RAS J-50

LIQUID RADIOACTIVE RELEASE

LESSONS LEARNED TASK FORCE

FINAL REPORT

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Task Force Members:

Stuart Richards, NRR
Timothy Frye, NRR
James Shepherd, NMSS
Thomas Nicholson, RES
George Kuzo, Region II
Undine Shoop, OEDO
Stacie Sakai, NRR
Michael Shannon, Region IV
Andrea Keim, NRR
Stephen Klementowicz, NRR
Ronald Nimitz, CHP, Region I
Steven Orth, Region III
Scott Burnell, OPA
Rich Allen, Illinois Emergency Management Agency, Bureau of Environmental Safety

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EXECUTIVE SUMMARY

The Liquid Radioactive Release Lessons Learned Task Force (LLTF) was established by the NRC Executive Director for Operations on March 10, 2006, in response to incidents at Braidwood, Indian Point, Byron, and Dresden related to unplanned, unmonitored releases of radioactive liquids into the environment. The scope of the task force work included reviews of industry experience, associated public health impacts (if any), the NRC regulatory framework, related NRC inspection and enforcement programs, industry reporting requirements, past industry actions following significant inadvertent releases, international perspectives, and NRC communications with public stakeholders.

The task force included representatives from all four regional offices: the Office of Nuclear Reactor Regulation (NRR), the Office of Nuclear Materials Safety and Safeguards (NMSS), the Office of Nuclear Regulatory Research (RES), the Office of Public Affairs (OPA), the Office of the Executive Director for Operations (OEDO), and a representative from the State of Illinois.

The focus of the task force was on releases of radioactive liquids that were neither planned nor monitored. An understanding of the routine discharge of radioactive materials from a nuclear power plant is necessary to gain a perspective on the unplanned releases.

Virtually all commercial nuclear power plants routinely release radioactive materials to the environment in liquids and gases. These releases are planned, monitored, and documented. NRC regulations in 10 CFR Part 20 and in 10 CFR Part 50 place limits on these releases to ensure the impact on public health is very low. On an annual basis, NRC guidelines require that the release of radioactive material in a liquid form from a nuclear power plant must not result in a radiation dose of greater than 3 millirem to any individual in an unrestricted area. All licensees routinely report to the NRC that they are well within this limit.

To place 3 millirem of radiation in perspective, the average member of the public in the United States receives a radiation dose of about 360 millirem per year, primarily from natural sources such as radon in the soil and cosmic radiation, and from medical sources such as diagnostic X-rays. A passenger on a single cross country airplane flight receives a radiation dose of about 3 millirem due to the flight occurring at a high altitude, resulting in a reduction in shielding of cosmic radiation by the earth's atmosphere.

In accordance with NRC regulations, nuclear power plant operators are required to submit an annual report to the NRC detailing the amount of radioactive material released to the environment during the past year. This report estimates the public health impact of the releases. Nuclear power plant operators are also required by NRC regulations to monitor the environment in the vicinity of the nuclear power plant to assess the cumulative impact of the radioactive material that has been released. On an annual basis, the results of the environmental monitoring program are submitted to the NRC. Both of these reports for all nuclear power plants regulated by the NRC are available to the public via the NRC website.

Most of the events that have recently received increased attention from the NRC have involved tritium, which is a radioactive isotope of hydrogen. However, the task force did not limit its review to tritium related events. Other radioactive isotopes have been inadvertently released into the environment. An example is leakage from spent fuel pools, particularly where the pool contains fuel with degraded outer cladding material, thereby allowing fission products to be released from the fuel into the pool water.

The most significant conclusion of the task force regarded public health impacts. Although there have been a number of industry events where radioactive liquid was released to the environment in an unplanned and unmonitored fashion, based on the data available, the task force did not identify any instances where the health of the public was impacted.

The task force did identify that under the existing regulatory requirements the potential exists for unplanned and unmonitored releases of radioactive liquids to migrate offsite into the public domain undetected. The following elements collectively contribute to this conclusion:

- Some of the power plant components that contain radioactive fluids that have leaked were constructed to commercial standards, in contrast to plant safety systems that are typically fabricated to more stringent requirements. The result is a lower level of assurance that these types of components will be leak proof over the life of the plant.

- Some of the components that have leaked were not subject to surveillance, maintenance, or inspection activities by NRC requirements. This increases the likelihood that leakage in such components can go undetected. Additionally, relatively low leakage rates may not be detected by plant operators, even over an extended period of time.

