DNFSB/TECH-26

# IMPROVING OPERATION AND PERFORMANCE OF CONFINEMENT VENTILATION SYSTEMS AT HAZARDOUS FACILITIES OF THE DEPARTMENT OF ENERGY

## Defense Nuclear Facilities Safety Board

## Technical Report

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## EXECUTIVE SUMMARY

Since its inception, the Defense Nuclear Facilities Safety Board (Board) has provided its observations on a number of issues associated with confinement ventilation systems. Most recently, the Board's report DNFSB/TECH-23, *HEPA Filters Used in the Department of Energy's Hazardous Facilities*, dealing with issues involving high-efficiency particulate air (HEPA) filters, was forwarded to the Department of Energy (DOE) on June 8, 1999.

Confinement ventilation systems are important safety features of DOE facilities in which hazardous materials are handled. These systems are generally relied on as the final barrier to the release of hazardous materials to the environment with potentially serious consequences to workers and the public. It is especially important that the integrity of these systems be uncompromised. Poor operation, surveillance, and maintenance can significantly reduce the effectiveness of even a well-designed confinement ventilation system in protecting workers and the public. Reviews of confinement ventilation systems at DOE's defense nuclear facilities conducted by the Board's staff, previous internal DOE reviews of these systems, and an analysis of information in DOE's Occurrence Reporting and Processing System (ORPS) have revealed the need for improved upkeep of confinement ventilation systems.

ORPS provides timely and comprehensive information regarding off-normal events occurring at DOE facilities, including analysis of lessons learned from these occurrences. However, closure of the feedback and improvement function, as part of a sound Integrated Safety Management program to achieve complex-wide improvement in the performance of confinement ventilation systems, has not been adequately undertaken.

Much of the evidence of poor management of confinement ventilation systems has been documented in ORPS reports. The operational history shows the need for improvements in preservation programs for confinement ventilation systems, particularly the operation, maintenance, testing, and surveillance of such systems.

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# 1. INTRODUCTION

The law establishing the Defense Nuclear Facilities Safety Board (Board), 42 U.S.C. § 2286, *et seq.*, requires that the Board review and analyze facility and system design, operations, practices, and events, and make recommendations to the Secretary of Energy that are necessary to ensure adequate protection of public health and safety. In reviewing the basic elements and structure of Department of Energy's (DOE's) safety management program, the Board gives priority attention to those facilities and activities that present the greatest safety risks—the elements of the defense nuclear complex devoted to (1) the stewardship, maintenance, and surveillance of nuclear weapons; (2) the stabilization of hazardous remnants of weapons production; and (3) the storage and disposition of strategic and highly radioactive materials, and the safe closure of facilities formerly used to support defense programs. For each of these elements, robust and reliable confinement systems play important roles in protection of workers and the public, and the integrity of ventilation systems for confinement structures is central to that role.

## 1.1 BACKGROUND

Most industries performing hazardous operations have developed safety policies and structured practices frequently encompassed by the term "formality of operations." The Board's technical report, DNFSB/TECH-15, *Operational Formality for Department of Energy Nuclear Facilities and Activities* (Defense Nuclear Facilities Safety Board, 1997a), provides a detailed description of the concept of formality of operations and offers additional guidance on how to tailor a strategy for its implementation. As embraced in DNFSB/TECH-16, *Integrated Safety Management* (Defense Nuclear Facilities Safety Board, 1997b), under the basic function of performing work safely, formality of operations includes:

- A work environment in which operating personnel are knowledgeable of their own work tasks and know what to expect from coworkers.

- Operating personnel with a thorough understanding of work hazards and associated controls and emergency response actions.

- Equipment that is maintained within required standards by trained technicians.

- Work evolutions that take place in accordance with technically accurate procedures.

When these elements are reinforced by all managers—from upper-level managers to first-line supervisors—formality of operations becomes second nature, and work can indeed be performed safely.

In preparing this report, the Board's staff focused on the original priority facilities identified in DOE's Implementation Plan for the Board's Recommendation 95-2, *Safety Management*. The report sets forth realistic expectations for confinement ventilation systems at these priority facilities. These facilities are representative of DOE's defense nuclear facilities; all are expected to have implemented and verified Integrated Safety Management programs by September 2000.

The present report describes inadequacies revealed by direct observations of the Board's staff, previous internal reviews by DOE, and an analysis of information in DOE's Occurrence Reporting and Processing System (ORPS). These findings, as well as others resulting from earlier reviews documented by the Board and its staff—coupled with DOE's slow response to previous urging by the Board on this matter—attest to an already undesirable health and safety situation. The integrity of these systems, which are generally relied on as the final defense in depth barrier to the release of hazardous materials, is being compromised. On the basis of this assessment, the staff believes that substantially improved preservation programs for confinement ventilation systems at DOE's hazardous facilities would enhance the performance and reliability of these important systems, in addition to providing a higher level of assurance that the public, workers, and the environment are adequately protected. Specifically, this report points to the need for robust and rigorously implemented efforts to support improved preservation programs in such areas as configuration management, maintenance, surveillance, training and qualification.

## 1.2 PAST INVOLVEMENT OF THE DEFENSE NUCLEAR FACILITIES SAFETY BOARD

The reliability and effectiveness of ventilation systems, most of which were installed years ago, have been matters of special attention by the Board during the years of its existence. A partial listing of the Board's historical interactions with DOE is provided below. Ventilation systems in many defense nuclear facilities provide vital safety functions. Strong reliance on these systems is an integral part of protection of the public and collocated workers against radiological hazards.

One of the Board's first formal communications with DOE explicitly regarding ventilation/filtration systems occurred in the fall of 1993 and addressed electrical power supplies at the Plutonium Facility in Technical Area 55 at the Los Alamos National Laboratory (LANL). This inquiry prompted a public meeting held by the Board on March 7, 1994. As a result of that meeting, LANL rewrote the operating procedure for the facility's diesel generator to ensure that the generator would start upon a loss of off-site power, thereby ensuring continued operation of the confinement ventilation system.

In March 1995, the Board issued DNFSB/TECH-3, *Overview of Ventilation Systems at Selected DOE Plutonium Processing and Handling Facilities* (Defense Nuclear Facilities Safety Board, 1995a), which addressed the design of confinement ventilation systems. In its

June 15, 1995 letter forwarding that report, and in subsequent correspondence in July 1995, the Board requested that DOE evaluate the design, construction, operation, and maintenance of ventilation safety systems in terms of applicable DOE and industry standards.

In May 1995, the Board issued DNFSB/TECH-5, *Fundamentals for Understanding Standards-Based Safety Management of DOE Defense Nuclear Facilities,* (Defense Nuclear Facilities Safety Board, 1995b) which stressed the importance, among other things, of functions that preserve those structures, systems, and components that are relied upon to protect the public, workers, and the environment (e.g., configuration management, training, and maintenance). In October 1995, the Board issued DNFSB/TECH-6, *Safety Management and Conduct of Operations at the Department of Energy's Defense Nuclear Facilities* (Defense Nuclear Facilities Safety Board, 1995c). The report underscores the importance of conduct of operations as the body of practice, or operational formality, that implements the Safety Management System for a defense nuclear facility. Such a program includes "Supervision by highly competent personnel who are knowledgeable as to the results of the safety analysis and operating limits for the facility or activity." Key aspects of facility safety management programs discussed in these two reports are central to the issues discussed in this report.

In June 1997, the Board issued a seminal report, DNFSB/TECH-16, *Integrated Safety Management* (Defense Nuclear Facilities Safety Board, 1997b), discussing the background, rationale, and concept of treating the environmental, health, and safety programs of DOE as an integrated whole. An essential function of such an integrated safety management program, feedback and improvement, is also central to the issues discussed in this report.

