Establishing an Authorization Basis for Decommissioning of a Major Plutonium Processing Facility

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Abstract

The Rocky Flats Environmental Technology Site (RFETS) recently completed decommissioning its first major nuclear facility, Building 779, a research and development facility that provided support for the manufacturing of plutonium weapons parts. Lessons learned during establishment and implementation of an authorization basis (AB) for Building 779 have been applied to establish the AB for decommissioning of the next major nuclear facility, Building 771that previously recovered plutonium from residues and has many more hazards and challenges. This paper will address some of the lessons learned for establishment of a decommissioning AB for Building 771.

To support completion of Building 771's remaining processing mission and deactivation activities to reduce hazards and risks, a new AB was developed in 1995-1997, based on the Department of Energy (DOE) necessary and sufficient standards development process that resulted in a Building 771 Basis For Operations (BFO) and Technical Safety Requirements (TSRs). The BFO was initially implemented as Revision 1 in early 1998, then Revision 2 was approved in 1998-1999 in several phases to authorize decontamination and decommissioning (D&D) activities as more specific plans and schedules were developed. The Building 771 Decommissioning Operating Plan defines the strategy for this project, and has been approved by the DOE Rocky Flats Field Office (RFFO) and other regulators. RFETS is accelerating Site closure by planning and budgeting for completion by the year 2006. With continuous D&D progress, Building 771 is scheduled for demolition in FY2004.

Building 771 planned to start major D&D strip-outs in Building 771 concurrent with other building mission activities that involved glovebox operations and the storage of large quantities of plutonium residues in drums. DOE RFFO required the Contractor, Kaiser-Hill Company and Rocky Mountain Remediation Services, to develop interactive accident scenarios and TSRs to address the potential involvement of D&D activities with processing mission activities, as well as the potential interaction of multiple D&D work sets. This necessitated a risk management approach to developing an integrated D&D schedule to minimize potential interactions and to consider eliminating higher-risks as early as possible. The interactive accident scenarios identified D&D-specific TSRs needed to eliminate unique hazards, to prohibit certain higher-risk D&D techniques or activities, and to establish specific combustible and ignition source controls.

Another D&D AB challenge relates to efforts to step-down from TSR controls as hazards are eliminated, and to eventually down-grade from a nuclear facility hazard classification to a radiological or industrial facility classification. The Site has established a concept of "operationally clean" to define the point at which all TSR controls can be eliminated for an affected area. After achieving this state for Building 779, the pace of demolition activities precluded down-grading from a Hazard Category 2 to Hazard Category 3, and then to a non-nuclear facility. Difficulties experienced during the final Building 779 demolition-ready phase, related to down-grading and TSR reductions, are discussed.

Introduction

This paper addresses lessons learned from developing an authorization basis (AB) for decommissioning a major nuclear facility at the Rocky Flats Environmental Technology Site through structural demolition to the foundation pad. Rocky Flats has completed its first nuclear facility decommissioning, Building 779, and is in the process of implementing a new authorization basis to support the continuing decommissioning of Building 771.

Building 779 was a research facility at Rocky Flats that supported the fabrication of plutonium weapons parts. Although its research focused primarily on plutonium, it also worked on uranium, beryllium, steels, and other materials. Building 779 began operations in 1965. It was demolished in late 1999, but removal of the rubble continued into 2000.

A Final Safety Analysis Report (FSAR) served as the authorization basis for Building 779 from 1987 until it was replaced by a DOE Standard DOE-STD-3011-94 Basis for Interim Operations (BIO) in 1998. A significant amount of deactivation and limited decommissioning was authorized via the Unreviewed Safety Question Determination (USQD) process based on its production-era FSAR. The purpose of the BIO was to update the authorization basis and to address the decommissioning and demolition of the building. The Building 779 BIO was cancelled in January 2000 after it was determined that the structures remaining in the 779 Complex were industrial or radiological facilities that did not require a nuclear safety AB.

