L-01
Introduction to ASME Code AG-1

History and Development

Dr. Ronald R. Bellamy
U.S. Nuclear Regulatory Commission

ASME Activities

Introduction

- "N" Committee and CONAGT Committee Background
- Identify the ASME code/standards
- Breakdown of code sections
- Discuss issues applying the code/standards
- Conclusion

"N" Committee (N45-8)

N45-8 Committee established in 1971

- Chartered by the Nuclear Technical Advisory Board (NTAB)
  - Original charter: Prepare a standard for boiling water reactor standby gas treatment systems
  - Immediately expanded: Included all Engineered Safety Features (ESF) air cleaning systems for all nuclear power plants

"N" Committee (N45-8) *(contd)*

- Published ANSI N510 (Standard for Testing Nuclear Air Cleaning Systems) in 1975
- Published ANSI N509 (Standard for Nuclear Power Plant Air Cleaning Units and Components) in 1976

ASME Codes and Standards

- **ASME AG-1** (Code on Nuclear Air and Gas Treatment)
  - Publication 1997, with 2000 Addenda,
  - Publication 2003, with 2007 Addenda,
  - Publication 2009, with 2010 Addenda
- **ASME N509** (Nuclear Power Plant Air Cleaning Units and Components)
  - Publication 2002, Revised Previous Editions
- **ASME N510** (Testing of Nuclear Air Treatment Systems)
  - Publication 1989, Reaffirmed 1995, Reissued 2007

ASME N509

- New revision published 2002
- System-based standard
- Component sections revised directing use of AG-1
- Specific sections still applicable
  - *All of Section 4 (Functional Design) includes:*
    - 4.1 General
    - 4.2 Design Parameters
    - 4.3 Size (installed capacity) of air cleaning unit
    - 4.4 Environmental Design Conditions
    - 4.5 Nuclear Air Treatment System Configuration and Location

ASME N510

- Latest revision 1989, reaffirmed 1995, reissued 2007
- Testing standard
  - Use only as guidance if system is not designed to N509
  - Housing Leak Tests
    - Housing leak test after major modification and at least once each 10 years per Table 1
  - Airflow capacity and distribution
  - Air-aerosol mixing uniformity
  - In-place leak tests

ASME N511

- Published 2008
- Covers in-service testing
- Means to verify that the systems continue to perform their intended function
- Monitor performance and equipment
- Establish system performance trends

ASME Committee on Nuclear Air and Gas Treatment (CONAGT)

Established February 1976

- Original scope included:
  - To develop, review, maintain, and coordinate Codes and Standards for design, fabrication, installation, testing and inspection of equipment for gas treatment for Nuclear Power Plants

ASME CONAGT Committee *(contd)*

Originally updated and corrected certain deficiencies within ASME/ANSI N509 and N510

- Began effort for new code
  - In approximately 1978, began work on ASME AG-1
    - Proposed code would cover all essential ventilation, air cleaning and process off-gas treatment equipment for all types of nuclear facilities
- ASME AG-1 originally published in 1985

ASME AG-1

- Component-based code
- Replacement for majority of N509
- Endorsed by NRC
- Broken into four divisions:
  - Division I: General Requirements
  - Division II: Ventilation Air Cleaning and Ventilation Air Condition
  - Division III: Process Gas Treatment
  - Division IV: Testing Procedures

ASME AG-1 *(contd)*

- Each section includes the same article breakdown
  - 1000 Introduction
  - 2000 References
  - 3000 Materials
  - 4000 Design
  - 5000 Inspection and Testing
  - 6000 Fabrication and Installation
  - 7000 Packaging, Shipping, Receiving, Storage, and Handling
  - 8000 Quality Assurance
  - 9000 Name Plates and Stamping

ASME AG-1 *(contd)*

- ***Division I**: General Requirements, Section AA*
  - Definitions
  - Structural
    - Natural Phenomena, dead loads, etc.
  - Welding
    - AWS Standards and Sec. IX
  - Packaging/Shipping/Storage
    - NQA-1 (Quality Assurance Program Requirements for Nuclear Facilities)
  - Quality Assurance
    - NQA-1

ASME AG-1 *(contd)*

- **Section FA** (Moisture Separators)
  - Qualifications required
    - Rough handling
- **Section FB** (Medium Efficiency Filters)
  - Identifies ASHRAE Standard 52
- **Section FC (HEPA Filters)**
  - Revised
  - Qualification Issues
  - Specific storage requirements

ASME AG-1 *(contd)*

- **Section FD** (Type II Adsorber Cells)
  - Single cell composed of 2" adsorber beds
  - Access panel(s) for recharging, and a gasket
  - Flange
- **Section FE** (Type III Adsorber Cells)
  - Gas phase adsorber characterized as being a single assembly, fixed and rechargeable in place, with an adsorbent

ASME AG-1 *(contd)*

- **Section FF** (Adsorbent Media)
  - Virgin Adsorbents prior to installation
- **Section FG** (Mounting Frames)
  - Covers both HEPA filter and Type II mounting frames
- **Section FK** (Section Round and Duct Connected HEPA Filters)
  - Specialized HEPA filters
- **Section IA** (Instrumentation and Controls)
  - Permanently installed

ASME AG-1 (contd)

- **Section BA** (Fans and Blowers)
  - Identifies requirements for different fans (centrifugal, axial)
  - Specific testing requirements (AMCA)
- **Section DA** (Dampers and Louvers)
  - If damper/valve meets ASME Section III of B31.1, it is excluded from AG-1 criteria
  - Specific testing requirement (AMCA)
- **Section SA** (Ductwork)
  - Specifies detailed joints and seams
  - Certified Materials Test Reports (ductwork & supports)

ASME AG-1 *(contd)*

- **Section HA** (Housings)
  - New section released December 2000
  - Written for side load housings and walk-in type
  - Manifold qualification
  - Specific testing requirements
- **Section RA** (Refrigeration Equipment)
  - Pumps, valves and compressors
- **Section CA**
  - Specifies coils both electric and fluid type
  - Limited material (copper and copper nickel)

ASME AG-1 *(contd)*

- Division III: Process Gas Treatment
  - In the course of preparation
    - Off-gas components include
      - Hydrogen re-combiners
      - Heat Exchangers
      - Gas Sampling