In its letter dated October 30, 1997, the Board pointed out several additional key issues associated with wetting of high efficiency particulate air (HEPA) filters during tests of fire sprinkler systems, and the need for complex-wide guidance from DOE concerning the relationship between maintaining filter integrity and fire fighting strategies. The importance of confinement ventilation systems at the Rocky Flats Environmental Technology Site (RFETS) was the primary motivation for the letter, but the applicability of the issue to other defense nuclear facilities was also noted. More recently, in June 1999, the Board issued a technical report addressing DOE's infrastructure supporting effectiveness of HEPA filters, which are vital components in confinement ventilation systems. DNFSB/TECH-23, *HEPA Filters Used in the Department of Energy's Hazardous Facilities* (Defense Nuclear Facilities Safety Board, 1999), focuses primarily on weaknesses in that infrastructure. In its June 8, 1999 forwarding letter, the Board requested a report outlining the steps DOE intends to take to resolve the issues identified in DNFSB/TECH-23. In recent weeks, individual Board members and the Board's staff have met informally with DOE representatives to resolve differences concerning DOE's proposed response to the Board's request.

The Board's June 8, 1999 letter also indicated that the Board intended to examine operational and maintenance aspects of confinement ventilation systems in general. In its July 8, 1999 letter addressing guidance set forth in draft Guide 420.1-X, *Implementation Guide for Non-Reactor Safety Design Criteria and Explosive Safety Criteria* (U.S. Department of

Energy, 1995b), the Board noted that requirements for confinement systems should be tailored according to a facility's level of hazard and the principles of an integrated safety management system. Further, the Board urged DOE to designate confinement ventilation systems as safety-class or safety-significant. For older defense nuclear facilities, where the design may not meet the requirements of DOE Order 420.1, *Facility Safety* (U.S. Department of Energy, 1995a), a need for additional compensatory measures may be indicated. When these older facilities have limited missions, it may be appropriate to enhance the rigor of maintenance and surveillance in lieu of facility modification that may be prudent for older facilities with significant remaining mission life.

## 1.3 ORGANIZATION OF THIS REPORT

Section 2 reviews the need for robust programs supporting confinement ventilation systems, frequently termed preservation programs, at defense nuclear facilities. Section 3 summarizes observations with regard to the operational state and preservation programs of confinement ventilation systems at DOE's defense nuclear facilities. Section 4 addresses the impacts of facility aging and remaining mission life on preservation programs. Appendix A discusses aspects of sound preservation programs. Appendix B is a compilation of important information concerning the age and mission life of confinement ventilation systems at the original 10 priority defense nuclear facilities identified in DOE's Implementation Plan for the Board's Recommendation 95-2, *Safety Management.*

## 2. THE NEED FOR ROBUST PRESERVATION PROGRAMS

Confinement, DOE's preferred method for protecting the public and workers from exposure to hazardous material at most facilities where such material is handled, encompasses both the physical structures in which the material resides and the associated ventilation systems. For highly hazardous materials, multiple confinement zones are often employed in series, each zone consisting of a separate structure and ventilation system. By design, air flows from areas with lower hazards to those with greater hazards, thus facilitating access to most areas with minimal risk and ensuring that air leakage always flows from a less hazardous to a more hazardous area, rather than the converse. Before air is discharged to the environment, it is filtered to ensure that any residual contamination is well below acceptable safe levels for public exposure (Burchsted et al., 1976).

For example, a typical three-zone system might comprise a building, a room within the building, and one or more gloveboxes within the room, each zone equipped with its own associated ventilation system. Differential pressures from zone to zone establish the desired air flow direction and volume between zones; thus activities within one zone can affect those in another. Safe and effective operation of the composite system requires considerable knowledge, thought, and care (U.S. Department of Energy, 1992b, 1994b; Burchsted et al., 1976).

The role of confinement in the defense in depth concept is a crucial one, since the confinement ventilation system is generally relied on as the final barrier to the release of hazardous materials to the environment. Since the consequences of such a release to workers and the public could be very severe, it is especially important that the integrity of these systems be uncompromised.

An acceptable confinement system starts with a robust and well-documented design—robust not only in the physical structures involved, but also in the attributes of defense in depth incorporated in the overall design of the system (U.S. Atomic Energy Commission, 1973). Confinement systems are expected to be described thoroughly and explicitly in applicable safety and authorization basis documents, such as Safety Analysis Reports (SARs) and Technical or Operational Safety Requirements (U.S. Department of Energy, 1992a). The demands imposed by the need for uninterrupted operation of confinement ventilation systems for extended periods of time—often years—have led to the exceptionally rugged designs found in many DOE applications today. For example, redundant filter banks and emergency or backup power supplies are common defense-in-depth features in modern applications (Defense Nuclear Facilities Safety Board, 1995a).

Confinement ventilation systems must not only be designed and built to exacting standards, but they must also be operated and maintained such that their safety function is continually accomplished for the life of the facility. Adequate protection of the public and workers at such facilities depends not only on soundly designed robust structures and systems, but also on failure-free operation to ensure that the safety functions these systems perform are uninterrupted.

In its report, DNFSB/TECH-5, *Fundamentals for Understanding Standards-Based Safety Management of DOE Defense Nuclear Facilities* (Defense Nuclear Facilities Safety Board, 1995b), the Board describes those functions associated with ensuring the continued integrity of adequately designed nuclear safety systems, structures, and components after they are placed in operation as “preservation” functions. The programs that codify these functions—the preservation programs—are the focus of the present report.

DOE has issued directives, standards, and guidance that describe such preservation programs aimed at achieving the necessary failure-free operation of systems affecting safety, including confinement ventilation systems. These programs include the following:

- Conduct of Operations (U.S. Department of Energy, 1995b)
- Configuration Management (U.S. Department of Energy, 1993)
- Maintenance (U.S. Department of Energy, 1994a)
- Testing and Surveillance (American Society of Mechanical Engineers, 1989)
- Training and Qualification (U.S. Department of Energy, 1994b)

In addition, although not specifically part of a preservation program, the function of technical review and oversight is a focal point of the present report.

The above programs must be carried out by competent, alert, well-trained, and technically inquisitive individuals backed up by adequate technical support, competent management, and adequate funding (Defense Nuclear Facilities Safety Board, 1997a). Additional information regarding these programs is provided in Appendix A.

Since issuing Recommendation 95-2, *Safety Management*, and DNFSB/TECH-16, *Integrated Safety Management*, the Board has placed special emphasis on the need for DOE to improve the development and implementation of authorization bases, the implementation and institutionalization of Integrated Safety Management programs throughout the complex, and the establishment of specific sets of control measures (authorization agreements) at major DOE sites. DOE has made significant progress toward developing Integrated Safety Management programs at every site, and improvements in safety and efficiency are becoming evident as work practices improve.

The Board issued Recommendation 98-1, *Integrated Safety Management*, in September 1998 to address the internal independent oversight element of the feedback and improvement function, which the Board believed was not being adequately addressed in DOE’s feedback and improvement initiatives. The Board determined that DOE-Headquarters' independent assessments of safety management in the field were treated largely as advisories, and follow-up actions were discretionary for lower levels of DOE line management. DOE accepted Recommendation 98-1 and provided an acceptable Implementation Plan, which addresses DOE's need for a clearly defined, systematic, and comprehensive process to address and resolve safety issues identified by internal independent oversight. The Secretary of Energy has tasked the complex with full implementation of Integrated Safety Management by the end of fiscal year 2000.

As a result of these and other efforts, more than 90 facilities or major activities are operating within the bounds of signed authorization agreements. However, the Board noted that those authorization agreements varied in quality and completeness, and urged DOE to perform its own review of authorization agreements for defense nuclear facilities. Two independent DOE reviews confirmed the Board's findings and resulted in more than 15 recommendations for improving authorization agreements.

These activities are relevant in the present context, not only because of the reliance placed on confinement ventilation systems as crucial elements of defense in depth, but also because of the need to ensure that hazard analyses performed during the development of authorization bases are thorough, and that the requisite controls of those hazards are appropriate. In addition, there is a clear need to improve the quality of technical review and oversight by senior DOE managers and to improve feedback and improvement measures, as illustrated by the experience documented in Section 3 of this report.