- Portions of some components or structures are physically not visible to operators, thereby reducing the likelihood that leakage will be identified. Examples of such components include buried pipes and spent fuel pool.

- Leakage that enters the ground below the plant may be undetected because there are generally no NRC requirements to monitor the groundwater onsite for radioactive contamination.

- Contamination in groundwater onsite may migrate offsite undetected. Although the power plant operator is required by NRC regulations to perform offsite environmental monitoring, the sampling locations are typically mostly in the vicinity of the point of release of the normal discharge flow path. For example, at Braidwood, most of the environment water samples were being taken near where the discharge pipe empties into the river, a distance of about 5 miles from the plant.

Furthermore, if groundwater contamination is detected, it may be difficult to monitor and to predict the movement of the contamination in the groundwater. The flow of groundwater can be influenced by a variety of factors and can be quite complex.

Another aspect of inadvertent releases of radioactive material to the environment that was illuminated by the Braidwood and Indian Point events was the level of public concern that can result. At both sites, media coverage was wide-spread. Concerns were expressed by Members of Congress, as well as by State and local officials. The Braidwood event led to the State of Illinois enacting legislation requiring reporting of events at a threshold well below that presently required by the NRC. Senator Obama of Illinois has introduced legislation in the United States Senate that would require additional reporting on a nationwide basis. Public meetings in the vicinity of the plants were widely attended, and the opinion expressed by the audiences was generally negative toward both the plant operator and the NRC. The events also led to the submission of a petition to the NRC in accordance with the provisions of 10 CFR 2.206. This petition was co-sponsored by 28 different public groups or individuals, and requested that the NRC take certain actions that the petitioners believed was warranted to protect public health.

When considering recommendations to be made as the result of the task force review, the task force members were challenged to weigh the likely benefit of implementing recommendations against the cost. The task force concluded that the relative potential benefit to protection of public health would generally be low, because the realistic potential for long term undetected radioactive leakage resulting in a more than minor radiation dose to members of the public is low. However, as illustrated by the Braidwood and Indian Point events, the task force concluded that the positive benefit to the NRC's goal of openness could be significant. The recommendations contained in the report reflect this judgement.

deviations from the sampling schedule are required to be documented in the annual radiological environmental monitoring report.

The regulatory guidance provides built-in flexibility in the scope of the REMP. It provides a generic minimum program and also states that individual sites may have special local characteristics which have to be addressed on a site specific basis. It also allows licensees to reduce the scope and frequency of the sampling program, without NRC approval, based on historical data. What NRC inspectors have typically seen is that if a licensee's environmental samples have not detected licensed radioactive material in several years, then the licensee typically reduces the scope and sample frequency of the associated environmental pathway. The guidance is designed to allow the REMP to focus its sampling protocol on the more dose significant pathways and to drop sampling in those areas that result in the lowest dose. NRC inspections have observed reductions in the scope and frequency of licensee programs, but in all cases the minimum required sampling of the required pathways continues.

Reporting Requirements

As discussed above, there are no specific regulatory requirements for licensees to conduct routine on-site environmental surveys and monitoring for potential abnormal spills and leaks of radioactive liquids. However, 10 CFR 50.75(g) requires that licensees keep records of information important to the safe and effective decommissioning of the facility. These records include information on known spills or other unusual occurrences involving the spread of contamination in and around the facility or site. These records may be limited to instances when significant contamination remains after any cleanup procedures or when there is reasonable likelihood that contamination may have spread to inaccessible areas. The rule does not define the magnitude of the spills and leaks that need to be documented by the licensee. Also, the rule does not define "significant contamination" that needs to be recorded after the cleanup process. Licensees maintain records of information on spills and leaks at their facilities. There is no requirement that this information must be submitted to the NRC. However, the records are available for review by NRC inspectors.

Although 10 CFR 50.75(g) discusses the requirement for records of any remaining residual contamination, there are no regulatory requirements which require remediation while the power plant is operating. A licensee's decision to remediate contamination before the plant is decommissioned is typically based on several factors, including ALARA considerations for potential worker and public dose, cost, feasibility, disposal options, and external stakeholder considerations.