ASME AG-1 *(Contd)*

- Division IV: Testing Procedures
  - **Section TA** (Field Testing of Air Treatment Systems)
    - Field acceptance testing
    - Visual inspection
    - Pressure boundary tests
    - System functional tests
      - Airflow distribution test
      - Air-aerosol mixing test

ASME AG-1 *(contd)*

- **Section TB** (Field Testing of Gas Processing Systems
  - In preparation
- **Mandatory Appendix**
  - Preparation of technical inquiries
    - Scope
    - Background
    - Inquiry structure
      - Precise question format
    - Proposed reply

Conclusion

- Codes and Standards
  - Revision necessary to support technology
    - Example: ASME N511, issued 2007
  - Volunteer support needed from the industry
  - Inquiries, questions and comments always welcomed
  - Currently being applied internationally
  - Future focus on gas processing

L-04

Particulate Filtration

Specifications

Section FB – Medium Efficiency Filters

Section FC – HEPA Filters

Dr. Ronald R. Bellamy
U.S. Nuclear Regulatory Commission

Section FB

Medium Efficiency Filters

This section applies to extended media, dry-type filters with an average atmospheric dust spot efficiency, per ASHRAE 52.1, greater than 40% but less than 99%.

The normal function of these filters is to reduce the particulate loading to HEPA filters.

***Filter frame**:* a structure that encloses the edges of the filter media (or filter pack) and provides a filter mounting surface.

Filter media: part of the filter designed to remove particulate matter from the air or gas stream.

***Sealants**:* materials used for the following purposes:

a) To hold the media in position in the filter frame
b) To attach gaskets
c) To splice media

Separator: device used to support and position folds in the filter media to provide air passage

Materials

The filter media shall be glass based, containing a binder to retain the fibers, with both fiber and binder suitable for the environment as specified in accordance with Article FB-4000.

The filter frames shall consist of corrosion-resistant material suitable for the environment as specified in accordance with Article FB-4000.

The separators shall consist of corrosion-resistant material suitable for the environment as specified in accordance with Article FB-4000.

Sealants and adhesives shall be suitable for the environment as specified in Article FB-4000 and shall qualify as self-extinguishing in according with UL 900, Class 1 requirements.

Gasket material shall be oil-resistant, expanded cellular elastomer, that conforms with the requirements of ASTM D 1056, Grade 2C3 or 2C4.

Design

Medium efficiency filters shall be replaceable, extended media, dry-type, and certified to UL 900, Class 1.

Criteria:

a) Type of gas to be treated
b) Rated flow, nominal, cfm (m^3/hr), per ANSI/ASHRAE 52.1.
c) Design pressure, in. wg (Pa)
d) Temperature operating range, °F (°C)
e) Relative humidity operating range, %RH
f) Contaminents to be removed, lb/scfm/hr (kg/sm^3/hr)
g) Average atmospheric dust spot efficiency as measured by ANSI/ASHRAE 52.1
h) Initial resistance, in. wg (Pa), at rated flow per ANSI/ASHRAE 52.1
i) Rated final resistance, in. wg (Pa), at rated flow per ANSI/ASHRRAE 52.1
j) Dust holding capacity, lb (kg), per ANSI/ASHRAE 52.1
k) Medium efficiency filter frame dimensions, in. (mm), (height x width x depth)

Inspection and Testing

Criteria:

a) Inspection of the filter media for splits, tears, or holes
b) Inspection of the connection between the filter media and the filter frame for splits, tears, or holes
c) Inspection for missing or incorrect parts or components
d) Inspection for incorrect fit of parts or components
e) Inspection for workmanship
f) Inspection for cleanliness and appearance
g) Inspection for correct identification on the filter nameplate and carton

If a lot is rejected, it may be resubmitted for inspection. Following 100% inspection of the rejected lot and repair or removal of all defective units, the lot will be accepted.

New or revised filter designs shall require qualification testing prior to acceptance and production.

To obtain standard ratings, three medium efficiency filters of the design to be qualified shall be tested and test results shall be provided in accordance with ANSI/ASHRAE 52.1. The rated performance may be obtained by averaging the results of the tests on the three filters for initial resistance, initial atmospheric dust spot efficiency, average atmospheric dust spot efficiency, average synthetic dust weight arrestance, and dust holding capacity.

Fabrication

The faces of the case shall be flat and parallel to within a total allowance of 1/16 in. (1.6 mm). The case shall be square to within allowance of 1/8 in. (3 mm) when measured diagonally across the corners of both faces.

Filters the size of 24 x 24 x 5-1/8 in. (610 x 610 x 149 mm) and larger shall be +0, -1/8 in. (+0, -3 mm) outside dimensions, except depth, which shall be +1/16 , -0 in. (+1.6, -0 mm). All filters smaller than the above shall be +0, -1/16 in. (+0, -1.6 mm) outside dimensions except depth, which shall be +1/16, -0 in. (+1.6, -0 mm). The above dimensions exclude gaskets.

QUALITY ASSURANCE DOCUMENTATION

a) A table or drawing giving outline dimensions of the filter
b) A list of the materials of construction with appropriate specifications
c) A copy of the qualification test results performed in accordance with FB-5200
d) Certificate of Conformance to this Code and purchase specifications

Labels

Each filter shall be equipped with a permanent label. The marking on the label shall be legible and shall provide the following information:

a) Manufacturer's name and location
b) Manufacturer's designation and part number
c) Date of manufacture (month and year)
d) Rated flow capacity, cfm (m^3/hr)
e) Rated initial pressure drop in inches of water gage (Pa)
f) Recommended maximum pressure drop in inches of water gage (Pa)
g) Rated atmospheric dust spot efficiency
h) Airflow direction arrow (showing both directions if allowable without impacting published ratings)
i) Installation orientation (e.g., "Install This Way Up" or "Install With This Side Vertical")
j) UL label
k) Temperature operating range, °F (°C)

Section C
HEPA Filters

This section applies to extended media dry-type filters for use in air and gas streams operating at no more than 250°F (120°C) maximum continuous temperature and with the size and ratings included in Table FC-4110.

HEPA filter: high efficiency particulate air filter. A throwaway, extended-media dry type filter with a rigid casing enclosing the full depth of the pleats. The filter shall exhibit a minimum efficiency of 99.97% when tested with an aerosol of 0.3 micron diameter test aerosol particles.