# 3. INADEQUACIES IN PRESERVATION PROGRAMS

As noted in Section 2, confinement ventilation systems must not only be designed and built to exacting standards, but they must also be operated and maintained such that their safety function is continually accomplished for the life of the facility. Reviews of ventilation systems have disclosed widespread inadequacies in DOE's preservation programs, particularly those associated with confinement ventilation systems. Many of these inadequacies have been identified in earlier reports by internal DOE reviewers as well as in other Board reports cited herein. The examples described in this report, which were obtained from DOE occurrence reports, are more recent evidence of the degraded status of preservation programs at defense nuclear facilities.

Summary information for confinement ventilation systems at the 10 priority facilities identified in DOE's Implementation Plan for Board Recommendation 95-2, *Safety Management*, is presented in Appendix B.

## 3.1 GENERAL OBSERVATIONS

Typically, confinement ventilation systems in DOE facilities that handle high-hazard materials are robust. It is not uncommon to find ventilation systems with all-steel filter housings, containing roughing filters and multiple banks of HEPA filters. The systems are often supplied with redundant sources of power. In many cases, hazard analyses are well-documented in authorization basis documents, in which the associated confinement ventilation systems are appropriately classified according to their safety significance.

Several vulnerabilities are unique to confinement ventilation systems. These vulnerabilities are described in the following subsections.

**HEPA Filter Medium Not Protected from Water Damage.** The weakest link of confinement is most often the 15- to 30-mil-thick HEPA filter medium. This medium consists of fiberglass and binder formed into a continuous sheet in a process similar to paper making. It is made water repellant, but not waterproof, before being incorporated into a filter. Fire protection systems may wet this medium, sometimes repeatedly, during system tests or responses to real fires, and like paper, the filter medium is subject to deterioration from moisture. Problems related to HEPA filters and the associated DOE infrastructure are discussed in DNFSB/TECH-23 (Defense Nuclear Facilities Safety Board, 1999).

**Filter Testing Poorly Understood.** Despite the importance of testing of confinement ventilation systems, there is a widespread lack of understanding about the purpose and applicability of the required testing. The differences between tests of HEPA filter efficiency performed at a filter test station and during in situ leak tests conducted at a facility are largely not understood (Burchsted et al., 1976).

A second common misconception is that in situ field testing demonstrates filter performance under upset conditions. In fact, incipient failure or severe internal structural degradation of the filter is unlikely to be detected by such tests; field testing merely tests the leak tightness of the filter's fit against the frame. Filters can be severely weakened by aging, wetting, loading, or prolonged exposure to chemical vapors or extremes in temperature without necessarily failing in situ field tests (U.S. Department of Energy, 1997). Studies have shown that filters not suitable for expected upset conditions are quite capable of passing field tests, which are conducted under less-challenging conditions. While some of these effects are understood, most are not, and the effects can act synergistically. Earlier reviews by the Board's staff identified some filters that have been in service for more than 20 years.

**Lack of Guidance for Safety Analysis of Confinement Ventilation Systems.** Although confinement ventilation systems are installed in many facilities, DOE has no complex-wide policy governing review and evaluation of safety analyses affecting these systems. DOE Order 420.1, *Facility Safety* (U.S. Department of Energy, 1995a), addresses the broad subject for new facilities, but confinement ventilation systems are not treated explicitly. In recent correspondence (Conway, 1999), the Board urged DOE to classify confinement systems as safety-class or safety-significant in accordance with DOE Order 420.1. However, many older facilities have confinement systems that cannot meet some of the specific requirements of DOE Order 420.1. Compensatory measures need to be instituted for those systems, and in some cases this has been done (see Section 4).

**Lack of DOE Standards for Performance Testing of Confinement Ventilation Systems.** Safety analyses are sometimes based on key assumptions that require nonstandard field verification on a periodic basis. For example, specification of acceptable levels of confinement out-leakage during periods when ventilation systems must be turned off would appear to be an appropriate subject for DOE-wide guidance, which should be based on peer-reviewed research. Instead, individual DOE facilities have developed site- or facility-specific solutions,[1] without rigorous, complex-wide review and evaluation by independent subject matter experts (U.S. Department of Energy, 1995b).[2] Unfortunately, no standardized, complex-wide method for testing of building out-leakage has been specified by DOE.

A similar condition involving bypass in-leakage occurs when air is drawn into the ventilation system through leaking shaft seals, duct joints, or holes in the system as a result of the negative pressure maintained between the filters and the exhaust fans. If the air thus drawn into the exhaust duct from secondary containment were contaminated, it would be discharged to the

[1] Clearly, site- and facility-specific characteristics associated with unique geographic and meteorological conditions need to be taken into consideration. The point here is that DOE has not developed a complex-wide set of acceptance criteria against which these characteristics can be measured.

[2] In this regard, it is heartening to note DOE's commitment to the Board to reinstate its sponsorship of important national air cleaning conferences, thereby providing a vehicle for independent peer review of proposed DOE-wide guidance.

environment without treatment. In this case, also, there is a lack of definitive DOE-wide guidance.

A review conducted by the Board's staff in anticipation of the proposed restart of the enriched uranium facility at the Y-12 Plant disclosed that the initially proposed Operational Safety Requirements did not contain a single limit for any of the six ventilation systems for which credit was taken in the safety analysis (Conway, 1998). The review also identified several additional ventilation/filtration issues, including inadequacies in conduct of operations, safety documentation, configuration management, testing and surveillance, and technical oversight. All of these issues were ultimately resolved.

**Lack of a Strategy for Isolating Confinement Ventilation Systems During Fires.** The situation is even more complex when firefighting strategies require isolation of the ventilation systems. A comprehensive evaluation by competent system design and operations personnel is needed to identify solutions that can balance potentially conflicting system requirements while providing an adequate level of safety (Owendoff, 1998).

For several reasons, the largest potential threat to the public from a facility containing radioactive materials is often identified through a scenario based on an accidental fire. Ventilation system failures due to fire are rare, but can have very serious consequences. First, fires generate smoke that could clog the filter with particles. The result would be an increased pressure drop across the filter, potentially high enough to cause the filter to fail and breach confinement. During some fire scenarios, it may be necessary to stop air flow to the filter system because its destruction is imminent. Such a decision needs to be carefully evaluated ahead of time, and the resulting strategy clearly captured in procedures and rigorously practiced (Owendoff, 1998). Second, the particulate material deposited on the HEPA filter is easily dispersed (U.S. Department of Energy, 1994c). If the filter were to rupture as a result of either an increased pressure drop arising from excessive loading or fire damage, the resulting fragments and particles would readily be lifted by buoyancy into the winds aloft and dispersed downwind. As a result, some fires could be more serious than explosions, which generally would drive much of the particulate matter into surrounding structures instead of elevating it into the prevailing winds. Third, fires within ventilation systems, even those that may appear to be isolated in specific areas of a facility (e.g., in a particular glovebox or hot cell) could result in embers being carried through the ventilation ductwork to the filter installation. There, undetected secondary fires could be ignited in a particularly vulnerable portion of the system.

One example of the importance of formality of operations in the context of the threat from fire is particularly informative. At a plutonium facility at the Rocky Flats Environmental Technology Site, there was neither a strategy nor an implementing procedure for isolating a confinement ventilation system, despite the fact that the facility had two major fires in the past. Further, DOE was unaware of what situation might exist at other facilities in this regard (Owendoff, 1998).

**Lack of a Vigorous Program for Instrument Calibration.** Calibration to ensure that instruments reflect system conditions accurately, usually considered an element of an adequate testing and surveillance program, is also an essential element of an acceptable overall maintenance program. The Board and its staff have observed inadequacies in this aspect of maintenance programs involving confinement ventilation systems. For example, the maintenance program at the Y-12 Plant did not include calibration of differential pressure gauges (Conway, 1998). Further, the calibration eventually carried out lacked adequate technical procedures. When procedures were ultimately written, considerable additional effort was required to make them workable. Specifically, it was not always clear where and when key steps were to be independently verified. Rigorous calibration programs, documented in written procedures, are generally not in place for confinement systems in the DOE defense nuclear complex.