The key authorization basis lessons learned during the decommissioning and demolition of Building 779 are that: (a) closure activities are substantially different than the previous operational activities; (b) closure activities require much greater flexibility in the way in which safety functions are met; (c) clear criteria are needed to determine when specific safety functions are no longer needed; (d) there is a greater reliance on administrative controls during D&D due to the unique activities and on-going dismantlement of engineered safety features which necessitates a major cultural change; and (e) the step-down of controls needs to be built in up-front in the D&D AB process, due to the quickness of D&D and scarce nuclear safety resources. The first four of these lessons were applied to establish an authorization basis for the decommissioning the next major nuclear facility at Rocky Flats, Building 771.

Building 771 is a Hazard Category 2 nuclear facility that recovered plutonium from a variety of residues from plutonium pit production processes at Rocky Flats. Building 771 was built in the early 1950's. Due to the duration and variety of processes and experimental activities conducted in Building 771 and the high throughput of nuclear materials during its 35 year operational mission, it has many more hazards than were encountered during decommissioning of Building 779. In addition, Building 779 had completed deactivation, decontamination, and material removal activities prior to commencing decommissioning of the facility, which left the highest holdup hazard locations with almost two orders of magnitude less nuclear material than is present in Building 771. Therefore, the Building 779 BIO model for authorizing decommissioning could not be simply adopted to evaluate the Building 771 hazards and provide controls. This paper focuses on the hazards and accident analysis and TSR development used to establish the decommissioning authorization basis for Building 771.

The first DOE-approved authorization basis for Building 771was a 1987 FSAR that authorized its production mission to recover plutonium from residues of other processes at the Site. The facility suspended operations in late 1989 but continued to store a substantial amount of plutonium in various forms and other special nuclear materials (SNM).

Beginning in late 1995, a new authorization basis for Building 771 was developed to address completing plutonium liquid residue stabilization, tank draining, storage of SNM, residues and transuranic (TRU)

wastes, and limited deactivation and decommissioning activities. The Building 771 Basis For Operations (BFO) was started as a pilot project for compliance with DOE Order 5480.23, *Nuclear Safety Analysis Reports*, but based on the DOE necessary and sufficient standards development process. The BFO was developed using an expert consensus process and does not fully meet either the Safety Analysis Report (SAR) guidance from DOE Standard DOE-STD-3009-94 or the Basis for Interim Operation (BIO) guidance from DOE-STD-3011-94. At the time that the BFO was originally developed, approved by DOE, and implemented (1996 to 1998 timeframe), if the BFO necessary and sufficient process proved to be successful, it was expected that the BFO could be revised, as needed, to support future D&D based on its activity-based approach to hazards assessment. Except for the Building 779 BIO that was being developed (1997) to authorize D&D, it was unclear at that point what type of AB document (*e.g.*, a new SAR, BIO, or BFO) would be needed for full facility deactivation and subsequent D&D of other RFETS nuclear facilities and it was unclear exactly how D&D of these nuclear facilities would be accomplished.

The BFO philosophy was to develop a necessary and sufficient set of controls for the facility based on potential accident consequences, rather than developing a detailed evaluation of frequencies, consequences, and risks of facility accidents. This was accomplished by identifying hazards and potential accident scenarios of concern and assuming all operational accidents, without specific, preventive controls were in the DOE Standard 3011 frequency bin of *Anticipated*. The scenarios of concern were those what might either cause a bounding consequence or identify necessary controls that might not be identified by other scenarios. The scenarios of concern were not intended to bound every possible accident, but rather a sufficient set of accidents to develop a necessary and sufficient set of controls. These controls addressed both prevention and mitigation. Adequacy of the controls was based on expert judgement and Evaluation Guidelines. The frequency and risks of accidents were not used as criteria for development of TSRs, but were discussed as part of a justification of adequacy for those accidents that could exceed Evaluation Guidelines when assumed to occur with a frequency in the *Anticipated* bin.

