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U. S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

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ATTN: Rulemaking, Directives, and Editing Branch

COMMENTS ON DRAFT REGULATORY GUIDE DG-4013, "RADIOLOGICAL ENVIRONMENTAL MONITORING FOR NUCLEAR POWER PLANTS"

Dominion Resources Services, Inc. (Dominion) appreciates the opportunity to comment on Draft Regulatory Guide DG-4013, "Radiological Environmental Monitoring for Nuclear Power Plants."

The proposed revision to this regulatory guide requires the establishment of an appropriate surveillance and monitoring program to obtain data on measurable levels of radiation and radioactive materials in the environment and to perform surveys in the unrestricted and controlled areas. Dominion concurs with Nuclear Energy Institute (NEI) comments, but would also like to offer the additional comments. Dominion comments are being electronically transferred to email address nrcrep.resource@nrc.gov.

If you would like further information on our comments, please contact:

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Respectfully,

C. L. Funderburk, Director
Nuclear Licensing & Operations Support
Dominion Resources Services, Inc. for
Virginia Electric and Power Company,
Dominion Nuclear Connecticut, Inc. and
Dominion Energy Kewaunee, Inc.

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Comments on DG-4013 (RG 4.1)

General Comments

1. The draft RG incorporates additional regulatory requirements and programs. The term Radiological Environmental Monitoring Program (REMP) has been consistently applied to the RETS/ODCM program intended to help demonstrate compliance with the Technical Specification effluent release rate limits (based primarily on 10 CFR 50 Appendix I) and the limits of 40 CFR 190 (which combine the offsite effluent dose consequences with the offsite direct dose consequences). As such, the REMP has been the offsite monitoring program defined in the RETS/ODCM. The existing RG was limited to guidance on such a program. Licensees should be given the option to continue using the current version of R. G. 4.1, as referenced by licensing documents.

   The draft RG tries to incorporate the following programs under the umbrella of the REMP:

   a. Surveillance programs used to demonstrate that onsite "members of the public" meet the 100 mrem/year limit of 10 CFR 20. These programs are typically performed as Health Physics procedures or analyses and are not a part of the REMP. They could involve the use of onsite area TLD's, but may also be limited to other controls such as design calculations and stored inventory control, or periodic surveys with portable instruments. If the NRC intends to provide additional guidance on demonstration of compliance with 20.1301 for onsite members of the public, such guidance should be in a new Section 1 Regulatory Guide (RG). Section 4 of the Regulatory Guides is related to "Environmental" guidelines.

   b. Surveys performed based on the requirements of 10 CFR 50.75(g). These surveys are performed, typically following an event such as a spill, to ensure sufficient radiological information is available to effectively and safely decommission a site. These onsite surveys are not part of the REMP, as the draft guide implies in the first paragraph of Section C.2. If the NRC intends to provide additional guidance on onsite surveys following spills or other events for 10 CFR 50.75(g) compliance, then such guidance should be removed from RG 4.1, expanded to provide some useful guidance, and incorporated as a new Section 1 RG.

   c. New monitoring programs have been employed as part of the new voluntary ground water monitoring program. These programs were established more for political reasons than for any technical basis of controlling dose to the public. They serve more of a leak detection function than a public dose consequence, although in many cases they also serve to address potential decommissioning issues. If implementation of these new ground water monitoring programs resulted in discovery at a specific site of a new dose pathway to the public, then surveillances for that dose pathway should be added to the official RETS/REMP programs. If the NRC intends to provide additional guidance on groundwater monitoring programs, then such guidance should be removed from RG 4.1 and incorporated as a new Section 1 RG. In reality, there is already more guidance on this ground water monitoring program than it deserves based on the recognition that it will never result in a significant public dose consequence.

   Are the above ties to 10CFR 100, 10 CFR 50.75(g) and ground water monitoring appropriate or should this guidance be located somewhere else? Assuming an agreement that this RG should only

address REMP, and based on the observation that NUREG-1301 and 1302 provide more detailed guidelines than this RG on a REMP program, a more appropriate action would be to update and improve NUREG 1301/1302 and delete RG 4.1 as being redundant and hence unnecessary. It is not clear why some of the details in the NUREG were carried over into the draft RG (e.g., reporting levels) and other details (e.g., sampling and analysis schedule) were not. Such a carryover provides unnecessary duplication and leads to interpretation issues when there is not an exact duplication. Furthermore, it leads to potential issues in any future revisions. Examples are provided below where there are inconsistencies between NUREG-1301/2 and this draft RG.

2. 10 CFR 72 requires an Environmental Monitoring program for dry fuel storage facilities. These facilities are often co-located at the nuclear power plant site. For such co-located facilities, the licensee typically takes credit for the existing nuclear power plant REMP to meet the requirements of 10 CFR 72. Augmentation of the existing program, such as new direct dose TLD locations at the site boundary in proximity to the dry fuel storage facility, may be implemented. The RG should be revised to recognize the 10 CFR 72 requirements and specify how the 10 CFR 50 licensed program can be used. Various ramifications should be addressed. For example, if TLD locations are added, should they be installed two years prior to the first dry fuel loading to be consistent with preoperational program guidelines?

3. The draft RG does not recognize the difference between release pathways and exposure pathways and hence makes confusing statements such as the need to evaluate the existence of "other " exposure pathways. An incident or spill, or a plant redesign may result in a new release pathway or direct dose pathway, and could impact the critical locations, but it will not create a different type of exposure pathway. Hence, it is not just new exposure pathways that could require a change to the program, but changes in release pathways could result in changes in the locations sampled or analyses performed.

Specific Comments

1. Introduction – Although the major sections are listed, a more formal and extensive Table of Contents would be useful.

2. Section C – 1st paragraph – 2nd sentence – In addition to providing supporting evidence on the performance of effluent control systems, the information also provides supporting evidence on the adequacy of controls for direct dose impact, such as shielding or inventory control. As discussed above (see General Comments), NUREG 1301 provides more descriptive information on why there is a REMP. For example, Section 6.8.4.g. of NUREG 1301 states: "The program shall provide ... verification of the accuracy of the effluent monitoring program and modeling of environmental exposure pathways." Similar wording to this or that listed in 10 CFR 50 Appendix 1, Section B.2 would seem appropriate in this paragraph.

3. Section C1 – 3rd sentence – This sentence states, "The preoperational program should be updated when new exposure pathways are identified and characterized during the annual land-use census." The term "new exposure pathway" is misleading. For example, if a new cow farm becomes more critical, it is not a new pathway if the cow's milk pathway existed, it is a new critical location. Additionally, the annual census results are not the only potential reason for updating the program.

Changes in station design, such as relocating a solid Radwaste storage facility, during the preoperational phase may also dictate the need for a REMP program revision such as a new TLD location. It is recommended that the sentence read, "The preoperational program should be updated when new pathways or critical locations are identified."

