

# HEPA Filter Scan Testing: Is it appropriate for the nuclear industry?

Presented by: Arthur Soma and Keith Woolard  
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# What we plan to cover.

- A brief history of filter testing.
- What is filter scanning?
- Where is it used?
- Conference discussion.



# What does the Code say?

**ASME AG-1-2009**  
(Revision of ASME AG-1-2003)

## Code on Nuclear Air and Gas Treatment

HA-D-1441:

“A useful method to locate nonuniform concentration is to scan in front of the manifold while the challenge aerosol is flowing. This will provide data to assist the redesign/modification of the manifold.”

ASME AG-1-2000

## HA-D-1441

A useful method to locate nonuniform concentration is to scan in front of the manifold while the challenge aerosol is flowing. This will provide data to assist the redesign/modification of the manifold.

## HA-D-1500 ACCEPTANCE CRITERIA

## HA-D-1510 SINGLE-POINT SAMPLE

All traverse concentration measurements taken at the single-point sample location cross section shall be within  $\pm 5\%$  of the calculated average concentration.

## HA-D-1520 SAMPLE MANIFOLD

The sample manifold concentration shall be within  $\pm 5\%$  of the single-point sample concentration for all artificial leak paths.

## HA-D-1600 DOCUMENTATION

## HA-D-1610

A sketch of the factory test setup shall be provided. It shall provide sufficient dimensions and detail to allow analysis by the Owner or designee prior to the start of testing.

## HA-D-1620

The details of the test instruments for airflow and aerosol generation and detection shall be provided. They shall include, as a minimum, the manufacturer, model, serial number, and calibration date.

## HA-D-1630

The test procedures shall be submitted to the Owner or designee for review prior to the start of testing. All data shall be presented in a manner that will allow independent analysis of the test results.

## HA-D-1640

The location, date, and the names of test engineers/technicians shall be listed with signatures.

## HA-D-1650

An ASME NQA-1, Level II Engineer shall sign the test report to be submitted to the Owner for review prior to shipping the unit.

# Is there a problem?

**“...it is possible to have eight different test results without changing the size or location of the leak. Test results ranging from “passing” to “failing” can be obtained on the same system depending on the test technique and methodology.”**

## HEPA FILTER IN-PLACE TESTING EFFICIENCY VARIATIONS DUE TO THE EFFECTS OF INADEQUATE MIXING AND VARYING AIRFLOW RATES

Eric M. Banks

NUCON International, Inc.

### Abstract

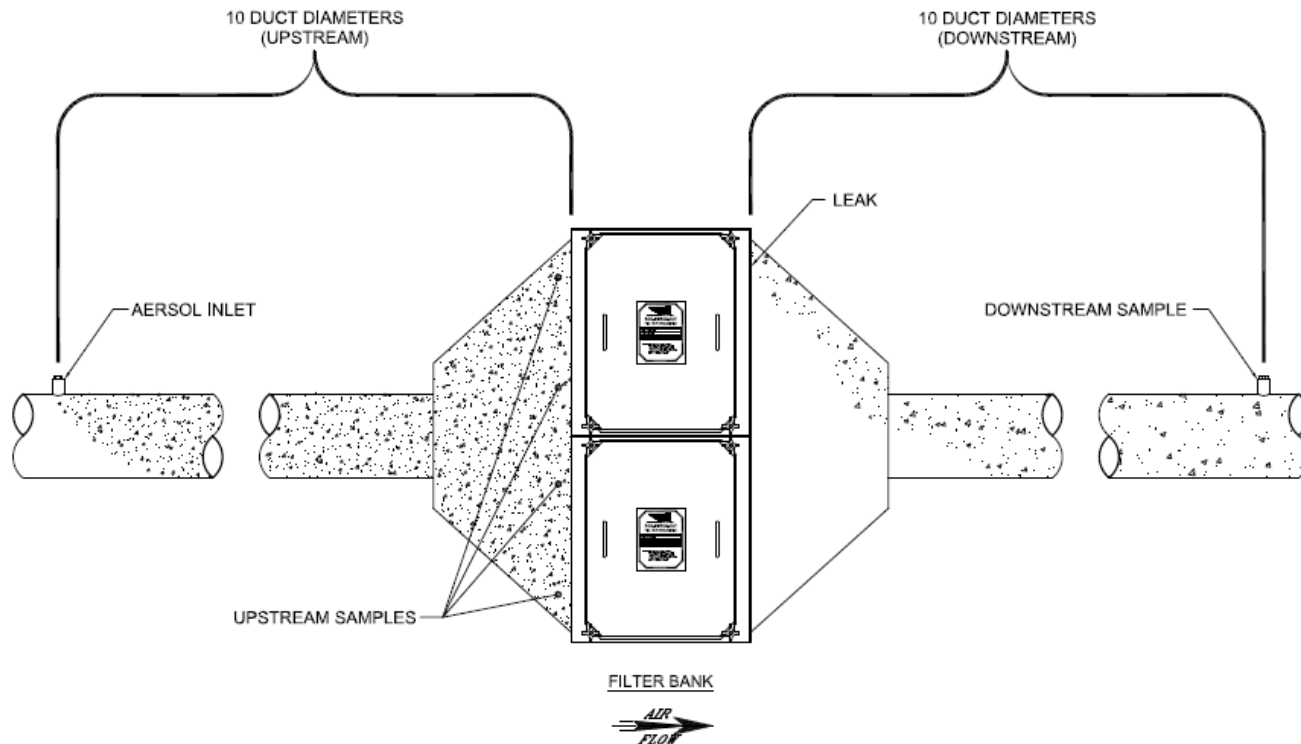
HEPA filters are subject to periodic in-place testing to determine the efficiency of the installed filter bank. This test consists of injecting an aerosol upstream of the HEPA bank and measuring of the upstream and downstream aerosol concentrations. The ratio between the upstream concentration and the downstream concentration indicates the bank's removal efficiency. This paper will present data showing that poor mixing of the challenge aerosol as a result of poor injection port location and uneven dust loading of the prefilter section causes large variations in the as-measured in-place test results. Also presented are the effects of airflow variations on measured efficiencies on a HEPA filter bank with a known leak.

