Company Report ARH-2537 (June 22, 1972).

TABLE 3

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Name of Facility ____________________ Docket No. __________

Location of Facility ____________________ Reporting Period __________

(County, State)

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analyses Performed	Lower Limit of Detection[a] (LLD)	All Indicator Locations Mean (f)[b] Range	Location with Highest Annual Mean: Name, Distance & Direction	Location with Highest Annual Mean: Mean (f)[b] Range	Control locations Mean (f)[b] Range	Number of Nonroutine Reported Measurements
Air Particulates (pCi/m^3)	Gross β 416	0.01	0.08(200/312) (0.05-2.0)	Middletown 5 miles 340°	0.10 (5/52) (0.08-2.0)	0.08 (8/104) (0.05-1.40)	1
	γ-Spec. 32						
	^{137}Cs	0.01	0.05 (4/24) (0.03-0.13)	Smithville 2.5 miles 160°	0.08 (2/4) (0.03-2.0)	<LLD	4
	^{131}I	0.07	0.12 (2/24) (0.09-0.18)	Podunk 4.0 miles 270°	0.20 (2/4) (0.10-0.31)	0.02 (2/4)	1
Fish pCi/kg (wet weight)	γ-Spec. 8						
	^{137}Cs	130	<LLD	-	<LLD	90 (1/4)	0
	^{134}Cs	130	<LLD	-	<LLD	<LLD	0
	^{60}Co	130	180 (3/4) (150-225)	River Mile 35	See Column 4	<LLD	0

[a]See Table 2, note b.

[b]Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses. (f)

Note: The example data are provided for illustrative purposes only.

TABLE 4

REPORTING LEVELS FOR NONROUTINE OPERATING REPORTS

Reporting Level (RL)

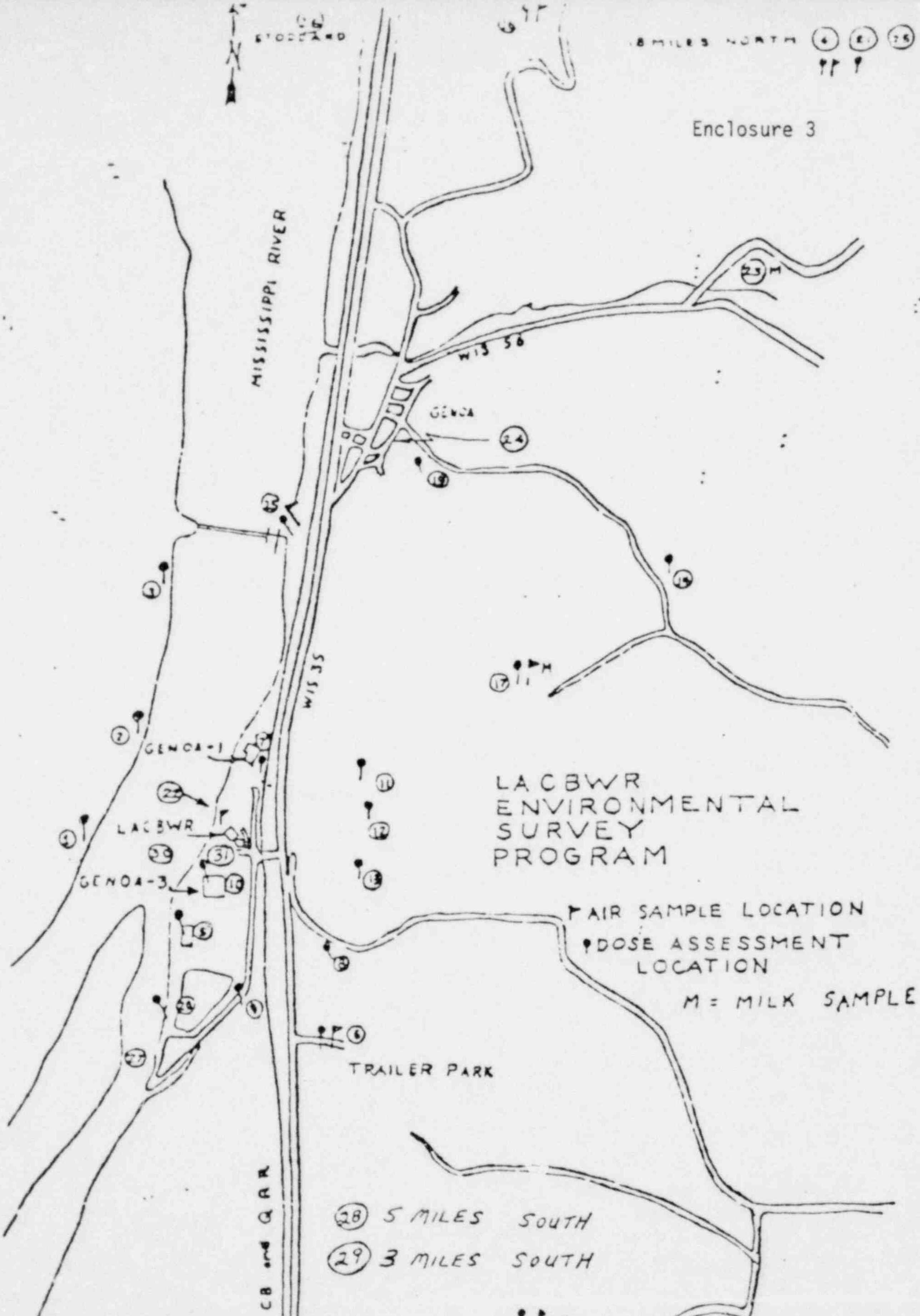
Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m³)	Fish (pCi/Kg,wet)	Milk (pCi/l)	Broad Leaf Vegetation (pCi/Kg, wet)
H-3	2×10^{4} [(a)]				
Mn-54	1×10^{3}		3×10^{4}		
Fe-59	4×10^{2}		1×10^{4}		
Co-58	1×10^{3}		3×10^{4}		
Co-60	3×10^{2}		1×10^{4}		
Zn-65	3×10^{2}		2×10^{4}		
Zr-Nb-95	4×10^{2}				
I-131	2	0.9		3	1×10^{2}
Cs-134	30	10	1×10^{3}	60	1×10^{3}
Cs-137	50	20	2×10^{3}	70	2×10^{3}
Ba-La-140	2×10^{2}			3×10^{2}	

[a]For drinking water samples. This is 40 CFR Part 141 value.

Figure 1

(This figure shall be of a suitable scale to show the distance and direction of each monitoring station. A key shall be provided to indicate what is sampled at each location.)

Enclosure 3



Radiological Environmental Monitoring Sample Locations
Figure 1