4. Section C.2 – 1st paragraph – see General comment 3 – revise second sentence.

5. Section C.2 – 1st paragraph – see General comment 1 – delete last 2 sentences as they are related to 10 CFR 50.75(g), not REMP.

6. Section C.2.1, C.2.2, and C.2.4 – The wording in these sections provides inconsistent and unclear guidance on what and where pathways are to be monitored.

   a. Are all the primary pathways (Section C.2.1) required? In several cases, some of these pathways (e.g., nuts) will be not applicable at many sites. If required, how does a site take exemption to these pathways?

   b. At what distance do these sampling requirements apply? In Section 2.1 there is an example that says "no milk animals in proximity." What is proximity? For milk, NUREG-1301/2 states to sample at 3 locations within 5 km, and if none exist that close, sample between 5 and 8 km if the projected dose exceeds 1 mrem. It is likely that no site's projected dose beyond 5 km exceeds 1 mrem. As mentioned earlier, it would be better to only have one set of guidance (e.g. NUREG-1301/2) on this and other information in this RG.

   c. In Section C.2.1, under food products, the parenthetical phrase "(if used as a local, common food product)" is only included next to "invertebrates." Does that imply that all the other listed food products must be sampled if they exist, even if not used as a food product? For example, if there are milking goats at 3 km, but that milk is not used for human consumption, does the milk still have to be sampled and analyzed? If yes, then should the same logic be applied to fish, which should be monitored if they exist even if not a local food product. If that's the case, then why does C.2.2.c state that fish may be an additional pathway if of local community interest? Should this section also include the statement that only those exposure pathways need to be monitored if the pathway is considered significant? However, how does this evaluation get adequately "verified" without being part of REMP?

   d. Does "meat" in Section C.2.1 mean just commercial meat production facilities? If not, why is hunting listed in C.2.2.c as an additional pathway (if of local interest). If meat is not just commercial, but also includes individual use, hunting could be a baseline meat pathway? Are any of the listed food product pathways considered as principal exposure pathways only if commercial facilities exist?

   e. There is no difference between C.2.1.e and Section C.2.2? Suggest deleting C.2.1.e.

7. Section C.2.3 – Based on General comment 1, this section should be removed from this RG.

8. Section C.2.3.1 (if this section is not deleted) – Does 2.3.1.b mean that exposure control TLD results which Health Physics typically handles need to be reported in the REMP report? What about onsite

air sampling assessments? The onsite water monitoring described for items 2.1.3.f and 2.1.3.h will normally be reported in the Annual Radiological Effluent Report. These requirements are more appropriate for DG-1186 (or another Section 1 RG as discussed in General comment 1.

9. Section 2.3.3 – The last sentence should be deleted. It should be acceptable to document long term tracking in either the AREOR or the ARERR.

10. Section 2.6 - The new proposed H-3 LLD (300 pCi/liter) is quite arbitrary. What is the basis for this specific value? Why not 500 or even 1000 pCi/liter? We realize we can take exception to this value based upon a written evaluation, but this sets a potentially dangerous precedent. Performing analyses to this low level, especially onsite, is not the norm, nor should it be. This may have a significant cost impact with little or no benefits. In many cases when looking for activity especially onsite near the potential sources, such low LLDs are unnecessary.

11. Section C.2.8 – This Section provides another example of why it is not a good practice to have two documents for the same thing (NUREG-1301/2 and RG 4.1). There are a number of inconsistencies between what the draft RG 4.1 specifies for a Land Use Census and what is in NUREG-1301. For example, the NUREG states that in lieu of performing a garden census, broadleaf vegetation can be sampled at the site boundary. Such an option is not provided in the draft RG. The draft RG requires the determination of drinking water supplies and feeding characteristics, whereas the NUREGs, and likely most ODCMs do not. These inconsistencies need to be resolved.

12. Section C.2.10 – Another case of inconsistencies with the NUREG. For example, the NUREG more clearly states that Table 1 reporting criteria only apply if the activity is plant related. Such a caveat is missing from the draft RG. This caveat does not appear until the second paragraph which may cause interpretation issues. The NUREG has a value of 15 pCi/l for I-131 in water if there is no drinking water pathway and the draft RG does not. Also, the values listed under the Milk column should be for Broad Leaf vegetation (or should it really be for Food Products as listed in the NUREG?). Again, the best solution is to update NUREG 1301/2 and delete RG 4.1 in its entirety. The reference to "health physics regional office" is also called NRC regional office. More consistent formal titles would seem appropriate.

13. Section C.2.11 – The two examples provided in this section are not representative of the comparisons intended by Section IV.B.2 of Appendix I to 10 CFR 50. A typical comparison that might be made is the calculated dose for the year from fish consumption based on the measured liquid effluent releases for the year input into RG 1.109 models (e.g., LADTAP) with the calculated dose based on the measured concentrations of radionuclides in REMP fish samples. The example comparison in the first paragraph discusses long term buildup trends in sediment, something that can't be compared as the effluent dose models do not calculate long term sediment buildup. The example comparison in the second paragraph compares the effluent dose calculations with the calculations performed for the design objective (the original Appendix I compliance calculations). Such a comparison is not routinely performed, nor is there a need to do so. The two examples in this section should be deleted.

14. Section C.2.12 – Per some Technical Specifications, the annual report is submitted to the NRC Document Control Desk, with copy to the Regional Administrator. Some plants must submit by May

1 per the TS. Suggest deleting the details on actual submittal requirements as guidance is not needed on clear TS requirements.

15. Glossary – "drinking water" – for the purposes of REMP compliance, drinking water is not the same as potable water as implied in the definition. To be considered drinking water, the water supply must be physically used to supply public drinking water, and not just considered satisfactory for human consumption.

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH

November 2008
Division 4

DRAFT REGULATORY GUIDE

Contact: S. Garry
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DRAFT REGULATORY GUIDE DG-4013

(Proposed Revision 2 of Regulatory Guide 4.1 dated April 1975)

RADIOLOGICAL ENVIRONMENTAL MONITORING FOR NUCLEAR POWER PLANTS

A. INTRODUCTION

This guide describes a method that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for use in establishing and conducting baseline environmental monitoring at nuclear power plants. To meet this objective, the guide describes programs for preoperational and operational environmental monitoring, including both onsite and offsite environmental monitoring. The guide also describes how information obtained in the environmental monitoring program can be used to document information on residual radioactivity that may be useful during decommissioning.

The regulatory framework that the NRC has established as the basis for the radiological environmental monitoring program (REMP) appears in Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50) (Ref. 1), Section IV.B of Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As Is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents"; and in 10 CFR 20.1302, "Compliance with Dose Limits for Individual Members of the Public" (Ref. 2). These regulations require the establishment of an appropriate surveillance and monitoring program to obtain data on measurable levels of radiation and radioactive materials in the environment and to perform surveys in the unrestricted and controlled areas.