Revision 0 of the Building 771 BFO was approved by DOE in January 1997. Revision 0 only authorized those Building 771 activities for which there was sufficient process and work step planning at that time, to allow for an adequate hazards assessment. The Revision 0 BFO did not attempt to authorize all of the activities needed to decommission Building 771. The BFO Revision 0 did authorize some limited deactivation and D&D activities. Deactivation included tank draining of fissile solutions, and removal of unused equipment that was never placed in service for radiological operations. Limited D&D activities were restricted to equipment not containing fissile material holdup.

Difficulties with implementing Revision 0 of the Building 771 BFO during 1997, led to the development and December 1997 approval of Revision 1, which was implemented in February 1998. Revision 1 of the BFO also attempted to authorize additional deactivation activities involving tapping and draining fissile solution systems that were “operationally empty”, but contained a significant volume of residual liquids. However, the safety analysis for this activity relied solely on the relative quantities of nuclear material being handled versus the previously analyzed accidents in the BFO. A detailed hazards assessment of the tap and drain activity had not been conducted. As a result, DOE initially limited their approval of tap and drain activities due to concerns over hydrogen detonation in pipes, the introduction of potential ignition sources (*e.g.*, drilling), and chemical incompatibility issues. While the general concern for fires with hydrogen and the general controls were addressed in the Revision 0 and 1 BFO accident analysis and TSRs, the mechanics of accident initiation during tap and drain and recent industry experience with work on abandoned process lines that contained residual hydrogen gas, were not. Additional safety analyses were needed to support a determination of whether new TSR controls were warranted. These issues were eventually resolved via the USQD process and page changes to the TSRs to authorize tap and drain deactivation activities.

D&D Authorization Basis

As more extensive deactivation activities were already ramping up in Building 771 during implementation of the Revision 1 BFO, work began in Spring of 1998 on Revision 2 of the BFO. The objective of Revision 2 was to define, analyze, control, and authorize Building 771 D&D up to the point of filter plenum removal and demolition of the exterior walls of the building.

By this time, two other facility D&D AB development efforts had already been initiated at RFETS to address nuclear facility D&D. The Building 779 BIO had been completed taking a graded approach based on the low risk of the already deactivated facility and the relatively low nuclear material holdup quantities. D&D process specifics were unknown or unavailable during the development of this AB, so a bounding accident approach was taken with resultant general administrative controls and limited, credited engineered safety features.

Concurrently, Building 776/777 BIO development commenced in the summer of 1997, with an objective to authorize D&D in that facility. Building 776/777 is a large, complex, and hazardous facility that more closely mirrors Building 771 in nuclear safety risk than does Building 779. The Building 776/777 BIO approach to D&D was to define a large array of possible D&D processes under various categories such as mechanical cutting and thermal cutting. This approach, rather than activity-based hazards assessments, was taken due to the reality that detailed planning and descriptions of specific D&D activities were not available at the time of D&D AB development due to the required lead times between AB development and the planned performance of authorized work.

The Building 771 Revision 2 BFO copied the Building 776/777 BIO approach to D&D AB development. The Building 771, Revision 2 BFO and Building 776/777, Revision 0 BIO divided closure activities into six phases: (a) major hazard reduction, (b) equipment dismantlement, (c) building decontamination, (d) utility system shutdown, (e) building demolition, and (f) site remediation. Major hazard reduction involves removal of SNM, removal of residues, removal of bulk chemicals, removal of holdup, and removal or fixing of contamination. Equipment dismantlement includes disassembly, size reduction as needed, and packaging for disposal. Many large items, such as gloveboxes, are being treated as Surface Contaminated Objects (SCO) and packaged in IP-1 cargo containers without any size reduction. Building decontamination includes building walls, floors and ceilings. Utility system shutdown involves the nuclear criticality accident detection and alarm system, the fire detection, alarm, and suppression systems, the HVAC and exhaust filtration systems, and any other facility utility systems. Building demolition includes demolition of the building down to a flat concrete slab and removal of the demolition debris. Site remediation includes soil remediation, placing a soil cap over the building site, and re-vegetation of the area.