Independent Filter Test Laboratory: an autonomous body not affiliated with a HEPA filter manufacturer or supplier subject to this Code section but capable of performing the tests necessary to demonstrate the ability of HEPA filters to meet this Code section.

Media velocity: the linear velocity of the air or gas into filter media.

Medium: the filtering material in a filter. The plural form is media.

HEPA Filters *(contd)*

Most penetrating particle size: that particle size for which the penetration of the filter medium by the test aerosol is a maximum at a specified velocity.

Particle size: the apparent linear dimension of the particle in the plane of observation, as observed with an optical microscope; or the equivalent diameter of a particle detected by automatic instrumentation. The equivalent diameter is the diameter of a reference sphere having known properties and producing the same response in the sensing instrument as the particle being measured.

***Penetrometer*:** a device for generating a test aerosol and for evaluating the aerosol penetration and air resistance of fabricated HEPA filters.

Test aerosol: dispersion of particles in air for testing the penetration of filter media or filters.

Materials

Case Materials

The case shall be made from the following materials:

a) Stainless steel Type 409, 304, 304L, 316, or 316I per ASTM A 240. Steel sheet, having maximum thickness equal to 0.0720 in. (14 gage USS)
(1.83 mm).

b) Marine plywood, minimum grade A (interior side) and minimum grade B (exterior side), APA PS-1. The minimum thickness shall be ¾ in. (19 mm). The grade shall be fire retardant treated. The plywood shall have a flame spread classification of 25 or less when tested as specified in ASTM E 84.

c) Exterior plywood, minimum grade A (interior side) and minimum grade C (exterior side, APA PS-1). The minimum thickness shall be ¾ in. (19 mm). The grade shall be fire retardant treated. The plywood shall have a flame spread classification of 25 or less when tested as specified in ASTM E 84.

Materials

Fasteners

Approved fasteners used for the assembly of HEPA filter cases are listed below:

a) Stainless steel bolts: 300 series per ASTM A 320 or ASTM A 193
b) Stainless steel nuts: 300 series per ASTM A 194
c) Stainless steel lock washers: 300 series per ANSI B18.21.1
d) Stainless steel plain washers: 300 series per ANSI B18.22.1
e) Carbon steel bolts: per ASTM A 325 or ASTM A 449
f) Carbon steel nuts: per ASTM A 563
g) Carbon steel lock washers: per ANSI B18.21.1
h) Carbon steel plain washers: per ANSI B18.22.1
i) Nails: carbon steel, galvanized, zinc coated, aluminum, per Fed Spec. FF-N-105B
j) Staples: carbon steel, galvanized, zinc coated, aluminum, per Fed Spec. FF-N-105B
k) Stainless steel rivets: 300 series per ASTM A 581

Gasket Material

Elastomer

Elastomer shall be of an oil-resistant, closed cell expanded cellular elastomer in accordance with grade 2C3 or 2C4 of ASTM D 1056, with the physical requirements specified for ASTM D 1056 (Cellular rubbers classified as Type 2, Class C, Grade 3 (2C3), or Grade 4 (2C4).

Gelatinous Seal

Gelatinous seals shall be self-adhesive and self-healing cured gel seals made of polydimethylsiloxane.

Filter Media

The filter media shall conform to the requirements of Appendix FC-I.

Faceguards

Metallic faceguards shall be fabricated from 4 x 4 mesh, wire fabric (hardware cloth) made from 0.025 in. (0.64 mm) steel conforming to either galvanized steel ASTM A 740, or 304 stainless steel ASTM A 580.

Adhesives

Adhesives used to fasten gaskets to filter case, and seal the filter pack or faceguards to the case, shall be self-extinguishing.

Gasket Material (contd)

Separators

a) ***Aluminum***: Aluminum separators shall be made from corrugated aluminum, 0.0015 in (0.038 mm) minimum thickness, conforming to ASTM B 209, Alloy 5052 H38, 3003-H18, or 1100-H18 aluminum. To protect the filter media, the separators shall be provided with a hemmed edge.

b) ***Acid Resistant Aluminum***: Acid resistant aluminum separators shall be made from corrugated aluminum, 0.0015 in. (0.038 mm) minimum thickness, conforming to ASTM B 209, Alloy 5052-H39, 3003-H19, or 1145 H-19 coated on both surfaces with a vinyl-epoxy coating. The coating should be tinted to verify the coverage of the separator. To protect the filter media, the separators shall be provided with a hemmed edge.

c) ***Glass Ribbon***: Glass ribbon separators shall be ribbons of glass fiber media bonded to the filter media.

d) ***String***: String separators shall be threads of non-combustible material bonded to the filter media.

e) ***Hot Melt***: Hot melt separators shall be a non-combustible material bonded to the filter media.

Design

Four types of HEPA filters are addressed:

a) Type A: folded filter media with corrugated separator/supports

b) Type B: minipleat media with glass ribbon or non-combustible thread separators

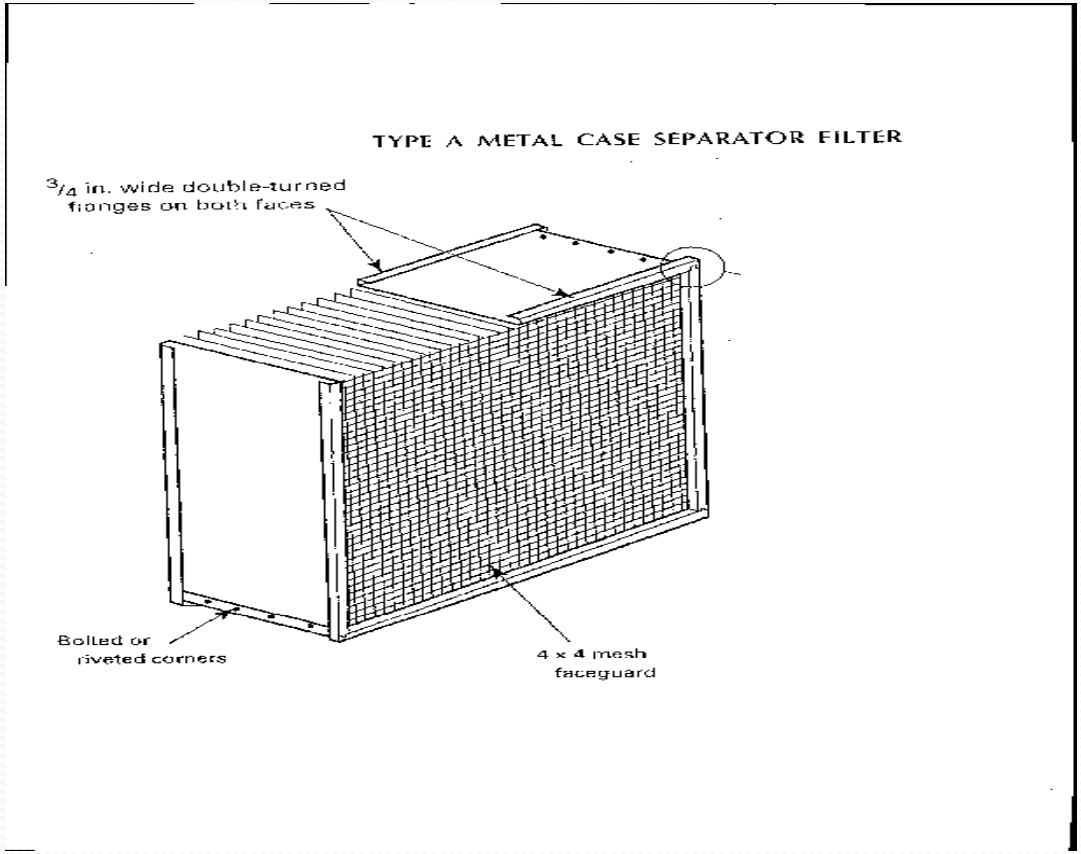
c) Type C: continuous corrugated filter media folded without separators