This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received final staff review or approval and does not represent an official NRC final staff position.

Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rulemaking, Directives, and Editing Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; emailed to nrcrep.resource@nrc.gov; submitted through the NRC's interactive rulemaking Web page at http://www.nrc.gov; faxed to (301) 415-5144; or hand-delivered to Rulemaking, Directives, and Editing Branch, Office of Administration, US NRC, 11555 Rockville Pike, Rockville, MD 20852, between 7:30 a.m. and 4:15 p.m. on Federal workdays. Copies of comments received may be examined at the NRC's Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by January 9, 2009.

Electronic copies of this draft regulatory guide are available through the NRC's interactive rulemaking Web page (see above); the NRC's public Web site under Draft Regulatory Guides in the Regulatory Guides document collection of the NRC's Electronic Reading Room at http://www.nrc.gov/reading-rm/doc-collections/; and the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML080660608.

The data on measurable levels of radiation and radioactive materials in the environment are used to evaluate the relationship between quantities of radioactive materials released in effluents and resultant radiation dose to individuals from principal pathways of exposure. This regulatory guide also provides methods of evaluating the relationship between effluents released and environmental monitoring results.

Plant Technical Specifications (TSs) requires the Offsite Dose Calculation Manual (ODCM) to describe the REMP. The TSs also require that the annual radiological environmental operating report describe the information collected in the environmental monitoring program.

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with them is not required. This regulatory guide describes basic features of methods acceptable to the staff for developing and maintaining a radiological environmental monitoring program. The methods used herein are general approaches that the NRC staff has developed in lieu of specific parameters and methods for individual sites. The use of site-specific parameters and methods is encouraged. However, the assumptions and bases used to develop these specific parameters and methods should be fully described and documented.

This regulatory guide contains information collection requirements covered by 10 CFR Parts 20 and 50 that the Office of Management and Budget (OMB) approved under OMB control number 3150-0014 and 0011. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number.

The major sections of this regulatory guide are listed below.

A. Introduction

B. Discussion

1. Regulatory Guidance
2. Objectives of the Radiological Environmental Monitoring Program

C. Regulatory Position

1. Preoperational Monitoring Program
2. Operational Radiological Environmental Monitoring Program
   - 2.1 Principal Exposure Pathways
   - 2.2 Site-specific Exposure Pathways
   - 2.3 Onsite Environmental Monitoring Program
   - 2.4 Offsite Environmental Monitoring Program
   - 2.5 Sampling and Analysis Schedule
   - 2.6 Analytical Detection Capabilities
   - 2.7 Sampling Schedule Contingencies

2.8 Land-Use Census

2.9 Periodic Environmental Program Review

2.10 Reporting Levels

2.11 Comparison of Effluent Control Programs and Environmental Monitoring Programs

2.12 Annual Radiological Environmental Operating Report

B. DISCUSSION

1. Regulatory Guidance

The following five documents contain NRC's guidance for implementing the regulatory requirements in 10 CFR Part 20, "Standards for Protection Against Radiation," and plant TSs related to monitoring and reporting of radioactive material in effluents and environmental media, solid radioactive waste disposal, and resultant public dose:

(1) Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants" (Ref 3);
(2) Regulatory Guide 4.1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants";
(3) Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination)—Effluent Streams and the Environment," (Ref. 4);
(4) NUREG-1301, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors," (Ref. 5); and
(5) NUREG-1302, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors," (Ref. 6).

These five documents, when used in an integrated manner, provide the basic principles and implementation details for developing and maintaining effluent and environmental monitoring programs at nuclear power plants. The three regulatory guides specify the principles of radiological monitoring, and the two NUREGs provide the specific implementation guidance for baseline monitoring programs.

Regulatory Guide 1.21 addresses the measuring, evaluating, and reporting of effluent releases, solid radioactive waste, and public dose from nuclear power plants. It describes the important concepts in planning and implementing a program for managing effluent and solid radioactive waste. Concepts covered include meteorology, release points, monitoring methods, identification of principal radionuclides, unrestricted area boundaries, continuous and batch release methods, representative sampling, composite sampling, radioactivity measurements, decay corrections, quality assurance (QA), solid radioactive waste shipments, and public dose assessments.

Regulatory Guide 4.1 addresses the environmental monitoring program. It discusses principles and concepts important to environmental monitoring at nuclear power plants. The regulatory guide addresses

the need for preoperational and background characterization of radioactivity. It also addresses onsite and offsite monitoring, including the principal exposure pathways and the significant exposure pathways. The guide defines the principal exposure pathways, the program scope of sampling media and sampling frequency, and the methods of comparing environmental measurements to effluent releases in the annual environmental report.

Regulatory Guide 4.15 provides the basic principles of QA in all types of radiological monitoring programs. It does not specifically address nuclear power plants but covers all types of licenses and licensees. It provides the principles for structuring organizational lines of communication and responsibility, using qualified personnel, implementing standard operating procedures, defining data quality objectives, performing quality control (QC) checking for sampling and analysis, auditing the process, and taking corrective actions.

NUREG-1301 and NUREG-1302 provide the detailed implementation guidance by describing baseline effluent and environmental monitoring programs. The NUREGs specify effluent monitoring and environmental sampling requirements, surveillance requirements for effluent monitors, types of monitors and samplers, sampling and analysis frequencies, types of analysis and radionuclides analyzed, lower limits of detection (LLDs), specific environmental media to be sampled, and reporting and program evaluation and revision.

2. Objectives of the Radiological Environmental Monitoring Program

The regulatory positions described in this document provide guidance on the establishment of an onsite and offsite environmental monitoring program. The environmental monitoring program for a nuclear power plant should have six basic objectives:

(1) Characterize the radiological conditions of the preoperational site and its surroundings. The preoperational conditions of the site and its surroundings should be understood in sufficient detail to provide a reasonable baseline for comparison with operational data. In addition, performing a preoperational environmental monitoring program provides experience that will improve the efficiency of the operational program.

(2) Provide data during plant operations on measurable levels of radiation and radioactive materials in the environment such that the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals from principal pathways of exposure can be evaluated.

(3) 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. Land use and exposure pathways may change over the operating life of the plant. The environmental monitoring program should identify these changes and be revised as needed to monitor the land use and principal exposure pathways.

(4) Provide early warning of onsite or offsite surface or subsurface contamination resulting from leaks/spills and other operational occurrences. Unanticipated or unnoticed leaks and spills of radioactivity may travel in the ground water towards the controlled area or unrestricted areas. The environmental monitoring program provides a method of early detection of radioactivity in the subsurface and monitors its movement.