### Introduction

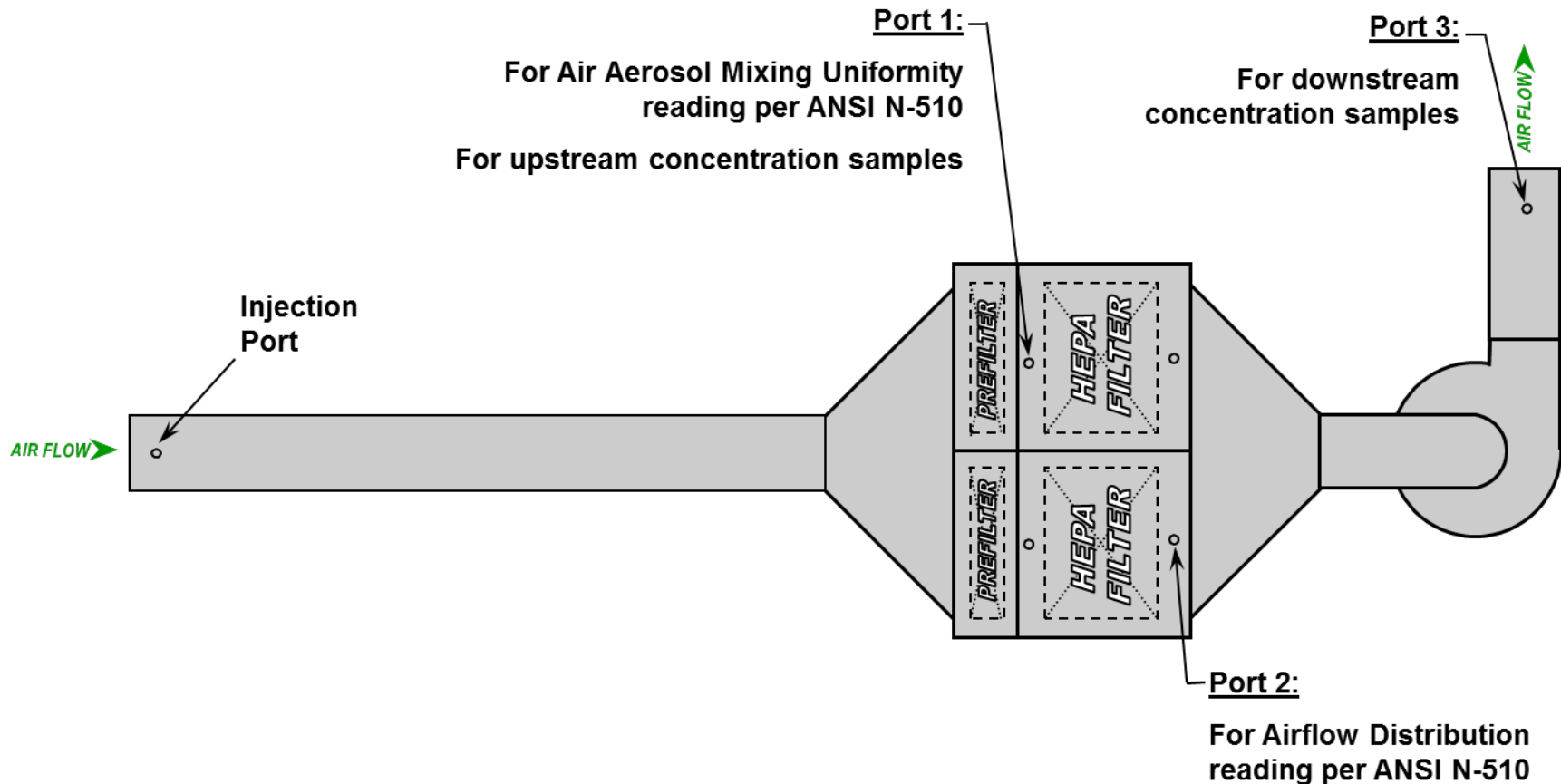
The purpose of performing an air-aerosol mixing test is to ensure that the challenge agent, as it approaches the bank being tested, is well mixed. If this can be proven, then a single point sample taken anywhere in the upstream plane of the bank being tested will yield valid test results.

There are many factors that may affect the in-place test results of installed HEPA filter banks. Of these, the following have a major effect on the measured HEPA bank efficiency: airflow rates, prefilter efficiency, prefilter loading, location of the injection point, method of injection, upstream sample line location and sample method, and downstream sample line location and sample method. To qualify an injection point, it is customary to perform an air-aerosol mixing test during acceptance testing and after any modification that may effect the mixing of the challenge agent. The methodology that is normally followed for aerosol mixing is presented in ASME N510, Section 9 or ASME AG-1 Section TA. The results presented in this paper are based on testing a 6000 SCFM Nuclear Air Treatment System (NATS) operated at 5000 SCFM. Various injection methods and sampling techniques were employed and the results are presented in this paper.