d) Type D: filter constructed with glass or non-combustible thread separators

The total media area provided within the filter pack shall be such that maximum media velocity is 5.0 ft/min (2.5 cm/s) at the rated flow.

No splices or patches are allowed.

Type A Metal Case Separator Filter



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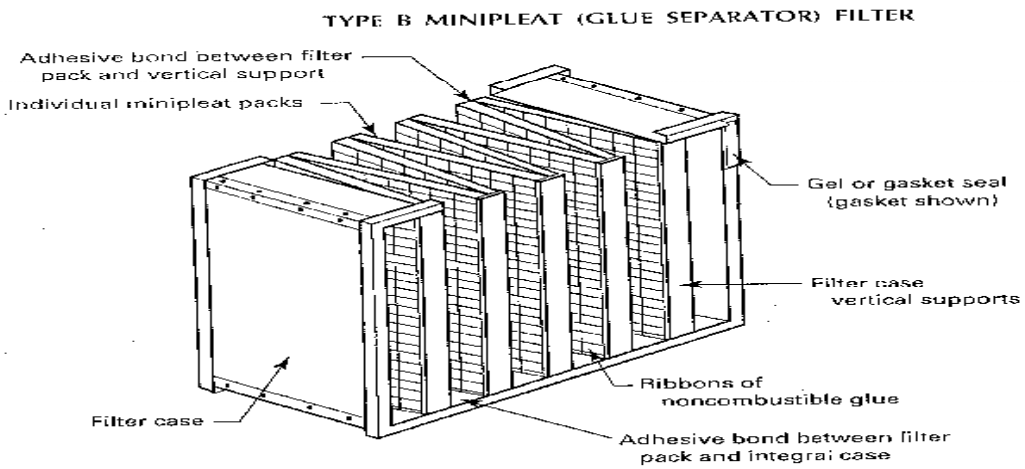
Type B Minipleat (Glue Separator) Filter



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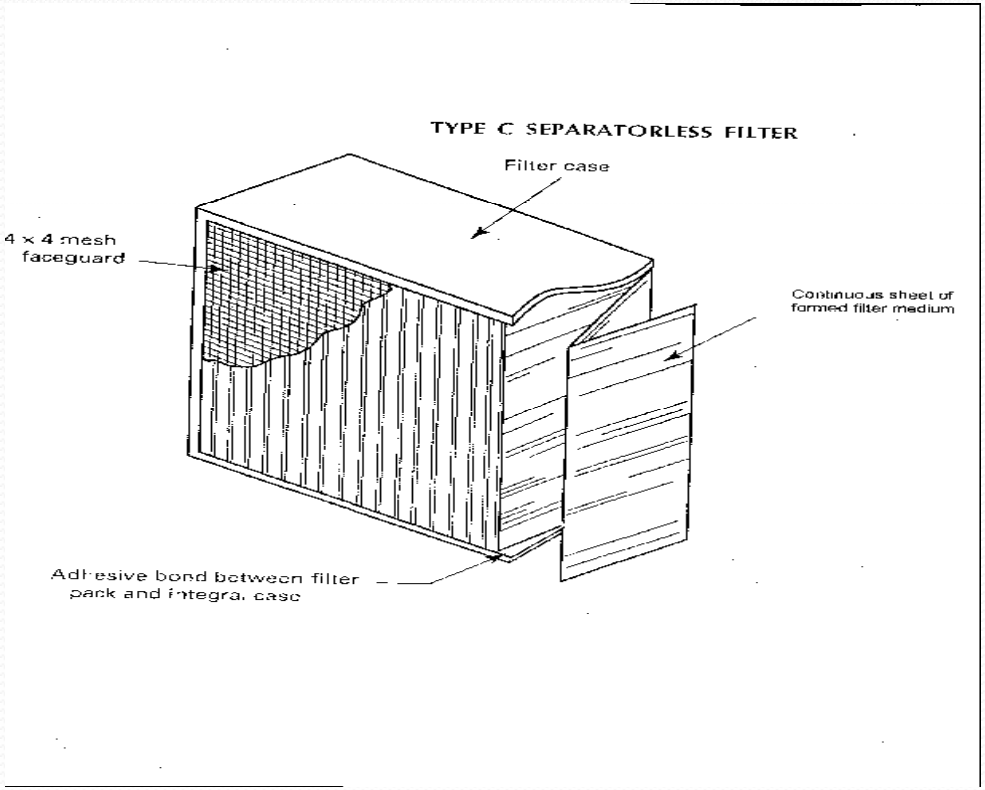
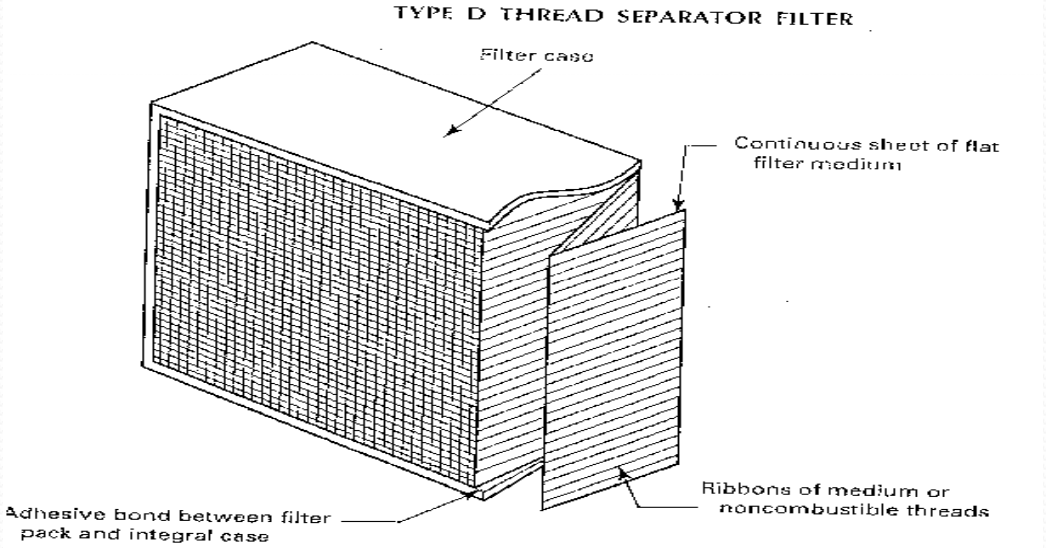
Type C Separatorless Filter



