UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

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CHAIRMAN

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September 28, 1979

The Honorable John Glenn, Chairman
Subcommittee on Energy, Nuclear
Proliferation and Federal Services
Committee on Governmental Affairs
United States Senate
Washington, D.C. 20510

Dear Senator Glenn:

Thank you for your letter of May 24, 1979, and for the opportunity to comment upon the issues raised by Mr. Robert Alvarez of the Environmental Policy Center in his testimony on May 10, 1979, before your subcommittee. Our response to the principal points raised by Mr. Alvarez are enclosed (Enclosure 1).

Mr. Alvarez has provided the Commission staff with a draft of the Environmental Policy Center report, "Environmental Monitoring of Radioactivity" prepared by Craig Swick. On June 7, 1979, members of the NRC and EPA technical staffs met with Mr. Swick to discuss the report on environmental monitoring. A detailed written response to that report is being prepared by the NRC staff. This response to Mr. Swick's report will include discussion of the major items of disagreement mentioned by Mr. Swick in his July 18 letter to you. Our conclusion is that the report inaccurately reflects the Commission's requirements for environmental radiation monitoring. The requirements for environmental radiological monitoring listed in NUREG-0475 (Enclosure 4) and in the NRC staff technical position (Enclosure 5) for areas around nuclear power plants were not recognized in Mr. Swick's report. These requirements were clarified with Mr. Swick during the June 7 meeting.

The possible role of vitamin B-12 in enhancing the uptake of radioactive cobalt is currently being examined by the NRC staff. However, it is important to note that even if the uptake of radioactive cobalt is increased by as much as a factor of 2300, as suggested by Mr. Alvarez, the doses, as calculated by the standard methodology for the licensing of nuclear power plants in the U.S., would not change by as much as a factor of two for the liver and the total dose to the liver of 1-3 mrem would still be well below the allowable limits. Therefore, staff conclusions regarding acceptability of these doses are not expected to change.

The Commission's requirements for effluent and environmental radiation monitoring are contained in the NRC regulations in Part 20 and Part 50 of Title 10 of the Code of Federal Regulations. Considerable additional guidance to licensees is contained in Regulatory Guides 1.21, 4.1, 4.13, 4.14, 4.15 and 4.16. If you desire, we will provide you with copies of these documents.

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The important features of these environmental monitoring requirements include: continuous sampling of several offsite locations for airborne radioiodine and particulates; periodic collection of cumulative direct radiation measurements in several different sectors; periodic sampling of environmental media for power plant related radionuclides in milk, water, and foods.

A comparison of the technical specifications for environmental radiation monitoring and the 1978 annual environmental monitoring report for the Three Mile Island Nuclear Station indicate that the licensee's program was consistent with NRC requirements. Also, the specification section requires the licensee and its contractors to participate in the EPA Crosscheck Program or an equivalent program and to report the results of these analyses to the NRC.

We are re-examining the monitoring programs required by NRC regulations as they relate to accident conditions. We plan to require licensees to place additional thermoluminescent dosimeters (TLD's) in all directions around nuclear power plants including dosimeters in population centers and in the vicinity of nearby residences and schools. NRC is also independently establishing a program to employ its own dosimeters in addition to requirements imposed on licensees. More comprehensive changes in the requirements for environmental radiation surveillance may result from our investigations of the actions and events leading to the accident at the Three Mile Island Nuclear Station and the implications of the accident for improving our regulatory program.

Thank you again for the opportunity to clarify these points. Please contact us if you have any further questions on the Commission's requirements for environmental radiation surveillance or require additional information.

Sincerely,

Original Signed by
Victor Gilinsky

for Joseph M. Hendrie
Chairman

Enclosures:
1. Response to comments
2. Draft Report of the Ad Hoc Interagency Dose Assessment Group
3. May 10 Report of the Ad Hoc Interagency Dose Assessment Group
4. NUREG-0475, "Radiological Environmental Monitoring by NRC Licensees for Routine Operations of Nuclear Facilities"
5. Radiological Assessment Branch Technical Position on Environmental Monitoring

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cc: Senator Jacob K. Javits

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NUCLEAR REGULATORY COMMISSION

STAFF RESPONSE TO COMMENTS MADE BY ROBERT ALVAREZ OF THE ENVIRONMENTAL POLICY CENTER IN TESTIMONY ON MAY 10, 1979 BEFORE THE SUBCOMMITTEE ON ENERGY, NUCLEAR PROLIFERATION AND FEDERAL SERVICES, COMMITTEE ON GOVERNMENTAL AFFAIRS, UNITED STATES SENATE

I. COMMENTS CONCERNING THE REPORT OF THE AD HOC POPULATION DOSE ASSESSMENT GROUP, "PRELIMINARY ESTIMATES OF POPULATION DOSE AND HEALTH EFFECTS" (APRIL 15, 1979 DRAFT REPORT)

1a Comment: The report does not mention possible effects from the inhalation of beta or gamma-emitting radionuclides from ingestion of contaminated food.