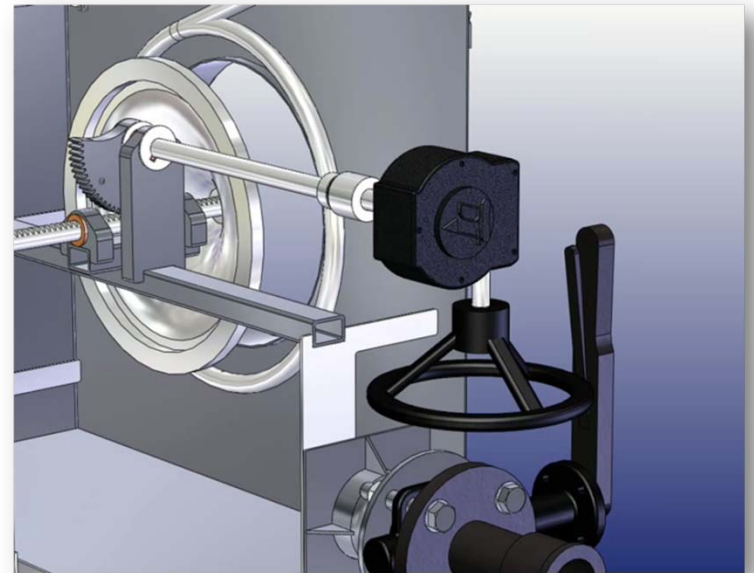
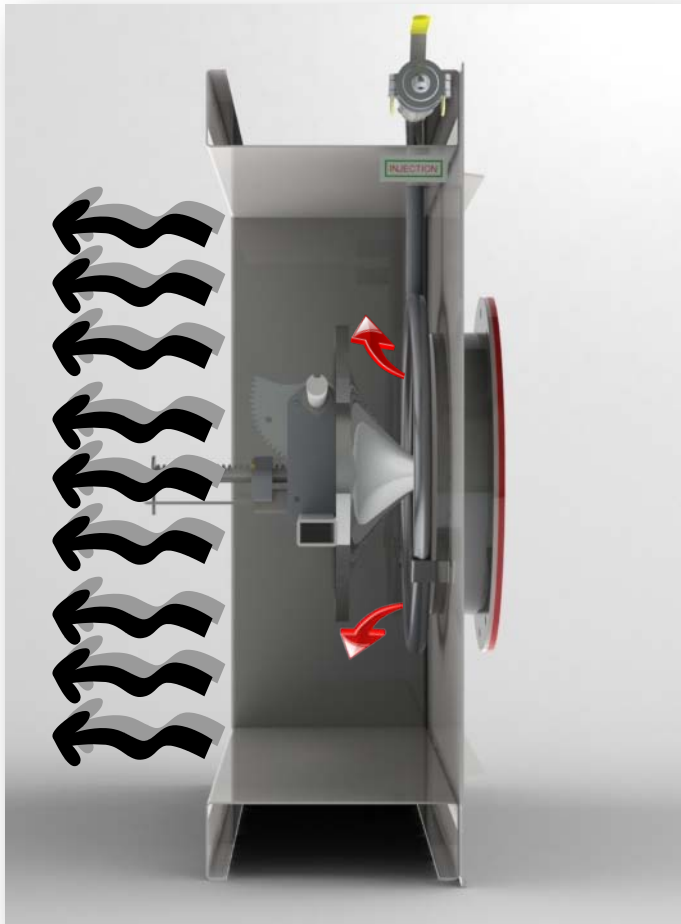
# Distance may resolve the problem.



# Distance may resolve the problem.



The linear damper disperses air uniformly across the face of the filter.





# Distance may resolve the problem?

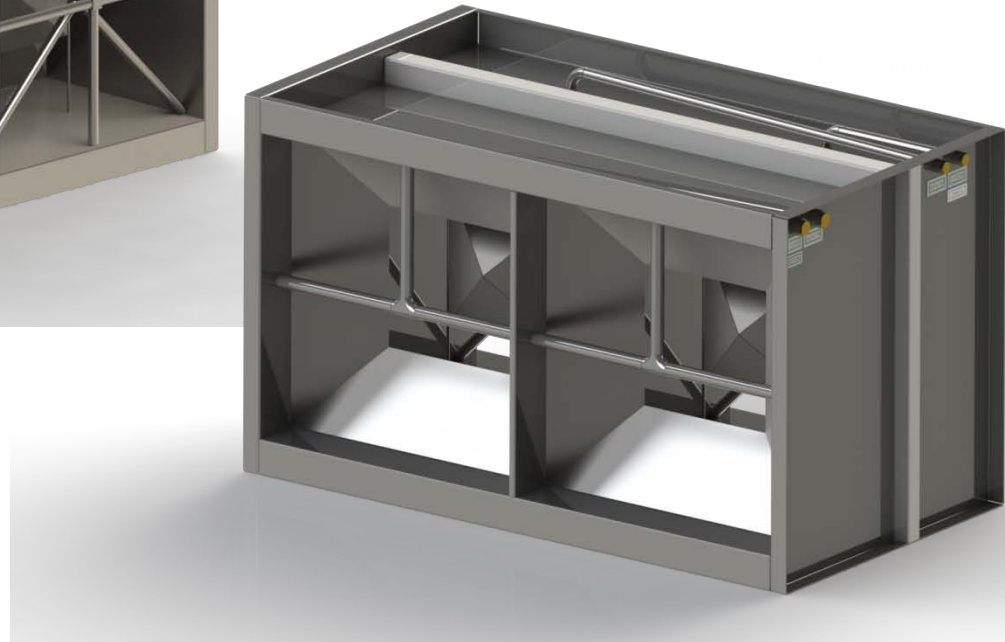




# What if there is more than one bank to test?



# Commercial Test Sections reduce airway length.



# There has been customer validation of test housings.

Paper: “*Analysis of Manufacturer Supplied ‘Air-Aerosol’ Mixing Data Collected for Qualifying Performance of Commercial HEPA Filter Testable Housings*” - Ronald Sripsick (LANL)