**Rudimentary Maintenance Work Planning.** Good planning of work in a sound preventive maintenance program increases the availability of equipment. Maintenance planning, in which the demands of operations, maintenance, and the safety envelope are integrated with personnel, training, material, and time, is somewhat rudimentary in the DOE defense nuclear complex as compared with the commercial nuclear arena (U.S. Department of Energy, 1994a).

**Inadequate Personnel Resources for Maintenance.** No amount of predictive or preventive maintenance will be effective unless a trained maintenance force is available. One review by the Board's staff disclosed that insufficient maintenance resources were being committed to supporting confinement ventilation systems (Zavadoski, 1997). As a result of these findings, additional maintenance personnel were assigned to the facility on a full-time basis. Generally, however, DOE has not analyzed the required staffing levels for maintenance programs involving confinement ventilation systems at other DOE facilities, except for sites where Operational Readiness Reviews have recently been conducted.

**Inadequate Technical Direction.** Strong technical direction of activities involving confinement ventilation has not been provided by DOE. The technical expertise that does exist is almost exclusively within the contractors' ranks. The spectrum of ongoing problems—from firefighting strategies, to filter wetting, to binding of filters due to collected smoke particles, to the need for adequate test facilities—is indicative of a lack of adequate senior management attention to this subject.

## 3.2 REPRESENTATIVE EXAMPLES OF AREAS NEEDING IMPROVEMENT

There is long-standing evidence of inadequate preservation programs involving confinement ventilation systems. The history summarized here demonstrates that improvements based on past experience have not been effective; rather, problems associated with these vital protective systems continue to emerge with distressing frequency, further exacerbating the situation. The examples cited in this section were gleaned from more than 100 occurrences involving ventilation systems or functions associated with preservation programs that have been reported since mid-1998.

The fact that none of the examples cited here led to unacceptable consequences is due, in part, to the fortuitous changes in missions and the concomitant reduction in the pace of hazardous activities at the defense nuclear facilities involved. The releases resulting from the fires at Rocky Flats in the 1960s are examples of serious consequences resulting, in part, from inadequacies associated with confinement ventilation systems during the period when a significantly higher operational tempo existed. It should be noted, however, that many current mission activities associated with stabilization of hazardous legacy materials as well as with decontamination and decommissioning of defense nuclear facilities no longer required for national security will entail conditions that may present even greater challenges to confinement systems than those associated with original facility missions. These challenges emphasize the seriousness of the identified inadequacies and the importance of improving preservation programs aimed at ensuring the integrity of those systems.

It is appropriate to acknowledge that DOE accumulates a large amount of data in ORPS. In addition, a sophisticated database, the Occurrence Reporting Binned Information Trending Tool, is available, and is apparently used to categorize the occurrences reported. Both of these powerful tools were used by the Board's staff to accumulate the information provided here. However, the extent to which these tools are used effectively by DOE and contractor managers to identify and correct problems is subject to some question, as is evidenced by an apparent inability to effect real, enduring resolutions of recurring deficiencies.

Most of the following examples disclose the need for improvement in more than one aspect of sound formality of operations. Furthermore, the cited examples, while representative, reflect only a small fraction of the number of unusual occurrences that support the conclusions reached by the authors.

**Los Alamos National Laboratory Waste Management Facility.** In February 1999, personnel at the LANL Waste Management Facility failed to replace a HEPA filter when the differential pressure across the filter was found to exceed the value specified as part of the facility safety analysis documentation. Investigation disclosed that the filter had last been replaced in May 1996. The replacement followed a related occurrence in March 1995, in which a DOE Facility Representative discovered that operating personnel had been recording the wrong gauge readings. Corrective action for this occurrence included an administrative requirement that the differential pressure across the filter be recorded daily and the logged readings reviewed by supervisory personnel. Logged entries from October 22, 1997, through February 3, 1999, exceeded the prescribed limit by at least a factor of four, but no investigative action was taken until the February 1999 occurrence was reported.

The extended period during which deficient conditions were recorded placed the ventilation system at risk of filter breakthrough. It also demonstrated the need for compliance with procedures for recording and monitoring of such parameters and for remediation of out-of-tolerance findings—all parts of an acceptable conduct of operations program. The fact that no release of radioactive material occurred was fortuitous.

**Los Alamos National Laboratory Chemistry and Metallurgy Research Facility.** When the Chemistry and Metallurgy Research (CMR) Facility began operation in 1952, automatic duct washdown systems to remove perchlorate salts and other chemical and radioactive byproducts that had condensed or settled on duct surfaces were installed in the exhaust ventilation systems for selected wings of the facility. Perchlorate salts can form percussion explosives when combined with impurities. They are also strong oxidizers that can promote fast-burning fires that could ignite the HEPA filter medium within the plenum. Over time, rust and other corrosion products from within the piping clogged the spray nozzles in the washdown systems, and because of inadequate maintenance, those systems began to fail.

During the decades since then, acid fuming operations continued, and perchlorate salts continued to accumulate within the exhaust ductwork. A comprehensive engineering study performed in 1983 concluded that these systems, as well as several others, needed replacement. None of these renovations were performed, and although the duct washdown systems and other aging systems were failing, all normal operations (including perchloric acid fuming) continued within the facility. A number of engineering studies in this period attested to the presence of perchlorates in the ducts and the need for refurbishment, but no substantive action was taken to correct the problem.

In late 1997, perchlorate salt residues were identified on surfaces within the exhaust plenum for one of the ventilation system fans during inspection of the turning vanes inside the plenum. At this time, facility management did perform a formal evaluation of an Unreviewed Safety Question, which revealed that specific accidents involving the perchlorate salt residues in the ductwork (i.e., a fire scenario involving the HEPA filter) had never been formally analyzed at CMR.

These conditions clearly demonstrate that although the facility's duct washdown systems, designed and installed to minimize perchlorate salt residue, were known to be either partially or completely inoperable for more than 20 years, no controls were developed and implemented for the operation and maintenance of these systems. This occurrence also shows inattention to potentially serious hazards and the effects of delaying or canceling needed improvements on the basis of budgetary or other administrative constraints.

A postscript to this episode occurred in early 1999 when it was discovered that perchloric acid fuming operations were being conducted in a hood that did not have an installed engineered washdown system, using compensatory measures specified in a work authorization package approved in late 1997. The approved interim technical safety requirement (ITSR), developed in December 1998, provided for no exception to the requirement that the hood washdown system be operable and in service for ventilated hoods where perchloric acid fuming is performed. The surveillance requirement associated with this ITSR also required an operational test of the hood washdown system before perchloric acid fuming was performed in a ventilated hood. Personnel conducting the operation had not yet been trained in the ITSR and were unaware of the new requirements when they conducted perchloric acid fuming twice during January 1999. This latter occurrence demonstrates the need for prompt training of operating personnel when changes in safety requirements are instituted, and the importance of careful and thorough work planning for all operations involving potentially hazardous activities.

**West Valley Demonstration Project.** In April 1999, during an in situ leak test of the filters installed in a confinement ventilation system at the West Valley Demonstration Project, flame was observed at the discharge port of the thermal aerosol generator placed in the system duct upstream of the HEPA filters to generate small particles used to challenge the leak tightness of the system. As discussed earlier, fire in a confinement ventilation system is a potentially serious situation. Thus, although this occurrence had no adverse effect on the integrity of the system under test, it demanded careful evaluation to prevent a recurrence.

The test, which had been performed successfully 13 times since the first of the year, involved an aerosol generating device that heats a synthetic hydrocarbon, polyalphaolefin (PAO), to an elevated temperature in a nitrogen atmosphere. The heated PAO then disperses into suitably sized droplets in an aerosol injected into the duct upstream of the HEPA filter. The concentration of these particles is measured both upstream and downstream of the filter installation to determine filter efficiency.