Type D Thread Separator Filter



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Inspection
Qualification Testing

New or revised filter designs shall require qualification testing prior to acceptance and production. Filter designs shall be requalified at least every 5 yrs. Tests shall be performed and certified by an independent test facility.

- Qualification sample of 12 filters
- Any filter not satisfying any requirement rejects the sample:

1. Resistance to air flow
2. Test aerosol penetration
3. Resistance to rough handling
4. Resistance to pressure
5. Resistance to heated air
6. Spot flame resistance
7. Structural integrity

Production Testing for Each Filter

1. Visual inspection
2. Test aerosol penetration
3. Resistance to air flow

Fabrication

Flat and Parallel

Dimensional Tolerances

Complete sealing media to case

No distortion, deformation, sagging, cracks, or holes

Packing

Pleat Direction

Stacking

Quality Assurance

Dr. Ronald R. Bellamy
U.S. Nuclear Regulatory Commission

Nameplates

Filter marking

Package marking

Mandatory Appendix for

- Filter Media
- Supercedes MIL-F-51079d
- Furnished on rolls
- Splices clearly marked

Physical and Chemical Properties

- Airflow resistance
- Test aerosol penetration for 0.3 micron particles less than 0.03%
- Tensile strength
  a) Elongation
  b) After heated air
  c) Wet tensile strength
  d) After gamma irradiation
- Water repellency
  a) Before irradiation
  b) After irradiation
- Thickness
- Combustible Material
- Flexing
- Qualification of a 3.05 M sample, full width every 5 years

L-06
Iodine Filtration Overview

Type II Adsorber Cells

Type III Adsorber Cells

Adsorbent Media

Dr. Ronald R. Bellamy
U. S. Nuclear Regulatory Commission

Type II Adsorber Cells

The Type II adsorber unit is a single cell composed of 2 in. adsorber beds, access panel(s) for recharging, and a gasketed flange.

Adsorber cell/cell: a modular container for an adsorbent, with provision for sealing to a mounting frame, which can be used singly or in multiples, to build up a system of any airflow capacity

Baffle: a non-perforated member oriented substantially perpendicular to the direction of airflow, connected to a wall or divider of the cell, and having the purpose of preventing wall effects and channeling.

Bed/adsorber bed: a layer of adsorbent contained between two perforated sheets spaced at a specified distance; also, the assembly of perforated and non-perforated members that comprises the volume into which the adsorbent is packed.

Blank/blank area: a non-perforated area within the perforated portions of a perforated sheet or screen.

Channeling: a flow of gas or vapor through passages or areas of lower resistance that may occur within a bed due to non-uniform packing, segregation, irregular sizes or shapes of granules, or displacement of granules by direct impingement of high-velocity air.

Adsorber Cells *(contd)*

Margin: an unperforated area at the side or end of, or around the perforated area of, a perforated sheet or screen

Mechanical leak: the measure of the direct leakage through metal parts of the cell or its gasket due to defects

Penetration: the exit concentration of a given gas from an air cleaning device, expressed as percentage of inlet concentration.

Refrigerant-11: trichloromonofluoromethane in accordance with ANSI/ASHRAE 34-89.

Refrigerant-12: dichlorodifluoromethane in accordance with ANSI/ASHRAE 34-89.

Residence time: the calculated time that a contaminant gas or vapor remains in contact with the adsorbent at a specified volume flow rate, based on net unbaffled screen areas and thickness of the bed.

Through bolt: a bolt or other fastener that passes through the adsorbent bed.

Wall effect: partial gas stream bypass of the adsorbent which occurs along an unbaffled metal to adsorbent interface.

