September 23, 2005

MEMORANDUM TO: Daniel M. Gillen, Deputy Director
Decommissioning Directorate
Division of Waste Management
and Environmental Protection
Office of Nuclear Material Safety
and Safeguards

THRU Andrew Persinko, Section Chief **/RA/**
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SUBJECT: GENERAL GUIDANCE FOR INSPECTIONS AND ENFORCEMENT TO PREVENT FUTURE LEGACY SITES, INTEGRATED DECOMMISSIONING IMPROVEMENT PLAN (IDIP), REVISION 1, ITEM 4.2

The purpose of this memorandum is to inform you of the staff's completion of general guidance for inspections and enforcement to prevent future legacy sites. This is the fiscal year (FY) 2005 product identified in item 4.2 of the Integrated Decommissioning Improvement Plan (IDIP) for FY2004-2007, dated March 29, 2005.

This work is being conducted in two steps as described in the IDIP. This report completes the first step for FY 2005 to review inspection procedures and enforcement guidance, including development of a risk-informed approach to identify operating sites with a high potential for subsurface contamination that could cause future decommissioning problems. This task included identifying the types of sites or specific sites and activities for heightened inspection, and identifying the types of inspection activities that should be completed at these sites. The second step, to be completed in FY 2006 in conjunction with rulemaking to prevent future legacy sites, will develop specific inspection procedures and enforcement guidance for the types of sites and inspections identified in the first step.

This action completes Ticket 200400143/WITS200300269.

Enclosure: General Guidance for Inspections and Enforcement to Prevent Future Legacy Sites and Indicators of Higher Risk of Subsurface Contamination

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GENERAL GUIDANCE FOR INSPECTIONS AND ENFORCEMENT TO PREVENT FUTURE LEGACY SITES AND INDICATORS OF HIGHER RISK OF SUBSURFACE CONTAMINATION

I. INTRODUCTION

A decommissioning legacy site is an existing decommissioning site that is complex and cannot decommission within existing resources for a variety of financial and technical reasons. By logical extension, potential future legacy sites are those operating sites at which current financial and technical factors could cause them to have an increased likelihood of becoming a decommissioning legacy site. To enhance public health and safety, and protect the environment, U.S. Nuclear Regulatory Commission (NRC) staff have developed a plan to prepare revised procedures and rules which will be directed at preventing future legacy sites.[1]

In this report, staff describe general guidance for inspections and enforcement to ensure measures are in place to identify practices that will allow corrective actions to be taken to prevent future legacy sites. This guidance addresses, among other things, the key operational and technical issues which underlie legacy sites - low level specific activity radioactive process leaks, spills, and controlled and uncontrolled effluents. These issues, if evaluated over a short term, tend to result in permissible near-field and short-term radiation doses. However, closer examination of the potential long-term radiological dose resulting from chronic releases, especially where releases accumulate in the subsurface environment, reveals them to be an important contributor to the development of legacy sites. One reason for this is that the decommissioning cost estimates, upon which financial assurance is based, sometimes do not adequately include the cost of remediating this contamination.

In the March 2005, Integrated Decommissioning Improvement Plan, Rev. 1, staff described a two step program for preventing future legacy sites. The FY 2005 efforts, which are summarized in this report, include development of general inspection and enforcement guidance, including developing a risk-informed approach to identify operating sites with a high potential for subsurface contamination that could cause future decommissioning problems. This report is internal guidance for staff. It summarizes general risk insights and suggestions that were identified through a staff study, discussed below, conducted in FY 2005. In a later step, to be initiated in FY 2006 and to be developed in parallel with the rulemaking, staff will consider these insights in developing specific new or revised guidance to licensees, and inspection procedures and enforcement guidance for the types of sites and inspections identified.

II. APPROACH

[1] In SECY-03-0069, "Results of the License Termination Rule Analysis," staff provided recommendations on nine implementation issues that have impacted the decommissioning of sites. The eighth set of recommendations was included as an attachment to SECY-03-0069, in "Results of Evaluations for Measures to Prevent Future Legacy Sites by Changes in Licensee Operations."

