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DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

October 29, 2020

The Honorable Dan Brouillette
Secretary of Energy
US Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Brouillette:

Over the past year, the Defense Nuclear Facilities Safety Board has reviewed the management of high efficiency particulate air (HEPA) filters in the technical safety requirements at a number of facilities across the defense nuclear complex. These reviews have led to recurring concerns with the testing acceptance criteria and the use of HEPA filters as design features.

As noted in the enclosure to this letter, the acceptance criteria for HEPA filter testing at many facilities do not incorporate a conservative margin from the assumed mitigation value in the accident analyses. Also some facilities consider these filters—replaceable parts requiring frequent monitoring and annual or biannual testing—to be permanent design features. The Board is aware that the Department of Energy is revising directives related to nuclear air cleaning and is providing this information to you to aid the authors in developing the sections of these directives related to how to credit these systems in safety bases.

The enclosure is provided for your information and use.

Yours truly,

Thomas A. Summers

Thomas A. Summers
Acting Chairman

Enclosure

c: Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

May 22, 2020

Management of High Efficiency Particulate Air Filters in the Safety Bases

Summary. A Defense Nuclear Facility Safety Board (Board) staff review team reviewed how Department of Energy (DOE) defense nuclear facilities credit high efficiency particulate air (HEPA) filters in the technical safety requirements (TSRs). The review evaluated the safety bases for all major facilities under the Board's jurisdiction that credited HEPA filters as part of facility confinement. The Board's staff determined that the way HEPA filters are credited in some facility TSRs has not been consistent with DOE directives. The review team identified observations dealing with the adequacy of acceptance criteria for HEPA filter testing and the identification of HEPA filters as design features across the complex.

Background. Confinement is a major component of defense-in-depth for defense nuclear facilities and the Board has interacted with DOE on multiple occasions related to maintaining the integrity of confinement ventilation systems. These interactions include the following technical reports that were focused on confinement ventilation systems.

- Tech 3, *Overview of Ventilation System at Selected DOE Plutonium Processing and Handling Facilitie*s, March 20, 1995.

- Tech 23, *HEPA Filters Used in the Department of Energy's Hazardous Facilities*, June 8, 1999.

- Tech 26, *Improving Operation and Performance of Confinement Ventilation Systems at Hazardous Facilities of the Department of Energy*, February 1, 2000.

- Tech 34, *Confinement of Radioactive Materials at Defense Nuclear Facilities,* October 1, 2004.

The Board has also written many other technical reports dealing with the programmatic areas of standards, integrated safety management, quality, operation, and maintenance that are relevant to confinement ventilation systems. In addition, the Board has issued two Recommendations with significant impacts on the management of confinement ventilation systems.

- 2000-2, *Configuration Management, Vital Safety Systems.*
- 2004-2, *Active Confinement Systems.*

The Board's staff continues to review and evaluate how the complex continues to implement the concerns raised in these Recommendations and technical reports. As a part of these reviews, the Board's staff has identified two complex-wide observations on the management of confinement ventilation systems in the safety bases.

Discussion. The review team identified the following safety observations.

Acceptance Values for Filter Testing—Filter testing is conducted in accordance with commercial standards, e.g., American Society of Mechanical Engineers (ASME) Standard N510, *Testing of Nuclear Air Systems*. These standards identify that the acceptance criteria be specified in the test program or by the owner. DOE Handbook 1169, *Nuclear Air Cleaning Handbook*, identifies 99.95 percent filtration efficiency as the recommended acceptance value for testing HEPA filters.

The review team identified that the surveillance requirement values used across the complex vary and facilities do not consistently use the DOE Handbook 1169 recommended value. In several cases, facilities used the same values for testing as they credited in the mitigated analyses, without accounting for testing uncertainty and non-conservatisms with the testing methodology. That approach is inconsistent with DOE Guide 423.1-1B, *Implementation Guide for Use in Developing Technical Safety Requirements*. DOE could benefit from providing additional guidance on acceptable testing values and approaches for providing a technical basis for unique testing values. Appendix A of this report provides more information.

HEPA Filters as a Design Feature—The review team identified instances in which facilities have credited HEPA filters as design features in the TSRs. In cases where the confinement strategy uses a passive confinement approach instead of an active confinement ventilation system, the documented safety analysis (DSA) equates passive components with design features. This approach is not consistent with DOE's expectations for design features in Section 4.3.6 of DOE Guide 423.1-1B, where design features are defined as permanently installed features that do not require, or only infrequently require, maintenance or surveillance. HEPA filters typically require frequent monitoring of differential pressure, annual or biannual testing, and routine replacement based on a site's HEPA filter aging program. Appendix A of this report provides more information.

Conclusion. The review team notes that DOE is rewriting DOE Handbook 1169 and is drafting a standard to document requirements from the handbook consistent with DOE's directives program. In developing these documents, the Board's staff concludes that it would be beneficial if DOE provides additional details on the topics included in this report. Doing so would ensure that the directives will not only support the design of air cleaning systems but also provide guidance to safety basis authors on how the system should be credited to ensure that controls for the systems are commensurate with their ability to provide safety functions.

