NUREG-75/087

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 6.5.1 ESF FILTER SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Effluent Treatment Systems Branch (ETSB)

Secondary - Electrical, Instrumentation and Control Systems Branch (EICSB)
Accident Analysis Branch (AAB)

I. AREAS OF REVIEW

At the construction permit (CP) stage of review, ETSB reviews the information in the applicant's safety analysis report (SAR) in the areas listed below. At the operating license (OL) stage, the ETSB review consists of confirming the design accepted at the CP stage and evaluating the adequacy of the applicant's technical specifications in these areas. The specific review areas are as follows:

1. The engineered safety feature (FSF) air filtration units designed for fission product removal in post-accident environments. These generally include primary systems, e.g., recirculation (in-containment), and secondary systems, including standby gas treatment systems and the emergency air cleaning systems for the fuel handling building, control room, and shield building and areas containing engineered safety feature components.

2. The system design, design objectives and design criteria. The ETSB reviews the methods of operation and the factors that influence the filtration capabilities of the system, e.g., system interfaces and potential bypass routes. The components included in each atmospheric cleanup system and the seismic design category of each system are reviewed. Redundancy of the atmosphere cleanup systems, the physical separation of the redundant trains, and the volumetric air flow rate of each train are reviewed.

3. The environmental design criteria, the design pressure and pressure differential, integrated radiation dose rate, relative humidity, maximum and minimum temperature, radiation source term, and the shielding of essential services such as power and electrical control cables associated with the atmosphere cleanup systems.

4. The component design criteria and qualification testing, qualification requirements of demisters, prefilters, and high-efficiency particulate air (HEPA) filters, design requirements of the filter and adsorber mounting frames, system filter housings, and water drains, the adsorbent used for removal of gaseous iodines (in the preliminary safety analysis report, PSAR), the physical properties of the adsorbent and the

design of the adsorber section of the filter trains (in the final safety analysis report, FSAR). Provisions to inhibit offdesign temperatures in the adsorber section and the design criteria of the system fans or blowers, ductwork, and housings are also reviewed.

5. Design provisions incorporated in the equipment and features to facilitate operation and maintenance. The design of doors to the filter housings, the spacing of components, alignment and support of filter elements, the spacing of filter elements in the same bank, design of test probes, and provisions for adequate lighting in the filter housing are also reviewed.

6. The design criteria for inplace testing of the air flow distribution to the HEPA filters, dioctyl phthalate (DOP) testing of the HEPA filter sections, and gaseous halogenated hydrocarbon refrigerant testing of the activated carbon adsorber section.

7. The laboratory testing criteria for the activated carbon adsorbent, qualification and batch tests, provisions for obtaining representative adsorbent samples for laboratory testing in order to estimate the amount of penetration of the system adsorbent throughout its service life (PSAR), and the provisions and conditions for each field and laboratory test (FSAR).

The review of the ESF filter systems involves secondary review evaluations performed by other branches. The conclusions from their evaluations on request are used by ETSB to complete the overall evaluation of the facility. The evaluations provided by the branches are as follows:

EICSB reviews the associated instrumentation including the power supply and electrical distribution systems under Standard Review Plans (SRP) 3.11, 7.3, 7.5, and 8.2; AAB calculates the doses that result as a consequence of postulated accidents under the SRP for Chapters 6, 9, and 15 of the SAR.

II. ACCEPTANCE CRITERIA

The installed ESF filter systems are needed to mitigate the consequences of postulated accidents by removing from the atmosphere radioactive material that may be released in the event of an accident. ETSB will accept ESF filter systems if the following criteria are met:

1. Air filtration units should be designed so that they can operate after a design basis accident (DBA) and retain radioactive material after the DBA.

2. For the system design, ETSB will use the following guidelines for determining acceptability:

   a. Each atmosphere cleanup train should be able to prefilter the air, remove moisture ahead of charcoal adsorbers, and remove particulate matter by HEPA filters before and after the charcoal adsorbers.

   b. Redundancy of filter trains should be provided, with the trains physically separated so that damage to one system will not cause damage to the other system.

   c. All components should be designated as seismic Category I, if failure of the component would lead to the release of fission products.

   d. Individual trains should be limited to a volumetric air flow rate of 30,000 cfm.

   e. Each train should be instrumented to signal, alarm, and record pressure drop and flow rate at the control room.

