

Criticality Safety Event Reporting Experience at NRC Regulated Fuel Cycle Facilities

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Introduction

In response to a significant criticality safety event at a U.S. Nuclear Regulatory Commission (NRC) licensed fuel cycle facility in 1991¹, the NRC issued Bulletin 91-01 to establish requirements for reporting substantial losses of control involving criticality safety. Since 1991, over 400 event reports have been received under these reporting requirements. As a result of event report experience and to accommodate changes to 10 CFR Part 70, an effort is underway to update these reporting requirements. In support of the update effort, NRC criticality safety inspection staff have reviewed and categorized Bulletin 91-01 event reports in order to identify possible weaknesses in reporting requirements and determine whether more detailed analysis might provide useful information to the update process. This paper summarizes the results of the review of nearly ten years of Bulletin 91-01 initial event reports.

Background

The 1991 criticality safety event described in Reference 1 occurred when approximately 150 kilograms of low enriched uranium solution was inadvertently pumped to a large, unsafe geometry liquid waste processing tank resulting in compromise of criticality safety controls, violation of criticality safety limits, and elimination of the safety margin against inadvertent criticality. In spite of the gravity of the situation, the licensee determined that the event did not meet existing immediate reporting requirements and the NRC learned of the event through an informal contact at the facility. The NRC considered the loss of control and resulting inability to quickly reestablish control to be very significant. The event ultimately led to the development and publication of NRC Bulletin 91-01². The Bulletin was designed to compel reporting of events involving “*significant failure of criticality safety controls*” or when “*substantial control over a controlled parameter is lost*” in order to improve the ability of the NRC to respond quickly and appropriately to such events with actions such as issuing press releases, activating the NRC operations center, or dispatching a reactive inspection team to the site. NRC Bulletin 91-01 Supplement 1³ was issued in 1993 to provide minor clarification and place time limits on reporting with the creation of four-hour and 24-hour criteria. Information Notice 94-73⁴ was issued in 1994 to further clarify immediate and 24-hour reporting criteria.

NRC Bulletin 91-01 Requirements

NRC Bulletin 91-01 and its supplements contain a framework designed to help identify substantial losses of criticality safety controls for reportability. The resulting reportability requirements are consolidated in this section and were used in the subsequent analysis. The Bulletin requires immediate reporting of criticality safety events when moderation is used as the primary criticality control, or more than a safe mass of fissile material is involved and one of the five criteria below is met:

- When, for a given criticality pathway, the controls, control systems, or controlled parameters that provide for double contingency cannot be reestablished within 4 hours.
- When, if double contingency has been reestablished within 4 hours, and

- a. only one controlled parameter is used for a given criticality pathway, and more than one control system has been replaced or modified; or,
 - b. more than one controlled parameter is used for a given criticality pathway, and the control systems for more than one controlled parameter have been replaced or modified.
- The occurrence of any unanticipated or unanalyzed event for which the safety significance of the event or corrective actions to re-establish the double contingency principle are not readily identifiable.
 - Any case where it is determined that a criticality safety analysis was deficient and where the necessary controlled parameters were not established or maintained.
 - Any event involving a controlled parameter previously identified by NRC or the licensee as requiring immediate reporting to NRC, and where the double contingency principle cannot be re-established within 4 hours after the initial observation of the event.

NRC Bulletin 91-01 requires reporting within 24 hours of all other criticality safety events that do not meet the aforementioned criteria, but still result in a violation of the double contingency principle, such as events where the double contingency principle is violated but control is immediately re-established.

Methodology

In order to perform the review, the authors requested searches of the NRC Operations Center database for initial 91-01 event reports. Lists of 91-01 events and separate copies of the text of the initial event reports were obtained from event type and keyword searches. The lists were compared to other tabulations of 91-01 events^{5, 6} in order to establish that the lists reasonably represented the reports filed during the period. The authors determined that 91-01 event reports were identified to within less than 1% of reports filed.

The text of an initial event report is entered into the NRC Operations Center database immediately upon receipt of the report and is never changed although it may have updates appended. Initial event reports contain enough information to allow the events to be sorted into the five general reporting areas in the Bulletin described above. The initial event reports also contain enough information to identify two sub-categories of control types, engineered and administrative. Additionally, the authors were involved in reviewing a majority of the events at the time the events were reported and were able to reach reasonable conclusions regarding whether the failure of an administrative control was due to an infraction or due to the general weakness of the control. An administrative control failure due to infraction was identified when a control failure resulted from an employee failing to comply with a requirement. An administrative control failure due to a weak control was identified when the control was so poorly chosen that eventual failure appeared to be likely. The resulting data is listed in the seven-column tables included as Tables 1 through 3 below.