The principal nuclear safety concern during closure activities is that the unusual, non-routine nature of D&D may cause fires or spills. Fires are a concern because closure activities may increase the amount and type of combustibles present and may introduce additional ignition sources. Spills are a concern because closure activities involve handling non-routine materials in non-routine ways. Therefore, appropriate controls need to be planned to address the risk of these accidents.

Building 779 D&D was accomplished with no significant fires or spills by using such controls. To reduce the risk of fires during closure activities, controls on combustible materials and ignition sources were needed. One combustible of particular concern was wooden LLW crates. Although the wood from which these crates are constructed is treated with a fire-retardant, they can still burn, and are assumed to burn for purposes of fire hazards analysis and nuclear safety analysis. Therefore, they contribute to the combustible loading inside the building, and are at risk of burning when stored outside a building. One possible control considered early on was to ban the use of wooden crates for low level wastes to be

generated during D&D, but this would have had a tremendous impact on the facility and the Site. Alternative controls were developed to address spacing and combustible loading restrictions.

Plastic contamination confinement structures (plastic houses) are also a significant addition of combustibles to a room and may allow a fire to propagate down a glovebox line or from one glovebox line to another. Where feasible, non-combustible contamination confinement structures (PermaCons) are preferred. Where plastic houses were used, there were significant restrictions on spark and heat generating work processes inside or near the plastic house. Combustibles inside and near the plastic house are also controlled. Other potential ignition sources, such as electrical wiring or electrical equipment should be controlled.

A variety of fixatives or strip-coats are available for treating contaminated surfaces. Some of them are combustible and some of them are not. To minimize the probability and consequence of a fire, only non-combustible fixatives and strip-coats were allowed. Other flammable or explosive gases or liquids may be involved in closure activities. These include items such as oxy-acetylene, oxy-gasoline, propane, solvents, and fixatives. These items, as well as other combustibles in the facility, were controlled to minimize the risk of a fire.

Spills may occur during closure activities because non-routine materials will be handled in non-routine ways. During normal operations, nuclear materials were contained in gloveboxes, piping systems, HVAC systems, or engineered packages. During closure activities, spills may occur as material, holdup, or contaminated items are removed from these systems. As these gloveboxes, piping systems, and HVAC systems are decontaminated, disassembled, size reduced, packaged, and removed, there is always a potential for a minor loss of confinement (spill). There is also a potential for a major spill if the component is dropped, broken, punctured, or involved in a collision (*e.g.*, with a fork truck).

The Revision 2 BFO was submitted for DOE review and approval at the end of May 1998. It requested authorization of the first four of six phases of D&D. The Contractor initially proposed to start equipment dismantlement concurrent with other building mission activities that involved glovebox operations and storage of large quantities of plutonium residues in drums. The hazards and accident analysis addressed a spectrum of potential D&D accidents. Several new bounding scenarios of concern, involving fires and spills or loss of confinement, were proposed to address the new D&D hazards and the need for the above mentioned controls. Work packages and procedures for specific D&D activities, using the processes defined and analyzed in the AB, were to be reviewed against the new bounding accidents in the USQD process.

Shortly thereafter that summer, DOE RFFO rejected the previously submitted Building 776/777 BIO, based in part on its D&D accident analysis and controls. Although formal DOE review of the Revision 2 BFO had not begun, it was expected that its D&D analysis and controls would present the same issues identified with the Building 776/777 BIO from which it was modeled.

For the Building 776/777 BIO and the Building 771 BFO, DOE RFFO identified the need for interactive accident analysis in the AB to ensure the adequacy of the D&D TSRs and to provide a more comprehensive basis for the USQD process when used for D&D activities. In addition, DOE RFFO established a position on risk acceptance during deactivation and D&D, which drove a risk management approach to nuclear safety during D&D, instead of the more traditional bounding accident approach used for operational nuclear safety. DOE RFFO took the position that their risk acceptance during D&D would be lower than the previous criteria that supported the weapons program mission of RFETS plutonium facilities.