Response: The dose associated with inhalation of xenon-133 (a beta and gamma emitting radionuclide which was the principal radionuclide detected in the environment follwing the accident) is estimated in section 5B of the April 15th Ad Hoc Group draft report (page 51). The inhalation dose from the radioactive xenons are discussed on pages 70 to 73 of the May 10, 1979 report of the Ad Hoc Task Group.

Inhalation and ingestion doses from radioiodine-131 (a beta and gamma emitting radionuclide) are discussed on pages 52 to 54 of the April 15th draft and on pages 74 to 77 of the May 10th Ad Hoc Task Group report.

Reported environmental measurements (air, water, grass, and soil) did not indicate the presence in the environment of additional beta or gamma emitting radionuclides at concentrations which would be attributed to the accident or to the normal operation of units 1 and 2 of the Three Mile Island Nuclear Station.

16 Comment: The report does not mention the risk of cataracts from beta and gamma skin [external] exposure.

Response: The reason that cataract production was not considered in the evaluation of the potential impact of the Three Mile Island Accident is that there is an apparent threshold dose (at least for beta and gamma radiation) for induction of visual impairment by cataracts below which observable injury or impairment is not produced. This "threshold" dose in man has been estimated to be 200 to 500 rem (200,000 to 500,000 millirem) by the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR) in their 1972 report[1], 1500 rem (1,500,000 millirem) by the International Commission on Radiological Protection[2], and approximately 600 rem (600,000 millirem) by the National Council on Radiation Protection and Measurements[3]. Because these "threshold" doses are, at a minimum, approximately 2000 times the estimated whole body dose which may have been received by any individual from the Three Mile Island Accident (less than 100 millirem) and 25,000 times the average dose estimated to have been received by individuals within 10 miles of the Three Mile Island site, the NRC staff does not believe that there is any possibility of cataract production due to the accident.

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[1] Advisory Committee on the Biological Effect of Ionizing Radiation (BEIR), "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," National Academy of Sciences, National Research Council (1972) p. 179.

[2] International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection (Adopted January 17, 1977)," ICRP Publication 26, Pergamon Press, Oxford, England (1977) pp. 12-13.

[3] National Council on Radiation Protection and Measurements (NCRP), "Basic Radiation Protection Criteria," NCRP Report No. 39, NCRP, Washington, D.C. (January 15, 1971) pp. 38-40.

1c Comment: The report provides no basis for its estimate "that the beta dose to the skin is probably four times . . . the gamma dose".

Response: The technical basis for this factor was discussed on pages 48-49 of the draft (April 15th) report and on pages 67-68 of the May 10th report of the Ad Hoc Interagency Dose Assessment Task Group. This discussion details the conservative assumptions used to determine that the combined outdoor beta/gamma dose to the skin of an individual exposed to a plume of noble radioactive gases (neglecting clothing) would be about 3.8 times the gamma dose to internal organs. This difference is due to the limited penetrating ability of the beta component of such a plume which results in more energy being deposited near the surface of the body.

1d Comment: The report states that the only radionuclides released were iodine-131 and xenon-133 (which are described as the least biologically significant because they decay to stable isotopes), when in reality there must have been releases of other isotopes and of krypton.

Response: The possible release of radioactive krypton isotopes is discussed on page 9 of the draft [April 15th] report and on page 11 of the May 10th Ad Hoc Group report. Both the form of other isotopes assumed to be present, i.e., particulate and/or soluble and their mode of release, i.e., through high efficiency particulate filters and charcoal adsorbers limits the possible isotopes of concern to those mentioned. This was confirmed by the fact that such isotopes as Strontium-90 and short-lived Kryptons were not detected in the plant environs above background levels.