(5) Identify the potential environmental accumulation of radioactivity that could impact decommissioning. Over the plant's operational lifespan involving many years of continued effluent releases and potential plant operational occurrences, radioactivity may accumulate in various environmental media such as sediment in a receiving water body or in the subsurface soil or ground water from leaks or spills. The environmental monitoring program provides data that allow estimation of the magnitude and extent of this accumulation of contamination. Knowledge of the extent of environmental contamination and levels of radioactivity will allow a reasonable estimate of the impact on the public and environment, as well as of the decommissioning costs.

(6) Confirm that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. One of the primary purposes of the REMP is to provide the final assurance that radioactive effluent releases are low and the public and environment are protected.

C. REGULATORY POSITION

The REMP for nuclear power plants should provide suitable information to estimate levels of radiation and radioactivity in the onsite and offsite environs of each plant. This information may also supply supporting evidence in evaluating the performance of systems and equipment installed to control releases to the environment. The basic principles set forth in this guide constitute a baseline environmental monitoring program.

1. Preoperational Monitoring Program

A preoperational environmental monitoring program should be instituted 2 years before initial plant operation. The schedule for initial sampling and analyses conducted during the preoperational environmental surveillance program should be continued for the first 3 years of commercial operation. The preoperational program should be updated when new exposure pathways are identified and characterized during the annual land-use census. Note that for sites with previously operating nuclear power plants, the existing environmental monitoring program meets the requirements for a preoperational environmental monitoring program.

2. Operational Radiological Environmental Monitoring Program

The baseline operational REMP requires monitoring of the principal exposure pathways (see below). Other exposure pathways must be periodically reevaluated (e.g., during the annual land-use census or at the time of an abnormal release (such as an operational occurrence involving a leak or spill)) to ensure that they are not, or have not become, a principal exposure pathway. For example, monitoring of a ground water exposure pathway may need to be initiated if a leak or spill occurs with the potential to cause a significant level of residual radioactivity. A significant level would be a quantity of radioactive material that would impact decommissioning by requiring remediation in order to terminate the license by meeting the unrestricted use criteria stated in 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use."

2.1 Principal Exposure Pathways

The principal exposure pathways below should be monitored in the baseline environmental monitoring program, unless otherwise justified by the site-specific conditions (e.g., no vegetable gardens in a desert environment or no milk animals in proximity). Human exposure occurs through the following principal exposure pathways:

a. direct radiation;
b. airborne radioactivity (inhalation and submersion exposure);
c. waterborne radioactivity in the following:
    i. drinking water,
    ii. surface water,
    iii. subsurface water (e.g., ground water), and
    iv. sediment.
d. food products:
    i. vegetables, fruit, nuts
    ii. milk,
    iii. meat
    iv. fish, and
    v. invertebrates (if used as a local, common food product).
e. other pathways may exist and should be evaluated on a case-by-case basis

2.2 Site-Specific Exposure Pathways

Site-specific exposure pathways should be considered as follows:

a. Local site characteristics should be evaluated to determine if there are any additional significant site-specific exposure pathways. Exposure pathways are considered significant if a realistic evaluation yields an additional dose increment equal to or more than 10 percent of the total from all pathways.
b. If additional site-specific significant exposure pathways are present, the environmental monitoring program should include additional sampling media (see Section 2.9 below).
c. Monitoring of additional pathways of local community interest may also be prudent, even when those pathways or radionuclides may not be significant (e.g., hunting or fishing pathways or strontium-90 in fish).

2.3 Onsite Environmental Monitoring Program

An onsite environmental monitoring program (i.e., in the restricted area and controlled area) should be developed. The program should include sampling and analysis protocols as needed to detect and monitor both routine releases (e.g., gaseous effluents, deposition of radionuclides from rain-out, liquid effluents released to the controlled area) and abnormal releases to the soil surface and subsurface before radionuclides migrate off site.

2.3.1 Program Considerations

Primary considerations for establishing an onsite environmental monitoring program include the following:

a. location of onsite facilities and work areas, including occupancy factors,
b. thermoluminescent dosimetry (TLD) locations for monitoring work areas where members of the public routinely have access in the controlled area,
c. an evaluation of the radionuclides in gaseous and liquid effluents to be sampled and analyzed;
d. an evaluation of the need for onsite air sampling for dose assessments to members of the public within the controlled area,
e. onsite sampling locations for storm drains or water collection or retention areas to monitor radionuclide deposition or rain-out,
f. sampling locations for the collection of water condensation from equipment operation;
g. sources of drinking water supplies,
h. onsite use of water containing disposed liquid effluents (e.g., use of lake or pond water containing unlicensed radioactive material from liquid effluent disposal),
i. an evaluation of the need for ground water monitoring, and
j. meteorological data

2.3.2 Information Sources

Onsite ground water monitoring programs are site specific and depend on the local hydrogeology, potential liquid leakage sources, and historical leaks and spills (to the ground surface or subsurface) and subsequent ground water contamination. Data from the ground water monitoring program can provide a basis for decisionmaking on whether and/or how to interdict offsite releases or whether to perform remediation.

The following sources of information should be considered in developing the onsite ground water monitoring program:

a. final safety analysis report (FSAR) sections and descriptions of potential sources of radioactive liquid releases (e.g., outdoor tank and buried piping systems such as refueling water storage tanks, condensate storage tanks, radioactive waste storage tanks), spent fuel pools, spent fuel transfer systems, outdoor storage areas for contaminated equipment, storm drains, and retention ponds, basins, canals, or lakes) that could cause ground water contamination events;
b. updated FSAR sections that describe the site hydrology, surface and ground water sources, and geotechnical engineering features affecting ground water transport pathways;
c. site-specific hydrologic and ground water studies performed to determine surface and ground water relationships and principal flow directions and flow rates; and
d. maps and maintenance records on structures, systems, and components containing radioactive liquids that may become potential sources of abnormal releases.

The ground water exposure pathway should be evaluated for its potential to provide a radionuclide transport mechanism and possible exposure pathways to the public. Consequently, it is important to evaluate the need for, and extent of, a subsurface ground water monitoring plan.

The objective of ground water monitoring is to detect abnormal radioactive releases before offsite migration, to determine ground water contamination levels and changes in contamination levels over time, and to provide the data for dose assessments (e.g., identification and determination of the potential for offsite dose) and for taking remedial actions (e.g., isolation and repair of leak and spill sources, interdiction of ground water transport by hydrologic barriers, pump-and-treat, and/or excavation of contaminated soils). A ground water monitoring plan that includes both onsite and offsite monitoring should be integrated to determine the proper selection, placement, and calibration of field instruments and methods to detect radionuclides released in the subsurface. Appropriate sensors, monitoring locations, monitoring frequencies, and data analysis methods should be used.