Appendix A: Evaluation of Crediting HEPA Filters in Safety Bases.

Acceptance Values for Filter Testing. In the course of recent reviews, the Defense Nuclear Facilities Safety Board's (Board) staff review teams have identified cases where the surveillance requirement acceptance criteria for high efficiency particulate air (HEPA) filters in the technical safety requirements (TSR) are the same values as those used in the mitigated dose consequence analyses.

The staff observed this situation at the Waste Isolation Pilot Plant (WIPP), the Device Assembly Facility (DAF) at the National Nuclear Security Site (NNSS), and Building 332 at Lawrence Livermore National Laboratory (LLNL). This practice is not consistent with DOE guidance on surveillance requirements. Department of Energy (DOE) Guide 423.1-1B, *Implementation Guide for Use in Developing Technical Safety Requirements*, states in Section 4.3.4, "Operating Limits & Surveillance Requirements":

> *When developing TSR limiting values or set points based on the DSA [documented safety analysis], the TSR developer should bear in mind that values in the DSA are generally the exact values at which something is assumed to happen. Because the values and set points in the TSR are measured and hence have some margin of error, TSR set points should be chosen on the conservative side of the DSA assumptions. The adjustments should account for calibration uncertainty, instrumentation uncertainty during operation and accident conditions, and instrument drift.*

HEPA filter testing has several areas of uncertainty that can impact test results, as identified in DOE Handbook 1169, *Nuclear Air Cleaning Handbook*, Section 8.10, "Review of In-Place Filter Testing at Selected DOE Sites":

> ***Uncertainty in In-place Filter Testing Results.*** *The issue of how such results are affected by measurement methods, system characteristics, and system abnormalities needs to be studied. Two principal conclusions emerged from these reviews. First, there was an immediate need to develop information on how filter mechanical integrity decreases with time, and to use this information to establish limits on filter service life. Second, there was a general need to ensure the validity of in-place filter testing results and to improve testing practices. A mathematical framework for describing the effects of abnormal system features on testing results was proposed as an aid in understanding the uncertainty in in-place filter testing results.*

In addition, the test aerosol particulate size is expected to introduce some uncertainty in the filtration efficiency. Both the manufacturer and DOE's independent filter test facility test the filters with a monodispersed 0.3 micron (*µm)* aerosol, approximately the maximum penetrating particle size for HEPA filters. This in-place testing performed in accordance with American Society of Mechanical Engineers (ASME) N510, *Testing of Nuclear Air Treatment Systems*, uses an aerosol with the following characteristics:

(a) Challenge aerosol (e.g., DOP [DiOctyl Phthalate] aerosol) for in-place leak testing of installed HEPA filter systems shall be a polydispersed liquid aerosol having an approximate light-scattering droplet size distribution as follows:

(1) 99% less than 3 µm diameter
(2) 50% less than 0.7 µm diameter
(3) 10% less than 0.4 µm diameter

This uncertainty becomes more pronounced when the DSA credits the particulate filtration range. For example, at WIPP the performance criteria is given as "filtration shall provide filtration efficiency of ≥ 99 percent when challenged with polydispersed aerosol particles with a diameter of 0.3–0.7 microns aerodynamic equivalent diameter." The N510 test aerosol can have more than 50 percent of the aerosol outside the range assumed by the performance criteria. Due to the mechanics of filtration, material outside the range will have a higher filtration efficiency, leading to potential for the 0.3 to 0.7 micron range particulate being filtered to have less efficiency than the overall test results.

A review of DOE Handbook 1169 does identify recommended values for HEPA filter testing acceptance criteria in section 8.6.1: "An acceptance criteria of 0.05 percent maximum leakage for the in-place system test is recommended for systems that are designed in accordance with this handbook." Also Section 2.5.2 states:

Accident analyses can typically assume a first stage credit of 99.9 percent efficiency for removal of plutonium aerosols. Second and subsequent stages typically assume an efficiency of 99.8 percent. These assumed efficiencies are based on the premises that:

(1) The HEPA filters have successfully been through the DOE Filter Test Facility (FTF);

(2) They are installed and in-place leak tested to at least 99.95 percent;

(3) They are installed in a system built to the specifications of AG-1; and

(4) They are tested in accordance with national standards.

The staff team conducted a review of how HEPA filters are credited in DSAs' mitigated accident analyses and TSRs' acceptance criteria. Table A-1 shows the results of this review. The credited confinement ventilation systems at the Los Alamos National Laboratory (LANL), the Y-12 National Security Complex (Y-12), and the Hanford Waste Treatment and Immobilization Plant (WTP) use the 99.95 percent acceptance criteria in their TSRs. A second category of facilities apply additional margin on their TSR acceptance criteria from the credited DSA value. A third category uses the same values for both. The final category does not identify a specific credited value and/or TSR acceptance criteria, typically in cases where the confinement is specified in the safety basis as a defense-in-depth feature but not relied on to meet specific dose reduction values.