- Some variations in test housings
- Most variations within ASME AG-1 guidelines

## 25<sup>th</sup> DOE/NRC NUCLEAR AIR CLEANING AND TREATMENT CONFERENCE

ANALYSIS OF MANUFACTURER SUPPLIED ‘AIR-AEROSOL’ MIXING DATA COLLECTED FOR QUALIFYING PERFORMANCE OF COMMERCIAL HEPA FILTER TESTABLE HOUSINGS\*

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Los Alamos National Laboratory  
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### Abstract

Commercial testable housing (CTH) manufacturer data on challenge concentration uniformity was analyzed and interpreted. Results found challenge concentration uniformity was between values observed in well-mixed systems and those found for an operating HEPA filter air cleaning system in a nuclear facility. Acceptance limits on in-place filter test results were found in a range such that photometer test methods can be used.

### Introduction

Replacement, upgraded and new HEPA filter aerosol emission control systems for nuclear facilities rely heavily on so-called commercial testable housings (CTHs). These are commercially available filter housings that, among other features, provide for in-place leak testing of individual filters (see Figure 1). The housings typically include test aerosol injection ports, sampling ports, and engineered flow obstructions to promote mixing. The injection and sample ports are frequently fitted with manifolds intended to reduce effects that spatial variation of aerosol concentration or concentration heterogeneity may have on uncertainty in in-place filter test results. The flow obstructions or aerosol mixers are intended to reduce these heterogeneities.

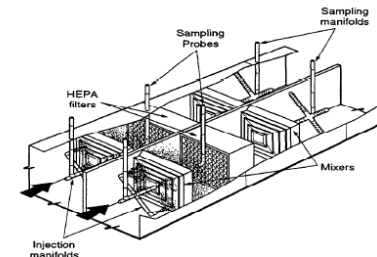


Figure 1 Diagram of commercial testable housing (CTH) showing components for aerosol injection, sampling, and mixing.

\*Support for this work comes from the US Department of Energy, the Office of Defense Programs (DP-45). The Program Manager is James W. Slawski.



These housings represent advancement in filter testing.

- Reduction of equipment length
- Ability to challenge individual filters
- Higher degree of testing accuracy