3. For environmental design, ETSB will use the following guidelines to determine acceptability:

   a. Expected conditions for the filter trains, including maximum and pressure differential, radiation dose rate, relative humidity, and maximum and minimum temperature, should be based on the conditions in a postulated DBA.

   b. The radiation source terms should be consistent with the guidelines in Regulatory Guides 1.3, 1.4, and 1.25.

   c. Shielding should be provided for essential services such as power and electrical control cables associated with the atmosphere cleanup system.

4. For component design and qualification testing, ETSB will use the following guidelines to determine acceptability:

   a. The demisters should be designed in accordance with the recommendations of MSAR 71-45 (Ref. 7) and meet the Underwriters' Laboratory (UL) Class 1 requirements (Ref. 8).

   b. Moisture removal equipment should be capable of reducing the relative humidity of the incoming atmosphere from 100% to 70%.

   c. If prefilters are provided, they should meet UL Class 1 requirements and be listed in the current UL Building Materials List (Ref. 9).

   d. HEPA filters should be designed in accordance with the recommendations of MIL-F-51068 D (Ref. 10) and MIL-F-51079 B (Ref. 11).

   e. Filter and adsorber mounting frames should be designed, arranged, and constructed in accordance with the recommendations of Sections 4.3 and 4.4 of ORNL-NSIC-65 (Ref. 12).

   f. Filter housings, including floors and doors, should be designed and constructed in accordance with the recommendations of Sections 4.5.2, 4.5.5, 4.5.7, and 4.5.9 of ORNL-NSIC-65.

g. Water drains should be designed in accordance with the recommendations of Section 4.5.6 of ORNL-NISC-65.

h. The adsorbent to be used for adsorbing gaseous iodine (elemental iodine and organic iodides) should be an adsorbent that has been demonstrated to remove the gaseous iodines from air at the required efficiencies listed in Table 2 of Regulatory Guide 1.52 Rev. 1 (PSAR). If impregnated activated charcoal is the adsorbent, the physical properties of the adsorbent should be in accordance with the guidelines of Table 2 of Regulatory Guide 1.52 Rev. 1 (FSAR). If an adsorbent other than impregnated activated charcoal is proposed, ETSB will review supporting data and accept adsorbents expected to perform equal to, or better than, impregnated activated charcoal.

i. The adsorber should be designed for a maximum loading of 2.5 mg of total iodine (radioactive plus stable) per gram of activated charcoal.

j. Provisions should be included to inhibit off-design temperatures in the adsorber section. To dissipate heat generated from iodine decay and charcoal oxidation effects, ETSB will consider cooling mechanisms such as low flow air bleed systems and cooling coils. To extinguish ignited charcoal, ETSB will consider water sprays, carbon dioxide injection systems, and liquid nitrogen cooling systems.

k. The system fan, its mounting, and ductwork connections should be designed and constructed in accordance with the recommendations of Section 2.7 of ORNL-NSIC-65.

l. Ductwork should be designed in accordance with the recommendations of Section 2.8 of ORNL-NSIC-65.

5. ETSB will accept ESF filter systems that are designed for accessibility of components and ease of maintenance in accordance with the recommendations of Section 2.5 of ORNL-NSIC-65 as follows:

   a. Components to be replaced should be provided with a minimum of three linear feet from mounting frame to mounting frame between banks of components; components to be replaced should be provided with a minimum of three linear feet plus the maximum length of the component.

   b. Provisions should be made for permanent test probes with external connections.

6. For in-place testing, ETSB will use the following guidelines for determining acceptability:

   a. Provisions should be made for visual inspection of the system and all associated components in accordance with the recommendations of Section 5 of ANSI Standard N510 (Ref. 6).

b. Provisions should be made for testing the air flow distribution upstream of HEPA filters and charcoal adsorbers, and demonstrating uniformity ± 20% of averaged flow per unit.

c. Provisons should be made for DOP testing of the HEPA filter sections in accordance with the recommendation of ANSI N510 (Ref. 6).

d. Provisions should be made for leak-testing the activated carbon adsorber section with a gaseous halogenated hydrocarbon refrigerant in accordance with the recommendations of ANSI N510 (Ref. 6).

e. Provisons should be made for in-place testing initially, and routinely thereafter. Frequency and testing requirements will be established in the technical specifications.