2.3.3 Ground Water Characterization

An understanding of the local ground water system (e.g., a ground water site characterization) is necessary before designing and operating a ground water monitoring program. Information from the site characterization study will identify the hydrogeologic parameters that include the depth to the local water table, subsurface water flow directions, and water quality classifications; i.e., drinking water quality or less than drinking water quality (such as brackish or saline). The U.S. Environmental Protection Agency and/or State environmental organizations have classified underground aquifers as Class I (drinking water), Class II (potential drinking water), or Class III (nondrinking water). In addition, the U.S. Geological Survey (USGS) can provide regional information on local ground water use, hydrogeologic units and flow properties, and seasonality in the relationships between surface and ground water (e.g., springs, base flow, and recharge rates). The USGS information is accessible through the Ground Water Resources Program Web site, http://water.usgs.gov/ogw/gwrp/.

A ground water characterization study may include an evaluation of the following:

a. site hydrogeology, which includes depth and variability of the water table, ground water supplies, surface water bodies, surface and subsurface water relationships, subsurface drains and barriers, sump pumps, existing onsite and offsite monitoring and pumping wells, and potential pathways for ground water radionuclide migration from onsite sources to offsite human exposure locations;
b. surface and subsurface media affecting ground water transport paths, including impermeable surface runoff, storm drains, construction backfill, soil types, and bedrock systems;
c. changes to on-site or off-site configurations that may have impacted the initial environmental and safety analysis reports regarding site hydrogeologic features;
d. an identification of potential sources of unmonitored gaseous and liquid releases of radionuclides (e.g., spent fuel pools and leak detection systems, fuel transfer tubes, buried pipelines, refueling water storage tanks or components, outdoor storage areas for contaminated equipment, retention ponds or basins, waste processing areas) whether in active use or previously abandoned;
e. an identification of existing and possible leak detection methods for each system or component deemed to be a potential leakage source; and
f. an evaluation of the historical site operating record with regard to routine and abnormal liquid releases (e.g., operational occurrences documented in the corrective action program and a review of 10 CFR 50.75(g) files showing previous leaks or spills that represent potential source(s) of ground water contamination).

Data collected from ground water monitoring can include contaminant concentrations, water content in the unsaturated zone, and ground water levels and velocities in the saturated zone. A ground

water monitoring plan will provide a systematic approach for monitoring subsurface flow and transport from the leaks on land surfaces or from underground leak sources through the unsaturated zone to the underlying water-table aquifer. The ground water monitoring plan should outline the logic for confirming dose assessment model predictions and their assumptions and for evaluating the efficacy of corrective actions, including interdiction and remediation approaches. The results of the ground water monitoring can be used in dose modeling to determine the need and effective approaches for remediation.

Leaks or spills may be detected at the source at the time of the leak or be subsequently detected via the environmental monitoring program. Prompt corrective actions should be taken to the extent reasonable, including isolation of the leak or spill at the source, prevention of the spread of the leak or spill, and remediation of the leak or spill. The event should be documented in the licensee's problem identification and resolution program (corrective action program) and placed in or cross-referenced to the 10 CFR 50.75(g) files. An evaluation should be made as to whether to notify the local authorities and the NRC of the event in accordance with 10 CFR 50.72, "Immediate Notification Requirements for Operating Nuclear Power Reactors."

After initial corrective actions are taken, an assessment of the leak or spill should be conducted to determine and document the location and extent of the impacted areas. The impacted areas will likely depend on factors such as the total time duration of the leak, leak rates and total volume of contaminant, and radionuclide concentrations of the effluent. Sampling and analyses of the undiluted effluent (i.e., the retained/residual effluent remaining in the system, structure, or component), as well as sampling of soil and/or contaminated ground water, should be performed as soon as practical. The leak/spill location and size or extent and movement of the contaminant plume should be estimated. The dose to members of the public from the leak or spill should be evaluated using realistic exposure scenarios.

Following leak or spill cleanup (if performed), a determination should be made on whether to expand the ground water monitoring plan (e.g., install new wells to monitor the leak or spill migration). Records of the leak or spill should be prepared and made readily retrievable for review during remediation or decommissioning. The leak or spill source term should be estimated based on available and historical data (e.g., estimated leak rates, historical records on measured concentrations of similar tank contents, sampling of undiluted effluent, sampling of local ground water or surface water). Records should include the date, a description of the event, an estimate of the source term (estimated concentrations and volume of the leak or spill), the recovered volume of the leak spill, the unrecovered source term in the subsurface or dispersed in local surface waterways (runoff to lakes, canals, rivers, or streams), an evaluation of the onsite and offsite dose consequences, and long-term plans for the remediation of impacted areas.

Impacted areas include locations where radiological leaks or spills have occurred within the onsite environs (i.e., outside of the facility's systems, structures, and components). Decommissioning records should include records of the leaks or spills, including an event description, the impacted areas (locations), source terms, and radiological surveys, including ground water monitoring results. Decommissioning records can include records that are maintained within corrective action programs with a cross-reference to decommissioning records.

Onsite ground water sample results that are part of the formal Radiological Environmental Monitoring Program (REMP) must be reported in the Annual Radiological Environmental Operating Report (AREOR). Additionally, other ground water sample results should be included in the AREOR if

they are associated with tracking an on-site plume resulting from spills or leaks that occurred in previous years.

By contrast, the Annual Radioactive Effluent Release Report (ARERR) should provide a narrative description of leaks and spills that occurred in the current (i.e., 12-month) reporting interval, as well as any such ground water analysis results that may be necessary to assist in the quantification (and reporting) of materials discharged off site (or which may eventually enter the unrestricted area). To aid in consistent reporting of ground water data across the industry, it is recommended that all "*pertinent*" ground water analysis results should be reported in the ARERR. "Pertinent" in this context means those ground water analysis results which provide such information that is reasonable and necessary to (1) characterize spills, leaks, and plumes discovered in the current reporting interval for the ARERR, and (2) to identify areas where spills, leaks, and plumes have not been discovered in the current reporting interval for the ARERR.

2.4 Offsite Environmental Monitoring Program

The principal exposure pathways should be monitored (see NUREG-1301 and NUREG-1302) as follows:

a. The direct radiation exposure pathway should be monitored using direct radiation monitoring stations (e.g., TLDs) located off site in each of the 16 sectors in a ring near the site boundary and at an outer ring in a range of 4–5-miles from the site. In addition, direct radiation monitoring stations should be placed in areas of special interest, such as population centers, nearby residences, and schools.
b. The airborne inhalation exposure pathway should be monitored using continuous air samplers in offsite locations in downwind sectors with the highest annual average deposition and in the vicinity of local communities.
c. The waterborne exposure pathway should be monitored by sampling and analyzing surface water, ground water, drinking water, and sediment.
d. The food products/ingestion pathway should be monitored by sampling of vegetation, milk, fish, and invertebrates, if applicable.
e. Control stations should be established and clearly distinguished from indicator stations for use in correlating control and indicator station results, unless otherwise noted.