Materials

Adsorbent

Screens

Casing

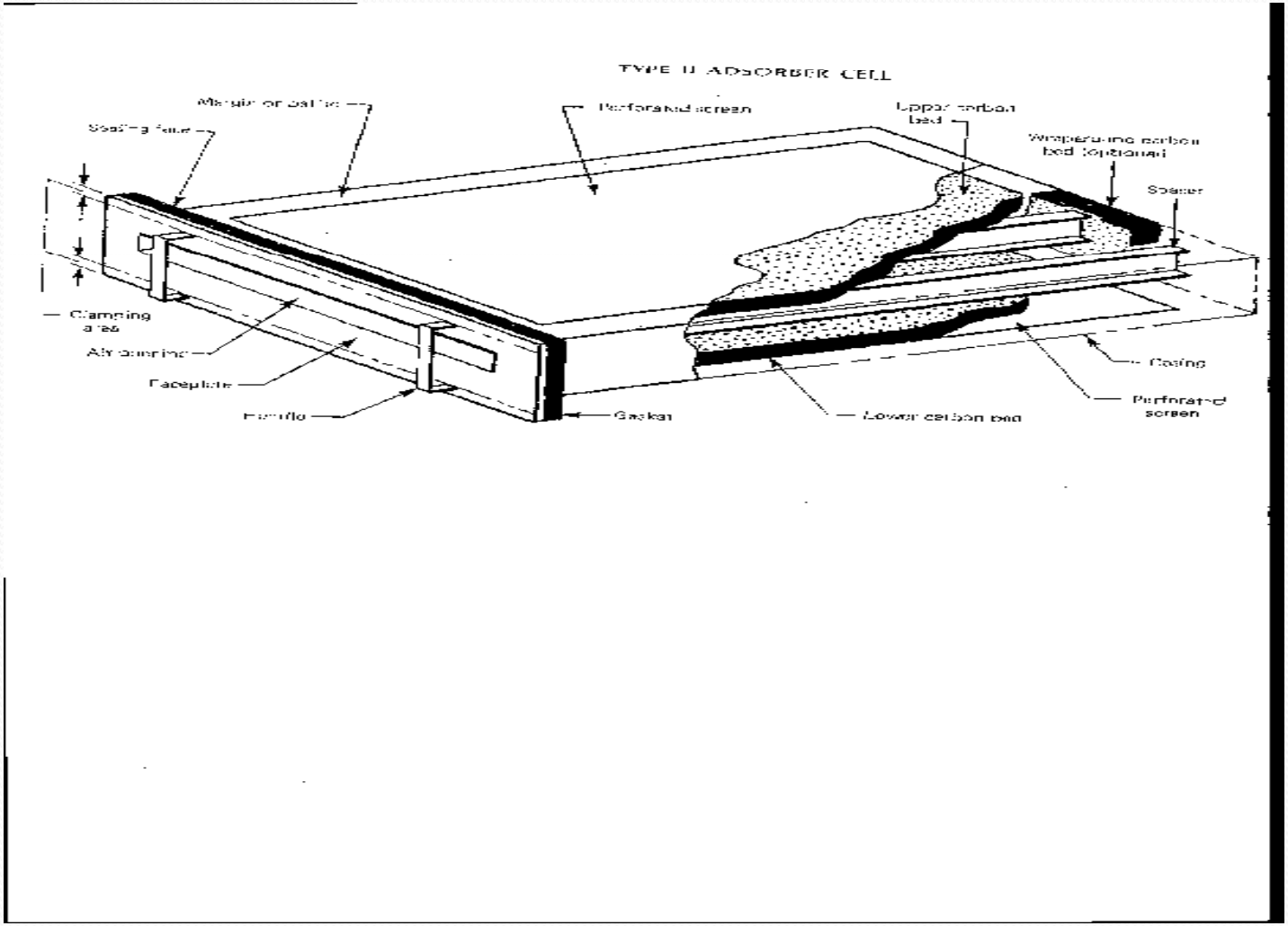
Gasket

Adhesive

Fasteners

Rivets

Design


TYPE II ADSORBER CELL
Perforated screen
Upper carbon bed
Spacer
Clamping area
Air sampling
Faceplate
Gasket
Lower carbon bed
Perforated screen

Design *(contd)*

When filled with sorbent, the cell shall have a minimum residence time of 0.25 sec at rated capacity of 333 cfm (9.43 m^3/min). The residence time shall be determined by the procedure in Mandatory Appendix I. The filled cell shall have a maximum airflow resistance of 1.25 in. wg (0.31 kPa) when tested at rated flow.

Inspection and Testing

Visual inspection of each cell and weld

Qualification every five years of cell and filling method

Four cells (random) subject to rough-handling machine

Tested for airflow resistance and refrigerant leak test to 99.9%

Fabrication

Dimensional tolerances

Damaged gaskets and screens are to be replaced

Welds can be redone

Packaging

Each cell individually wrapped for moisture and water-vapor resistance and stored with screens horizontal

No more than five cells high on a pallet

No more than two pallets

Nameplates

1. Each cell shall be legibly and permanently marked on the front of the faceplate or on a metal label affixed to the faceplate with the following information:
   a) Type II cell
   b) Manufacturer's name or symbol
   c) Serial number
   d) Month/Year (of manufacture)
   e) Empty weight

2. Each cell shall bear a replaceable label with the following information:
   a) Adsorbent Manufacturer's name or symbol
   b) Adsorbent type and grade designation, lot, and batch
   c) Filled weight
   d) Adsorbent weight
   e) Airflow resistance at specified airflow rating
   f) Refrigerant leak test results
   g) Date of filling

Residence Time

Residence time, the theoretical time that the gas remains within the bed of the adsorber cell, at a specified airflow, by remaining in contact with the adsorbent, is calculated from the following equation:

Customary Units $\quad T = \frac{t(A-B)}{28.8Q}$

where

A = gross screen area of all screens on inlet side or outlet side, whichever is smaller, $in.^2$

B = total area of baffles, blanks, margins of all screens, $in.^2$

Q = total cell volumetric airflow, cfm

T = resident time, sec

t = thickness of bed, in.

Resident Time *(contd)*

SI Units

$$T = 3.6 \times 10^{-3} \frac{t(A - B)}{Q}$$

Where

A = Gross screen area of all screens on inlet side or outlet side, whichever is smaller, cm^2

B = Total area of baffles, blanks, margins of all screens, cm^2

Q = Total cell volumetric airflow, m^3/h

T = Residence time, sec

t = Thickness of bed, cm

Type III Adsorber Cells

The Type III adsorber is a gas phase adsorber characterized as being a single assembly, fixed and rechargeable in place, with an adsorbent.

