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NRCB 91-01

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
WASHINGTON, D.C. 20555

October 18, 1991

NRC BULLETIN 91-01: REPORTING LOSS OF CRITICALITY SAFETY CONTROLS

Addressees

All fuel cycle and uranium fuel research and development licensees.

Purpose

This bulletin requests that addressees inform the Commission of their criteria and procedures that assure the prompt evaluation and reporting of the degradation of any controlled parameters used to prevent nuclear criticality to licensee management and the immediate reporting to the Commission of any significant degradation of such controls as required by 10 CFR 20.403(a). A written response to this bulletin is required.

Background

On October 3, 1990, all licensees who possess more than a critical mass quantity of special nuclear material were informed of the need for management attention to the establishment and maintenance of their nuclear criticality safety program (Information Notice No. 90-63, attached). That Notice referred to previous Information Notice No. 89-24, dated March 6, 1989, also on the subject of criticality safety. The Commission needs assurance that proper attention is being addressed to these important criticality concerns. Also, licensees must assure that significant degradation of any controls used to prevent criticality is promptly reported to management, and as required by 10 CFR 20.403(a)(1), to the Commission, to assure that appropriate actions are taken to prevent further system degradation.

Description of Circumstances

In May 1991, a process upset occurred in the solvent extraction portion of a uranium recycle unit of a fuel manufacturing operation. The process upset caused the accumulation of enriched uranium in favorable geometry tanks in a waste processing area. When these tanks filled, their uranium contents were transferred, in some instances without sample measurement, to an unfavorable geometry tank waste accumulation tank, and then to a second, unfavorable geometry waste treatment tank. Although the upset was observed by operators late on an evening shift, the process was not shut down until around 5:30 the next morning, when measurements indicated high uranium concentrations in the favorable geometry tanks. A high concentration of uranium was measured in the waste treatment tank at 7:00 a.m.

Licensee management was made aware of the incident later that morning, and a technical evaluation/recovery team was established. The NRC was notified of the incident around 3:45 p.m. that day. A criticality incident did not occur, but the margin of safety was reduced. The licensee removed the excess uranium from the waste treatment tank over a period of several days using centrifuge techniques.

The licensee's investigation team concluded that there were several areas of operational control which were significant contributors to the incident, including: (1) failure to always follow procedures or inadequate procedures; (2) insufficient supervision and/or technical support of operations; (3) lack of adequate overchecks/audits on conformance with criticality safety control requirements; and (4) inadequate records systems. The Commission's investigation is reported in NUREG-1450.

Discussion of Safety Significance

Because of the above event and knowledge of similar circumstances at other licensed activities, the Commission is concerned that there may be insufficient attention by licensees to the need for internal reporting and prompt evaluation of failures of controlled parameters related to criticality safety. The Commission is also concerned that licensees may not have procedures in place to assure compliance with the requirements under 10 CFR 20.403 to report immediately to the Commission any significant failure of criticality safety controls. As discussed in the appendix to this bulletin, several controls may be used to maintain a controlled parameter for preventing a criticality excursion. If substantial control over a controlled parameter is lost, the event should be reported to the Commission.

Following are specific examples of events related to criticality control that should be reported to the Commission immediately:

1. Complete loss of a controlled parameter.

2. Substantial degradation of a controlled parameter.

3. Failure of a controlled parameter previously identified by the Commission or the licensee's criticality safety specialists as requiring reporting upon failure.

4. Determination that a criticality safety analysis was deficient in evaluating actual plant conditions and necessary controlled parameters were not established.

5. An unusual event or condition for which the severity and remedy are not readily determined.

Reports of such events must be made to the NRC Operation Center, which is staffed 24 hours per day, and to the appropriate Regional Administrator.

Some types of events, though not warranting reporting to the Commission, nevertheless merit attention within the licensee's own organization, particularly by the criticality safety specialists. The Commission intends that all events involving degradation of criticality controls be reported for evaluation within the licensee's organization. Since some events which can occur in process systems and their relative importance to criticality safety cannot be determined before the event, criteria are needed in order to make the judgment as to whether the event should be reported to the Commission as required by 10 CFR 20.403(a). Each recipient of this bulletin, therefore, should assure that specific criteria for such internal reporting is in place. When doubt exists as to the extent of degradation, licensees are encouraged to report to the Commission. If initial indications of an event do not seem to warrant Commission notification, but further developments prove it to be more serious, the Commission should be immediately notified at that point.