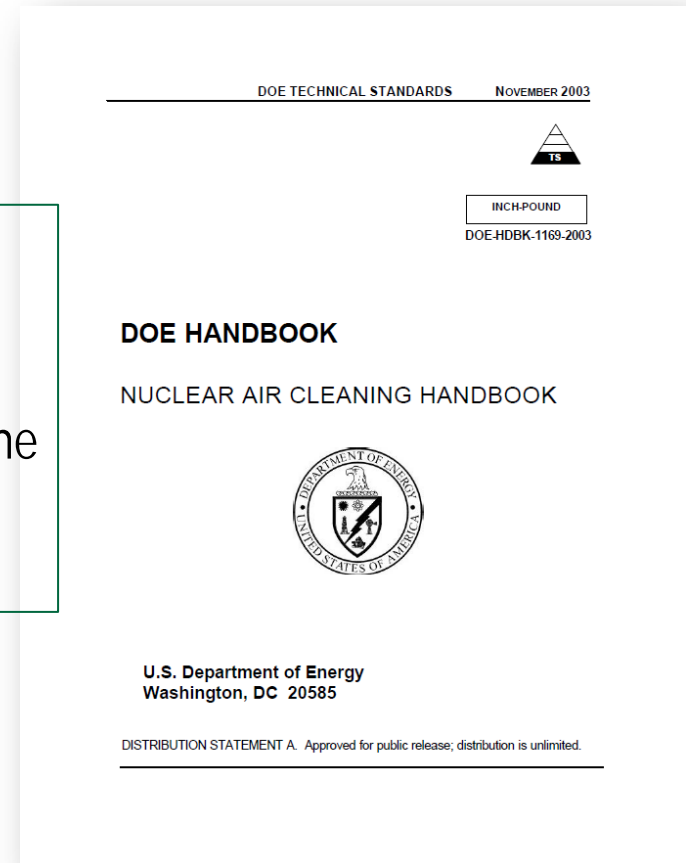


# What if there is a localized leak?

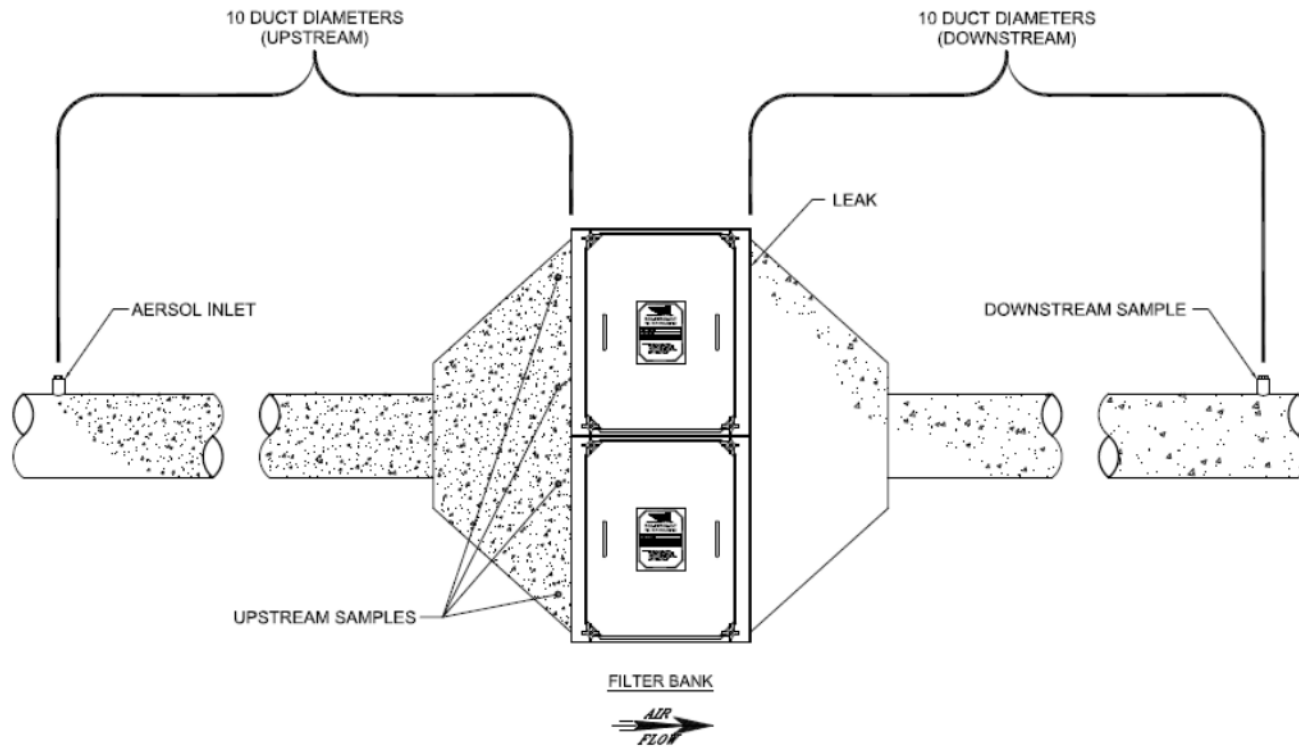
## 4.4.10.2 Downstream Mounting of Filters

### Advantages:

- Leak-scanning of installed filters is more sensitive. ... the driving force of air entering the filter forces the test aerosol through the leak, and they are readily detected.