Staff developed a risk-informed approach to prepare this general guidance for preventing future legacy sites. Staff qualitatively considered three elements of the risk within the context of subsurface contamination: (1) what can go wrong at current operating sites, based on knowledge of past operating experiences at similar sites that have undergone (or are undergoing) decommissioning; (2) how likely are future events, based on current operating practices and/or the existence of same or similar operations within the U.S.; and (3) what is the potential for future subsurface contamination at current operating sites. As a result, the risk-informed approach described below is based on the staff's experience with decommissioning sites, as it applies to current operating sites.

The staff used a stepwise approach to evaluate current decommissioning sites and obtain risk insights for consideration in future rulemakings and inspection/ enforcement procedure development. In the first step, staff assembled a list of current decommissioning sites and recently completed decommissioned sites and surveyed cognizant NRC project managers (PM)s to ascertain whether groundwater and/or subsurface contamination exists at these sites.[2] Where such contamination does exist, PMs were asked to identify which radionuclides are present and the potential origin or source of the contamination. The 82 sites for which staff collected preliminary information are listed in Table 1. In the subsequent steps, staff focused on sites with known subsurface contamination and developed a structured protocol that was used to interview the PMs, as necessary, to obtain more detailed information on sources and causes of contamination. The protocol for follow-up interviews is summarized in Figure 1.

In addition to the protocol, staff assembled a team of NRC experts for a round-table style discussion of likely sources and causes of subsurface contamination at sites with potential for such release . The NRC expert team members had experience and expertise in one or more of the following technical areas related to subsurface/groundwater contamination: hydrology, geology, decommissioning inspection, dose modeling, health physics reactor decommissioning and material decommissioning technical review experience. This technical team met to review and discuss the list of general activities at different types of NRC sites that either had exhibited subsurface contamination or had the potential to result in subsurface contamination that may not immediately affect worker or public dose constraints. Team members were asked to provide any additional comments or insights on identifying the systems related to the root cause of subsurface contamination. The Team's comments and recommendations were reviewed and incorporated into Table 2.

In the final steps, staff reviewed existing inspection procedures to assess the extent to which sources and causes of subsurface contamination in Table 2 are the subject of these procedures, and identified any new inspection approaches and other guidance that may address the specific sources and causes of subsurface contamination.

III. APPLYING PAST EXPERIENCE TO CURRENT OPERATING SITES

[2] In this report, the subsurface means structures and soil below six inches and extending to the top of the water table. Groundwater means the zone below the top of the water table. If the presence of contamination was identified, for the purposes of this study, the staff did not note whether or not the levels or concentrations were above or below any regulatory standards, limits, or guidelines.

A. Sites No Longer Operating in the U.S. or Operating Under Different Regulatory or Physical Conditions

Of the eleven types of facilities described in Table 1, three are either no longer extensively operated within the U.S., or are operated under a different regulatory paradigm, or under different physical conditions than in the past. The first of these three types are metal extraction facilities, where uranium and thorium contamination resulted from the production of ferrocolumbium (niobium) from pyrochlore. Currently, the United States does not produce steelmaking-grade ferrocolumbium from pyrochlore, and the U.S. steel industry requirements for ferrocolumbium are satisfied virtually entirely by imports (Cunningham, 1997). Therefore, at this time, there is no need to focus future inspection and enforcement activities on this type of facility.

For similar reasons, magnesium-thorium (Mag-Thor, alloy HK31A) production facilities may be excluded from further detailed consideration. Mag-Thor is an alloy that has been commonly used for aircraft engine parts. In NUREG-1717, "Systematic Radiological Assessment of Exemptions for Source and Byproduct Material," staff indicated that there were only two U.S. manufacturers of magnesium thorium alloys (Wellman Dynamics Corp. and Hitchcock Industries) and they were considering ceasing production. Therefore, at this time, there is no need to focus future inspection and enforcement activities on this type of facility.

With regard to low-level waste disposal facilities, current NRC and state regulations establish requirements for siting, design and operation, including provisions for buffer zones of land surrounding and under the waste to permit monitoring and possible corrective actions. When a disposal facility ceases operations, a post-closure period of maintenance and monitoring is required to confirm that the closed site is safely performing as expected before transfer to a government custodial agency for long-term control. Therefore, at this time, there is no need to focus future inspection and enforcement activities on currently operating disposal facilities.