Similar definitions as Type II

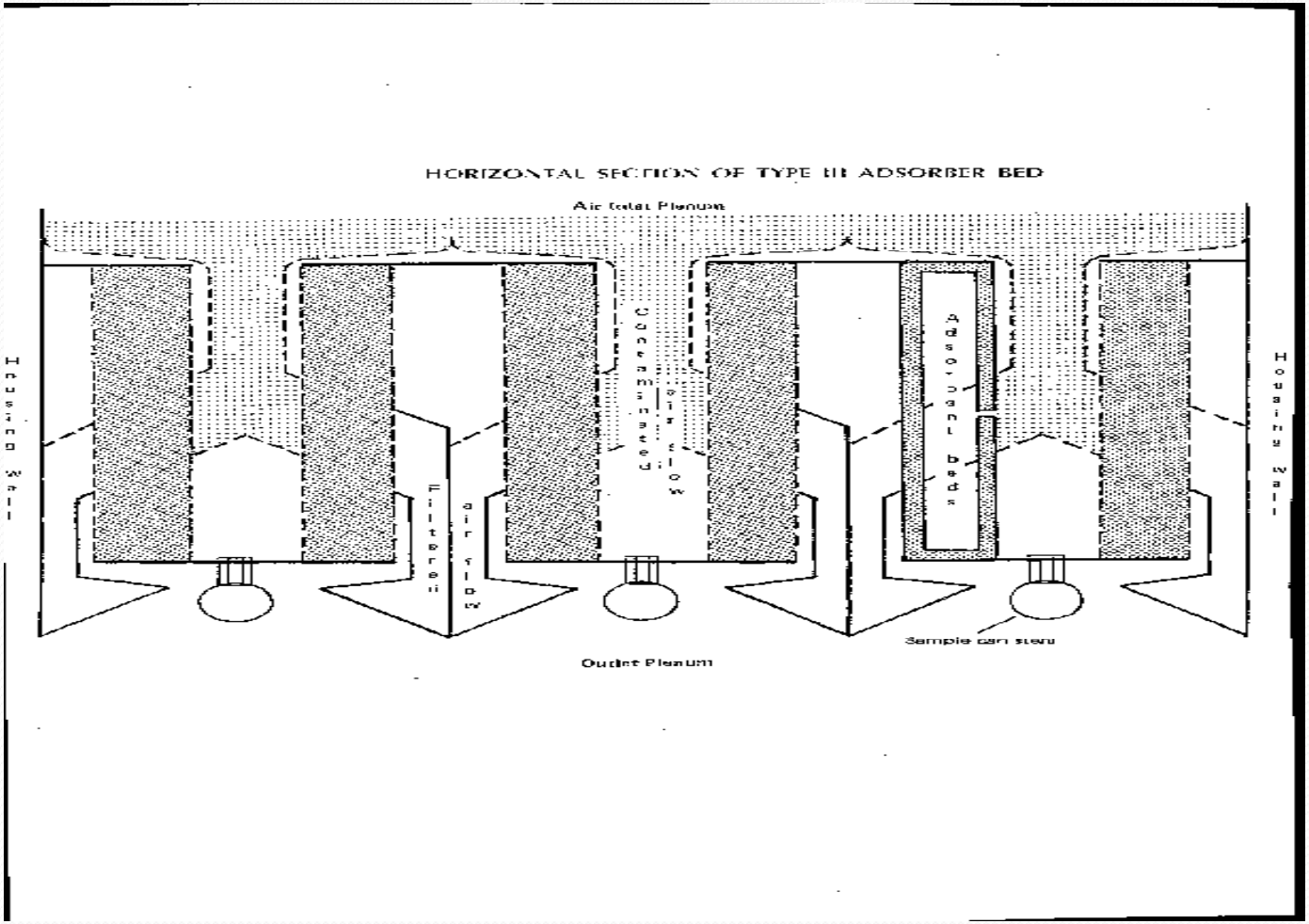
Materials

Adsorbent

Screens and Casings

Gaskets and Seal Pads

Design


HORIZONTAL SECTION OF TYPE III ADSORBER BED
Air Inlet Plenum
Outlet Plenum
Sample Cell Stem

Design *(CONTD)*

Type III adsorbers are characterized as consisting of single or multiple beds of activated carbon (adsorbent), fixed in place, and sized to process a given volume of air or gas. The bed is fabricated, using perforated sheet and structural pieces, into a welded assembly. Air enters the upstream face of the bed, passes through the packed adsorbent and exits from the downstream face.

Each bed section shall consist of perforated sheets, spaced uniformly to form the bed. The sheets shall be assembled to a formed, nonperforated frame by welding.

Loading systems shall provide for the uniform distribution and packing of adsorbent into the bed assembly.

Adsorbent removal connections from the adsorber beds shall be piped external to the filter housing and provided with a mechanically sealed, leak-tight closure system.

The Type III adsorber design shall include a means to obtain samples of the adsorbent. The preferred method is one which incorporates a set of sample canisters.

Inspection and Testing

Visual

Dimensional

Bed depth

Screens – Waviness

Adsorbent Reservoir

Qualification

- Functional
- Filling Method

Calcuation of Residence Time

Mandatory Appendix for Screen Waviness

- Variation in bed depth
- Affect on residence time

Check on each section

- Any depressions more than 5% using a flat edge needs bed depth measurement

Mandatory Appendix for Adsorber Filling Qualification

1. Determine density and adsorbent size distribution using ASTM procedures.
2. Calculate bed volume
3. Fill adsorber using fill procedure
4. Obtain samples of filled adsorbent
   a. Determine particle size distribution
   b. Calculate packing density

$$CP = \frac{W - L}{V_B}$$

CP = packing density, lb/ft³

L = loss attributed to adsorbent fines or dusting, lb

where V_B = measured bed volume, ft³

W = measured weight of adsorbent in the bed (less moisture content), lb

Use weight change in HEPA filter during vacuum cleaning for L

5. Acceptance criteria
   a. Density ± 10%
   b. Particle size distribution ± 5%

Adsorbent Media

The specific testing procedures and acceptance criteria contained in this section were developed for activated carbon as the adsorbent medium. However, any adsorbent medium that can be demonstrated to perform equal to or better than activated carbon for the conditions specified herein shall be acceptable for nuclear safety-related air and gas treatment systems.

Activated carbon: a family of carbonaceous substances manufactured by processes that develop adsorptive properties

Batch: a quantity of adsorbent, not to exceed 10 m^3 in size, of the same grade or type that has been produced under the same Manufacturer's production designation using a consistent manufacturing procedure and equipment and that has been homogenized to exhibit the same physical properties and performance characteristics throughout its mass.

Coimpregnants: two or more different impregnants fixed on the carbon in conjunction, to further enhance radiodine removal properties.

Adsorbent Media *(CONTD)*

Grade or type: the Manufacturer's designation for an adsorbent having a given set of performance capabilities and physical properties, manufactured according to a fixed set of procedures.

Impregnated activated carbon: a material that, after activation, is impregnated with a chemical compound or compounds to increase its ability to retain organic iodides, particulary at high temperatures and humidity condition. Typical impregnants include iodides such as potassium iodide and triiodide, amines such as triethylenediamine (TEDA), and combinations thereof.

