

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

January 20, 1999

NRC INFORMATION NOTICE 99-01: DETERIORATION OF HIGH-EFFICIENCY
PARTICULATE AIR FILTERS IN A PRESSURIZED
WATER REACTOR CONTAINMENT FAN
COOLER UNIT

Addressees

All holders of licenses for nuclear power, research and test reactors; and fuel cycle facilities.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to previously unknown service life and service condition limitations of high efficiency particulate air (HEPA) filters that are used in ventilation systems by licensees of power, research and test reactors; and certain fuel cycle facilities. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response to this notice is required.

Description of Circumstances

On September 13, 1998, the operators at Consolidated Edison's (Con Edison's) Indian Point 2 (IP-2) Nuclear Power Plant received a low-flow alarm on one of the five containment fan cooler units (FCUs). Con Edison personnel inspected the FCU's internal components and found that one of the HEPA filters in the bottom row had failed and clogged the fan intake screen. The FCU contains a bank of 64 HEPA filters, each 2 feet by 2 feet in size. Five other filters near the failed filter were badly damaged. To confirm the extent of the problem, Con Edison subsequently inspected the other 4 FCUs. One FCU had HEPA filters in which the urethane seal had pulled away from the filter frame and the filter medium had assumed an hour-glass shape. Con Edison concluded that the problem had a potential common-mode failure mechanism that could significantly degrade both the cooling of the FCU and the filtering by the HEPA filters.

Discussion

The HEPA filters in the two affected FCUs were Series Model 8 manufactured by Flanders Filter Corporation; they are no longer made. The Series 8 filter consists of a square stainless steel frame and a convoluted filter medium made of glass fibers held together by an acrylic latex binder and coated with a silicone waterproofing agent. The filter medium is secured to all

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four sides of the filter frame by a urethane coating and, unlike many other HEPA filter designs, does not have internal stiffeners or corrugated separators to support the glass fibers. These HEPA filters were installed in 1991 and, due to being located in the normal air flow, have been in almost continuous use since then; many other FCU designs have the filters in service only during testing or an accident.

Con Edison identified many causes contributing to the unexpected failure and degradation of the HEPA filters, such as (1) excess water (from condensation as well as carryover from the upstream de-misters, which had plugged or partially plugged drain lines) which increased filter loading and distortion, (2) inadequate surveillance for detecting filter degradation or determining when HEPA filters should be replaced, and (3) no established service life. A technical report prepared for Con Edison following testing of samples of new and used HEPA filter media provided quantitative support for this root cause determination. While inherent weaknesses in the FCU design (such as having the HEPA filters in the normal flow stream) and poor preventive maintenance practices (such as not monitoring the condition of the upstream FCU de-mister drains) were noted, previously unknown limitations regarding HEPA filter service life and the effect of service conditions were revealed.

HEPA filters used in the FCUs at IP-2 are required by Technical Specifications to be surveillance tested every refueling outage. Such testing involves (1) visual inspection in accordance with ANSI Standard N510-1975 for indications of filter damage (e.g., filter medium tears, cracks, or burns, and damage to seating gaskets) and excessive dirt loading, (2) a check for filter bypass by a dioctylphthalate (DOP) aerosol efficiency test, and (3) measurement of air flow and differential pressure across the filter bank. This testing does not check for evidence of current or prior media wetting. The initial qualification testing of the HEPA filters, as specified in Military Specification F-51068, did subject the filter to a continuous water spray during the resistance-to-pressure test performed at higher than accident condition flows. However, the filters were not subsequently subjected to any type of testing to demonstrate that they remain capable of performing their intended function. Consequently, loss of structural strength and deterioration can go undetected and can result in failure during design-basis conditions when the filters will be subjected to a much higher temperature, much higher differential pressure and much more entrained moisture than during normal service conditions.


Filter media testing found a significant loss of silicone waterproofing agent from filter media samples that had seen a long service life - up to 7 years. This reduction allowed the filter medium to absorb water readily; little or no observable water absorption was observed on new filter media. As the water is absorbed, the medium expands and closes the medium filter pores. However, since the differential pressure is typically measured across an entire bank of filters, local water loading in one or more filters does not enable the overall differential pressure to rise sufficiently to disclose a problem with the HEPA filters. Moreover, a damaged or failed filter could reduce the differential pressure across the filter bank. Water absorption also increases the weight of the filter medium and can weaken it. The service life of a filter is highly dependent upon HEPA service conditions, which includes high moisture content, entrained solids in the air, and elevated temperatures.

The Department of Energy (DOE) recently sponsored research into HEPA filter deterioration when several HEPA filters in a ventilation system at the Rocky Flats Environmental Technology Site failed. Those filters had been in service for more than 15 years and had been repeatedly subjected to wetting by an upstream fire protection deluge system test. The testing conducted involved filter media from a variety of HEPA filter manufacturers, although most manufacturers

use similar filter media. This research also showed significant losses in the tensile strength of HEPA filter following the wetting of used filters; it also showed that the tensile strength was not recovered fully restored after drying. Further water exposures resulted in additional losses in filter media tensile strength. The results of this research were publicized at the 25th DOE/NRC Nuclear Air Cleaning and Treatment Conference. The DOE research data cannot be used to quantify the useful life of a HEPA filter, but the data do demonstrate that there is a finite HEPA filter life and that wetting of the filter medium reduces its strength.

In response to the research findings, Con Edison replaced the filters in the two affected FCUs with new Flanders Series F & W filters that incorporate internal stiffeners to help support the filter medium. Con Edison has limited the service cycle of the FCU HEPA filters to 6 years and implemented inspections to confirm the following: (1) the integrity of the urethane seal between the filter medium and filter housing, (2) proper drainage from the FCU, and (3) the extent of water condensation and/or direct wetting of the filters.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below, the appropriate regional office, or the appropriate office of Nuclear Reactor Regulation (NRR) Project Manager.


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98-44	Ten-year Inservice Inspection (ISI) Program Update for Licensees that Intend to Implement Risk-Informed ISI of Piping	12/10/98	All holder of operating licenses for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor
98-43	Leaks in the Emergency Diesel Generator Lubricating Oil and Jacket Cooling Water Piping	12/04/98	All holder of operating licenses for nuclear power reactors, except those licensees that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel
98-42	Implementation of 10 CFR 50.55a (g) Inservice Inspection Requirements	12/01/98	All holders of operating licenses for nuclear power reactors
98-41	Spurious Shutdown of Emergency Diesel Generators from Design Oversight	11/20/98	All holders of operating licenses for nuclear power reactors, except for those who have ceased operations and have certified that fuel has been permanently removed from the reactor vessel

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Con Edison has also applied for a Technical Specification amendment that would delete the requirement for HEPA filters and the downstream charcoal beds from the containment FCUs. This amendment is based on analyses that show the equipment can be removed without significantly affecting the radiological consequences of a design-basis loss-of-coolant accident at IP-2.

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