The PAO challenge aerosol used for this test had been selected as a replacement for the formerly used di-octyl phthalate (DOP), which has been identified as a mild carcinogen. The autoignition temperature of PAO is lower than that of DOP (650°F versus 735°F). The aerosol generator used is designed to maintain a constant, nonadjustable temperature of 720°F in an oxygen-free environment, provided a prescribed sequence of valve manipulation is followed.

Several years earlier, the manufacturer of the aerosol generator had revised the sequence of valve manipulation to accommodate the change from DOP to PAO, but the West Valley operating staff had not made commensurate changes in the procedures for conducting the test, assuming erroneously that the recommended changes were simply editorial in nature. This error established conditions that ultimately led to the observed flame. This occurrence demonstrates the importance of maintaining a vigorous configuration management program that accommodates changes in equipment operating procedures necessitated by alterations in the materials used for this kind of testing.

Investigation of this occurrence disclosed at least four earlier related occurrences. The earliest of these took place at the Hanford Site in January 1992, when PAO was substituted for DOP as the challenge aerosol before DOE had approved its use. Subsequently, at the same Hanford facility in April 1993, a small fire was observed in several sections of plastic tubing leading from the aerosol generator to the upstream vicinity of the HEPA filters. This fire was found to have been caused by refilling the generator with liquid PAO without shutting it down. This action interrupted the flow of nitrogen to the generator, leading to ignition of the PAO.

Clearly, recent increased awareness of previously unanalyzed hazards from fires and correction of safety analyses to account for these occurrences is a positive development. Nevertheless, failure to recognize the potentially adverse effects of conditions that could lead to compromise of the integrity of confinement ventilation systems for such an extended period calls into question the adequacy of the original safety analyses, as well as the ongoing assessment of those analyses.

DOE's own evaluation, conducted as part of its review of this occurrence, identified 98 complex-wide instances in which discrepancies in Safety Analysis Reports had resulted in degradation of safety status; 65 percent of these instances involved management problems. The extremely long time that elapsed before the problems were recognized and the number of complex-wide discrepancies in safety analyses identified as a result of the investigation serve as clear evidence of a pervasive and long-standing lack of management attention.

**Savannah River Site.** Recent occurrences at the Savannah River Site (SRS) provide evidence of inadequacies in the contractor's instrument calibration program, while also illustrating the effects of an inadequate configuration management program.

In an occurrence at the HB-Line facility in March 1999, operators found that a pressure switch was frequently failing its calibration check. This switch provided indication of the canyon tunnel vacuum and was classified as safety-significant. Investigation disclosed that the design engineering group had selected an improper pressure switch for use in this system. The required vacuum in the canyon tunnel is -0.2 inches water column. The installed switch had an operating range of -0.2 to -1.0 inches water column, clearly an inappropriate range for this parameter.

A similar occurrence was recorded at the H-Canyon facility in November 1999. This occurrence involved several safety-class vacuum pressure switches that measure canyon vacuum, control canyon exhaust, supply fans, and low-vacuum alarms. As an example, stand-by canyon exhaust fans are required to start when vacuum drops to $-1.00 \pm 0.03$ inches of water. The installed switches were operating outside of this desired range, and facility personnel had difficulty calibrating the switches so that they would remain within tolerance. Upon contacting the manufacturer, the contractor learned that the switches may be overly sensitive to atmospheric conditions such as temperature fluctuations. This factor was not carefully considered by engineering personnel during selection of the switches.

Several other occurrences at SRS indicate poor pre job planning, inadequate job hazard analyses, or simply inattention to detail by maintenance workers. These occurrences include the following:

- While wiping down the control panel of the #1 diesel generator, an Auxiliary Systems Operator inadvertently snagged a control panel switch with his rag, placing the diesel in the idle setting, securing the operating canyon exhaust fan, and causing the standby exhaust fan to start.

- The safety-class interlock for low vacuum in the H-Canyon exhaust duct was activated when a construction worker bumped the on/off button on the #1 exhaust fan control panel, causing the canyon supply fans to shut down as a result of the momentary interruption of the power to the #1 exhaust fan.

- The air supply for the HB-Line facility was secured when a safety-class interlock was inadvertently activated. A maintenance worker accidentally tripped an energized electrical breaker while racking out an adjacent breaker for replacement. The loss of power caused the ventilation dampers to reposition and activated the interlock.

**Rocky Flats Environmental Technology Site.** Ventilation systems installed in Buildings 371 and 707 at the RFETS are subject to the triggering of numerous alarms in a short time period. During a review conducted in the fall of 1999, the Board's Site Representatives observed that the alarm system monitoring software in Building 371 provides clear discrimination of those alarms directly related to safety basis requirements, whereas the alarm system in Building 707 lacks this capability. The RFETS contractor is now in the process of upgrading the alarm system in Building 707, but this action was initiated only after the matter had been pointed out by the Board's staff, thus calling into question the effectiveness of the contractor's own program for applying lessons learned at one facility to other facilities exhibiting similar characteristics.

# 4. AGE AND MISSION LIFE OF FACILITY INFRASTRUCTURE

As shown in Appendix B, many of the important confinement ventilation systems called upon for protection of the public, workers, and the environment at DOE's defense nuclear facilities represent an aging infrastructure. This situation demands increased attention to preservation programs or upgrades to, or replacements of, critical structures, systems, and components. In determining the appropriate course of action for each facility, consideration of the remaining mission life is essential. Steps need to be taken to ensure that preservation programs are sufficiently robust to compensate for age-related losses of reliability and availability. At some point, a decision must be made as to whether an aging system with significant remaining mission life can continue to be relied upon with enhanced preservation efforts, or substantial upgrading or outright replacement of a degraded infrastructure is prudent.

The following subsections present examples of the effects of aging on structures, systems, and components of confinement ventilation systems and the actions taken to address these effects.

**Lawrence Livermore National Laboratory.** Safety-class exhaust ducting in the loft of Building 332 at Lawrence Livermore National Laboratory has several circumferential cracks as the result of intergranular stress corrosion cracking. The cracks have been repaired using a rubber-like composite substance held in place with metal sheeting. Analysts have concluded that the repair renders the duct capable of withstanding design basis accidents.

A Technical Safety Requirement calls for periodic inspection of the ducting for "...new cracks or enlargement of existing cracks." Further, it specifies that the "...ducting ...shall be inspected for potential leaks and structural integrity periodically and after earthquakes." If the functional requirements and performance criteria for the glovebox exhaust system cannot be met, normal glovebox operations must be suspended, or compensatory measures must be taken to ensure safe operation. However, the associated administrative controls have no provisions for determining crack growth, structural integrity, or potential leaks.

**Savannah River Site.** The age and deteriorating nature of much of the equipment and many of the facilities at the SRS complicate the maintenance of confinement ventilation systems. Old equipment and facilities require additional time, money, and personnel for increasing levels of routine and preventive maintenance, as indicated by the following occurrences during the past year:

- H-Canyon engineering and maintenance personnel identified a 3-foot-long split in the canyon exhaust fan discharge duct. The split was located downstream of the filters but upstream of the stack monitors. The contractor estimates that repairs to this duct and other ventilation system components will take more than a year to complete.

- Contractor personnel discovered evidence of ventilation system degradation in the exhaust plenums and sand filters serving the SRS canyons. Two failure mechanisms were identified. First, the inlet plenum to the H-Canyon stack, at the transition from metal duct to concrete, has holes in the concrete that allow a small portion of the exhaust (estimated to be less than 1 percent) to bypass the stack and stack monitoring system. The leakage path is downstream of the sand filters and thus is not a release path under normal conditions. The F-Canyon stack is similarly affected.

Second, acid fumes appear to have etched away the concrete over large exposed areas of the roof, walls, and columns inside the new F-Canyon sand filter (built in the mid-1970s).

**Rocky Flats Environmental Technology Site.** At RFETS in July 1998, during routine surveillance of pressure differential indicating devices, a digital readout was not visible and could not be used to verify the existence of the appropriate differential pressure. Although at the time, the operating engineer did not take the actions called for by the authorization basis, a supervisor later noted the problem and did take appropriate actions. Subsequent evaluation revealed that the failure of this device was a previously known problem. RFETS engineers had decided to not replace the deficient equipment since it was believed that indications of failure would be noted before total failure occurred. However, operators were apparently not sensitive to the need to be alert for such precursor indications; thus differential pressures may have been incorrect, and confinement could conceivably have been compromised.

