

Lessons Learned from the Rocky Flats Building 771 Near Miss Criticality Accident

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INTRODUCTION

The purpose of this paper is to document a first-hand, eye-witness history of events that accurately predicted a criticality accident near-miss. The hope of sharing this history is to provide some generally useful leading indicators which might then be used by management in the future to take preventative action.

BACKGROUND

The Rocky Flats Plant was in the process of accelerating deactivation and decommissioning (D&D) of Building 771 in 1993. The facility contained large volumes of high concentration fissile solution in the form of plutonium nitrate as a legacy from production operations. The solution was contained in favorable geometry tanks, Raschig-Ring filled tanks, and process piping that was interconnected. Solution was moved via vacuum transfer by controlling valve lineups according to established procedure. Solution could be moved from any given location to virtually any other location in the building, and even outside the building, depending upon the specific valve lineup. In order to prepare the building for eventual demolition, the solutions had to be removed. The method selected to accomplish this was to drain the fissile solutions from the tanks with their passive engineered controls into arrays of 4-liter polyethylene bottles ensuring criticality safety with only administrative controls. The 4-liter bottles of solution would then be transported to another facility on site for final processing and disposition.

Manufacture of plutonium primaries (i.e. “pits”) for nuclear weapons, plutonium recovery, and plutonium processing operations had been halted since 1990. The focus was on D&D, as well as environmental compliance issues, especially those associated with Resource Conservation and Recovery Act (RCRA) requirements. In addition, contract incentives were initiated that emphasized achievement of agreed-upon D&D milestones for items such as fissile solution tank draining operations and waste shipments. The plant had pursued vigorous improvements in the conduct of operations (CONOPS) processes in the resumption buildings (e.g., Buildings 559 and 707) under the former plan to restart production. This effort was so resource intensive during the 1990–1992 time-frame that little had been done to improve CONOPS in the remainder of the facilities at the site during those years. In the period between 1990 and 1993, the prevailing operating culture rapidly

came to the point where it was assumed that the potential for a criticality accident was reduced, so management was focused on achieving performance incentives and avoiding RCRA-related fines from the State of Colorado. In essence, almost overnight, the safety culture that had prevailed at Rocky Flats since its inception—that the risk of a criticality accident was ever present—was replaced by complacency with respect to criticality safety and an over-riding fear of the risk of RCRA fines if tanks were not drained on schedule.

OBSERVED PRECURSORS

The criticality safety staff provided a line operations management support function. Line operations management provided the funding to the criticality safety staff to provide criticality safety evaluations, criticality safety operating limits, procedure reviews, etc. The criticality safety staff became aware of the following concerns and reported their concerns to the criticality safety manager.

- Multiple CONOPS failures – individually low consequence events
- Immature procedure system/work authorization process
- “Production” mindset - cost/schedule and waste compliance
- Operators and line supervisors stating during criticality safety training and limit development activities that they would knowingly violate criticality safety controls to maintain compliance with waste handling criteria
- Management more concerned about contamination than criticality
- Perception that criticality accident not credible
- Presence of solution operations and uncharacterized fissile material holdup
- Shift from passive engineered controls to administrative controls for schedule expediency
- Inadequate independent safety oversight by the contractor (criticality safety staff is line support, not independent oversight; nor is it sufficiently independent of operations. Stop work authority was only permitted functionally when danger was imminent and only useful on a case-by-case basis, not for programmatic pauses.)
- Prior history of CONOPS failures leading to other near-miss criticality events in the facility during its operating lifetime which were only avoided by prompt operator actions

- Line operations management authorization of work with outdated limits against the advice of the criticality safety staff
- Line operations management responding to abnormal events involving fissile material without involving criticality safety staff in the review of corrective actions

MANAGEMENT ACTIONS

The contractor's criticality safety manager made several formal attempts in writing to get the attention of senior plant management. The chronology of those attempts is as follows:

- March, 1993 – Criticality safety manager issued an informal memorandum to contractor senior management expressing concerns for the potential for a criticality accident. The memo contains specific recommendations for preventative actions. Senior management listened but took no action.
- November, 1993 – Criticality safety manager updated the March memorandum with more recent plant data that indicated an incident was likely and provided it to senior management. In addition, the contractor's Nuclear Criticality Safety Committee (NCSC) briefed senior management on the concerns, and local DOE was made aware of the concern and briefed its management. The Contractor NCSC served only in an advisory capacity to contractor senior management and had no authority to direct safety improvements. No action was taken.
- February, 1994 – One final draft memorandum from the criticality safety manager was submitted to contractor senior management for approval and issuance to the plant. This draft memorandum documents the history of criticality accident near miss events in Building 771 from 1982–1993 and includes several recommended actions including one to cease movements of fissile solution until the safety culture is improved. The draft memo concludes with the following statement:

Without proper attention given to training operators and strengthening barriers in the field (not only on paper) a criticality accident is almost certain to occur. Reliance cannot be placed on a "paper infrastructure" which always precedes actual implementation of a new safety culture.

Senior management called the memorandum "posturing" in editorial notes on the draft, and it was never issued.

- August, 1994 – The criticality safety manager resigned from the company.

DESCRIPTION OF THE EVENT

In September 1994, one operator in Building 771 took the initiative to conduct an unauthorized activity to drain fissile solution from a tank into multiple 4-liter bottles after completing an approved and authorized tank draining activity with a second operator. The tank was not part of the approved evolution, and no procedures or criticality safety limits were provided for the unauthorized tank draining operation. The second operator, rather than notifying supervision of the unauthorized tank draining, conspired with the first operator and their line supervision to cover up the incident by not reporting it and by conducting another unauthorized, unreviewed, and unapproved solution blending-mixing activity in an attempt to lower the concentration of the solution from the unauthorized activity to more closely match the solution concentration involved in the approved task. These activities occurred on the second and third operating shifts.

The US Department of Energy (DOE) Rocky Flats Field Office Facility Representative for Building 771 asked the DOE criticality safety staff and support service contractor to look at the array of four liter bottles containing the solution from the tank draining operation the day after the evolution was performed. This team discovered the discrepant condition by noticing the differences in solution color (indicating variations in plutonium concentration) that indicated that the solutions did not originate from the same tank due to the process used to mix the solutions and the location of the outlet port used to drain the tanks. Their questions eventually led to the discovery and investigation of the event. Operations were curtailed over six months while investigations were conducted and safety improvements implemented. Operators were fired, and the process to bring in a new contractor was initiated shortly thereafter, culminating in the changeover on July 1, 1995.

If the tank had not run dry, a criticality accident would have occurred sometime between filling the 8th and 10th bottles (five bottles were actually collected). If the concentration of the solution had been higher, the system could have gone critical in the as-found condition. There were no barriers in place preventing a criticality accident when the unauthorized operation took place.

LESSONS LEARNED

Based on this specific case at Rocky Flats and consistent with the history of world-wide criticality accidents, if several of the following conditions are present in a facility simultaneously, the risk of a criticality accident is unacceptably high. These are listed roughly in decreasing order of their risk contribution.

- Presence of fissile solutions or uncharacterized fissile material capable of sustaining criticality
- Primary reliance upon administrative controls to prevent criticality in solution operations
- Tolerance of CONOPS failures; failure to eliminate low-consequence recurrent events
- Line management focus on other issues (performance incentives, environmental, contamination, radiation control, etc.) resulting in failure to adequately plan work and failure to recognize criticality safety implications of abnormal events – breakdown of integrated safety management processes
- Line management perception that criticality risk is trivial or diminished in a given fissile material operation or facility (Note: As demonstrated in this case history, this can arise in instances where line management abdicates its responsibilities for criticality safety under the assumption that the criticality safety support staff has adequately managed the risk regardless of the amounts and types of fissile materials actually present.)
- Absence of independent safety oversight in contractor organization empowered by senior management to direct line management safety improvement actions based on ongoing reviews of abnormal events and monitoring the safety culture
- Ensure that line management at all levels has a continuing role in actively monitoring and participating (i.e., not delegating it to staff) in the criticality safety of their operations. This should be evidenced by performance of routine audits and inspections, participation on the NCSC, and by periodic independent criticality safety program reviews conducted by external experts.
- Establish an NCSC reporting to the highest level of management that is empowered to direct safety improvements with the highest authority across the organization. The NCSC should review all criticality safety-related incidents, abnormal events, and infractions. Criticality safety related positive unreviewed safety questions (USQs) should be reviewed by the NCSC. The NCSC should adjudicate all decisions to opt for administrative controls instead of engineered controls for cases in which engineered controls are recommended by the criticality safety staff, especially in those operations involving fissile solutions. The NCSC should investigate any concern with the adequacy of the criticality safety posture of operations. Finally, the NCSC should conduct periodic criticality safety reviews of operations.