The description of the results of the Department of Energy analyses of environmental samples which confirmed the absence of detectable levels of other radionuclides are in Appendix "B" to the April 15th and May 10th Ad Hoc Group reports.

1e Comment: The report does not account for strontium in either the containment building or the environment, although krypton decays in strontium.

Response: The radioactive strontium in the containment and auxiliary buildings has not contributed to off-site population exposures. Although both strontium-90 and strontium-89 have noble gas precursors ("parents"), these radionuclides have very short half-lives. Krypton-89 (which decays to rubidium-89 and then to strontium-89) has a 3.2-minute half-life and krypton-90, (the parent of rubidium-90 and then strontium-90 has a 33-second half-life, so that it would be unlikely that significant quantities of the gases would have survived long enough to escape from the containment building or sump tanks before decaying into the particulate rubidium or strontium isotopes. These particulates should have remained in the water or should have been trapped by high-efficiency particulate air filters in the major effluent release paths. In any case, as noted on p. 11 of the May 10, 1979 Ad Hoc Group report, to our knowledge no strontium-90 has been detected in the environment above pre-existing fallout levels.

EPA has been designated by the White House as the lead agency for coordinating the collection and documentation of the environmental radiation data obtained by all the Federal agencies involved in monitoring in the vicinity of Three Mile Island. We plan to request that they ensure appropriate measurements are made to confirm this position on strontium levels.

1f Comment: The report offers the "highly unlikely" explanation that all the cesium detected in milk after the accident was from spring fallout.

Response: The draft (April 15th) report states (page 54): "The presence of this radionuclide is probably due to the deposition of residual fallout produced from previous atmospheric testing." The draft report notes that

this maximum concentration of cesium-137 is within the variation that one would expect between individual farms and composite (EPA pasturized milk network samples) samples. This point is further clarified in the May 10th Ad Hoc Group report (pages 75-76). The Department of Energy environmental measurements of cesium-137 in soil also support the contention that the cesium-137 levels are consistent with expected levels from residual fallout (page B-3 of Appendix B in both the April 15th and May 10th Ad Hoc Group reports).

19 Comment: The report does not discuss the possibility that radionuclide levels in milk will increase as cattle eat grass that was growing at the time of the accident rather than food that had been stored.

Response: This does not appear to be a likely possibility because increased concentrations of long-lived fission products were not detected in either grass or soil. Moreover, continuing routine environmental surveillance should detect any increases in radionuclide levels in milk above background.

II. COMMENTS ON THE POSSIBLE INCREASED UPTAKE OF COBALT-60 AS VITAMIN B-12

The IAEA paper regarding Co-60 uptake is an elaboration of a portion of the report "Radiological Assessment of the Wyhl Nuclear Power Plant" which has been translated from the original German and is being reviewed by the NRC staff. The staff is examining the appropriateness of incorporating data from references provided in that report in later revisions of NRC regulatory guidance. However, it is important to note that even if the uptake of radioactive cobalt by the critical organ, the liver, is increased by as much as a factor of 2300, as suggested by Mr. Alvarez, the doses to that organ, as calculated by the standardized "Appendix I" methodology used for licensing

nuclear reactors in the U.S., would not change by as much as a factor of two. Typical calculated doses to this organ would be on the order of 1 to 3 mrem, using Mr. Alvarez's assumptions, as compared to the Appendix I objectives of 15mrem. Therefore, staff conclusions regarding acceptability of these doses are not expected to change.

III. COMMENT IN THE ENVIRONMENTAL POLICY CENTER REPORT "ENVIRONMENTAL MONITORING FOR RADIOACTIVITY"

The report by Craig Swick was sent to Mr. Robert Minogue, Director of the NRC Office of Standards Development, as a draft report with a request for our review and comment. The principal issues raised in Mr. Swick's report were:

3a Comment: "The decision to eliminate the strontium-90 monitoring requirements rather than to investigate collection methods and laboratory procedures that yielded no evidence of Sr-90".

Response: Experience with many plant -years of operating data showed that radiostrontium related to nuclear plants was being detected at insignificant levels or not at all. Strontium-90 from world-wide fallout was being detected at very low concentrations. However, these low concentrations of fallout strontium-90 masked the presence of the even lower concentrations of any plant-related strontium-90. Thus the environmental radiostrontium monitoring program was unproductive. Monitoring both strontium-89 and strontium-90 continues to be required for radioactive effluents from nuclear power plants where their changing levels and higher concentrations can be more easily detected. Should unusual circumstances warrant environmental monitoring for radiostrontium, it will be required, on a case by case basis, by the NRC staff.