The NRC has clearly defined radiation limits for the decommissioning of a nuclear reactor and release of the facility or site for unrestricted use by members of the public. The requirements are contained in 10 CFR Part 20, Subpart E - "Radiological Criteria for License Termination." The NRC will terminate a Part 50 license and allow the site to be used for any purpose provided that any remaining reactor produced radioactive contamination does not result in an annual dose above 25 mrem. The dose is calculated from all environmental pathways; air, water, food products, residential occupancy and/or industrial use.

10 CFR Part 20, Subpart M — Reports

Section 20.2202 provides criteria for notification of incidents. For incidents involving the release of licensed radioactive material, the reporting criteria is that immediate notification of the NRC is required when the event may have caused or threatens to cause a large dose in excess of regulatory limits to an individual (i.e, 25 rem to the whole body, 75 rem to the lens of the eye, or a shallow-dose equivalent skin or extremity dose of 250 rads). Note that 1 rem is equal to 1000 mrem.

Incidents which require notification within 24 hours involve radiation doses which are lower than

Dresden Storage Tank Piping Leak

In 2004, leakage was discovered in the supply line piping between the condensate storage tank and the high pressure coolant injection (HPCI) system. The piping is approximately 175 feet long and is located in a dirt trench. The licensee replaced approximately 75 feet of piping where leaks had been identified in 2004. The replaced section of piping is buried in a low-strength grout material. In February, 2006, the licensee identified elevated levels of tritium in a monitoring well located near the underground piping. The licensee suspects that the current leak is from the 100 feet of piping that was not replaced in 2004. The licensee had planned to replace the piping in June, 2006 prior to the identification of elevated tritium. The condensate storage tank and associated piping is made of aluminum and is not categorized as Class I. In addition, the licensee has not categorized the condensate storage tank and the associated piping to the HPCI system as safety related. The licensee's UFSAR lists the safety related water source as the torus for the HPCI system. The piping is classified as non-safety related, although the licensee lists it as Augmented Quality under the Exelon quality assurance program. The piping is designed to meet ANSI B31.1 standards. The piping is wrapped with polypropylene pipe wrap material to provide protection from corrosion and electrolysis. The piping consists of 12-inch, 16-inch, 18-inch and 24-inch diameter sections having a nominal wall thickness of 0.375-inch. The required installation testing includes hydrotesting and visual inspection. The licensee's technical specifications require quarterly HPCI surveillance using the subject section of piping as part of the flow path. In addition, the Exelon excavation procedures have the licensee visually inspect the buried piping if the area is excavated in the future. The task force could not identify any generic regulatory requirements that applied to maintenance, surveillance, or routine testing of non-safety related condensate storage tanks and associated piping.

3.2.2.3 Conclusions

Review of regulatory requirements for SSCs that have experienced unmonitored or unplanned liquid radioactive effluent releases as described above, leads to the following conclusions:

(1) Systems containing radioactive liquid that are designated as safety-related, or that are addressed under some aspect of a licensee's quality assurance program, are generally subject to maintenance, inspections, tests, and/or other quality assurance requirements that provide added assurance that the system will not leak, or if it does leak, that the leakage will be detected. Systems that are not safety-related and that are not covered under the quality assurance program generally are subject to less of these measures.

(2) Systems or structures can experience undetected radioactive leaks over a prolonged period of time. Systems or structures that are buried or that are in contact with soil, such as SFPs, tanks in contact with the ground, and buried pipes, are particularly susceptible to undetected leakage.

(3) SFP leakage may be reduced by improved maintenance and trending of the telltale leak detection/monitoring system.

(4) SFP performance deficiencies are not specifically addressed in the NRC inspection program significance determination process.

(5) Leakage from components containing radioactive liquids may be reduced by the use of improved materials, the use of higher level consensus code repair/replacement requirements, improved quality assurance, improved design standards, improved and expanded inspection requirements, improved protection of buried components (galvanic protection, coatings) and/or improved design considerations.

APPENDIX B

CONSOLIDATED RECOMMENDATIONS LIST

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(1) The staff should review and develop a position to address using lake water that contains licensed radioactive material for other site purposes, such as for use in the fire protection system (Section 2.0)

(2) The NRC should develop guidance to the industry for detecting, evaluating, and monitoring releases from operating facilities via unmonitored pathways (Sections 3.1 and 3.4).

(3) The NRC should revise the radiological effluent and environmental monitoring program requirements and guidance to be consistent with current industry standards and commercially available radiation detection technology (Section 3.2.1).

(4) Guidance for the REMP should be revised to limit the amount of flexibility in its conduct. Guidance is needed on when the program, based on data or environmental conditions, should be expanded (Section 3.2.1).