Some event reports were retracted for various reasons and at least one retraction was retracted⁷ (Event #33619). There is no formal basis for retracting 91-01 reports in the Code of Federal Regulations or the licensing basis for any facility. Although it would appear reasonable to retract a report if the event concerned was not actually related to criticality safety, this was not found to be the case in any reported event. Therefore, data from all initial event reports was tabulated and used to develop conclusions. Repeated retraction of 91-01 reports indicates inability to timely and accurately characterize criticality safety events which defeats the purpose of the Bulletin to assure that criticality safety events are effectively evaluated and reported.

Results

Between November 1991 and December 2000, a period encompassing 110 months, 406 events were reported in accordance with NRC Bulletin 91-01 by nine licensed fuel cycle facilities. An initial summary of totals is:

- November 1991 until February 1997 (64 months) 74 events
Eight fuel cycle facilities licensed under 10 CFR Part 70
- March 1997 until December 2000 (46 months) 33 events
Eight fuel cycle facilities licensed under 10 CFR Part 70
- Total Part 70 events during 110 months of Bulletin 91-01 107 events

In March of 1997 the NRC assumed regulatory jurisdiction over the Gaseous Diffusion Plants (GDP) at Portsmouth, OH and Paducah, KY. Totals from these plants are:

- March 1997 until December 2000 (46 months) 299 events
- Total events during 110 months of Bulletin 91-01 406 events

This means that the GDPs filed nearly three-fourths of all reports during less than one-half of the period that the bulletin was in effect. In order to identify trends, the authors reviewed the Part 70 facility events separately from the GDP events.

Tables 1 through 3 below summarize the data obtained from the review of initial event reports.

Table 1

Facility	Total	Cause of the Report						
		Loss of Control			Control Replcd/ Modif	Unanal Cond	Inadeq Anal	Report Reqd
		Engr Control Failure	Administrative Control Failure					
			Infract	Weak				
BWXT	25	3	13	3	0	4	2	0
NFS	10	4	4	0	1	0	1	0
Siemens	20	3	8	5	1	2	1	0
Global	30	18	7	1	0	4	0	0
West-Col	14	9	3	0	0	0	2	0
CE-Hem	7	3	2	0	1	1	0	0
FCF	0	0	0	0	0	0	0	0
GA	1	1	0	0	0	0	0	0
Totals	107	41	37	9	3	11	6	0

Reports filed by Part 70 Licensees between November 1991 and December 2000

Table 2

Facility	Total	Cause of the Report						
		Loss of Control			Control Repled/ Modif	Unanal Cond	Inadeq Anal	Report Reqd
		Engr Control Failure	Administrative Control Failure					
			Infract	Weak				
Ports	237	13	154	38	0	15	17	0
Paducah	62	2	51	2	0	5	2	0
Totals	299	15	205	40	0	20	19	0

Reports filed by Gaseous Diffusion Plants between March 1997 and December 2000

Table 3

Table 5

Facility	Total	Cause of the Report						
		Loss of Control			Control Replcd/ Modif	Unanal Cond	Inadeq Anal	Report Reqd
		Engr Control Failure	Administrative Control Failure					
			Infract	Weak				
Ports	237	13	154	38	0	15	17	0
Paducah	62	2	51	2	0	5	2	0
BWXT	25	3	13	3	0	4	2	0
NFS	10	4	4	0	1	0	1	0
Siemens	20	3	8	5	1	2	1	0
Global	30	18	7	1	0	4	0	0
West-Col	14	9	3	0	0	0	2	0
CE-Hem	7	3	2	0	1	1	0	0
FCF	0	0	0	0	0	0	0	0
GA	1	1	0	0	0	0	0	0
Totals	406	56	242	49	3	31	25	0

Reports filed by all Licensees between November 1991 and December 2000

Analysis

A previous review of 91-01 reports⁶ resulted in the conclusion that failure of criticality safety controls occurs at most facilities and involves most of the reporting criteria. This conclusion was based on a review of the first 43 event reports. The authors reviewed the distribution of event reports from Part 70 licensees and determined that this conclusion still held with criticality safety control failures at most facilities and involving most controls. The fraction of events considered significant by Reference 6 (events involving loss of control leading to violation of a criticality safety limit) is about 25% (10 of 42 events). Determining this ratio for all available reports would be useful but would require additional effort since many initial event reports do not fully address the issue.