2.5 Sampling and Analysis Schedule

The baseline environmental sampling and analysis program should include collection and analysis on the schedule specified in NUREG-1301 and NUREG-1302. An analysis of site-specific radionuclides should be conducted periodically to determine the principal radionuclides, as noted in the following examples:

a. site-specific source term (factoring in fuel performance history, effectiveness of waste processing, and chemical injection and controls such as hydrogen-water chemistry, pH control scheme, and zinc injection); and
b. relative radionuclide importance (see Electric Power Research Institute (EPRI) Report No. 101173, "Ground Water Monitoring Guidance for Nuclear Power Plants," issued

September 2005 (Ref. 7), for an evaluation of the relative importance of radionuclides based on their characteristics (e.g., emissions, half-life, mobility)).

Additional sampling locations that supplement the required locations identified in NUREG-1301 and NUREG-1302 should be added to the ODCM.

2.6 Analytical Detection Capabilities

Sample analysis should employ analytical techniques such that the "a priori" LLDs are achieved as specified in NUREG-1301 and NUREG-1302. Deviations from the a priori LLD capabilities are anticipated during actual sample analyses because of interference from other radionuclides. However, on an a priori basis, these LLDs should be achievable (unless otherwise evaluated and documented). Licensees should report the LLD capabilities of the REMP in the annual radiological environmental operating report.

Note that a revised LLD is recommended for tritium in ground water of 300 picocuries/liter (pCi/L). This is applicable to samples collected for purposes of monitoring ground water for spills and leaks, and may also be used for the subsequent tracking of any resulting plumes. This recommended detection capability is not a regulatory required LLD. Instead, it is intended to provide enhanced detection capability for early detection (i.e., "discovery") of (1) spills, (2) leaks, and (3) plumes (generated from spills and leaks) prior to their entering an unrestricted area. As such, this early detection capability for tritium in ground water may not be applicable to all ground water samples (e.g., where a plume is well characterized and where initial entry of tritium from the spill, leak, or plume is not imminently (e.g., within the next 12 month reporting period) anticipated to enter the unrestricted area). According to federal regulations, water is safe to drink if all contaminants are below the safe drinking water standards. Because the safe drinking water standard for tritium is 20,000 pCi/l, ground water with a tritium concentration of 300 pCi/l does not represent a significant challenge to the health and safety of the public. As a result, the use of the 300 pCi/l "enhanced detection capability" is not necessarily required for purposes of effluent accountability or any restrictions regarding environmental LLD. Indeed, values other than 300 pCi/l may be used for purposes of providing an "early detection capability," however in those cases, a written evaluation should be documented (and available for inspection). A basis for such a deviation may be obtained using objective methodology (e.g., MARLAP, "Multi-Agency Radiation Laboratory Analytical Protocols", Ref. 13).

2.7 Sampling Schedule Contingencies

Deviations from the baseline sampling schedule are permitted if specimens are unobtainable because of hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment, and other legitimate reasons. If specimens are unobtainable because of sampling equipment malfunction, reasonable effort under the circumstances should be made to complete corrective action before the end of the next sampling period, or else compensatory sampling and analysis are required. The annual radiological environmental operating report should document deviations from the baseline sampling schedule other than those provided for in NUREG-1301 and NUREG-1302.

Changes in the environmental monitoring program can be made based on operational experience; however, the baseline program should be maintained, and changes should not reduce the effectiveness of the overall environmental monitoring program. The basis for environmental monitoring program changes

should be documented and retained in accordance with 10 CFR 20.2107, "Records of Dose to Individual Members of the Public," and reported in the annual radiological environmental operating report.

2.8 Land-Use Census

An annual land-use census should be conducted, typically during the growing season. The purpose of the land-use census is to determine the realistic exposure pathways to members of the public and to identify sampling locations and media to be sampled. The land-use census provides the following:

a. a reevaluation of the onsite exposure pathways, including locations and occupancy factors for members of the public in both controlled and restricted areas;
b. a reevaluation of the offsite exposure pathways, including the following:
    i. locations of nearest residences, gardens, and drinking water supplies;
    ii. locations of milk animals and feeding characteristics (e.g., pasturing periods, irrigation, food and water sources); and
    iii. identification of any other significant changes in exposure pathways (e.g., new actual exposure pathways to members of the public and new or obsolete sampling locations or media).

2.9 Periodic Environmental Program Review

A periodic environmental program review should be conducted to reexamine the REMP. The review should ensure that the site environs are being monitored properly for radioactivity in the principal and site-specific exposure pathways. It should also verify that the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals is being evaluated properly.

The periodic review should involve performance of a land-use census that will identify potential changes in exposure pathways, including the following:

a. ensuring the maintenance of the baseline environmental monitoring program;
b. evaluating the need to expand the baseline environmental monitoring program given the results of the periodic program review (e.g., identifying the need for any increases or changes to the environmental monitoring program);
c. confirming the validity of any site-specific information or data used in lieu of the maximum consumption and occupancy factors of actual exposed individuals;
d. reviewing the list of radionuclides and analysis schedule;
e. identifying new drinking water or irrigation systems in use;
f. reviewing 10 CFR 50.75(g) files for residual contamination from leaks, spills, or other events, with the objective of identifying any additional monitoring locations needed (e.g., new ground water sampling locations that should be added to or deleted from the REMP);
g. reviewing trends of radionuclide buildup (e.g., radionuclide buildup trends in lakes or sediment);
h. evaluating and verifying the relationship between quantities of radioactive material released in effluents and resultant environmental radioactivity levels and radiation doses to individuals from exposure pathways (in accordance with Section IV.B.2 of Appendix I to 10 CFR Part 50); and

i. identifying any special studies that may be needed as a followup to evaluations made when comparing effluent and environmental program results under Section IV.B.2 of Appendix I to 10 CFR Part 50 (see Section 2.10 below).

2.10 Reporting Levels

Table 1 defines reporting levels for measured radionuclide concentrations. Reporting levels apply to an average of the radionuclide concentrations in a quarterly period. These reporting levels approximate the direct radiation levels that would be equivalent to the annual design objectives in Appendix I to 10 CFR Part 50. If a measured radionuclide concentration in an environmental sampling medium averaged over a quarterly time period exceeds the reporting level, a confirmatory reanalysis of the original, a duplicate, or a new sample should be obtained and reanalyzed as appropriate. The results of the confirmatory analysis should be completed at the earliest time consistent with the analysis, but in any case within 30 days.

Table 1. Reporting Levels

ANALYSIS	WATER (pCi/L)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/L)	MILK (pCi/L)	BROADLEAF VEGETATION (pCi/kg, wet)
H-3	20,000 [(a)]				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		100	
Cs-134	30	10	1,000	1,000	
Cs-137	50	20	2,000	2,000	
Ba-La-140	200				

For drinking water samples, this is the value from 40 CFR Part 141, "National Primary Drinking Water Regulations" (Ref. 8). For nondrinking water liquids, the applicable value is 30,000 pCi/L.