The interactive accident identification and analysis for D&D nuclear safety and RFFO's position on D&D risk acceptance were among the major topics discussed by the senior management of RFFO and the Contractor during, what was termed at RFETS, the AB Summit of September 1998. It was agreed that interactive accident scenarios and TSRs to address the potential involvement of D&D activities with other mission activities, as well as the potential interaction of multiple D&D work sets, needed to be developed and incorporated into AB documents to authorize D&D. The Building 771 D&D AB was designated to be the developmental model for D&D interactive accident analysis. It was also agreed that, while D&D activity risk acceptance should be on a risk management approach, AB controls should allow for, and, if possible, provide incentive to consider eliminating higher-risks as early as possible. For example, certain controls that encumber D&D activities could be eliminated once component-specific nuclear material holdup is reduced below a threshold, either by component removal or material recovery. Also, although hot work can increase the risk of fires, some D&D techniques have other safety benefits such as minimizing radiation exposure times and resulting occupational doses. An example is plasma arc cutting, which significantly speeds up equipment size reduction. These risk tradeoffs needed to be balanced from a risk management perspective.

Implementing the risk management approach would eventually affect two areas in the D&D AB process. First, since the accident initiation frequency during D&D was presumed to be higher (*i.e.*, near the high end of the frequency bin approaching a frequency of once per year) than the accident initiation frequency during routine normal operations, even though both may be classified as in the *Anticipated* frequency bin, it followed that "real" risk was likely higher for a D&D accident. To offset the possibility of a "real" risk increase within a given DOE STD 3011 Risk Class, the approach to controlling risk during D&D would be one of as low as reasonably achievable (ALARA). Thus, the bounding accidents for D&D activities would be expected to be controlled to a lower risk than would a similar bounding accident for operations and/or nuclear material storage.

The second effect of the risk management approach would eventually require that the annual updates of AB documents for D&D facilities would incorporate the effects of risk reduction during the preceding period. The AB safety analysis would be revised to reflect changes in material inventory that affected accident scenario material-at-risk and other changes that may have rendered some bounding accident scenarios no longer credible.

DOE commenced formal review of the Revision 2 BFO in Fall of 1998 and issued a partial or limited approval of it in late November 1998, with extensive technical direction. As noted in the DOE review report, the Revision 2 BFO did not address the risk of interactive accidents during D&D and did not reflect the risk management approach to D&D recently agreed upon at the AB Summit. It was directed that the safety analysis needed to develop interactive accident scenarios and TSRs to address the potential involvement of D&D activities with other mission activities, as well as the potential interaction of multiple D&D work sets. DOE viewed the need for these interactive accident scenarios because of the potential increase in the frequency of accidents due to non-routine D&D activities and due to a large quantity of material-at-risk associated with the facility's SNM and residue storage mission and holdup in untoward areas.

The DOE review also addressed concerns with attempting to authorize D&D activities using bounding accident scenarios from the facility's previous mission activities that had been eliminated during the preceding months (*e.g.*, SNM and residue drums were removed from the facility after the BFO Revision 2 was submitted so the analysis still included them), and the lack of additional controls for combustible fixatives whose radiological consequences could exceed accident Evaluation Guidelines. The DOE RFFO directed a rebaseline of the BFOs bounding accident scenarios to eliminate accidents that were no longer representative for closure activities. Therefore, the RFFO limited its approval of the BFO

Revision 2 D&D work scope to a few work sets with minimal material-at-risk and minimal potential for interaction with other activities or areas of the facility.

DOE also directed the Contractor to perform a cost/benefit analysis for development of the options for an AB document authorizing D&D in Building 771. After performing the cost/benefit analysis of upgrading the BFO or developing a new AB document (*e.g.*, BIO or FSAR), the Kaiser-Hill Team developed an AB strategy to authorize additional D&D activities through revisions of the BFO.