B. Potential Sources and Causes of Subsurface Contamination at High Risk Operating Sites

The Decommissioning Directorate staff's inventory of 82 sites have been subdivided into 11 types of facilities in Table 1. The table identifies 54 sites with subsurface contamination and groundwater contamination. Of the 54 sites, contamination was detected at 8 of 14 power reactor sites, 8 of 17 test and research reactors; 15 of 16 fuel cycle facilities; and 23 of 35 complex materials sites. Table 2 summarizes generic information that the Team considers as the source and causes of subsurface contamination. These sources and causes are discussed below for each facility type.

<u>Reactors</u>

At power reactors, process vessels, tanks and piping, and spent fuel pools, have been known to be the source of contamination leakage into the subsurface. Also, in at least five cases examined in this study, groundwater contamination at power reactors resulted from these leaks or spills. With regard to the potential creation of a legacy site, the relatively large volume of low specific activity radioactively contaminated liquids which are typically handled at power reactors is the major reason why such sites are considered to have a particularly high potential for subsurface and groundwater contamination. Potential sources include spent fuel pools, component cooling water tanks, condensate holding tanks, refueling water storage tanks, borated water storage tanks, buried piping and ventilation systems. Typically because these

systems contain low specific activity contaminated liquid, regardless of the volume of throughput or capacity, they have been considered low risk systems and therefore located outside of buildings. Similar components are known to have caused contamination at test and research reactors. In addition, the Team identified neutron activation in the zone surrounding test and research reactor cores as a potential source of subsurface contamination.

Material Sites

Among the byproduct materials licensees, where subsurface and groundwater contamination exists, the contamination results mostly from permissible burials under the now-rescinded regulations in 10 CFR §20.304. As a result of new waste disposal requirements promulgated in 10 CFR 20 and 10 CFR 61, new future legacy sites are not expected from current operations with byproduct materials. Similarly, two sites which processed relatively small quantities of source material for reasons not pertaining to the fuel cycle (a ceramic glazing operation and a pilot-scale thorium mill) did not produce significant subsurface or groundwater contamination, due in part that the contamination is typically insoluble. These sites are not expected to be legacy sites.

Fuel Cycle Sites

Fuel manufacturing sites, as with power reactors, process large amounts of liquids but contain long-lived radionuclides uranium and thorium. At several sites, the operation of large outdoor liquid low-level radioactive waste treatment lagoons have resulted in chronic releases to the subsurface and groundwater. In addition, many of these sites have historically used permissible low-level waste burial practices. Therefore, existing fuel manufacturing facilities have the potential to become legacy sites.

Depleted Uranium Sites

The Team evaluated five sites where depleted uranium (DU) munitions have been manufactured or test-fired. At these sites, the DU contamination remains mostly in the subsurface. Test-firing practices have raised concerns that at least one site (Jefferson Proving Ground) has the potential for groundwater contamination. Therefore, existing depleted uranium manufacturing and munitions test facilities have the potential to become legacy sites.

Mining Facitilies

At four sites, the practice of dry mining and processing of indigenous heavy mineral-bearing sands has historically resulted in the generation of wastes containing monazite. Monazite is a very insoluble iron-phosphate mineral that contains natural levels of uranium and thorium. At one site in New Jersey, the use of an alkaline chemical dissolution process generated thorium phosphate tailings which were stored in underground storage areas. The storage methods employed for the chemicals may have resulted in groundwater contamination. However, at most of the remaining dry mining sites, the monazite sand was separated using physical processes which ensured that the uranium and thorium-bearing mineral remained insoluble and contamination was limited to the surface and shallow subsurface. In general, procedures are in place to ensure that uranium and thorium concentrations in tailings remain below the NRC licensable quantity of 0.05 weight percent. Therefore, significant new future legacy sites are not expected from current dry mining operations, even though dry mining is still practiced in the United States (e.g., the Iluka Old Hickory Mine at Stony Creek, VA). Periodic Licensee surveillance and NRC inspections of the licensee surveillance program at these sites should ensure that these requirements are maintained.