In August 1998, at another of the aging facilities at RFETS, an interlock designed to ensure that supply fans do not operate when the exhaust fans are not operating has had a history of periodic, unplanned activation. Troubleshooting of the system failed to identify the cause. Faulty activation of the system leads to shutting down the supply fans while the exhaust fans continue to run, establishing minimum ventilation conditions in the building. While this is an analyzed condition in the authorization basis documents, such aging safety equipment requires increased vigilance to ensure that unacceptable conditions do not occur. It was noted that funding was not allocated for extensive repair or replacement of this equipment.

**F- and H-Canyon Exhaust Upgrades.** When critical mission needs necessitate continued operation of an aging system or facility under degraded conditions, rigorous adherence to robust preservation programs is necessary to ensure that the public, workers, and the environment continue to be protected. Where warranted, system or facility upgrade or replacement needs to be considered, as demonstrated in the following example:

The SRS canyon exhaust systems are critical components for worker safety, and as such, they must be highly reliable to provide required contamination control for protection of workers and the environment. The existing canyon exhaust system equipment is nearing the end of its design life, resulting in degraded system performance and reliability. As the equipment begins to fail, facility operations are impacted. These failures necessitate more frequent maintenance. The canyon exhaust upgrade project is intended to enable the facilities to meet the demands of their mission by providing minimal facility upgrades needed to meet system reliability requirements and prevent curtailment of operations when equipment malfunctions occur. The project will replace electrical and mechanical equipment associated with the exhaust systems in both F- and H-Canyons at SRS, including diesel generators and associated components, diesel fuel tanks, motor control centers, exhaust fans, and motors. This project is also intended to resolve safety issues concerning the safety-class power systems.

## APPENDIX A. SAFETY SYSTEM PRESERVATION PROGRAMS

The following programs, described in detail in the references cited in Section 2 of this report, apply to all systems important to safety. They are particularly pertinent to the subject of this report, and are discussed here in that context.

**Conduct of Operations.** Provisions for operational control, staff qualifications, development and implementation of appropriate procedures, monitoring of equipment status, deficiency reporting, and feedback are normally associated with the term "conduct of operations." Effective conduct of operations requires that all changes to the operational status of any piece of equipment in the confinement system be made only by well-trained and formally qualified individuals who (1) perform work with the proper discipline, (2) are well aware of the current and projected system status, (3) follow approved written procedures, (4) communicate any such changes to facility management, and (5) document the changes. Any deviation from an expected response should set formal processes in motion for determining what went wrong, identifying potential corrective actions, and feeding back information concerning the analysis.

**Configuration Management.** The purpose of a vigorous configuration management program is to ensure that when changes to a system are made, the integrity of design features, safety analyses, and operating procedures is maintained, and the changes are adequately documented. Failure to implement a strong configuration management program inevitably leads to questionable physical changes to affected systems, loss of fidelity in operating procedures, and lapses in compliance with procedures.

Allowing hardware problems to remain unrectified or temporary solutions to remain in effect for extended periods with no long-term resolution in sight obviously can also affect the integrity of ventilation systems (U.S. Department of Energy, 1993). Without adequate configuration management, it is virtually inevitable that the integrity of ventilation systems will be compromised. An old facility for which a configuration management program has been either absent or poorly executed in the past often requires a difficult and costly program to reestablish a technical baseline, including preparation of accurate drawings and system descriptions against which necessary changes can be assessed.

Operation within the safety envelope requires a strong configuration management program that preserves the integrity of the purpose of the original design, including control over replacement parts and materials (U.S. Department of Energy, 1994a). An effective configuration management program must also take into consideration the service life of substituted items (Fretthold et al., 1997). As a facility ages, configuration management inevitably becomes more difficult; it also becomes more important that any changes be fully understood before being implemented (U.S. Nuclear Regulatory Commission, 1991).

**Maintenance.** A vigorous maintenance program staffed with trained and qualified personnel who are guided by technically accurate and proven written procedures is another crucial element for the reliable performance of any confinement system. The program must provide for both predictive and preventive maintenance. A comprehensive maintenance history must be readily available and consistently reviewed. An effective maintenance program includes strong critique and feedback provisions to enhance learning from past experience, and is integrated into the day-to-day work planning function (Defense Nuclear Facilities Safety Board, 1997b). The work planning function should incorporate key verification steps, and the requirements of applicable safety documentation, the conduct of operations program, the maintenance program, resources, support services, configuration management, and procurement practices should be integrated into planning for safe execution of maintenance activities (U.S. Department of Energy, 1993). A single chain of authority and responsibility for control of all maintenance activities, from the facility manager to workers on the floor, needs to be clearly delineated; no maintenance tasks should be performed without the knowledge and approval of senior facility management.

A maintenance program that merely reacts to breakdowns without anticipating them runs counter to acceptable formality of operations (U.S. Department of Energy, 1994a). Yet this is the very type of maintenance that is most visible throughout the defense nuclear complex. Predictive and preventive maintenance programs, hallmarks of acceptable maintenance programs in the nuclear industry (Institute for Nuclear Power Operations, 1990), appear to be in their infancy for confinement ventilation systems at DOE's defense nuclear facilities. Maintenance history programs, too, appear to be quite rudimentary at these facilities.

**Testing and Surveillance.** Testing and surveillance programs provide assurance that a system will perform as expected when called upon. These programs also ensure that key parameters and assumptions used in safety analyses will remain valid and within acceptable levels (U.S. Department of Energy, 1993, 1997).

**Training and Qualification.** Operation, maintenance, testing, and surveillance activities must be conducted by trained and qualified personnel in accordance with written procedures that reflect the actual configuration of the system. Results of these activities should be reviewed routinely by the operations staff to confirm that the mode of operation continues to be appropriate (U.S. Department of Energy, 1992a). Special training may be required when periodic tests could compromise confinement integrity; for example, unique skills are required when field leak tests and bypass leak tests are conducted on filters installed in confinement ventilation systems.

**Technical Review and Oversight.** Technical review and oversight are necessary to ensure that the boundaries of the safety envelope have not been violated. This element is particularly crucial when older equipment is involved. Assessments of equipment functionality need to be performed more frequently and proactively for operations involving older equipment in unique configurations or situations. Another element of the technical review program should be aimed at ensuring that in-place programs continue to perform as expected. This review must be constant, ongoing, objective, and independent. It should not duplicate internal programmatic reviews that provide feedback to individual programs. Rather, it must provide a broader review of the integrated functioning of all programs, with specific emphasis on shortcomings that impede the safe accomplishment of the facility's mission (Defense Nuclear Facilities Safety Board, 1997b).

## APPENDIX B. CONFINEMENT VENTILATION SYSTEM DATA

As noted in Section 1.1, this report focuses on the original priority facilitates identified in DOE's Implementation Plan for the Board's Recommendation 95-2, Safety Management. This appendix provides salient information for these facilities and their ventilation systems in Table B-1.

The aging infrastructure prevalent in today's defense nuclear complex is underscored by the data in the table—the overwhelming majority of facilities are from 30 to more than 50 years old. Many of these facilities have a long-term remaining mission life (i.e., more than 10 years). Although some infrastructure replacements and upgrades are planned, these are not necessarily consistent with current out-year funding profiles for the sites. An exception is the SRS Canyon Upgrade Project, discussed in Section 4 of this report.

Table B-1 also notes where facilities have confinement ventilation systems and identifies those systems designated as safety-class or safety-significant. Additional comments are provided in those instances where no confinement ventilation systems exist or where these systems are not designated as safety-class or safety-significant.