As an agreed to action from the AB Summit, the Contractor established a team comprised of RMRS personnel involved with Building 779 D&D that was in progress, Building 771 D&D planning and nuclear safety, and Kaiser-Hill Closure Projects technical oversight. This team established a model for hazard identification and hazard evaluation that formed the basis for developing four new interactive accident scenarios for Building 771, three involving fires and one involving spills, as well as addressing accident scenarios for outdoor storage of low level wastes (LLW) stored in wooden containers.

The team evaluated the accident scenario parameters that could be controlled without significant facility upgrade or modification. This was a reasonable objective given that the work activity was decommissioning of the facility. They derived a set of administrative controls to reduce accident initiation frequency, limit the material-at-risk in a given accident, and prohibit the use of combustible fixatives, which would have increased dose consequences by two orders of magnitude.

These administrative controls, affecting the accident scenario parameters, were generalized into spacing requirements, combustible fixative prohibition, and material segregation. The latter controls were quantified by the nuclear safety analysts based on Risk Class thresholds, while the former were submitted to an offsite fire protection engineering consultant, Hughes Associates, Inc. (HAI), for refinement and quantification. HAI performed fire modeling to determine the necessary spacing requirements/separation distances to preclude fire propagation from the various standard elements of the interactive fire accident scenarios. They also supplied the separation distance for unassociated hot work from a given glovebox D&D site and criteria for determining whether a given fixative was in fact combustible. These items were based on fire protection standards and practice and their professional judgement. The team's output was integrated into a major page change to the Revision 2 BFO known as Revision 2c, which was submitted for DOE review and approval in late March of 1999.

In a Revision 2c to the BFO, the Contractor evaluated two variations of potential fires: Case (a) assumed propagation of a fire to multiple gloveboxes or to TRU waste storage drums, and Case (b) credited TSR controls to prevent such interactions. Although the BFO credited one stage of high efficiency particulate air (HEPA) filtration to reduce consequences to less than the Evaluation Guidelines for both cases, the DOE RFFO viewed the Case (a) propagating accident when preventive controls were not considered, similar to a BIO/SAR unmitigated hazards evaluation, and did not accept the risk associated with these events as part of the authorization basis for future USQ evaluation criteria. Instead, the Case (b) scenarios of concern, with application of the TSR controls that eliminated the interaction potentials, were accepted and formed the basis for future USQ evaluations.

The conclusion of RFFO's review of the BFO Revision 2c in June 1999 was that it provided an adequate analytical basis and set of controls to authorize the full scope of D&D activities as defined in the AB document with the exception of hot work in temporary confinement enclosures. The four additional interactive scenarios of concern adequately addressed RFFO's concerns regarding analyzing full D&D operations. RFFO also commissioned an independent Fire Protection Engineering verification of the combustible controls, separation distances, and hot work controls being proposed for the D&D activities. The fire scenarios were independently modeled during the verification and the assessment concluded that

the separation distances being proposed were conservative. Also, after extensive deliberations, Building 771 chose to ban the use of wooden crates for low level waste, and to use metal crates instead.

However, DOE was concerned that the control set presented by the BFO Revision 2c page change did not adequately address the minimization of fire risk to D&D workers. RFFO still had concerns that hot work inside or close to temporary confinement enclosures had not been adequately analyzed by Fire Protection Engineering and other safety disciplines (*e.g.*, Industrial Safety and Radiation Protection). Therefore approval of this activity was withheld until further justification for the adequacy of the proposed controls could be submitted to RFFO. Several technical submittals from the Contractor addressed DOE's issues, without requiring a change to the Technical Safety Requirements (TSR) in the BFO. However, these issues were ultimately resolved in Revision 3 of the BFO, which included more conservative required actions for a not operable fire suppression system and specific provisions for planned out-of tolerances of the fire suppression system as necessary to support D&D activities.