Sewage Facilities

The Team also studied two sewage treatment plants which had byproduct and source material contamination resulting from permitted sewer disposal of licensed-material. In these cases, radioactive material is concentrated in sludges, where it had accumulated following years of permissible sewer discharges from nearby byproduct material licensees, fuel cycle facilities or nuclear laundries. Therefore, existing municipal sewage treatment plants which are connected to licensed facilities that practice permissible sewer disposal of long-lived radioactivity have the potential to become legacy sites.

In conclusion, the Team has determined that the generally lower risk of subsurface contamination at most byproduct material facilities, small source material licensees, and dry mining (monazite sand processing) sites can be eliminated from further analysis in the rule making and guidance development activities planned for FY06, However, the following remaining types of sites are generally at higher risk of becoming future legacy sites and are recommended for detailed analysis:

- power reactors
- test and research reactors
- fuel manufacturing facilities
- depleted uranium munitions manufacturing and testing sites, and
- sewage treatment plants

This conclusion is consistent with SECY-03-0069, in which the staff had defined sites with “high risk” of subsurface contamination as those with large volumes of long-lived radionuclides, large throughput, or liquid processes. In general, the results of the Team’s assessment, supports the staff’s earlier conclusion. However, the Team recommends including processes which involve large quantities of solid radioactive material, especially where material is stockpiled outdoors, since such sites are also at high risk of having subsurface contamination and therefore, the potential to become legacy sites.

C. Review of Existing Inspection Procedures

Staff reviewed representative procedures to determine whether new inspection procedures might be required or existing procedures might be modified to address NRC enhanced oversight of the common sources and causes of subsurface contamination. The staff’s review included the following procedures:

IP42700, “Plant Procedures”
IP62709, “Configuration Risk Assessment and Risk Management Process”
IP69004, “Class I NonPower Reactor Effluent and Environmental Monitoring”
IP71846, “Review of Conduct of Operations”
IP80210, “Environmental Protection - Initial and Periodic Inspections”
IP83822, “Radiation Protection”
IP84750, “Radioactive Waste Treatment, and Effluent and Environmental Monitoring”
IP87102, “Maintaining Effluents from Materials Facilities As Low As Reasonable Achievable (ALARA)”
IP88045, “Environmental Protection”
IP88104, “Decommissioning Inspection Procedure for Fuel Cycle Facilities”

In general, these procedures address existing regulatory requirements for worker and public health and safety, which tend to focus on protection in the near-term during facility operations. These existing procedures as written do not apply to factors which contribute to long-term radiological doses that are currently addressed during decommissioning and explicitly do not address factors to prevent future legacy sites.

Past NRC generic communications pertaining to environmental protection and waste management practices are listed in Table 3. As with the above procedures, the generic communications do not address factors which contribute to long-term radiological doses that are currently herein addressed. However, the information may be useful, if modified and re-applied to decommissioning sites, to the rulemaking and procedure development teams that will address NRC oversight of the common sources and causes of subsurface contamination.

IV. GENERAL GUIDANCE FOR FUTURE INSPECTIONS AND ENFORCEMENT

The analysis described above suggests that the staff's general licensing as well as inspection approach for prevention of future legacy sites should be modified to enhance existing inspection and enforcement procedures. Such enhancements should include the license requirements for licensee surveillance and monitoring programs and the consideration of inspection activities that focus on operational practices and surveillances which can result in long-term radiological doses resulting from chronic releases. Future staff evaluations may also reveal the need for new procedures to address factors which contribute to potential future legacy sites. In general, staff concluded that license requirements, as well as the types of inspection procedures and enforcement procedures that could be either updated or developed focus on six broad areas: (1) preventive maintenance, (2) spill protection, (3) environmental monitoring, (4) waste management, (5) source reduction, and (6) financial assurance.