Addressees are also reminded that all necessary corrective actions must be taken promptly, regardless of any reporting action. Reports to the Commission do not require that corrective actions be completed prior to reporting.

Requested Action

Addressees are requested to evaluate their criticality safety criteria and procedures, modify them as appropriate to assure that events involving degradation of controls will be promptly evaluated and reported to licensee management and NRC as appropriate, and provide a description of their criteria and procedures to NRC. In completing this evaluation, licensees should include the following:

1. Based on your current analyses of criticality safety, and any further criticality analyses that may be necessary for this determination, identify and examine each individual controlled parameter whose failure could contribute to a decrease in criticality control. For each individual controlled parameter, determine whether or not degradation of the system of controls would constitute a significant loss of effectiveness. Loss of a single controlled parameter should be considered to have occurred upon total failure or substantial degradation of the control.

2. Any list of methods of control, such as indicated in the appendix, should be considered from the point of view of importance to maintaining its associated controlled parameter. The possibility of combinations of loss of more than one control should be considered; i.e., are some controls likely to fail simultaneously and what is the level of significance of such an occurrence?

3. Whenever an event occurs in which criticality safety controls do not function entirely as expected, a management-established reporting system should ensure that proper levels of licensee management will be promptly informed. This reporting system will allow plant and safety management to evaluate the significance of a criticality event precursor and to take appropriate action. Significant loss of control may dictate activation of the Emergency Plan during the evaluation and recovery activities.

Reporting Requirements

Within 90 days of the receipt of this bulletin, pursuant to 10 CFR 70.22(d), each recipient shall provide the Commission with a statement describing its reporting criteria and management implementation procedures for evaluation and reporting related to loss of criticality safety controls which meet the requirements of 10 CFR 20.403(a). The statement should indicate the means whereby responsible licensee management will be made aware of any relevant failures, the criteria used by licensee management to determine the importance of those failures to criticality safety, and the related reporting levels. The statement should also indicate how the determination will be made that a controlled parameter is sufficiently degraded such that any Emergency Plan procedures will be activated and indicate how the implementation of these procedures for reporting will be documented. Implementing procedures and documentation will be reviewed during NRC inspection.

The written reports required above shall be submitted to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, D.C. 20555. In addition, a copy shall be submitted to the appropriate Regional Administrator. The reporting requirements for reports in response to this bulletin are covered by OMB clearance number 3150-0009, which expires May 31, 1994. The estimated average number of burden hours is 80 person hours per licensee response, including those needed to assess the new recommendations, search data sources, gather and analyze the data, and prepare the required letters. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Information and Records Management Branch, Division of Information Support Services, Office of Information Resources Management, U.S. Nuclear Regulatory Commission, Washington, DC 20555, and to the Paperwork Reduction Project (3150-0009), Office of Information and Regulatory Affairs, NEOB-3019, Office of Management and Budget, Washington, DC 20503.

On November 19, 1991, the Commission will sponsor a workshop concerning reporting of criticality safety events. The location for the workshop will be announced as soon as arrangements can be made.

If you have questions about this matter, please contact one of the technical contacts listed below.

Richard E. Cunningham, Director
Division of Industrial and
Medical Nuclear Safety
Office of Nuclear Material Safety
and Safeguards

Technical contacts: George H. Bidinger, NMSS
(301) 492-0683

Robert E. Wilson, NMSS
(301) 492-0126

A. Thomas Clark, NMSS
(301) 492-3424

Attachments:
1. Information Notice No. 90-63, "Management Attention to the Establishment and Maintenance of a Nuclear Criticality Safety Program"
2. Appendix - Principals of Criticality Safety
3. List of Recently Issued NMSS Bulletins
4. List of Recently Issued NRC Bulletins

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
WASHINGTON, D.C. 20555

October 3, 1990

NRC INFORMATION NOTICE NO. 90-63: MANAGEMENT ATTENTION TO THE ESTABLISHMENT AND MAINTENANCE OF A NUCLEAR CRITICALITY SAFETY PROGRAM

Addressees:

All fuel cycle licensees and other licensees possessing more than critical mass quantities of special nuclear material.

