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WHC-SA-2344-FP

Emery 3004

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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Emery 3004

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EMERY 3004*
AS A CHALLENGE AEROSOL
for
HEPA FILTER TESTING

Prepared by
D. A. Gilles
Operations Maintenance Support
Westinghouse Hanford Company

February, 1994

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EMERY 3004 CHALLENGE AEROSOL

HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTERS

HEPA filters are used in nuclear facilities for contamination control and air treatment and are constructed to be 99.97% efficient in trapping particles of 0.3 microns or larger in size. These filters are normally installed in ventilation exhaust systems near known or potential sources of radioactive contaminants such as hoods, glove boxes, and regulated rooms. HEPA filters may also be installed at the air supply inlet if the potential for airflow reversal is great enough.

Prior to installation at Hanford facilities HEPA filters are tested against the manufacturer's efficiency specifications by the Hanford Environmental Health Foundation (HEHF) using an aerosol with a monodispersed particle size of 0.3 microns.

Periodic efficiency testing must be conducted to ensure the filters are performing to specifications once they are installed in an air cleaning system. The testing consists of challenging the filter, in place and with the air supply system operating, with an aerosol of known particle sizes, then measuring the resultant penetration downstream of the filter. Testing is performed annually, semiannually, quarterly, or monthly depending on the operating application of the air system.

Aerosol testing is conducted according to ASME/ANSI N510-1989, which specifies acceptable particle size distribution as:

- **99% less than 3.0 microns.**
- **50% less than 0.7 microns.**
- **10% less than 0.4 microns.**

EMERY 3004 CHALLENGE AEROSOL

For comparison:

- Cigarette smoke ranges from 0.01 to 1 microns,
- Milled flour ranges from 1 to 70 microns,
- Cement dust ranges from 3 to 100 microns.

INSTRUMENTS

Testing is performed using an aerosol generator and a photometric light-scattering linear readout penetrometer. Two types of aerosol generators are used at Hanford:

- "Laskin nozzle" pneumatic generators

  The Laskin nozzle generators work on the same principal as an atomizer. When the nozzle is constructed to the proper specifications, operated at the correct pressure and temperature, and used with an approved oil it produces an aerosol with particles meeting ASME N510 requirements.

- Thermal nitrogen generators.

  The thermal generators have a small heated block into which a coarse aerosol of an approved oil is injected. In the block the oil is vaporized and then using nitrogen as a safety/fire blanket it is recondensed into an aerosol with particles meeting ASME N510 requirements.

The photometer is a particle counter using a halogen light source and a photomultiplier tube. It is linear, insensitive to particle size, and is capable of reading aerosol concentrations as low as 10^{-3} micrograms/liter of air.

EMERY 3004 CHALLENGE AEROSOL

IN SITU HEPA FILTER TESTING PROCEDURE

To set the photometer baseline, an appropriate amount of aerosol is injected downstream of the filter with the system operating and the airstream is sampled downstream of the injection point.

The aerosol is then injected upstream of the filter and the airstream downstream of the filter is sampled using increasingly sensitive settings on the photometer.

Final aerosol penetration of the filter is calculated using the following equation:

$$E = 100 - 100(ds/us)$$

where **E** = filtration system penetration efficiency in percent.

us = concentration of aerosol upstream in the unfiltered air (upstream reading)

ds = concentration of aerosol downstream in the filtered air (downstream reading)

THE PROBLEM

The oil or material used for generating the aerosol, has historically been Dioctl Phthalate (DOP). This oil was well suited to the task of producing aerosol, producing large amounts of smoke and not clogging or harming the instruments.

EMERY 3004 CHALLENGE AEROSOL

In 1980 DOP was classified as a suspected carcinogen. As a suspected carcinogen, it required special handling and management. Workers dealing with this material were required to wear special respiratory equipment, protective clothing, have specific health monitoring performed, and observe extra hygiene requirements. The material itself had to have special handling and, in Washington State, special waste disposal.

At that time the Department of Energy (DOE) recommended the replacement of DOP and suggested corn oil as suitable substitute challenge aerosol. The corn oil was subsequently tested and, while it did produce good quantities of properly sized aerosol, it tended to clog up the generating equipment and congeal on the walls of the duct work or anything else it came in contact with, including the filters. After a period of time the oil would turn rancid and create an obnoxious odor and posed a possible health hazard.

Additional products suggested and tested were Polyethylene Glycol 400 (PEG) and Dioctyl Sebacate (DOS). PEG performed well in the pneumatic aerosol generators, but did poorly in the thermal generators.

DOS performed adequately in both types of generators and was selected as the challenge aerosol for use at Hanford. However, because of its similarity in chemical structure to DOP, DOS was also eventually added to the suspected carcinogen list. With this change in status of DOS a search was initiated for a suitable replacement. Informational queries into the 16th and 21st Nuclear Air Cleaning Conference indicated Emery 3004 might be a proper replacement for DOS.

Westinghouse Hanford Company (WHC) personnel conducted tests using Emery 3004 in both types of generators and produced very good results. Emery 3004 produced a good quantity of correctly sized aerosol and did not clog or damage the equipment in any discernable way.

EMERY 3004 CHALLENGE AEROSOL

Further testing was performed at the Hanford Environmental Health Foundation (HEHF) and the United States Army Environmental Hygiene Agency (AEHA).

WHC determined that Emery 3004 met the particle size distribution criteria called out in ASME N510 during eight months of field testing which also demonstrated that Emery 3004 behaved like traditional aerosols. Based on the results of this testing and with the concurrence of AEHA, HEHF, and Dames and Moore, WHC petitioned DOE for approval to use Emery 3004 as a challenge aerosol for HEPA filter testing, as it had proven to be a suitable substitute for DOS.

On September 24, 1992, the Department of Energy, Richland Operations (DOE-RL) office authorized the use of Emery 3004 for in situ HEPA filter testing on the Hanford site.

THE BENEFITS

WHC has realized a annual cost savings of over $25,000 by changing to Emery 3004. This was realized from expense reductions in:

- Training (for working with a carcinogen),
- Extra testing on employees physicals,
- Chemical monitoring,
- Work site sampling, and
- Disposal of regulated waste.

THE FUTURE

WHC is contributing this information to the "Savings through Sharing" program.

At present Westinghouse Idaho Nuclear Company (WINCO) is in the process of replacing their material with Emery 3004, using the WHC research and testing as justification.

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6/22/94

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