7. For laboratory testing of activated carbon adsorbent, ETSB will use the following guidelines for determining acceptability:

a. Qualification and batch tests on new unused adsorbent should be performed in accordance with the guidelines of Table 2 in Regulatory Guide 1.52.

b. Provisions should be made for obtaining representative adsorbent samples in order to estimate the amount of penetration of the system adsorbent throughout its service life (PSAR).

c. Provisions should be made for laboratory testing initially, and routinely thereafter. Frequency and testing requirements will be established in the technical specifications.

ETSB will accept the following deviations from the above acceptance criteria for the post loss-of-coolant accident (LOCA) hydrogen purge filtration system:

1. If the calculated dose (sum of the long-term doses from the LOCA and the purge dose at the low population zone outer boundary) is less than the guidelines of 10 CFR Part 100, no filtration system is required.

2. If a radioiodine decontamination factor of 10 or less is needed for the calculated dose to be below Part 100, a filtration system that meets the acceptance criteria listed in Item 5 of Acceptance Criteria in SRP 11.3 should be provided.

3. If a radioiodine decontamination factor of greater than 10 is needed for the calculated dose to be below Part 100, the filtration system should meet all of the above acceptance criteria, except for Items 2b and 2c.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from this review plan, as may be appropriate for a particular case.

1. In the ETSB review the plant design is reviewed to determine where ESF units are needed.

2. The ETSB review is carried out by making a detailed comparison of filtration unit designs with the acceptance criteria of Section II, above. The capability of a system to remove fission products in the atmosphere after a DBA is reviewed, based on a design loading of 2.5 mg of total iodine (radioactive plus stable) per gram of activated charcoal adsorbent. Designs consistent with the guidelines of Regulatory Guide 1.52 will be assigned the system efficiencies for removal of elemental iodine and organic iodides given in Table 2 of Regulatory Guide 1.52 and a system efficiency of 99% for removal of particulates resulting from a DBA. The assigned efficiencies are for Accident Analysis Branch use in accident analyses to calculate offsite doses to the whole body and thyroid.

IV. EVALUATION FINDINGS

ETSB verifies that sufficient information has been provided and that the review is adequate to support conclusions of the following type, to be included in the staff's safety evaluation report:

> "The ESF atmosphere cleanup systems include the equipment and instrumentation to control the release of radioactive materials in gaseous effluents following a postulated design basis accident. The scope of our review included an evaluation of these systems with respect to the guidelines of Regulatory Guide 1.52. We have reviewed the applicant's system descriptions and design criteria for the ESF air filtration units. The basis for acceptance in our review has been conformance of the applicant's designs, design criteria, and design bases for the ESF air filtration units to applicable regulations and guides and to staff technical positions and industry standards. Based on our evaluation, we find the proposed ESF air filtration units are acceptable, and the filter efficiencies given in Table 2 of Regulatory Guide 1.52 are appropriate for use in accident analyses."

V. REFERENCES

1. Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling Water Reactors."

2. Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized Water Reactors."

3. Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors."

4. Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

5. ANSI N510, "Testing of Nuclear Air Cleaning Systems," American National Standards Institute (1975).

6. G. H. Griwatz, J. V. Friel, and J. L. Bicehouse, "Entrained Moisture Separators for Fine (1-10u) Water-Air-Steam Service: Their Performance, Development and Status," MSAR 71-45, Mine Safety Appliances Research Corporation (1971).

7. UL-900, "Air Filter Units," Underwriter's Laboratories, Inc.

8. "Building Materials List," Underwriters' Laboratories, Inc.

9. MIL-F-51068 D, "Filter, Particulate, High Efficiency, Fire Resistant," Government Printing Office (1974).

10. MIL-F-51079 B, "Filter Medium, Fire Resistant, High Efficiency," Government Printing Office (1974).

11. "Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Application," ORNL-NSIC-65, Oak Ridge National Laboratory (1970).

12. 10 CFR Part 100, "Reactor Site Criteria."

11/24/75

SRP 6.5.3