

APPENDIX D

FIRE PROTECTION GUIDANCE FOR NUCLEAR FILTER PLENUMS

D1. Filter Plenum Construction

All high-efficiency particulate air (HEPA) filters should meet the requirements of ASME AG-1, Section FC and be listed as tested in accordance with Underwriters Laboratories, Inc. (UL) 586. Entrance filters and prefilters located upstream or made part of final HEPA filter exhaust plenums should be listed as Class 1 air filter units as tested in accordance with UL 900. Filter framing systems and filter plenum housing should be of noncombustible construction.

D2. Fire Rating Requirements for Plenum Housing, Openings, and Dampers

1. Filter plenum enclosures inside buildings or located less than 1.5 m (5 ft) from an adjacent building should be of 2-hour fire rated construction. For enclosures greater than 1.5 m (5 ft) from an existing building, the fire rating may be either one-hour or as determined by the FHA.
2. Door openings into a 2-hour rated filter plenum enclosure should be 1.5-hour minimum fire rated. Door openings into a 1-hour rated filter plenum enclosure should be 0.75-hour minimum fire rated.
3. For ducts not required to function as a nuclear confinement system:
 - (1) A 1.5-hour damper should be used where the duct penetrates a 2-hour rated barrier.
 - (2) A fire damper is not necessary where the duct penetrates a 1-hour barrier provided that automatic sprinkler protection is provided on both sides of the barrier and the duct passes through the wall and extends into the area outside the enclosure. Transfer grills and similar openings without ducting should be provided with an approved damper.
4. Fire dampers should not be utilized when penetrating fire rated construction where ducting is an integral part of the air filter system equipment that is required to continuously function as part of the confinement system. Such duct material may be made part of the fire rated construction by wrapping, spraying, or enclosing the duct with an approved material to provide a minimum 2-hour rating, or be qualified for a 2-hour fire rated exposure to the duct at the penetration location using the fire damper criteria as specified in UL 555.
5. All mechanical and electrical penetrations made into fire-rated plenum enclosures should be fire stopped by listed materials meeting the requirements of ASTM E-814.

D3. Materials and Hazards Inside Plenums

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1. Filter plenum enclosures should only be used for ventilation control equipment. The storage and accumulation of combustible materials (including spare filters) as well as combustible and flammable liquids should not be permitted.
2. Electrical equipment should comply with NFPA 70, and all electrical wiring inside the enclosure should be in metal conduit.
3. The concentration of flammable vapors inside the final filter plenum should not exceed 25 percent of their lower flammable limit. If flammable and combustible gases are expected as a result of facility processes, fixed combustible gas analyzers should be provided with analyzer alarms set to sound at 25 percent of the lower flammable limit and transmitted to a continuously manned position.

D4. Fire Screens for Filter Plenums

1. Fire screens should be located upstream from the prefilters and final filter plenums.
2. Fire screens with metal meshes from 3 to 6 openings per cm (8 to 16 openings per inch) should be provided and located at least 1.2 m (4 ft) upstream from all prefilters and at least 6.1 m (20 ft) upstream from all final filter plenum enclosures.
3. Where prefilters are located in final filter enclosures, fire screens should be located at least 6.1 m (20 ft) upstream from the prefilters.

D5. Fire Detection Systems

1. Automatic fire detectors should be rate-compensated type heat detectors, approved for the specific use and conform to NFPA 72. The detectors should be of the 88 °C (190 °F) temperature range, unless operations require higher temperature air flows.
2. Heat detectors or pilot sprinkler heads should be provided in the final filter enclosure and in ducting prior to the final filter enclosure. Airflow should be considered when determining detector or pilot head location in ducting.
3. Detector installations should be engineered and installed for testing over the life of the detector. Where contamination levels permit, detectors can be removed and tested externally.

D6. Deluge Spray Suppression Systems

1. Automatic and manual water deluge spray systems should be provided inside all final filter plenums for protection of the filters where there is a leading filter surface area greater than 1.5 m² (16 ft²).
2. Automatic deluge systems should be designed as per the applicable provisions of NFPA 13 and 15 and as follows:
 - (1) Water spray density should be 10.2 lpm per m² (0.25 gpm per ft²) over the entire filter area or 3.8 lpm per 14 m³ per min (1.0 gpm per 500 ft³ per min) air flow, whichever is greater.
 - (2) Spray heads should be deluge type sprinkler heads.
 - (3) The spray pattern of the deluge head should be in the form of a downward vertical water curtain approximately 15 cm (6 in) in front of the filter. Heads should be spaced so that each head does not exceed 1.2 linear m (4 linear ft) of curtain coverage.
3. Manual spray systems should be designed as per the applicable provisions of NFPA 15 and modified as follows:
 - (1) Water spray density should be 10.2 lpm per m² (0.25 gpm per ft²) over the entire filter area.
 - (2) Nozzles should be deluge spray nozzles that form a full circle solid cone discharge.
 - (3) Spray nozzles should be horizontally directed at the face of the HEPA filters so that all areas of the first stage filters and framing support system are wetted.
4. Automatic and manual water spray system water supplies should be hydraulically calculated and capable of supplying a simultaneous flow of the automatic and manual water spray systems as well as the overhead ceiling automatic fire sprinkler systems for the fire area providing air to the plenum for a minimum period of two hours.
5. Water for the deluge spray system should be provided by two separate water supply connections for reliability. One connection may be a fire department connection.
6. Demisters should be installed to protect the final stage of HEPA filters from being wetted by operation of the deluge water spray system.

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Most of the guidance presented here is taken from U.S. Department of Energy (DOE) Standard, "Fire Protection Design Criteria" (DOE-STD-1066-97, March 1997). The items of guidance presented are considered to be pertinent to the filter systems likely to be used at the MOX facility. The items presented also represent the NRC responsibility for fire safety as related to facility nuclear safety rather than property protection. A more comprehensive discussion of Nuclear Filter Plenum Fire Protection can be found in Chapter 14 of the DOE Standard and the references cited in the standard.