When more than one of the radionuclides in NUREG-1301 or NUREG-1302 is detected in the medium, the reporting level would be exceeded if the following is true:

$$\frac{concentration\_1}{reporting\_level\_1}+\frac{concentration\_2}{reporting\_level\_2}+\ldots+\frac{concentration\_n}{reporting\_level\_n}\geq 1$$

If radionuclides other than those in Table 2 are detected and are a result of 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 Appendix I to 10 CFR Part 50. If it can be demonstrated that the level is not the

result of plant effluents (i.e., by comparison with control station or preoperational data), a report need not be submitted, but the annual radiological environmental operating report should give an explanation.

If a reporting level is exceeded, licensees may verbally notify the onsite NRC resident inspector as well as the regional health physics office and file a written report in accordance with 10 CFR 50.4, "Written Communications," with 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.

Table 2. Sample 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	LLD [a]	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 ß 416	0.01	0.08 (200/312) (0.05–2.0)	Middletown 5 miles 340 degrees	0.10 (5/52) (0.08–2.0)	0.0 (8/104)	1
	γ spec 32						
	^{137}Cs	0.01	0.05 (4/24) (0.03–0.13)	Smithville 2.5 miles 270 degrees	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 degrees	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 NUREG-1301 and NUREG-1302 for LLD valucs.
b. Mean and range based on detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (f).

Notc: The example data are provided for illustrative purposes only

2.11 Comparison of Effluent Control Programs and Environmental Monitoring Programs

Section IV.B.2 of Appendix I to 10 CFR Part 50 requires that results from the environmental monitoring program be used to validate the modeling of the radiological effluent control program. Methods of comparison should be developed that compare predicted effluent concentrations with measured environmental concentrations, such as to allow verification or modification of the dispersion and dose modeling of the effluents control program. For example, trend graphs should be developed to identify radionuclide buildup trends in the environment (e.g., particulates in sediments or tritium in receiving bodies of water). For many radionuclides, nuclear power experience has shown that effluent releases have not caused any readily detectable concentrations in environmental media, thereby negating the need to compare effluent releases with measured environmental concentrations.

If the comparison between the radiological effluent control program and the REMP indicate the existence of significant differences (e.g., if the relationship between the quantities of radioactive material released in liquid and gaseous effluents and the dose to individuals in unrestricted areas is significantly different from that assumed in the calculations used to determine design objectives), the significant deviations should be reported in the Annual Radiological Environmental Operating Report.

2.12 Annual Radiological Environmental Operating Report

An annual report for the previous calendar year should be submitted electronically or as a hard copy 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 15 each year. Note that the period of the first report should begin with the date of initial criticality and end on December 31. Table 2 provides a sample of the data that the report should include.

The Annual Radiological Environmental Operating Report complements the Annual Radioactive Effluent Release Report that is generated using guidance from Regulatory Guide 1.21. The REMP report should include a summary description of the REMP, a map of all sampling locations keyed to a table giving distances and directions from the reactor or site centerline, the changes identified in the land-use census, data summary interpretations, and an analysis of trends.

A summary or comparison should be made of current environmental monitoring results with preoperational data (as appropriate), results of previous environmental surveillance reports, comparisons to measured effluent releases, and predicted environmental concentrations to provide an overall assessment of the radiological impacts of plant operation to the environment. NUREG-1301 and NUREG-1302 provide more guidance on preparing the radiological environmental operating report.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC's plans for using this draft regulatory guide. The NRC does not intend or approve any imposition or backfit in connection with its issuance.

The NRC has issued this draft guide to encourage public participation in its development. The NRC will consider all public comments received in development of the final guidance document. In some cases, applicants or licensees may propose an alternative or use a previously established acceptable alternative method for complying with specified portions of the NRC's regulations. Otherwise, the methods described in this guide will be used in evaluating compliance with the applicable regulations for license applications, license amendment applications, and amendment requests.

REGULATORY ANALYSIS

1. Statement of the Problem

Revision 1 of Regulatory Guide 4.1, issued in January 1973, described acceptable programs for estimating levels of radiation and radioactivity in the environs of each plant. The regulatory guides set forth the basic principles and methods for use in establishing an environmental monitoring program. These principles were also to be used as bases for developing the licensee's TSs.

The methods for environmental monitoring have evolved and improved over the past 30 years. Revision 1 of Regulatory Guide 4.1 does not fully reflect current staff positions that have changed based on the lessons learned and operating experience gained over the past 30-plus years. New guidance is needed to inform licensees of staff-approved methods of environmental monitoring.

On March 10, 2006, the NRC Executive Director for Operations established the Liquid Radioactive Release Lessons Learned Task Force in response to incidents at some nuclear power plants related to unplanned, unmonitored releases of radioactive liquids into the environment. The task force issued a final report, "Liquid Radiation Release Lessons Learned Task Force Final Report" (Ref. 9) that recommended the revision of effluent and environmental monitoring program requirements and guidance and the provision of additional guidance on detecting, evaluating, and monitoring unplanned and unmonitored releases of radioactive liquids into the environment.

2. Objective

The objective of this regulatory action is to update the regulatory guide to describe the improved methods of environmental monitoring. In addition, this regulatory action would provide other editorial corrections and revisions to enhance clarity.

3. Alternative Approaches

The NRC staff considered the following alternative approaches:

- Do not revise Regulatory Guide 4.1.
- Update Regulatory Guide 4.1.

3.1 Alternative 1: Do Not Revise Regulatory Guide 4.1

Under this alternative, the NRC would not revise the guidance and the current guidance would be retained. If NRC does not take action, there would not be any changes in costs or benefit to the public, licensees or NRC. However, this "no-action" alternative would not address identified concerns with the current version of the regulatory guide. This alternative provides a baseline condition from which any other alternatives will be assessed.

3.2 Alternative 2: Update Regulatory Guide 4.1

Under this alternative, the NRC would update Regulatory Guide 4.1 to provide current staff guidance. The impact to the NRC would be the costs associated with preparing and issuing the regulatory guide revision. The impact to the public would be the voluntary costs associated with reviewing and providing comments to NRC during the public comment period. The value to NRC staff and users of the

regulatory guide would be the benefits associated with enhanced efficiency and effectiveness gained by using a common guidance document as the technical bases for license applications and other interactions between the NRC and its regulated entities.

4. Conclusion

Based on this regulatory analysis, the staff recommends revision of Regulatory Guide 4.1. The staff concludes that the proposed action will enhance compliance with NRC regulations associated with environmental monitoring.