The following sections provide guidance statements proposed by the Team in four general programs, which recommend changes to enhance oversight of: (1) licensee safety programs, such as operator training and surveillances; (2) a licensee's facility change control program, to ensure long-term environmental consequences are considered; (3) the radiation protection and environmental protection programs which detect and track low-level, chronic releases; and (4) licensee documentation of events that may trigger decommissioning record keeping requirements and/or reporting to NRC. Staff related the six broad areas for procedure update or modification, identified above, to the guidance statements in the four general programs by noting the applicable areas at the end of each guidance statement. This was done to emphasize that, for the prevention of future legacy sites, it may be necessary that inspection and/or enforcement procedures relate to or address more than one type of program. Staff concluded that financial assurance relates to all of the guidance statements because the actions in the guidance statements have the potential to impact decommissioning funding estimates. Staff believes that any new requirements or procedures related to the prevention of future legacy sites will likely result in additional costs associated with prevention of spills and other releases, and potentially documenting and tracking the spread of contamination from operations through decommissioning. These costs should be compared to the cost of cleanup of low-level chronic releases at the time of decommissioning. The FY06 rulemaking will address the issue of financial assurance in relationship to these potential additional costs.

Guidance pertaining to 10 CFR 20.1406 contamination and waste minimization practices are applicable to new applicants. However, as described in SECY-03-0069, staff is considering a

rule change to make this requirement broadly applicable to existing licensees. As noted previously, developing inspection procedures and enforcement guidance addressing the prevention of future legacy sites will be accomplished in parallel with the rulemaking. The inspection procedures and enforcement guidance should apply to existing operational sites, new applicants, and sites currently in decommissioning. More insights may be obtained if current operating sites were examined in a way similar to this study. The following guidance statements are provided for staff to consider during the proposed rulemaking and associated procedure development efforts scheduled for FY 2006:

A. Licensee Safety Programs

1. Radiation Protection Programs

a. Required surveys and decommissioning recordkeeping: Facility surveys are required under 10 CFR 20, Subpart F to be conducted with an appropriate frequency and sensitivity to the radionuclides that are present. In addition, licensees are required to document spills and other unusual occurrences in accordance with §§30.35(g)(1), 40.36(f)(1), 70.25(g)(1), 72.30(d)(1). Periodic licensee surveys (in accordance with Subpart F) in areas of spills and other unusual occurrences would ensure that the decommissioning records reflect up-to-date radiological conditions, even where residual contamination is otherwise ALARA and would not cause the licensee to exceed worker dose limits. Required records might include data on the migration of contamination, performance of any containment systems, and verification of parent to progeny or potential surrogate ratios. (Environmental Monitoring, Spill Prevention, and Financial Assurance).

b. Authorized disposal practices under 10 CFR 20, Subpart K: Licensees are required to dispose of waste in accordance with practices described in Subpart K. Enhanced inspections of waste disposal practices, including licensee provisions for adequate weather protection of wastes during temporary storage, appropriate confinement engineering for liquid waste processing, and provisions for monitoring radionuclide solubility in sewer discharges and resultant impacts on surrounding environmental matrices could reduce the risk of subsurface contamination. In addition, licensees' safety and compliance evaluations should include the long term radiological dose impacts from waste management practices (Waste Management, Preventive Maintenance, Financial Assurance).

c. Contamination minimization and waste minimization: New licensees are required to minimize facility contamination and waste generation. Revising this requirement so that it applies to existing licensees could reduce the risk of subsurface contamination at existing sites. These practices include minimization of licensed material storage locations, restrictions on commingling of different waste streams, filtration of effluent streams, use of non-porous materials in facility construction and material handling equipment, and use of ventilation stacks and ductwork with minimal lengths and minimal abrupt changes (NUREG-1736). These practices may be similar to or touch upon pollution prevention issues recognized by other regulatory agencies, such as the US Environmental Protection Agency (EPA), and industry. For example, the EPA has established guidance in the areas of Best Management Practices, has incorporated Pollution Prevention (P2) concepts of the 1990 Pollution Prevention Act

(for hazardous materials) into its policies, and participates in the Pollution Prevention Voluntary Standards Network (US EPA). Staff recommends that FY06 rulemaking and/or procedure development teams obtain and assess information from EPA and industry regarding lessons learned in the (1) participation in voluntary international standards organizations (ISO 14000) both for particular products and for environmental management issues and in the (2) development and/or implementation of pollution prevention programs. This information maybe useful to NRC to further develop its risk-informed and performance-based approaches to prevent future legacy sites. (Preventive Maintenance, Waste Management, Source Reduction and Financial Assurance).