RECOMMENDED PREVENTIVE ACTIONS

The following recommendations for improved management practices would likely have prevented this near miss.

- Require documented justification and management review and approval to relax engineered controls in favor of administrative controls consistent with DOE Standards 3009 and 3007.
- Require documented justification and management review and approval to select an administrative control over passive or active engineered controls when fissile solutions are involved.
- Track and trend all abnormal events that indicate CONOPS failures. Highlight events in which the investigation into causal factors indicates that line management was focused away from criticality safety for whatever reason. Develop a performance metric to avoid repeat criticality safety infractions and to close open criticality safety infractions in a timely manner.
- Consistent with the recommendations for best practices for criticality safety programs promulgated at the 1999 DOE Nuclear Criticality Safety Self-Improvement Workshop (workshop handbook and presentations may be found at <http://ncsp.llnl.gov/ncsinfoMain.html>) ensure that the criticality safety organization is independent of line operations and has substantial institutional funding (~30%) apart from direct line support.

DOE promulgated a Self-Assessment Standard (DOE-STD-1158) to guide contractors in maintaining safe operations and administrative practices in accordance with ANSI/ANS-8.19. Thoughtful application of this standard by management (not as a checklist, but relying upon subjective technical expertise to use the tool as intended) with an appropriately staffed and empowered NCSC would serve well to prevent degradation of criticality safety programs to the point where conditions for such a near miss are favorable.

EPILOGUE ON MANAGEMENT CULTURE

Finally, one observation on overarching management style and human culture is potentially worth some consideration. DOE and its contractors have repeatedly shown that they are not capable of anticipating and preventing serious criticality safety problems such as the Rocky Flats problem presented here and the more recent set of events at the Los Alamos PF-4 facility which have unfolded from 2011 until now. Even with written and credible warnings by criticality safety and management experts in both cases, the crises were not averted. The system only seems capable of responding to lagging indicators, not leading soft indicators.

One possible contributor for this complete inability to recognize and act upon clear warnings of impending disaster lies in how DOE and its contractors select managers. DOE is a bureaucratic organization that rewards process and stability of process above almost all other values. The typical successful DOE manager has a Myers-Briggs

personality type of introverted-sensing-thinking-judging (ISTJ). The process for selecting and promoting federal managers favors such personality types. By virtue of how these traits are manifested, the entire management structure becomes sensitive only to easy-to-understand, preselected factual data (lagging performance metrics and performance incentives), and therefore operations and systems are managed by procedures. The severe security incident at the Y-12 plant in 2012 was another clear indicator of this behavior, and it caught DOE completely by surprise. Conclusions are forced upon management after the fact by acquisition of more brute facts, and programs and operations are summarily “improved” by writing more and more processes, standards, and procedures. Simply put, an ISTJ-dominated organization which displays these attributes simply cannot hear warnings based on a forecast of what will surely occur according to informal and unwritten connections between seemingly unrelated, individually benign events. Anyone operating outside this preferred style is often labeled a whistle blower with all the negative organizational and career repercussions that it brings. It would seem prudent for DOE to explore how it can change its management culture and style to cultivate and promote more intuitive-feeling (NF) senior managers, especially in the safety programs of field offices and headquarters. The frequency of repeat system failures at several sites over the past decades indicates that the pendulum has swung too far toward standards- and process-based management systems. This has deprived the nation of accountable, responsible, experienced technical management personnel who are chosen based on demonstrated expertise and leadership. Senior managers are no longer free to manage based on their best judgement and held accountable for the consequences of that best judgement.

REFERENCES

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4. ANSI/ANS-8.19, *Administrative Practices for Nuclear Criticality Safety* (2014).