# Table B-1. Confinement Ventilation System Data

| Facility/Activity | Authorization Agreement in Place (Date)? | Confinement Ventilation System (CVS)? | Safety-class or Safety-significant in Authorization Basis? | Approximat e Age (years) | Remaining Mission Life 10 Years? | Replacement/ Upgrade Planned? | Comments |
|---|---|---|---|---|---|---|---|
| **1. Lawrence Livermore National Laboratory Superblock** | | | | | | | |
| Bldg. 332, Plutonium Facility | Yes (1/28/99) | Yes | Safety-class | 38 | No | No | |
| Bldg. 334, Weapon Design and Testing Facility | Yes (1/28/99) | Yes | No | 12 | No | No | Presently a Category 3 facility, but under evaluation for upgrade to Category 2. |
| Bldg. 331, Tritium Facility | Yes (1/28/99) | No | No | 41 | No | No | Category 3 tritium facility. |
| **Los Alamos National Laboratory** | | | | | | | |
| 2. Technical Area-55, Bldg. 4, Plutonium Facility | Yes (1/8/99) | Yes | Safety- significant | 21 | No | Yes (long-term) | |
| 3. Technical Area-3, Bldg. 29, CMR Facility | Yes (1/8/99) | Yes | Safety- significant | 47 | No (11 years) | Yes | |
| **4. Oak Ridge Y-12 Plant** | | | | | | | |
| Bldg. 9212, Wet Chemistry, Casting, Storage | Yes (5/15/98) | Yes | No | 51 | Yes | Replacement by modernization (RBM) 3rd priority | Has been downgraded in its significance to safety, using evaluation guidelines as criteria. |

## Table B-1. Confinement Ventilation System Data (Continued)

| Facility/Activity | Authorization Agreement in Place (Date)? | Confinement Ventilation System (CVS)? | Safety-class or Safety-significant in Authorization Basis? | Approximate Age (years) | Remaining Mission Life 10 Years? | Replacement/ Upgrade Planned? | Comments |
|---|---|---|---|---|---|---|---|
| Bldg. 9206, Enriched Uranium Chemical Processing | No (Expected Jan., '00) | No | No | 54 | Yes | No | Building not designed with CVS because of its perceived low operational risk.[3] |
| **4. Oak Ridge Y-12 Plant (Continued)** | | | | | | | |
| Bldg. 9720-5, Warehouse Operations | Yes (4/6/98) | No | No | 55 | Yes | RBM 1st priority | Building not designed with CVS because of its **perceived low operational risk**.[3] |
| Bldg. 9204-2E, Disassembly Operations | Yes (4/6/98) | No | No | 31 | No | RBM 4th priority | Building not designed with CVS because of its perceived low operational risk.[3] |
| Bldg. 9204-4, Quality Evaluation | Yes (4/6/98) | No | No | 51 | Yes | RBM 4th Priority | Building not designed with CVS because of its perceived low operational risk.[3] |
| Bldg. 9215, Special Nuclear Material Processing and Fabrication | Yes (5/15/98) | No | No | 41 | Yes | RBM 3rd priority | Original of the Building design did not have CVS. Recently, HEPA filters have been installed but are not operational because the authorization basis does not require them to be safety systems. |
| **5. Pantex Plant** | | | | | | | |

[3] The recent authorization basis upgrade program indicates that this building does not need a safety-class CVS because the evaluation guideline of 25 rem is used as a criterion for identification of safety–class systems. In fact, the analyses indicate there is no need for any safety-class systems.

## Table B-1. Confinement Ventilation System Data (Continued)

| Facility/Activity | Authorization Agreement in Place (Date)? | Confinement Ventilation System (CVS)? | Safety-class or Safety-significant in Authorization Basis? | Approximate Age (years) | Remaining Mission Life  10 Years? | Replacement/ Upgrade Planned? | Comments |
|---|---|---|---|---|---|---|---|
| Zone 12, Nuclear Explosive Bays and Cells | Yes | No[4] | N/A | 20-50 | No | No | Authorization agreements will be approved for specific weapon activity. |

[4] Cells are equipped with blast valves and dirt overburden; blast valve confine the material to the cells, and overburden provides filtration of the releases from an explosion. Bays are equipped with inlet HEPA filters and dirt overburden; HEPA filters protect the workers in the unaffected bays, and overburden provides some filtration of the releases from the affected bay.

## Table B-1. Confinement Ventilation System Data (Concluded)

| Facility/Activity | Authorization Agreement in Place (Date)? | Confinement Ventilation System (CVS)? | Safety-class or Safety-significant in Authorization Basis? | Approximat e Age (years) | Remaining Mission Life 10 Years? | Replacement/ Upgrade Planned? | Comments |
|---|---|---|---|---|---|---|---|
| **Hanford Site** | | | | | | | |
| 6. K-Basins | Yes (9/24/98) | No | N/A | 45-50 | Yes | No | |
| 7. Tank Farms | Yes (7/24/98) | Yes | Safety-class | 30-50 | | Yes (limited scope) | |
| **Rocky Flats Environmental Technology Site** | | | | | | | |
| 8. Bldg. 371, Plutonium Chemical Processing Facility | Yes (9/11/97) | Yes | Safety-class | 19 | Yes | No | |
| 9. Bldg. 771, Plutonium Recovery Facility | Yes (12/31/97) | Yes | Safety-class | 47 | Yes | No | |
| **10. Savannah River Site Canyons** | | | | | | | |
| F-Canyon | Yes (9/9/97) | Yes | Safety-class | ~45 | Yes | Part of Canyon Upgrade Project | |
| FB-Line | Yes (9/26/97) | Yes | Safety-class | ~45 | Yes | Part of Canyon Upgrade Project | |
| H-Canyon | Yes (8/1/97) | Yes | Safety-class | ~45 | Yes | Part of Canyon Upgrade Project | |
| HB-Line | Yes (3/19/98) | Yes | Safety-class | ~45 | Yes | Part of Canyon Upgrade Project | |

## GLOSSARY OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| Board | Defense Nuclear Facilities Safety Board |
| CMR | Chemistry and Metallurgy Research |
| CVS | Confinement Ventilation System |
| DOE | Department of Energy |
| DOP | di-octyl phthalate |
| HEPA | high-efficiency particulate air |
| ITSR | Interim Technical Safety Requirement |
| LANL | Los Alamos National Laboratory |
| ORPS | Occurrence Reporting and Processing System |
| PAO | polyalphaolefin |
| RBM | Replacement by Modernization |
| RFETS | Rocky Flats Environmental Technology Site |
| SAR | Safety Analysis Report |
| SRS | Savannah River Site |

# REFERENCES

## REFERENCES CITED

American Society of Mechanical Engineers, 1989, *Testing of Nuclear Air Treatment Systems*, ASME N510-1989, New York, NY, December 15.

Burchsted, C. A., J. E. Kahn, and A. B. Fuller, 1976, *Nuclear Air Cleaning Handbook*, ERDA 76-21, Energy Research and Development Administration, Washington, D.C.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 1995, Letter to H. R. O'Leary, Secretary, U.S. Department of Energy, concerning observations made at plutonium processing facilities and forwarding DNFSB/TECH-3, Washington, D.C., June 15.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 1997, Letter to F. F. Peña, Secretary, U.S. Department of Energy, concerning ventilation systems at the Rocky Flats Environmental Technology Site, Washington, D.C., October 30.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 1998, Letter to V. H. Reis, Assistant Secretary for Defense Programs, U.S. Department of Energy, concerning Enriched Uranium Operations restart at the Y-12 Plant, Oak Ridge, Tennessee, Washington, D.C., January 30.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 1999, Letter to T. J. Glauthier, Deputy Secretary, U.S. Department of Energy, concerning the provisions of DOE Order 420.1, *Facility Safety*, Washington, D.C., July 8.

Defense Nuclear Facilities Safety Board, 1995a, *Overview of Ventilation Systems at Selected DOE Plutonium Processing and Handling Facilities*, DNFSB/TECH-3, Washington, D.C., March 20.

Defense Nuclear Facilities Safety Board, 1995b, *Fundamentals for Understanding Standards-Based Safety Management of Department of Energy Defense Nuclear Facilities*, DNFSB/TECH-5, Washington, D.C., May 31, 1995, p 11.