2. Environmental Protection Programs

   a. Environmental Monitoring and Surveillance: Licensees are required to conduct surveys of environmental media pursuant to 10 CFR 20, Subpart F. An inspection emphasis on appropriate minimum detectable limits to detect and adequately characterize and track the migration of spills and leaks from processes and waste treatment systems within the site boundary, could reduce the risk of subsurface contamination (Environmental Monitoring, Waste Management, and Financial Assurance).

   b. Management measures required under 70.62(d), and similar rules: Where a licensee has committed to programs and procedures to reduce the likelihood of leaks in safety-related systems, such as a corrosion control program for in-plant liquid process piping, staff should evaluate the efficacy of the program for systems containing large quantities of long-lived, liquid radionuclides (Preventive Maintenance and Financial Assurance).

B. Changes to Licensee Operations

1. Updating Documentation of Site Characteristics

   In general, licensees are required to document site characteristics (e.g., geology, seismology, hydrology, and meteorology) which are important to facility safety. However, for those plants with higher potential for subsurface contamination, more detailed knowledge is necessary before plant operation to determine the appropriate locations (x, y, z) of monitoring systems and the frequency of sampling to detect the occurrence of subsurface contamination. Further, as plant conditions change, including the occurrence of spills and unusual events, the level of detail in the licensee's knowledge of site characteristics should change accordingly. For example, during operational life stage of the plant, the licensee may need additional information on site specific radionuclide transport factors in subsurface soil (Spill Prevention, Environmental Monitoring and Financial Assurance).

2. 10 CFR 20.304 Low-level Waste Burials

   For previously authorized burial pits or trenches, licensees should have sufficiently documented and characterized the area so as to assess potential long term radiological doses. If documentation and characterization are not sufficient, licensees should be

committed to collect such information (Waste Management, Environmental Monitoring, and Financial Assurance).

C. Detecting Chronic, Low-Level Releases

1. Maintenance of Contaminated Areas

Licensees should be required to assess and document the factors which could affect and prevent the spread of existing contaminated areas (Environmental Monitoring and Financial Assurance).

2. Maintaining Confinement

Licensee preventive maintenance programs should include periodic monitoring of the efficacy of secondary confinement structures, leak detection, and capture systems (drip pans) on liquid low-level waste systems containing relatively low levels of radioactivity, in addition to monitoring of higher-risk process-related systems (Preventative Maintenance, Environmental Monitoring and Financial Assurance).

3. Cleanup Criteria During Operations

For existing facilities, if an NRC dose-based criterion for decontamination or cleanup of soils and structures within the site boundaries affected by spills and other unusual occurrences was applicable long before the site was in decommissioning, it could reduce the magnitude of subsurface contamination at the time of facility decommissioning. (Spill Prevention, Environmental Monitoring and Financial Assurance).

D. Documenting Spills and Reporting Deficiencies

An inspection focus on requirements in 30.35(g)(1), 40.36(f)(1), 70.25(g)(1), and 72.30(d)(1) for licensee recordkeeping of spills and unusual occurrences could reduce the likelihood of undocumented subsurface contamination. Additional guidance to licensees on spill reporting and follow up surveillance actions associated with potential long term dose impacts resulting from such spills, may also be needed. (Spill Prevention and Financial Assurance).

E. Figure and Tables

1. Is groundwater or subsurface contamination the result of process-related spills or leaks?
   1.A. If yes, what process components failed?
   1.B .How did the following factors, or lack thereof, affect the extent of contamination?
   - secondary confinement features
   - corrosion control program
   - broken welds or similar structural failures
   - leak detection systems
   - monitoring wells
   - contaminant solubility
   - regional hydrology and meteorology
2. Did programmatic failures contribute to the loss of material control?
3. Is the contamination attributable to permissible past practices? Are these practices ongoing?
4. What authority might NRC have invoked at the time the spill or leak was discovered which might have mitigated the extent of contamination?
5. Did the accumulation or stockpiling of wastes contribute to the extent of spills or leaks?
6. Did the licensee consider processing alternatives to reduce environmental damage?
7. Has the licensee installed barriers to prevent the spread of contamination?
8. If yes to 7., are these barriers currently under surveillance and inspection?