Revision 2 of the BFO was approved in several phases during 1998 and 1999 to authorize D&D activities as more specific plans and schedules were developed. Revision 2 was implemented by the Contractor in 1999 and Revision 3 is expected to be implemented by May 2000. RFETS is accelerating Site closure by planning and budgeting for completion by the year 2006. With continuous D&D progress, Building 771 is scheduled for demolition in FY2004. The strategy to develop multiple AB revisions to facilitate early deactivation activities and limited D&D activities concurrent with mission activities for Building 771 was not an efficient process. It involved protracted negotiations and numerous iterations to negotiate an acceptable authorization basis. These negotiations are probably not over. The Contractor is currently considering the development of a BIO to replace the BFO in an attempt to streamline the TSR controls now being implemented. Due to delays in D&D planning, Revision 2c that was approved by DOE in June 1999 was never implemented by the Contractor because a subsequent Revision 3 to the BFO, driven by annual review requirements and a Site initiative on administrative controls and safety management programs, was submitted to DOE in late August 1999 and approved by DOE in early January 2000.

Step-Down Of Controls

Another challenge for a D&D authorization basis relates to efforts to step down from TSR controls as hazards are eliminated, and to eventually down-grade from a nuclear facility hazard classification to a radiological or industrial facility classification. Based on the Building 779 experience, the Site has established a concept of "operationally clean" to define the point at which all TSR controls can be eliminated for the affected area. Operationally clean is defined as the point in closure when: (a) individual components (*e.g.*, gloveboxes, B-boxes, hoods, tanks, process piping, and contaminated ductwork) have been dismantled, packaged, and removed from the affected area; (b) no radioactive waste is stored or staged in the affected area except that which may be generated during structural decontamination; (c) no unnecessary combustibles are present; and (d) the associated filter plenum(s) first stage filters have been removed or isolated from the affected area, and the plenum decontaminated (if required). Depending on the configuration and the plan for closure of the facility, this condition of operationally clean may be achieved room-by-room, area-by-area, or for the whole facility at once.

It is essential that required controls for closure activities be stated in terms of functional requirements, rather than specific hardware controls. For example, pressure differential and exhaust filtration functions may be taken over by portable air movers, rather than the installed exhaust fans and HEPA filter plenums. Electric power and lighting in an area may be isolated and ripped out while a temporary power supply and temporary lighting is used.

This operationally clean definition worked for Building 779, but still required a lot of interpretations which resulted in a significant commitment of resources for the safety evaluation process as Building 779 D&D work packages were developed and evaluated for potential USQs. One of the lessons learned from 779 was that a more quantitative definition of contamination levels could significantly shorten the USQD process, but would require more frequent surveys of the facility to assure that large quantities of holdup of radioactive materials were not present. Alternatively, operationally clean could be achieved by defining conditions of the building or rooms such as when all gloveboxes and equipment over a specified fissile holdup value have been removed. Also, some systems such as the Health Physics vacuum system with low levels of contamination could be categorically defined as a non-nuclear activity. Another lesson was to write the TSR Bases in more prescriptive detail to support the USQD process, especially for Safety Significant systems that provide a defense-in-depth function.

Building 779 was able to utilize the concept of operationally clean for segments of the facility, and thus gained relief from TSR controls for specific rooms or auxiliary structures. This facilitated the overall D&D schedule by allowing Surface Contaminated Objects to be removed more readily from the facility in accordance with the requirements of the various safety management programs.

However, after achieving the operationally clean state for Building 779, the pace of demolition activities was so quick that it precluded down-grading the facility from a Hazard Category 2 to Hazard Category 3, and then to a non-nuclear facility. Rather, Building 779 was able to rapidly lower it's fixed holdup of plutonium in equipment due to their removal, and thus in a relatively short period became a de facto radiological facility rather than a nuclear facility. The facility holdup fell below Hazard Category 2 thresholds for only a short period before it met the operationally clean definition; therefore, there was little benefit to be gained by down-grading the facility from Hazard Category 2 to Hazard Category 3.