Purpose:

This information notice is provided to alert addressees to an incident resulting from inadequate management attention to the establishment and maintenance of a nuclear criticality safety program. The licensee's inattention to Information Notice No. 89-24, Nuclear Criticality Safety, dated March 6, 1989, may have been a contributing factor in the incident. It is expected that licensees will review this information and the 1989 Information Notice for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this Information Notice do not constitute U.S. Nuclear Regulatory Commission (NRC) requirements; therefore, no specific action or written response is required.

Description of Circumstances:

In March 1990, a licensee's routine sample analysis for a Raschig-ring filled waste collection tank (a non-favorable geometry vessel) yielded a concentration of approximately 2 grams of highly enriched uranium per liter of solution. Contents of the tank are normally transferred to a second larger tank (a non-favorable geometry vessel without Raschig rings) at a release limit of 0.01 grams uranium per liter. The analysis of a second sample confirmed that a major upset had occurred in the waste collection system. Consequently, the waste processing area was shutdown, and the waste collection tank was isolated. Corrective actions were taken to recover the uranium (in excess of 4 kilograms).

The licensee's investigation team concluded that the contents of two favorable diameter 11-liter cylinders, one or both containing high concentration solution, had been dumped into a sump used to pump solution to the waste collection tank. By procedure, operators were allowed to dump low concentration uranium solutions into the sump after receiving authorization and key access from supervisors. Findings which supported the team's conclusion are: (1) the quantity of uranium in the tank, (2) an operator's statement that two 11-liter cylinders of process

[redacted]

solution were poured into the sump, (3) traces of yellow uranium solids in the sump and filter, and (4) ineffective isolation of the sump caused by failure to perform maintenance and to conduct access control. The investigation team also speculated that one or both of the 11-liter cylinders had been mislabelled based on an operator's statement that 11-liter cylinders were mislabelled in the past and the team's observation of an 11-liter cylinder of high concentration solution that was improperly labelled.

The failure of the licensee's management control systems resulted in an unsafe transfer of the uranium solution through the sump into the collection tank. Both the sump and the collection tank had risks of a criticality event and no controls remained. Even though the administrative control led to the detection of the high concentration of uranium and precluded its transfer to the second larger tank, an additional unsafe transfer could have occurred with only one unlikely, independent, and concurrent change in process conditions (viz., recording the wrong analysis or using the wrong sample analysis, etc.). In both the actual incident and the postulated case of transfer of concentrated solution to the second larger tank, controls to satisfy the double contingency principle were not implemented.

Discussion:

This event and those events described in the 1989 Information Notice emphasize the need for continuing vigilance in providing a sound nuclear safety program. Although the licensee had a copy of the 1989 Information Notice on file, no action was taken to avoid similar events. Some of the recommendations made by the licensee's investigation team are listed below. Licensees are encouraged to review these recommendations, the 1989 Information Notice, and their own programs to ensure nuclear criticality safety.

- Eliminate sumps and install piping to transfer waste solutions, thereby, eliminating the use of the 11-liter cylinders in this application.

- Evaluate the procedures and practices for affixing labels to 11-liter cylinders in all process areas.

- Install in-line detectors and totalizers on all streams to waste collection tanks containing Raschig rings. Consider automatic shutoff of the flow when a detected uranium concentration exceeds an acceptable nuclear criticality control limit.

- Install additional controls on all streams to the collection tank without Raschig rings. This should include an evaluation of interlocked valves, as well as valves controlled by in-line detectors or conductivity meters connected to an alarm system.

- Develop training material for, and train, first responders to unusual events.
- Retrain supervisory personnel on issues important to safety, labor relations, training, and emergency response.
- Evaluate the existing training program to ensure that personnel are trained and knowledgeable of assigned tasks in waste processing areas and of nuclear criticality safety issues, including selected criticality accident histories.
- Reevaluate all nuclear criticality safety analyses to ensure proper application of the double contingency principle, with emphasis on unsafe geometry vessels.
- Reevaluate the audit and inspection programs to ensure that management control systems are being properly implemented.
- Review operating procedures for accuracy and completeness.
- Retrain personnel with procedural requirements with emphasis on mandatory compliance.