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36 Comment: "Requiring labs to participate in EPA's Environmental Radioactivity Laboratory Intercomparison Studies without (a) setting standards for the level of work, (b) requiring utilities to use the studies results or--perhaps most important--(c) acknowledging that the program is inappropriate because it was designed to monitor fallout from nuclear explosions, i.e., radiation levels higher than those generally found around nuclear power plants . . ."

Response: Environmental monitoring requirements currently being imposed on nuclear power plants require participation in the EPA Environmental Radioactivity Laboratory Intercomparison Studies ("Crosscheck") Program (or an equivalent program) as part of a quality assurance program for effluent and environmental monitoring following guidance in Regulatory Guide 4.15. This Regulatory Guide states that if the result of "cross-check" analysis is outside of specified limits, an investigation should be made to determine the reason for this deviation and corrective action should be taken as necessary.

Participation by NRC licensees in this "cross-check" program is the subject of an interagency agreement between NRC and EPA. The EPA "Cross-check" program was not "designed to monitor fallout". It was designed to provide an independent check on the precision and accuracy of laboratory measurements of radioactive materials in environmental media. NRC has recognized that the concentrations of radionuclides in samples supplied by EPA are generally above the concentrations found in environmental media around nuclear power plants. In accordance with the interagency agreement, NRC has requested the EPA include in its "cross-check" program samples that better meet NRC needs. The samples requested include samples that have concentrations of radionuclides that are lower than those previously supplied in order to more closely approximate the concentration found in the environment around nuclear power plants.

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3c Comment: "The policy of collecting milk samples only twice monthly--allowing nearly two I-131 half-lives to pass between collections--and then diluting them with other milk, which may result in an estimated "typical" dose but not comply with EPA guidelines setting an annual whole-body dose limit of 25 mr for each person in the general public".

Response: The statement that milk samples are diluted with "other" milk is incorrect. In the monitoring programs required by NRC for nuclear power plants, milk samples are collected at farms in the vicinity of the plant. They are not diluted with "other" milk before analysis. The twice monthly sampling of milk is, in our view, a reasonable compromise between the increased sensitivity of detection by more frequent sampling and analysis and the increased cost of additional sample collection and analysis. The continuous sampling of airborne radioiodine releases from the plant and the very low detection limits required by NRC for the determination of I-131 in milk combine to ensure that radiation doses to individuals from I-131 in milk in excess of NRC and EPA dose standards do not go undetected.

3d Comment: Use of thermoluminescense dosimeters (TLD's) that can detect only gamma radiation at Three Mile Island.

Response: This question is addressed in the Summary and Section 5 of the May 19, 1979 report, "Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station," by the interagency Ad Hoc Population Dose Assessment Group . In brief, although the beta radiation dose from the Three Mile Island accident cannot be quantitatively assessed from direct measurement by TLD's, it can be, and has been, estimated from a knowledge of the predominant radionuclide released (Xe-133) and from information in the NRC Regulatory Guide 1.109 and NUREG-0172. The potential health effects of beta radiation dose are shown in that report to be a small fraction of the gamma radiation effects.

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3e Comment: A standardized monitoring program should be established.

Response: NRC agrees with this comment and is establishing a "standardized monitoring program". It is the program described in the Branch Technical Position (BTP), "An Acceptable Radiological Environmental Monitoring Program," dated March 1978. This "standardized" monitoring is incorporated within the "standard" radiological effluent technical specifications for nuclear power reactors that are being required for all nuclear power plants.

3f Comment: NRC should publish its guidelines in the Federal Register.

Response: The NRC guidance for the standardized monitoring program, discussed above, has been made widely available to those involved in radiological monitoring programs for nuclear power plants. If additional guidance is determined to be desirable, a modified technical position or a Regulatory Guide addressing this matter will be prepared. Regulatory Guides receive wide public circulation for information and comment.

To the extent that this recommendation goes to incorporation of detailed specifications for the design of environmental radiation monitoring programs in NRC's regulations (in the Federal Register) that action would remove the flexibility to incorporate newer monitoring methods or modify programs to account for specific unusual site characteristics or changes in plant operation promptly. Because of the rulemaking procedures required for issuing and amending regulations, any modification of the standardized design would require considerable time and effort by the NRC staff.