# What if there is a localized leak?

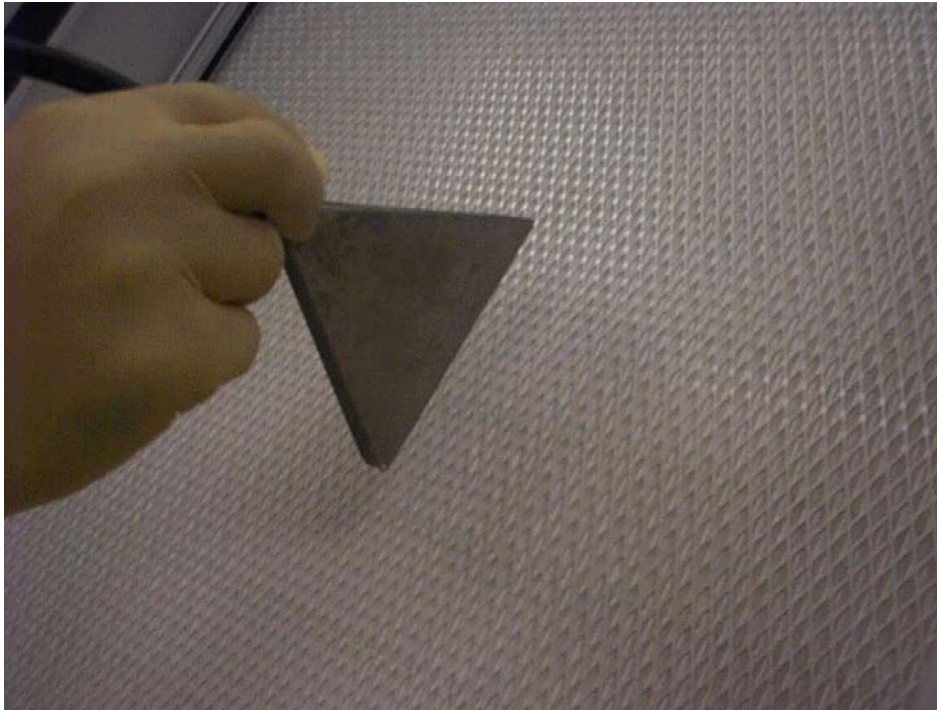


# Scan testing can spot pin-hole leaks.





# What is filter scanning?



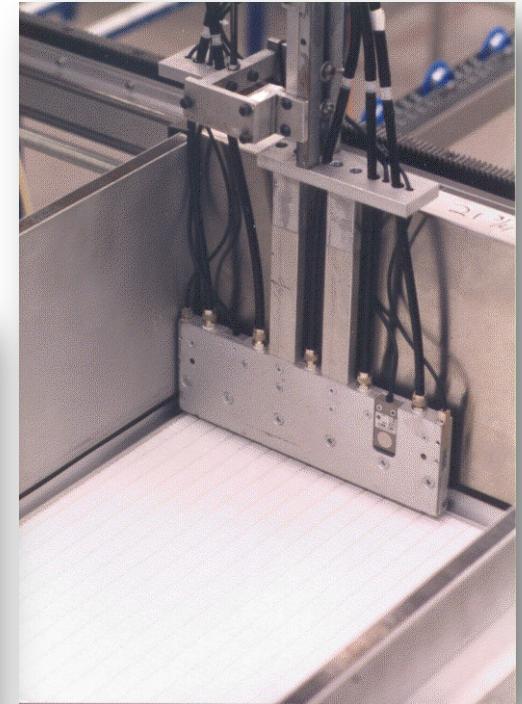
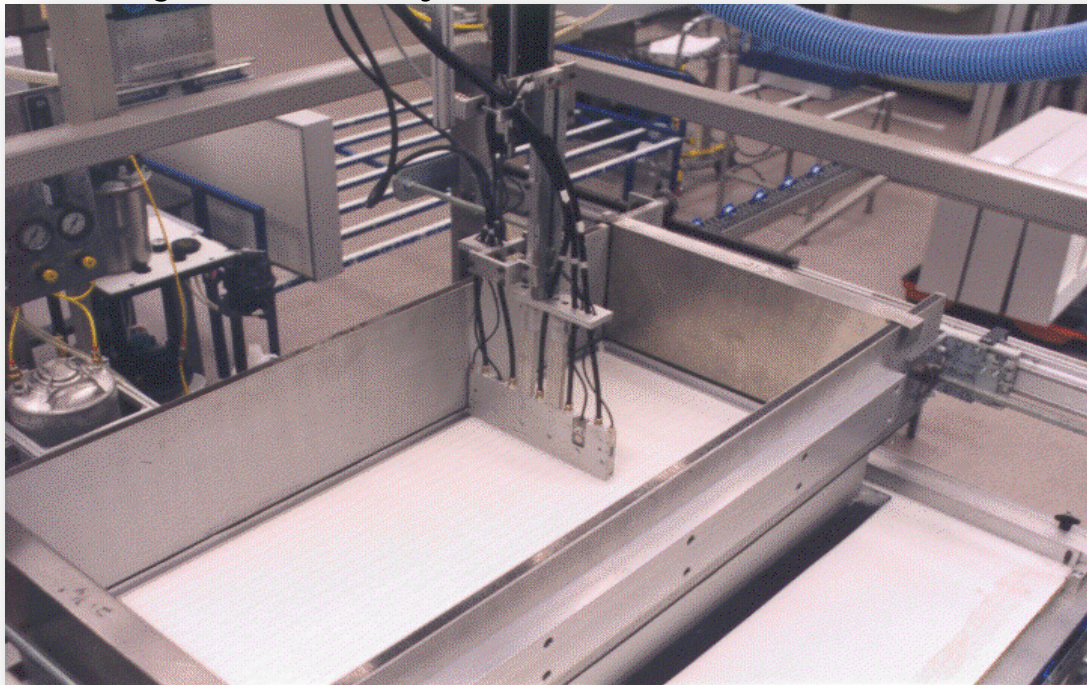
# What is filter scanning?

Computer-controlled.

6 particle counters (fast accurate leak detection).

Detect leaks, measures DP and efficiency.

Advanced edge detection system



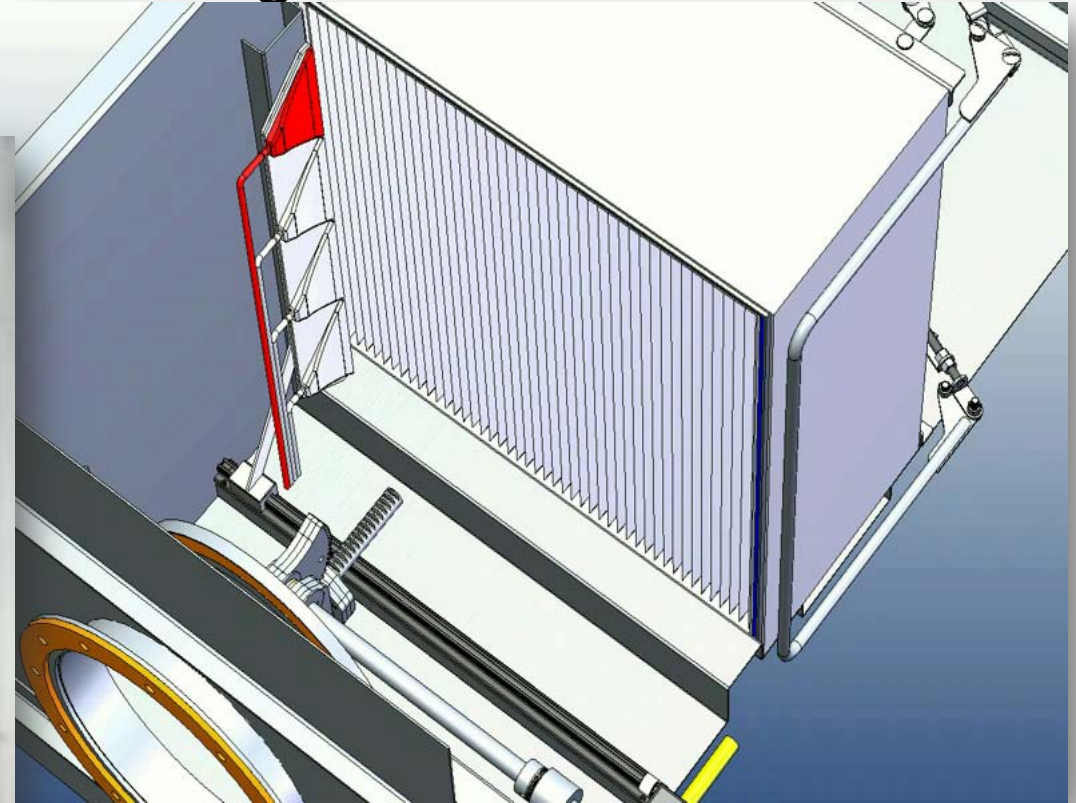
5 Probes Counting  
Downstream



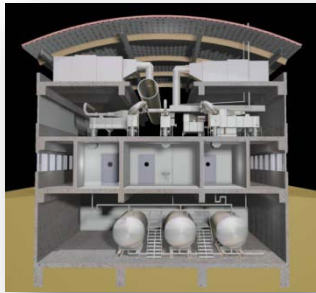
# What is filter scanning?