Defense Nuclear Facilities Safety Board, 1995c, *Safety Management and Conduct of Operations at the Department of Energy's Defense Nuclear Facilities*, DNFSB/TECH-6, Washington, D.C., October 6.

Defense Nuclear Facilities Safety Board, 1997a, *Operational Formality for Department of Energy Nuclear Facilities and Activities*, DNFSB/TECH-15, Washington, D.C., March.

Defense Nuclear Facilities Safety Board, 1997b, *Integrated Safety Management*, DNFSB/TECH-16, Washington, D.C., June.

Defense Nuclear Facilities Safety Board, 1999, *HEPA Filters Used in the Department of Energy's Hazardous Facilities*, DNFSB/TECH-23, Washington, D.C., May.

Fretthold, J. K., A. R. Stithem, and R. M. Suyama, 1997, *Evaluation of HEPA Filter Service Life*, RFP-5141, Rocky Flats Environmental Technology Site, July 14.

Institute for Nuclear Power Operations, 1990, *Maintenance Programs in the Nuclear Power Industry*, INPO 90-008, Revision 01 (General Distribution), Atlanta, GA, March.

O'Leary, H. R., Secretary, U.S. Department of Energy, 1996, Letter to J. T. Conway, Chairman, Defense Nuclear Facilities Safety Board, concerning the *Plutonium Ventilation System Study Report*, with commitments and schedules, Washington, D.C., March 15.

Owendoff, J. M., Acting Assistant Secretary for Environmental Management, U.S. Department of Energy, 1998, Letter to J. T. Conway, Chairman, Defense Nuclear Facilities Safety Board, concerning resolution of the inconsistencies pointed out in the March 26, 1998, letter from the Board, Washington, D.C., April 27.

Roberson, J. M., Manager, Rocky Flats Field Office, U.S. Department of Energy, 1997, Memorandum to A. L. Alm, Assistant Secretary for Environmental Management, concerning transmittal of *Assessment of Confinement System Bypass Leakage at Plutonium Facilities Report, Rev. 2*, March 3.

U.S. Atomic Energy Commission, 1973, *AEC Manual*, Chapter 6301, "General Design Criteria," AEC-6301-01.CONS, Washington, D.C., February 7.

U.S. Department of Energy, 1992a, *Nuclear Safety Analysis Report*, DOE Order 5480.23, Washington, D.C., April 30.

U.S. Department of Energy, 1992b, *Conduct of Operations Requirements for DOE Facilities*, DOE Order 5480.19, Chg. 1, Washington, D.C., May 18.

U.S. Department of Energy, 1993, *Guide for Operational Configuration Management Program*, DOE STD-1073-93, Washington, D.C., November.

U.S. Department of Energy, 1994a, *Maintenance Management Program*, DOE Order 4330.4B, Washington, D.C., February 10.

U.S. Department of Energy, 1994b, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, DOE Order 5480.20A, Washington, D.C., November 15.

U.S. Department of Energy, 1994c, *Airborne Release Fractions/Rates and Respirable Fractions for NonReactor Nuclear Facilities*, DOE-HDBK-3010-94, Washington, D.C., December.

U.S. Department of Energy, 1995a, *Facility Safety*, DOE Order 420.1, Chg. 1, Washington, D.C., November 16.

U.S. Department of Energy, 1995b, *Implementation Guide for Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria* (draft), DOE G 420.1-X, Revision G, Washington, D.C., September.

U.S. Department of Energy, 1997, *Specification for HEPA Filters Used by DOE Contractors*, DOE-STD-3020-97, Washington, D.C., January.

U.S. Nuclear Regulatory Commission, 1991, *Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants*, Final Rule 10 CFR 50.65, Washington, D.C., July 10.

Zavadoski, R., 1995, *Review of Selected Ventilation Systems at Oak Ridge's K-25, Oak Ridge National Laboratory and Y-12 Facilities*, Trip Report, Defense Nuclear Facilities Safety Board, Washington, D.C., July 11–13.

Zavadoski, R., 1997, *Review of Ventilation Systems at Rocky Flats Environmental Technology Site*, Trip Report, (forwarded to Secretary of Energy, October 30, 1997), Defense Nuclear Facilities Safety Board, Washington, D.C., August 11.

## OTHER REFERENCES

Alm, A. L., Assistant Secretary for Environmental Management, U.S. Department of Energy, 1998, Letter to J. T. Conway, Chairman, Defense Nuclear Facilities Safety Board, concerning the response to an October 30, 1997, letter regarding the ventilation systems at the Rocky Flats Environmental Technology Site, Washington, D.C., January 15.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 1995, Letter to T. P. Grumbly, Assistant Secretary for Environmental Management, U.S. Department of Energy, concerning ventilation systems at the Rocky Flats Environmental Technology Site, Washington, D.C., July 21.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 1998, Letter to F. Peña, Secretary, U.S. Department of Energy, concerning the January 15, 1998, response of A. L. Alm, Assistant Secretary for Environmental Management, Washington, D.C., February 9.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 1998, Letter to J. M. Owendoff, Acting Assistant Secretary for Environmental Management, U.S. Department of Energy, concerning inconsistencies in the A. L. Alm response to the January 15, 1998, letter, Washington, D.C., March 26.

Institute for Nuclear Power Operations, 1990, *Performance Objectives and Criteria for Operating and Near-term Operating License Plants*, INPO 90-015 (General Distribution), Atlanta, GA, August.

Klein, K. A., Deputy Manager for Technical Programs, U.S. Department of Energy, Rocky Flats Field Office, 1998, Letter to G. M. Voorheis, Vice President, Nuclear Operations, Kaiser-Hill Company, L.L.C. and A. M. Parker, Vice President, Closure Projects Integration, Kaiser-Hill Company, L.L.C., concerning Rocky Flats Field Office disposition of high-efficiency particulate air filter Unreviewed Safety Questions/issues, April 24.

Kouts, H. J. C. and J. J. DiNunno, 1995, *Safety Management and Conduct of Operations at the Department of Energy's Defense Nuclear Facilities*, DNFSB/TECH-6, Defense Nuclear Facilities Safety Board, Washington, D.C., October 6.

National Fire Protection Association, 1994, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* NFPA 25, Quincy, MA.

Nuclear Management and Resources Council, 1993, *Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Stations*, NUMARC 93-01, Revision 2, Washington, D.C.

U.S. Atomic Energy Commission, 1973, *General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants,* Regulatory Guide 3.12, Washington, D.C., August.

U.S. Department of Energy, 1989, *General Design Criteria,* DOE Order 6430.1A, Washington, D.C., April 6.

U.S. Department of Energy, 1991, *Unreviewed Safety Questions,* DOE Order 5480.21, Washington, D.C., December 24.

U.S. Department of Energy, 1995, *Independent Oversight Evaluation of Environment, Safety and Health Programs at the Rocky Flats Environmental Technology Site*, Office of Oversight and Office of Environment, Safety and Health, Washington, D.C., August.

U.S. Department of Energy, 1995, *Startup and Restart of Nuclear Facilities*, DOE Order 425.1, Chg. 1, Washington, D.C., October 26.

U.S. Department of Energy, 1997, *Oversight Followup Rocky Flats Environmental Technology Site*, Office of Oversight and Office of Environment, Safety and Health, Washington, D.C., August.

U.S. Nuclear Regulatory Commission, 1975, *General Design Guide for Ventilation Systems for Fuel Reprocessing Plants*, Regulatory Guide 3.32, Washington, D.C., issued for comment in September.

Zavadoski, R., 1993, *Trip Report on Ventilation/Filtration Systems in Buildings 371, 707 and 771 at the rocky Flats Plant*, (forwarded to Assistant Secretary for Environmental Management, February 1, 1994), Defense Nuclear Facilities Safety Board, Washington, D.C., November 9

Zavadoski, R., 1994, *Hanford--PFP Ventilation Systems Trip Report (May 24-26, 1994)*, Defense Nuclear Facilities Safety Board, Washington, D.C., June 30.