Lot: one or more batches of adsorbent that comprises and satisfies a purchase order.

Qualification test: a test performed at lease once every 5 yr on three representative samples taken from a single batch of a Manufacturer's grade or type of adsorbent. This test qualifies the specific grade or type of adsorbent for all similar future uses for a period not to exceed 5 yr.

Virgin activated carbon: a material that has not seen service and has not been reactivated.

ASTM Documents

D 2652 Definitions

D 2854 Apparent Density

D 2862 Particle Size Distribution

D 3466 Ignition Temperature

D 3467 Carbon Tetrachloride Activity

D 3802 Hardness

D 3803 Radioiodine test methods

D 4069 Radioiodine Specifications

ASTM Documents *(CONTD)*

- Activation of base material determines surface area
- Reactivation not allowed
- Impregnants for enhanced performance at high humidities
- Reimpregnation is acceptable

Inspection and Testing

Physical

1. Before impregnation, carbon tetrachloride activity >60% (ASTM D 3467)

   After impregnation, apparent density >0.38 gm/ml (ASTM D 2854)

2. Particle size distribution (ASTM D 2862)
3. Ignition temperature >330°C (ASTM D 3466)
4. Hardness >92% (ASTM D 3802)

Radioactive Testing

Qualification tests every five years

1. Methyl iodide >99% at 80°C and 95% RH (ASTM D 3803)
2. Elemental iodine >99.9% at 30°C and 95% RH (ASTM D 3803)

Inspection and Testing *(CONTD)*

Tests on Every Batch

1. Methyl iodide >97% at 30°C and 95% RH
   (ASTM D 3803)
2. Elemental iodine retention >99.5% at 130°C
   (ASTM D 3803)

L-11
Applicability to Regulatory Requirements

- ASME Code
- Regulations
- Regulatory Guides
- Technical Specifications

Dr. Ronald R. Bellamy
U. S. Nuclear Regulatory Commission

Regulatory Guide 1.52, Rev. 3

Design, inspection and testing criteria for air filtration and adsorption units of post-accident ESF atmosphere cleanup systems in light-water-cooled nuclear power plants.

1. Introduction repeats General Design Criteria from 10 CFR 20:

   19, 41, 42, 43 and 61, as applicable, clearly defining the air filtration systems as ESF. Environmental factors during a DBA need to be considered during the design.

- Δ P
- Dose Rate
- RH
- Temperature (maximum and minimum)
- Integrated radiation dose

Systems Design Criteria

1. Typical Components:

Demister
Heater
Prefilter
HEPA
Carbon Adsorber
HEPA
Fan
Housing

Systems Design Criteria *(contd)*

2. Redundant
3. Seismic Category I
4. Flow Rate < 30,000 CFM per train
5. Instrumentation
   - Appropriate IEEE Criteria
6. Component Design Criteria and Qualification testing
   1) ANSI N509 "Nuclear Power Plant Air Cleaning Units and Components" used as main reference
   2) Activated carbon assumed as adsorbent

System Design Criteria *(contd)*

- Maintenance
  1. Accessability – Three feet between components
  2. Permanent test probes
- In-Place Testing
  1. Visual
  2. Flow Distribution
  3. HEPA DOP test leak tightness >99.95% warrants 99% of particulate removal credit
  4. Carbon freon test-leak tightness >99.95%
  5. Carbon laboratory testing – ANSI N509, BED depth determines decontamination efficiency
  6. Frequency

Technical Specifications

- Two separate and independent standby gas treatment system circuits shall be operable when secondary containment is required.
- With one standby gas treatment system circuit inoperable:

Tech Specs *(contd)*

During power operation:

- Verify the operability of the other standby gas treatment system circuit within 2 hours. If testing is required to demonstrate operability and significant painting, fire or chemical release has taken place in the reactor building within the previous 12 hours, then demonstration by testing shall take place within 1 hour of the expiration of the 12 hour period, and
- Continue to verify the operability of the standby gas treatment system circuit once per 24 hours until the inoperable standby gas treatment circuit is returned to operable status.
- Restore the inoperable standby gas treatment circuit to operable status within 7 days.

Tech Specs *(contd)*

During Refueling:

- Verify the operability of the other standby gas treatment system within 2 hours. If testing is required to demonstrate operability and significant painting, fire or chemical release has taken place in the reactor building within the previous 12 hours, then demonstration by testing shall take place. Within 1 hour of the expiration of the 12 hour period, and
- Continue to verify the operability of the redundant standby gas treatment system once per 7 days until the inoperable system is returned to operable status.

Tech Specs *(contd)*

- Restore the inoperable standby gas treatment system to operable status within 30 days or cease all spent fuel handling, core alterations or operation that could reduce the shutdown margin (excluding reactor coolant temperature changes).

If specifications are not met, reactor shutdown shall be initiated and the reactor shall be in the cold shut down condition within 24 hours.

Standby Gas Treatment System

1. The capability of each standby gas treatment system circuit shall be demonstrated by:

   a) At least once per 18 months, after every 720 hours of operation, and following significant painting, fire, or chemical release in the reactor building during the operation of the standby gas treatment system by verifying that:

      1) The charcoal adsorbers remove ≥ 99% of a halogenated hydrocarbon refrigerant test gas and the HEPA filters remove ≥ 99% of the DOP in a cold DOP test when tested in accordance with ANSI N510-1975.

      2) Results of laboratory carbon sample analysis show ≥ 95% radioactive methyl iodide removal efficiency when tested in accordance with ASTM D 3803-1989 (30°C, 95% relative humidity, at least 45.72 feet per minute charcoal bed velocity).

Standby Gas Treatment System *(contd)*

b) At least once per 18 months by demonstrating:
   1. That the pressure drop across a HEPA filter is equal to or less than the maximum pressure drop indicated in figure 4.5.1
   2. The inlet heater is capable of at least 10.9 KW input
   3. Operation with a total flow within 10% of design flow

c) At least 30 days on a staggered test basis by operating each circuit for a minimum of 10 hours

d) Anytime the HEPA filter bank or charcoal adsorbers have been partially or completely replaced, the test per 4.5.H.1.a (as applicable) will be performed prior to returning the system to operable status

e) Automatic initiation of each circuit every 18 months