Part 70 facility reports also revealed other interesting features including a facility highly dependent upon administrative controls, BWXT, reported slightly more than half of events as failures of administrative controls, a facility highly dependent upon engineered controls, GNF, reported slightly more than half of events as failures of engineered controls and a facility, NFS, which did not perform production operations during half of the time that the reporting requirements were in effect reported proportionately fewer total events. NRC inspection reports while Bulletin 91-01 reporting requirements have been in effect do not identify any instance of failure to report a 91-01 event.

The vast majority of GDP event reports were failures of administrative controls. A substantial number of the events involving administrative control failures at the GDPs did not appear to meet Bulletin 91-01 reporting criteria and were essentially reports of minor infractions including such issues as historical analytical problems⁹ (Event #33219), unanalyzed processes not in operation¹⁰ (Event #33538), and laboratory processes involving gram quantities of LEU¹¹ (Event #37120). Also, double contingency does not appear to be violated in many of these GDP event reports particularly those involving spacing violations, inadvertent containers, dry active waste handling, or the X-710 laboratory at Portsmouth. The numbers and significance of events reported by the GDPs in categories other than administrative controls appears to be reasonable based on the size of the facilities and known programmatic difficulties with criticality safety. Insight into criticality safety control failures at the GDPs could be gained by eliminating those reports falling below a minimum level of significance and analyzing the remainder. Updating of reporting requirements must address elimination of less significant event reports through the provision of specific guidance, possibly related to evaluation of remaining safety margin.

Conclusions

Reporting guidance needs to address criteria on what information belongs in a report. Useful information for staff would include identification of the category under which the event is being reported, description of limits that were compromised, remaining safety margin, and discussion of what controls remain so that possibility of criticality can be established.

The authors concluded that the Part 70 licensees understand 91-01 reportability and are reporting substantive events in accordance with the Bulletin. Events occur at most facilities and involve most of the reporting criteria. Event clusters observed appear to be related to the types of controls that predominate at the facilities. No evidence of report mischaracterization or failure to report was identified. Inspection reports do not indicate any instance of failing to report a significant event at any facility. Current reporting criteria is adequate to assure that significant losses of control at the fuel fabricators will be timely and accurately reported to the NRC in order to facilitate an appropriate response.

Significant GDP criticality safety events must be filtered from literally hundreds of less significant 91-01 reports. Reporting based on the mere possibility that double contingency may have been violated, that a control may have been compromised in the past, or based on infractions involving equipment not in use does not appear to meet the reporting criteria. Based on a comparison of categories other than administrative, event occurrence at all facilities appears to be comparable between the GDPs and other fuel cycle facilities. By roughly normalizing the GDP data to the Part 70 facility data (ie. eliminating five “spikes” including 239 event reports) an estimate can be reached that about 15 of the 299 events reported were actually significant and that, at most, 60 of the 299 events should really have been reported. Reportability requirements and guidance for the GDPs must be upgraded. An apparent root cause for GDPs reporting 91-01 events not meeting reportability requirements appears to be an overly broad control structure resulting in the appearance of excessive and unenforceable controls that are frequently violated. An additional apparent root cause is the unwillingness risk disagreement over reportability such that even the most minor event get reported.

The following additional information would be useful for revising reportability requirements:

- The number of significant events, those involving loss of control leading to violation of a limit;
- The number of events where the root cause of the event was a weak or poorly chosen control;
- The number of event retractions, retractions of retractions, and root cause of retractions.
- The number of repeated events by reporting category and facility;
- The number of events that do not reasonably involve a loss of double contingency.

References

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4. NRC Information Notice 94-73, *Clarification of Criticality Reporting*, U.S. Nuclear Regulatory Commission, October 1991.
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8. NRC Bulletin 91-01 Event Report #33619, *Deficient Nuclear Criticality Safety Analysis Involving Wet Air Evacuation Parameters*, USEC Portsmouth GDP, January 1998.
9. NRC Bulletin 91-01 Event Report #33219, *Deficient Nuclear Criticality Safety Analyses Involving Approximately 30 operations On-site*, USEC Portsmouth GDP, November 1997.
10. NRC Bulletin 91-01 Event Report #33538, *Failure to Prepare Nuclear Criticality Safety Analyses for Abandoned Equipment*, USEC Portsmouth GDP, January 1998.
11. NRC Bulletin 91-01 Event Report #37120, *Failure to Process Sample Batches Involving 2.4 grams U-235 as NCS Samples*, USEC Portsmouth GDP, June 2000.