No specific action or written response is required by this Information Notice. If you have any questions, please contact the technical contacts listed below or the Regional Administrator of the appropriate regional office.

Glen L. Sjoblom for
Richard E. Cunningham, Director
Division of Industrial and
Medical Nuclear Safety
Office of Nuclear Material Safety
and Safeguards

Technical Contacts: Edward McAlpine, Region II
(404) 331-5547

W. Scott Pennington, NMSS
(301) 492-0693

Attachments:
1. Information Notice No. 89-24, Nuclear Criticality Safety, dtd March 6, 1989
2. List of Recently Issued NMSS Information Notices
3. List of Recently Issued NRC Information Notices

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
WASHINGTON, D.C. 20555

March 6, 1989

NRC INFORMATION NOTICE NO. 89-24: NUCLEAR CRITICALITY SAFETY

Addressees:

All fuel cycle licensees and other licensees possessing more than critical mass quantities of special nuclear material.

Purpose:

This information notice is being provided to alert addressees to potential problems resulting from inadequate administration and application of the double contingency principle in establishing nuclear criticality safety limits and controls. It is expected that licensees will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute U.S. Nuclear Regulatory Commission (NRC) requirements; therefore, no specific action or written response is required.

Description of Circumstances:

The double contingency principle, as used in ANSI/ANS-8.1-1983*, states that "Process designs should, in general, incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible." Proper application of the double contingency principle provides assurance that no single error or loss of a control will lead to the possibility of a criticality accident.

In March 1988, an NRC licensee was authorized to operate a new pilot plant operation involving highly enriched uranium solution. Provisions were made to remove liquid scrap in 2.5 liter bottles from the operations area (Area 1). Because of increased quantities of scrap solution and lack of temporary storage, an alternate liquid-handling process was established. The alternate method allowed both dilute and concentrated scrap solution to be stored in 11-liter bottles in the same area. After an analysis of a single sample, the 11-liter bottles of dilute scrap solution were to be transferred to an adjacent area (Area 2) and emptied into mass-limited 55-gallon drums.

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*American National Standard For Nuclear Criticality Safety in Operations With Fissionable Materials Outside Reactors, ANSI/ANS-8.1-1983.

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During an inspection in July 1988, NRC personnel recognized that an operator could inadvertently transfer an unsafe quantity of scrap solution into a drum by either selecting the wrong bottle of solution or as a result of an erroneous sample analysis. Such an unsafe transfer could have been effected with only one unlikely, independent, and concurrent change in process conditions (viz., selecting the wrong bottle, recording the wrong analysis or using the wrong sample analysis, etc.) and hence, the double contingency principle was not satisfactorily implemented. Because this method of handling 11-liter bottles was somewhat similar to the handling method contributing to the Wood River Junction accident in 1964, the NRC inspectors expressed concern. The licensee immediately ceased all scrap handling and subsequently shutdown the entire process area to review the safety limits and controls.

Further review disclosed that the nuclear criticality safety analyst who had analyzed the process before startup was not familiar with the alternate scrap-solution-handling procedure. Administrators within the licensee's safety group had approved the change because a safe mass limit had been imposed on each drum in Area 2. The licensee claimed that the alternate method of solution-handling, permitted by procedure, had not been used because the material control and accounting restrictions made the method inefficient.

NRC personnel also noted that Area 2 contained several open 55-gallon drums. Area 2 was used to remove solids from Raschig ring filled drums which were used in Area 3 (scrap recovery). Raschig ring filled drums and drums of chemicals were taken from Area 2 into Area 3. Because a 55-gallon drum was involved in the Oak Ridge Y-12 accident, NRC personnel expressed concern with the lack of controls on open drums. The licensee immediately shutdown Areas 2 and 3 so that the nuclear criticality safety limits and controls could be re-examined.