Figure 1, Structured Protocol for Expert Elicitation

Table 1
Decommissioning Sites Reviewed for Surface (S) and Groundwater (G) Contamination

REACTORS

Power Reactors (14)
- Big Rock Point (S, G)
- Fermi Unit 1
- Haddam Neck (S,G)
- LaCrosse
- Maine Yankee (S,G)
- Pathfinder
- Peach Bottom Unit 1
- San Onofre 1 (S)
- TMI 2
- Trojan (S,G)
- Indian Point 1 (S)
- Millstone 1 (S)
- Saxton (S,G)
- Vallecitos BWR

Test & Research Reactors (17)
- Cornell U.- ZBR
- Cornell U.-TRIGA
- Ford Nuclear Reactor (S)
- Gen. Atomics TRIGA, Mark F (S)
- Gen. Atomics - TRIGA, Mark I (S)
- Gen. Electric - GETR
- General Electric - VESR
- Manhattan College
- NASA - College (S)
- NASA - Plum Brook (S)
- U. of Buffalo
- U. of Illinois
- U. of Virginia - Cavalier
- U. of Virginia (S,G)
- U. of Washington (S)
- Veterans Administration
- Westinghouse Waltz Mill (S,G)

FUEL CYCLE

Fuel Manufacturing (13)
- Babcock & Wilcox - Parks (S,G)
- Battelle Columbus Laboratories (S,G)
- Curtiss-Wright Cheswick (S)
- Framatome Richland (S,G)
- General Atomics (S)
- Honeywell
- Kerr-McGee Cushing (S,G)
- Sequoyah Fuels (S,G)
- UNC Naval Products (S)
- Union Carbide Corp.
- Westinghouse Electric Co. (S) (Blairsville, PA)
- Westinghouse Electric Co. (S, G) Hematite, MO)
- Westinghouse Waltz Mill (S,G)

Low-Level Waste Disposal (3)
- Babcock & Wilcox (SLDA) (S,G)
- Kerr-McGee - Cimmarron (S,G)
- West Valley (S,G)

COMPLEX MATERIALS

Byproduct Materials (8)
- Augustana College (S)
- Envirotest Laboratories
- Kerr-McGee Tech. Center
- Kirtland AFB
- Minnesota Mining & Manufacturing
- Quehanna (S)
- Safety Light Corp (SLC) (S,G)
- U. of Wyoming (S)

Depleted Uranium Munitions (5)
- Alliant Ordinance and Ground Systems, LLC (S)
- Jefferson Proving Ground (S, G)
- Eglin AFB (S)
- Watertown - GSA
- Lake City Army Ammo. Plant (S)

U/Th-Containing Processes (2)
- Homer Laughlin
- Salmon River

Monazite Sand Processing (4)
- Englehard Minerals-IL (S)
- Englehard Minerals-OH
- Heritage Minerals
- Stepan Chemical Company (S,G)

Sewage Treatment Plants (2)
- Kiski Valley Water Pollution Control Authority (S)
- Royersford Wastewater Treatment Facility

Metal Extraction (9) (tantalum/columbium)
- Cabot Performance Materials, Inc. (S)
- Cabot Corp. - Revere, PA
- FMRI, Inc (Fansteel) (S,G)
- Mallinckrodt Chemical, Inc. (S,G)
- Molycorp, Inc. - York (S,G)
- Molycorp, Inc. - Washington (S,G)
- NWI Breckenridge (S)
- Sheildalloy Metallurgical Corp
- Whittaker Corporation (S,G)

Magnesium-Thorium Alloy (5)
- AAR Manufacturing (S)
- Dow Chemical Co. (S,G)
- Kaiser Aluminum (S)
- Michigan Dept. of Natural Resources (S,G)
- SCA Services (S,G)