GLOSSARY

a priori—Terminology used in this regulatory guide to indicate that the measurement process has been established before the fact (before interference from other radionuclides). In this regulatory guide, "a priori" describes the concept that minimum detectable levels of isotopic radiological measurements should be determined before interference occurs with other isotopes during actual measurements.

abnormal release—An unplanned or uncontrolled release of licensed radioactive material, including leaks and spills, to the site environs (i.e., locations outside of nuclear power plant systems, structures, and components as described in the FSAR or ODCM). Abnormal releases can occur in restricted areas, controlled areas, or unrestricted areas.

controlled area—The licensee-defined area, outside of a restricted area but inside the site boundary, to which the licensee can limit access for any reason.

determination—A quantitative evaluation of the release or presence of radioactive material under a specific set of conditions. A determination should be made by direct or indirect measurements (e.g., with the use of scaling factors).

drinking water—Also known as potable water; water that does not contain an objectionable pollutant, contamination, minerals, or infective agent and is considered satisfactory for domestic consumption. Potable water is simply water that is suitable for human consumption, and it can come from surface or ground water sources.

drinking water standards—Standards that define allowable concentrations of coliforms and certain chemicals, physical characteristics, and radioactivity in drinking water (e.g., EPA 40 CFR 141).

effluent discharge (radioactive)—A discharge of licensed material through a liquid or gaseous pathway from a facility into the site environs:

- An authorized effluent discharge of licensed material is a discharge made in accordance with 10 CFR 20.2001(c) and technical specifications and/or the ODCM.
- An unauthorized effluent discharge of licensed material is a discharge not made in accordance with 10 CFR 20.2001(c) and technical specifications and/or the ODCM.

ground water—All subsurface water, or simply water in the ground, regardless of its quality, including saline, brackish, or fresh water. Ground water can be moisture in the ground that is above the regional water table in the unsaturated or vadose zone, or ground water can be at and below the water table in the saturated zone.

impacted areas—Areas with reasonable potential for residual radioactivity in excess of natural background or fallout levels (see 10 CFR 50.2, "Definitions," and NUREG-1757, "Consolidated Decommissioning Guidance," issued September 2006). Impacted areas include locations where radiological leaks or spills have occurred within the onsite environs (i.e., outside of the facility's systems, structures, and components).

licensed material—Source material, special nuclear material, or byproduct material received, possessed, used, transferred, or disposed of under a general or specific license issued by the Commission.

lower limit of detection (LLD)—The a priori detection capability for the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95-percent probability with only 5-percent probability of falsely concluding that a blank observation represents a real signal (NUREG-1301, NUREG-1302, and NUREG/CR-4007, "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements" (Ref 10).

member of the public—Any individual except an individual who is receiving an occupational dose. This includes onsite personnel who are not receiving an occupational dose.

monitoring—An analysis or determination of the characteristics of radioactive material that is accomplished by use of installed instrumentation or by sampling and analyses.

non-routine release—A planned, monitored, and controlled release through a release pathway not defined in the ODCM (e.g., a nonroutine release occurs when a spill (abnormal release) is recovered, monitored, and discharged from a release pathway not defined in the ODCM).

principal exposure pathways—The primary exposure pathways to mankind (i.e., direct radiation, airborne exposure, waterborne exposure, and ingestion exposure pathways).

realistic exposure—Exposure to individuals based on evaluations and models that are expected to yield the most accurate assessments of actual dose (see SECY-03-0069, "Results of the License Termination Rule Analysis," dated May 2, 2003 (Ref. 11).

reporting levels—Levels of environmental radioactivity that must be reported to the NRC within 30 days via a special report (see 10 CFR 50.4). The levels are measured radionuclide environmental concentrations averaged over any calendar quarter that are reported to the NRC within a 30-day timeframe (see NUREG-1301 and NUREG-1302). The reporting levels correlate to direct radiation levels that approximate the design objective dose criteria in Appendix I to 10 CFR Part 50.

residual radioactivity—Radioactivity in structures, materials, soils, ground water, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee but excludes background radiation. It also includes radioactive materials remaining at a site as a result of routine or accidental releases of radioactive materials at the site and previous burials at the site, even if those burials were made in accordance with 10 CFR Part 20.

restricted area—An area where the licensee limits access for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

saturated zone—Subsurface zone below the regional water table.

significant exposure pathway—An exposure pathway that contributes more than 10 percent of the total public dose.

significant residual radioactivity—A quantity of radioactive material that would later require remediation during decommissioning to meet the criteria of 10 CFR 20.1402.

site boundary—That line beyond which the licensee does not own, lease, or otherwise control the land or property.

site environs—Locations outside of the nuclear power plant's systems, structures, or components as described in the FSAR or ODCM.

surface water—Water on the land surface, whether intermittent or permanent (e.g., streams, rivers, lakes, and wetlands).

unlicensed material—Radioactive material that was formerly licensed material that was discharged in effluents, background radioactivity, or global fallout. Unlicensed radioactive material is not controlled under a general or specific license unless concentrations exceed the criteria in 10 CFR 30.14, "Exempt Concentrations," (Ref. 12) In addition, exempt radioactive sources under 10 CFR 30.15, "Certain Items Containing Byproduct Material," or 10 CFR 30.18, "Exempt Quantities," are unlicensed material. Note that licensed radioactive material becomes unlicensed radioactive material upon discharge in effluents in accordance with 10 CFR 20.2001, "General Requirements."

unrestricted area—An area for which the licensee neither limits nor controls access.

REFERENCES

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington, DC.

2. 10 CFR Part 20, "Standards for Protection Against Radiation," U.S. Nuclear Regulatory Commission, Washington, DC.

3. Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC.

4. Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)—Effluent Streams and the Environment," U.S. Nuclear Regulatory Commission, Washington, DC.

5. NUREG-1301, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors," U.S. Nuclear Regulatory Commission, Washington, DC, April 1991.

6. NUREG-1302, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors," U.S. Nuclear Regulatory Commission, Washington, DC, April 1991.

7. EPRI Report No. 101173, "Ground Water Monitoring Guidance for Nuclear Power Plants," Electric Power Research Institute, Palo Alto, CA, September 2005.

8. 40 CFR Part 141, "National Primary Drinking Water Regulations," U.S. Environmental Protection Agency, Washington, D.C.

9. NRC document "Liquid Radiation Release Lessons Learned Task Force Final Report," September 2006.

10. NUREG/CR-4007, "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," U.S. Nuclear Regulatory Commission, Washington, DC, September 1984.

11. SECY-03-0069, "Results of the License Termination Rule Analysis," U.S. Nuclear Regulatory Commission, Washington, DC, May 2, 2003.

12. 10 CFR Part 30, "Rules of General Applicability To Domestic Licensing of Byproduct Material," U.S. Nuclear Regulatory Commission, Washington, DC.

13. NUREG-1576, , MARLAP, "Multi-Agency Radiation Laboratory Analytical Protocols," July 2004, EPA 402-B-04-001A

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ANSI/ANS-2.17-2008, "Evaluation of Subsurface Radionuclide Transport at Commercial Nuclear Power Production Facilities," American National Standards Institute, New York, NY, (2008 draft in progress).

ANSI/HPS N13.1-1999, "Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities," American National Standards Institute, New York, NY, January 1999.

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