Discussion:

These events highlight the need for continuing vigilance in providing a sound nuclear safety program. Some of the licensee's actions taken after the inspection are discussed here. Licensees are encouraged to review these actions and their own vigilance in assuring nuclear criticality safety.

A team led by a safety director from another of the licensee's nuclear facilities conducted an immediate audit of the three areas. The team consisted of safety and production personnel. The audit team confirmed NRC's findings and identified other safety items.

All nuclear criticality safety analyses were reviewed to ensure proper application of the double contingency principle. Documentation of analyses has been revised to provide explicit consideration of the double contingency principle.

The nuclear criticality safety analysis group now reviews all changes to nuclear criticality limits and controls. The administrative group can no longer approve seemingly simple changes such as authorizing new mass limits for work stations, based on established safe mass limits.

Production personnel were not involved in establishing nuclear safety limits and were not familiar with the above-mentioned nuclear criticality accidents. The safety training program has been revised to include selected accident histories.

All involved personnel, including production operators, have reviewed all procedures. Before startup of Areas 1, 2, and 3, procedures were revised to include nuclear safety limits and controls. Procedures in other plant areas will be revised to include safety limits.

Liquid scrap from Area 1 is now collected in favorable geometry containers. After analysis, the solution is transferred to a favorable geometry quarantine tank for a second analysis. Then the solution is transferred to uniquely identified favorable geometry containers, for transfer to the drums in Area 2.

Most 55-gallon drums in Area 2 have been eliminated by engineering redesign. Barriers and other controls are in place to prevent unauthorized transfer of drums into Area 3. Engineering studies are underway to eliminate or reduce the use of all unfavorable geometry containers in Area 3.

No specific action or written response is required by this information notice. If you have questions about this matter, please contact the technical contacts listed below or the Regional Administrator of the appropriate regional office.

Richard E Cunningham

Richard E. Cunningham, Director
Division of Industrial and
Medical Nuclear Safety
Office of Nuclear Material Safety
and Safeguards

Technical Contacts: Gerald Troup, Region II
(404) 331-5566

George Bidinger, NMSS
(301) 492-0683

Attachment: List of Recently Issued NRC Information Notices

See File Jacket

APPENDIX

PRINCIPALS OF CRITICALITY SAFETY

The basic tenet of nuclear criticality prevention is that at least two, unlikely, independent, and concurrent changes in process conditions must occur before a criticality accident is possible. This is the so-called "double contingency" principle in ANSI/ANS-8.1-1983. Controls or systems of controls are used to limit process variables in order to maintain safe operating conditions. A list of these typical controls is presented below. The analysis for criticality safety should identify the multiple scenarios by which nuclear criticality can occur. Then controlled parameters and their supporting methods of control must be established to prevent each scenario. A defense-in-depth of two or more controlled parameters is necessary to make criticality unlikely, thereby satisfying the double contingency principle. If a controlled parameter is lost or is substantially degraded, the special nuclear material could threaten to cause exposures to radiation or release of radioactive materials as described in 10 CFR Part 20.403(a) and should be reported immediately to the Commission.

Several controls may be involved in maintaining a controlled parameter. For example, a large tank used to receive process solution containing a fissile material might use Raschig rings for one control parameter and concentration limits for another. Both parameters may have several related controls to assure that their loss is highly unlikely. The Raschig rings may be inspected before and after installation, both as to boron content and volume fill level. There may be several controls on concentration, such as initial feed preparation, in-line monitors, and sampling and analysis. The product of all the controls combined provide the "highly unlikely" character of the failure of the controlled parameters.

STANDARD CONTROLLED PARAMETERS AND TYPICAL SUPPORTING CONTROLS

Controlled Parameters	Typical Supporting Controls
° Favorable Geometry	- Configuration control - Periodic examination (Quality Assurance) - Spacing
° Use of Poisons	- Configuration control - Neutron absorption measurement - Periodic examination and analysis - Concentration
° Mass	- Batch size weighing, sampling and analysis - Volume and density measurements
° Concentration	- Dual sampling and dual analysis - On-line monitoring
° Automatic Engineered Systems	- Temperature - Pressure - Moisture