(5) Develop guidance to define the magnitude of the spills and leaks that need to be documented by the licensee under 10 CFR 50.75(g). Also, clearly define "significant contamination." Summaries of spills and leaks documented under 10 CFR 50.75(g) should be included in the annual radioactive effluent release report (Section 3.2.1 and 3.4).

(6) The staff should provide guidance to the industry which expands the use of historical information and data in their 50.75(g) files to the operational phase of the plant. The data provides good information on current and future potential radiological hazards that are important during routine operation, and can aid in planning survey and monitoring programs (Sections 3.2.1 and 3.4).

(7) The NRC should evaluate the need to enact regulations and/or provide guidance to address remediation (Section 3.2.1).

(8) The NRC should require adequate assurance that leaks and spills will be detected before radionuclides migrate offsite via an unmonitored pathway (Sections 3.2.1, 3.2.2, and 3.4).

(9) To support one possible option for recommendation (6) of Section 3.2.1, regulatory guidance should be developed to define acceptable methods to survey and monitor on-site groundwater and sub-surface soil for radionuclides (Section 3.2.1).

(10) The NRC should revise radioactive effluent release program guidance to upgrade the capability and scope of the in-plant radiation monitoring system, to include additional monitoring locations and the capability to detect lower risk radionuclides (i.e., low energy gamma, weak beta emitters, and alpha particles) (Section 3.2.1).

(11) Determine whether there is a need for improved design, materials, and/or quality assurance requirements for SSC's that contain radioactive liquids for new reactors (Section 3.2.2).

(12) The staff should consider whether further action is warranted to enhance the performance of SFP telltale drains at nuclear power plants (Section 3.2.2).

(13) The staff should verify that there has been an evaluation of the effects of long term SFP leakage (boric acid) on safety significant structures (concrete, rebar), or the staff should perform such an evaluation (Section 3.2.2).

(14) The staff should assess whether the maintenance rule adequately covers SSCs that contain radioactive liquids (Section 3.2.2).

(15) The staff should verify that the license renewal process reviews degradation of systems containing radioactive material such as those discussed in this report (Section 3.2.2).

(16) The NRC staff should open a dialogue with the States regarding the application of the NPDES system to discharges of radioactive materials to promote a common understanding of how the associated legal requirements in this area are addressed (Section 3.2.3).

(17) Inspection guidance should be developed to review onsite contamination events including events involving contamination of ground water (Section 3.3).

(18) The inspection program should be revised to provide guidance to evaluate effluent pathways such that new pathways are identified and placed in the ODCM as applicable. In addition, guidance should be included as to when a new release path becomes "permanent" for purposes of inclusion in the ODCM and routine annual reporting (Section 3.3).

(19) Limited, defined documentation of significant radioactive releases to the environment should be allowed in inspection reports for those cases where such events would not normally be documented under the present guidance (Section 3.3).

(20) The staff should revise the Public Radiation SDP to better address the range of events that can occur, including unplanned, unmonitored releases or spills (Section 3.3).

(21) 10 CFR 20.1406 requires in part that applicants for licenses shall describe in their application how facility design and procedures for operation will minimize contamination of the environment. The NRC should develop regulatory guidance to describe acceptable options to meet this requirement (Sections 3.4 and 3.5).

(22) NRC should evaluate whether the present decommissioning funding requirements adequately address the potential need to remediate soil and groundwater contamination, particularly if the licensee has no monitoring program during plant operation to identify such contamination (Section 3.4).

(23) The NRC should consider the development of guidance on the evaluation of radionuclide transport in groundwater. American National Standard (ANSI/ANS) 2.17 addresses this issue and is being extensively updated (Section 3.5).

(24) The NRC's guidelines for "immediate notification" public communications should continue to be based on public health and safety considerations. To support the NRC's openness goals, the NRC staff should consider whether to notify the public of radioactive releases to the environment that are not significant from a radiation dose perspective, but that could be of general public interest nonetheless (Section 3.6).

(25) NRC staff should review NUREG/BR-0308, "Effective Risk Communication," and other training tools to ensure an event's risk is provided with appropriate context (Section 3.6).

(26) Nuclear power plant licensees should consider entering into agreements with local and state agencies to voluntarily report preliminary information on significant radioactive liquid releases that do not otherwise trigger reporting requirements. The present industry groundwater protection initiative may address this (Section 3.6).