Table 2
Sources and Causes of Subsurface Contamination

Sources	Causes
Unauthorized or undetected discharges	• insufficient storm water control • environmental surveys insufficient to detect fugitive releases • inadequate sampling protocol - releases not detected • inadequate oversight (e.g., NRC split samples) • improper disposal • inadequate baseline and periodic monitoring to confirm no contamination in vulnerable areas • inadequate siting and design requirements for storage and piping systems • inadequate pollution prevention or waste management measures incorporated in waste management program • inadequate documentation of contamination sources, recharge areas and associated land use controls • inadequate worker training • lack of or inadequate tracking and trending of environmental surveillance data (onsite and offsite) • inadequate protocols or procedures for decision making on future actions needed in response to the review of monitoring reports or tracking and trending. • lack of or inadequate periodic measurements of water levels and/or water quality control parameters (well) • inadequate water management measures (such as provisions for vulnerability maps, prioritization of protection areas, etc.)
Unprotected or outdoor storage of solid waste and/or demolition debris and leaching	• high waste disposal costs • inadequate environmental controls • inadequate storage design or siting criteria that accounts for impacts on subsurface or groundwater
Unprotected excavations and ground surface water intrusion	• inclement weather • insufficient funds • inadequate oversight • inadequate environmental controls (such as run off controls, etc.)
Leaks through drains and floor joints and seals	• poor housekeeping • inadequate corrosion control • inadequate maintenance • inadequate leak detection • inadequate secondary containment
Tank and piping leaks (including spent fuel pools)	• inadequate corrosion control • inadequate maintenance • inadequate leak detection • inadequate secondary containment
Vent stacks and discharge pipes	• past accidents or events • inadequate discharge assessments/calculations

Table 3
NRC Generic Communications on Environmental Protection and Waste Management

Information Notices	
IN 79-07	Rupture of Radwaste Tanks
IN 79-09	Spill of Radioactively Contaminated Resin
IN 80-22	Breakdowns in Contamination Control Programs
IN 85-12	Buildup of Enriched Uranium in Ventilation Ducts and Associated Effluent Control Systems
IN 87-03	Segregation of Hazardous and Low-Level Radioactive Wastes
IN 88-02	Disposal of Sludge from Onsite Sewage Treatment Facilities at Nuclear Power Stations
IN 89-13	Alternative Waste Management Procedures in Case of Denial of Access to Low-Level Waste Disposal Sites
IN 90-09	Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Materials Licensees
IN 90-75	Denial of Access to Current Low-Level Radioactive Waste Disposal Facilities
IN 91-16	Unmonitored Release Pathways from Slightly Contaminated Recycle and Recirculation Water Systems at a Fuel Facility
IN 92-11	Soil and Water Contamination at Fuel Facilities
IN 94-07	Solubility Criteria for Liquid Effluent Releases to Sanitary Sewerage Under the Revised 10 CFR Part 20
IN 94-23	Guidance to Hazardous, Radioactive and Mixed Waste Generators on the Elements of a Waste Minimization Program
IN 94-81	Accuracy of Bioassay and Environmental Sampling Results
IN 95-46	Unplanned, Undetected Release of Radioactivity from the Exhaust Ventilation System of a Boiling Water Reactor
IN 96-14	Degradation of Radwaste Facility Equipment at Millstone Nuclear Power Station, Unit
IN 96-47	Recordkeeping, Decommissioning Notifications for Disposals of Radioactive Waste by Land Burial Authorized under Former 10 CFR 20.304, 20.302, and Current 20.2002
Regulatory Information Summary	
RIS 2002-02	Lessons-Learned Related to Recently Submitted Decommissioning Plans and License Termination Plans (Item 2 pertains to groundwater monitoring for site characterization and dose assessments)

V. REFERENCES

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http://www.epa.gov/OW-OWM.html/iso14001/isofaq.htm
http://es.epa.gov/cooperative/topics/iso14000.html
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http://www.epa.gov/p2/pubs/standards.txt
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U.S. Nuclear Regulatory Regulatory Commission, 2001, NUREG-1717, “Systematic Radiological Assessment of Exemptions for Source and Byproduct Materials”

U.S. Nuclear Regulatory Regulatory Commission, 2001, NUREG-1736, “Consolidated Guidance: 10 CFR Part 20 - Standards for Protection Against Radiation”