Table A-1. *Values for HEPA filter credit in DSA mitigated analyses and TSR surveillance requirement acceptance criteria.*

Site and Facility	**Filter Safety Level**	**DSA or PDSA credit** (Percent)	**TSR Acceptance Value** (Percent)
Hanford 324 Building	Safety Significant (SS)	95 [A-1]	95 [A-2]
Hanford T-Plant	SS	99 [A-3]	99.5 [A-4]
Hanford Waste Receiving and Processing Facility	SS	99 [A-3]	99.5 [A-4]
Hanford WTP	Safety Class (SC)	99.5 [A-5] (2 Stages)	99.95 [A-5]
LANL TA-3-29 Chemistry and Metallurgy Research Facility	SS	Note 1 [A-6]	99.95 [A-7]
LANL TA-50-69 Waste Characterization Reduction and Re-packaging Facility	SS	Note 1 [A-8]	99.95 [A-9]
LANL TA-55 Plutonium Facility	SC	99.9 first stage 99 subsequent stages [A-10]	99.95 [A-11]
LLNL Building 332	SC	99.9 first stage 99.8 second stage [A-12]	99.9 first stage 99.8 second stage [A-13]
NNSS Draft DAF (DSA rewrite project)	SS	99.9 [A-14] Note 3	99.9 [A-15]
ORNL Transuranic Waste Processing Center	SS	99 [A-16]	99 [A-17]
Savanna River Site (SRS) Concentration, Storage, and Transfer Facilities	SS	99.5 [A-18]	99.5 [A-19]
SRS H Canyon Center Section	SS	97.78 [A-20]	98 [A-21]
SRS K-Area Complex	SS	99.5 [A-22]	99.5 [A-23]

SRS Salt Waste Processing Facility	SS	99 [A-24]	99 [A-25]
SRS Savannah River National Laboratory	SS	Note 1 [A-26]	99.5 [A-27]
SRS 235-F Facility E6 Inlet Filter	SS	Note 1 [A-28]	Note 4 [A-29]
WIPP Underground Ventilation System	SS	99 [A-30]	99 [A-31]
Y-12 Highly Enriched Uranium Materials Facility	SS	Classified document	99.95 [A-32]

Note 1: The accident analyses does not specifically credit mitigated dose reduction attributed to filter efficiency.
Note 2: The filtration is credited as a design feature.
Note 3: The currently implemented DAF DSA does not credit a filtration efficiency. In 2019 the staff reviewed a 90 percent draft of a DAF DSA revision and identified the credited filtration efficiency noted in the table. The staff also notes that the DSA revision is still in development, and that National Nuclear Security Administration's Nevada Field Office has not approved the confinement strategy presented in the draft that the staff reviewed.
Note 4: The filtration was previously covered as an administrative control but this control was deleted in the current revision of the TSRs as facility deactivation progresses.
TSR Acceptance value meets guidance in DOE Handbook 1169.
TSR Acceptance value has some margin.
TSR Acceptance value is the same value as the mitigation value.
No TSR Acceptance value is Provided.

HEPA Filters as a Design Feature. The review team identified instances where HEPA filters have been credited in the TSRs as design features. In cases where the confinement strategy uses a passive confinement approach instead of an active confinement ventilation system, DSA analysts appear to have equated passive components with design features. This approach is not consistent with DOE's expectations for design features in Section 4.3.6 of DOE Guide 423.1-1B:

> *Design Features (DFs) specify the inherent characteristics or qualities of an object or component required to protect the validity of the DSA accident analysis. DFs may be intrinsic characteristics—such as enrichment, neutron absorption, fire rating, and load capacity—or physical characteristics such as siting, berms, and fueling locations.*
>
> *DFs are normally passive attributes of the facility not subject to significant alteration by operations personnel. Examples of passive attributes include shielding, structural walls, relative locations of major components, installed reactivity poisons, or special materials. The DF section captures those permanently built-in features critical to safety that do not require, or infrequently require, maintenance or surveillance.*

HEPA filters are not permanently built-in features, but replaceable components based on loading or age. A HEPA filter requires frequent monitoring to ensure that the allowable differential pressure across the filter is not exceeded by filter loading or by a filter breach. In addition, a HEPA filter requires periodic testing to ensure that the filter efficiency criteria are being met. The Board's staff's review of all credited HEPA filter systems identified that the DAF at NNSS treat HEPA filters as design features. The facilities manage periodic filter efficiency testing either as an in-service inspection or a specific administrative control. In the case of the Sandia Pulse Reactor Facility, no TSR control deals with filter testing. In addition, prior to the February 2020 update to the safety basis, the SRS Building 235-F E6 HEPA filters were credited as part of the safety significant boundary, but were only managed as part of a HEPA filter administrative control program. This is in contrast to the SRS H-Canyon center section filters that provided a similar safety function. Those filters are managed by a limiting condition of operation.

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