The NRC regulations provide requirements for having such programs and our Regulatory Guides provide guidance as to more specific details of an acceptable

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program. Detailed requirements for a specific site are contained in the facility license conditions. This approach provides for greater flexibility and adaptability to meet particular or unusual conditions, or to incorporate improvements, while still providing adequate opportunity for public comment and input.

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 has developed the following Branch Position on the radiological portion of the environmental monitoring program. The position was formulated by an NRC working group which considered comments received after the issuance of the Regulatory Guide 4.8.

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 agricultural 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. The LLDs for I 131 in water, milk and other food products correspond to one-quarter of the Appendix I (10 CFR Part 50) design objective dose-equivalent of 15 mrem/yr for atmospheric releases and 10 mrem/yr for liquid releases to the most sensitive organ and age group. They are based on the assumptions given in Regulatory Guide 1.109, Rev 1.

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

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[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.

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.

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 sq. 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 sq. 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 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

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[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.

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 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 sq. 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.

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 ~~statistical evaluation~~ of 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.

an analysis of trends

In the event that some results are not available the report shall be submitted noting the 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; ~~including sampling methods for each sample type, size and physical characteristics of each sample~~ type, ~~sample preparation methods, analytical methods, and measuring equipment used;~~ 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 the Environmental Protection Agency's Environmental Radioactivity Laboratory Intercomparisons Studies (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 shall be discussed 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.

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[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 3 offsite locations (in different sectors) of the highest calculated annual average ground-level D/Q.		Radioiodine Cannister: analyze weekly for I-131
	1 sample from the vicinity of a community having the highest calculated annual average ground-level D/Q.	Continuous sampler operation with sample collection weekly or as required by dust loading, whichever is more frequent[e]	Particulate Sampler: Gross beta radioactivity following filter change, composite (by location) for gamma isotopic[c] quarterly
	1 sample from a control location 15-30 km (10-20 miles) distant and in the least prevalent wind direction[d]		
DIRECT RADIATION[f]	2 or more dosimeters or one instrument for measuring and recording dose rate continuously to be placed at each of the same locations as for air particulates, and at each of three additional offsite locations (different sectors) or highest calculated annual average ground-level X/Q.	Monthly or quarterly	Gamma dose monthly or quarterly

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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 which could be affected by its discharge	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
	1 sample from a control location		
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 calcuiated 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.

15/A 342

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 semiannually 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. I-131 analysis on broad leaf vegetation
	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 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 chip, and two or more chips in a packet may be considered as two or more dosimeters.

[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 composition 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	

TABLE 2

Detection Capabilities for Environmental Sample Analysis[a]

Anaysis	Lower Limit of Detection (LLD)[b] 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~~ 2[c]	1×10^{-2}				
^{3}H	~~330~~ 2000 (1000[c])					
^{54}Mn	15		130			
^{59}Fe	30		260			
$^{58,60}Co$	15		130			
^{65}Zn	30		260			
^{95}Zr-Nb	~~10~~ 15[e]					
^{131}I	~~1~~[c] ~~0.5~~[d]	7×10^{-2}		1 0.8[d]	60 25[d,e]	
$^{134,137}Cs$	15 (10[c]), 18	1×10^{-2}	130	15	~~80~~ 60	150
^{140}Ba-La	15[e]			15[e]		

Note: This list does 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 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 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.

[d] LLDs for ^{131}I in water, milk and other food products correspond to one-quarter of the Appendix I (10 CFR Part 50) design objective dose-equivalent of 15 mrem/year for atmospheric releases and 10 mrem/yr for liquid releases to the most sensitive organ and age group using the asssumptions given in Regulatory Guide 1.109, Rev. 1.

[e] LLD for leafy vegetables.

* 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	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)	<' LD	4
	^{131}I	0.07	0.03 (2/24) (0.01-0.08)	Podunk 4.0 miles 270°	0.05 (2/4) (0.01-0.08)	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	120 (3/4) (90-200)	River Mile 35	See Column 4	<LLD	0

[a] See Table 3, note b.

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

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

TABLE 4

REPORTING LEVELS FOR NONROUTINE OPERATING REPORTS

Analysis	Reporting Level (RL) Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/Kg,wet)	Milk (pCi/l)	Broad Leaf Vegetation (pCi/Kg, wet)
H-3	2×10^4				
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 (1)				
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 (1)			3×10^2 (1)	

(1) Total for parent and daughter

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.)