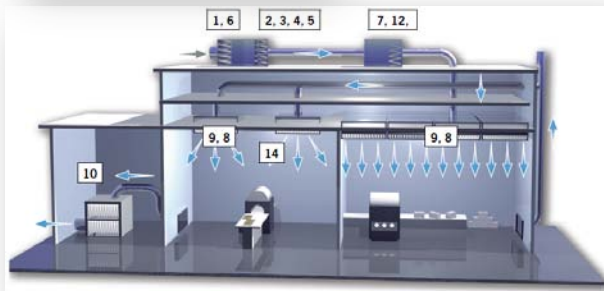
# What is filter scanning?



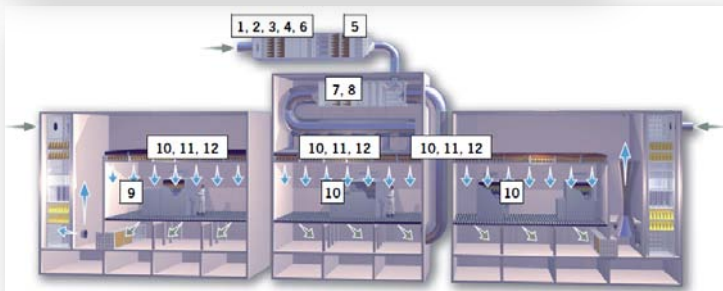
# Who uses filter scanning today?