In addition, due to the very low threshold values from the DOE Standard DOE-STD-1027 used to classify nuclear facilities and the inherent uncertainty band in holdup scanning measurements, it is a very protracted process to certify that a nuclear facility has been decontaminated and decommissioned to level below the nuclear facility threshold. In the case of Building 779, such a certification was essentially concurrent with readiness to demolish the facility's structural shell. Final decontamination was able to reduce the structural shell material of the building to a low level waste classification as it was demolished and packaged for offsite shipment. A lesson learned is to build the step downs into the AB document because after implementation, nuclear safety resources are too busy performing USQ safety evaluations on detailed work planning documents that they can't dedicate time to demonstrate material-at-risk reductions and therefore control step-downs. A second lesson learned is to not place much emphasis on planning to reach a milestone in D&D that will allow for reclassifying a nuclear facility to a radiological facility. Unless criteria are revised, the current threshold is so low that a facility undergoing D&D passes through it, to final structural demolition, in less time than formal reclassification can occur.

For Building 771, segmentation to achieve an operationally clean state is achievable for a small portion of the facility that housed nuclear activities. Due to past incidents of spills of plutonium nitrate and other acid solutions, and other major fire and explosion accidents, the extent of fixed holdup embedded in concrete floors and walls is much more extensive than was encountered in Building 779. Other than meeting the operationally clean definition, other strategies for down-grading of TSR controls for Building 771 D&D may be beneficial. For example, developing more prescriptive TSR Applicability Statements or modes of operation would better define the point at which a credited control is no longer justified. This was done to some extent in Revision 3 to the BFO based on lessons learned from specific situations that developed during the Building 779 D&D. However, much of the controls reduction during the Building 779 D&D was qualitatively determined and is difficult to transfer to other facility ABs. Rather, a given facility should have sufficient understanding and documentation of the relationship of its controls to the accident analysis to allow for defining applicability in specific, if not quantitative, terms.

One lesson learned from the Building 779 project is to perform the accident analysis for the step down of controls up-front for the TSR applicability statements or modes of operation. As an alternative, the Site is also re-evaluating the cost/benefit of whether a BIO rather than a control-oriented BFO would be more beneficial for providing the technical basis to step down from TSR controls.

One last consideration is that once TSR controls are eliminated, discoveries may occur that would warrant re-activation of the TSR control. A procedure or process should be preplanned for this possibility. Related to this are definitions for out-of-service versus deactivated equipment and when DOE approval is required for eliminating such equipment from the TSRs.

Conclusion

Rocky Flats has successfully developed and implemented an authorization basis that supported its first nuclear facility demolition, Building 779. Based on AB lessons learned from that project, an authorization basis has been developed and approved for the first four phases of Building 771 D&D and is currently being implemented. The Building 771 D&D AB has a technically defensible hazards and accident analysis and bases for derivation of TSR controls. The new TSR control set will optimize fire prevention and minimize the possibility for spills, and at the same time provide operational flexibility. The control set also encourages the Contractor to focus on eliminating the higher risk gloveboxes and plenums and thereby significantly reduce the need for TSR controls that can be replaced by those required by safety management programs. With some modifications (*e.g.*, formally documenting an unmitigated hazards evaluation) Rocky Flats now has a model for developing future D&D ABs that will be based on the BIO or FSAR methodologies.

Overall, some of the more significant lessons learned include: (1) reflect reality and risks for the current conditions of the facility and don't rely on the previous bounding accidents associated with the former mission activities; (2) address the potential increase in frequency of D&D accidents such as spills, fires, and with hot work, through evaluation of interactive accident scenarios; (3) ensure the step-down of TSR controls by performing the accident analysis up-front and clearly determining and documenting the relationship of the controls to the accident analysis; (4) don't plan for multiple AB revisions to authorize D&D piecemeal; and (5) don't expect detailed descriptions of planned D&D activities to be available when the planning schedule requires D&D AB work to commence, but hold out for as much detail as possible to avoid omissions in the safety analysis and to allow for more specificity in the basis for the D&D AB controls. This ultimately should smooth the step-down of controls during D&D without an encumbering use of the USQD process and/or protracted negotiations between the regulator and the Contractor as was done for the Building 779 D&D effort.