- High Containment Labs

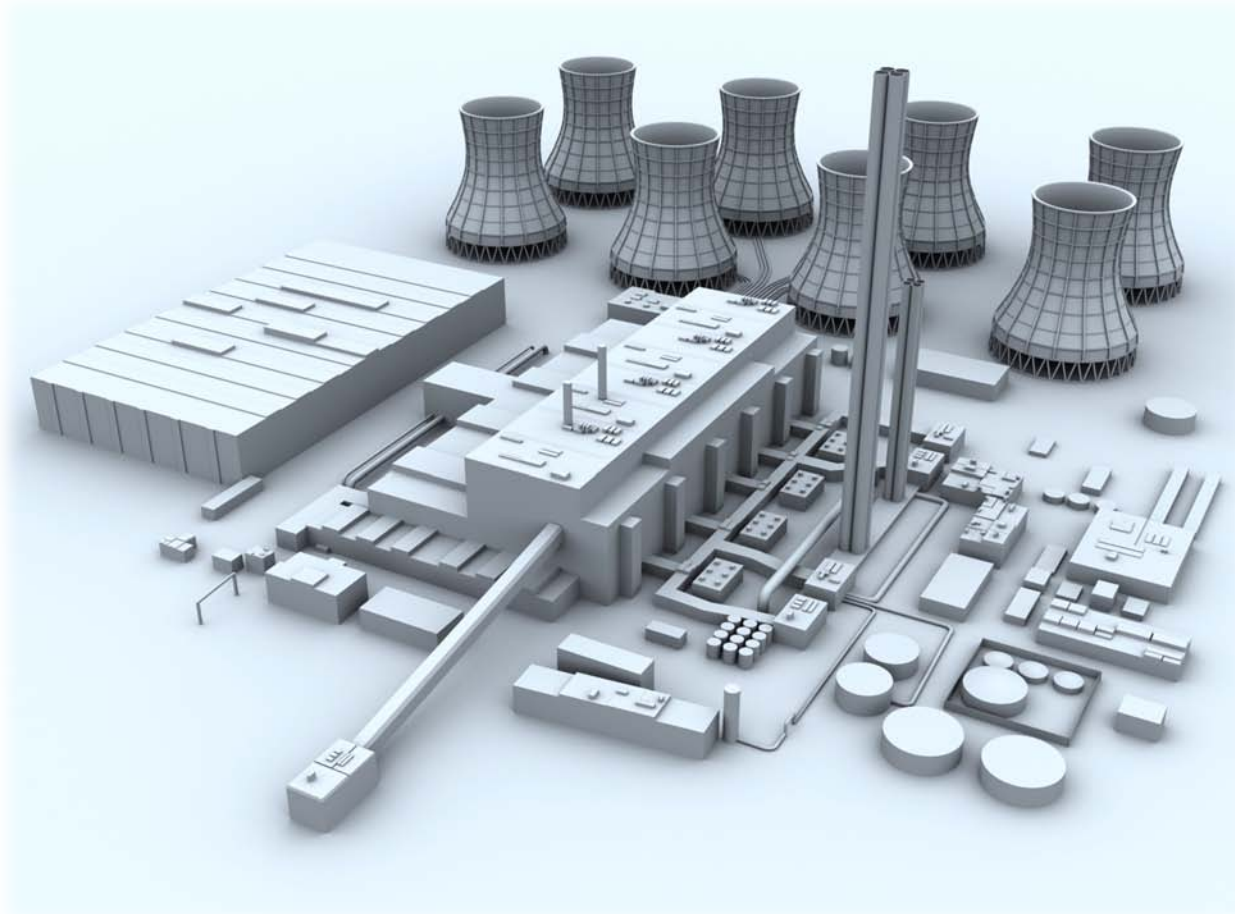


- Bio-pharma



- Microelectronics

# Scanning: How about in the nuclear industry?

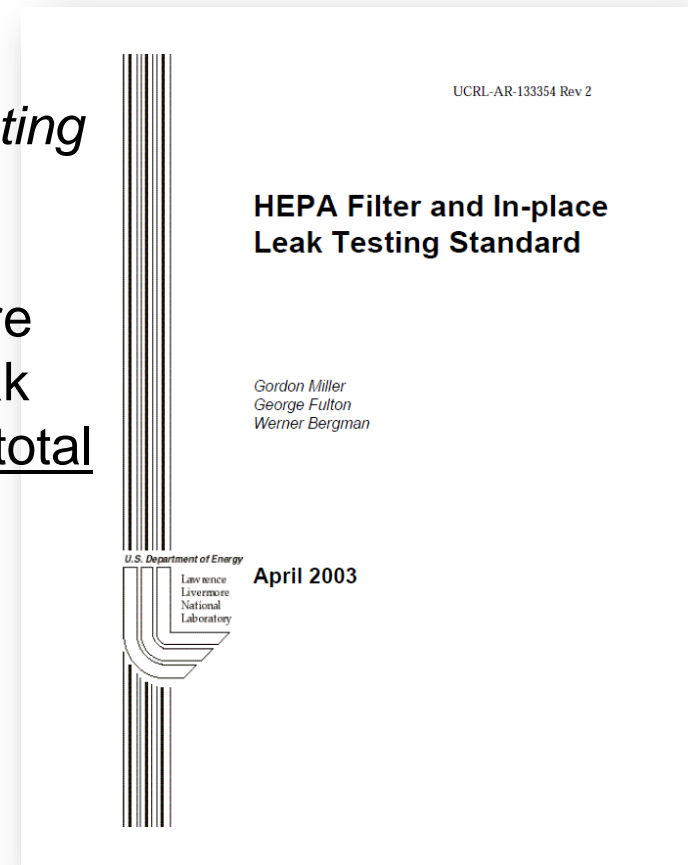




# Is there a reason for not scanning filters?

Paper: *"HEPA Filter and In-place Leak Testing Standard"* – Gordon Miller et al (LLNL)

"...There are two types of leak tests that are permitted: 1) total leak test and 2) scan leak test. For radioactive applications, only the total leak test is allowed."

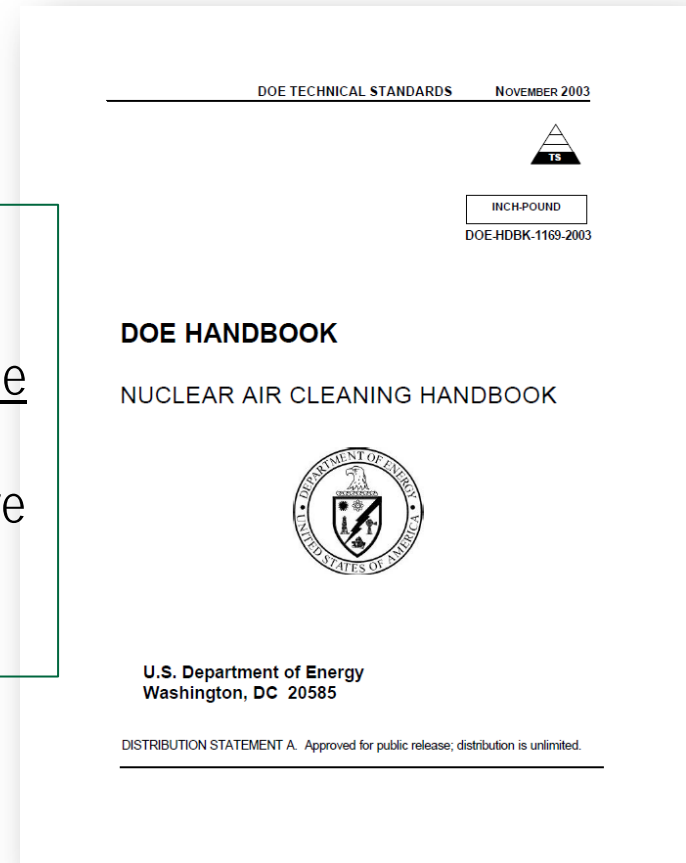




# Is there a reason for not scanning filters?

## 8.7 In-Place Testing for Multistage Systems:

"For testing multistage HEPA filter banks, scanning the downstream face of the stage to be tested is an approved technique, in accordance with the procedure outlined in Section 4 of Institute of Environmental Sciences and Technology (IEST) RP-34.1."

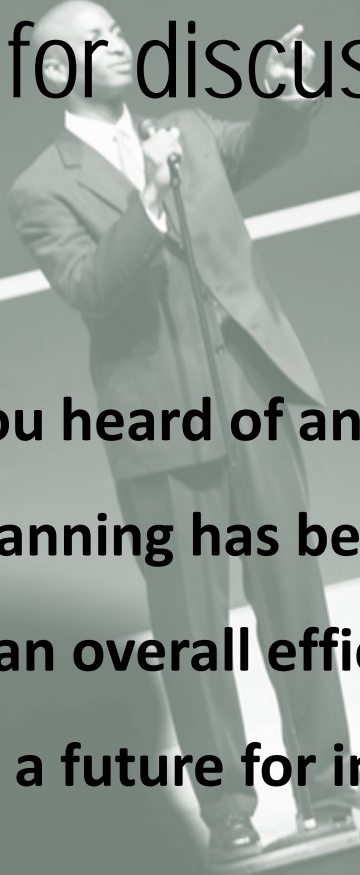


# Audience participation...





# Topics for discussion

- 
- A man in a suit is standing at a podium, speaking into a microphone and gesturing with his right hand. He is the central figure in the background of the slide.
- 1. Have you heard of any nuclear applications where HEPA filter scanning has been used?**
  - 2. Why is an overall efficiency in situ filter test acceptable?**
  - 3. Is there a future for in situ filter scanning in our industry?**

[illegible]

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