SECTION TA
ACCEPTANCE TESTING

DRAFT
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Note: This is a draft document. An approved code section may differ in many respects. This draft version is made available for discussion purposes only.

SECTION TA
DRAFT
FIELD TESTING OF NUCLEAR AIR TREATMENT, HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

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ARTICLE TA-1000
INTRODUCTION

TA-1100 SCOPE

This section provides requirements for the field acceptance testing of nuclear safety-related air treatment, heating, ventilating, and air conditioning systems in nuclear facilities.

TA-1110 PURPOSE

The purpose of this section is to provide requirements for field acceptance testing, the results of which are used to verify that nuclear air treatment, heating, ventilating, and air conditioning systems perform their intended function.

TA-1120 APPLICABILITY

This section applies to acceptance testing of nuclear safety-related air treatment, heating, ventilating, and air conditioning systems which are assembled, installed and ready for use. Included are requirements for integrated system performance testing under simulated conditions of operation. It is the Owner's responsibility to meet each of the applicable requirements in this section.

TA-1130 DEFINITIONS AND TERMS

The definitions provided in this section supplement those listed in AA-1000.

Abnormal Incident - - any event or condition which may adversely affect the functionality of the nuclear air treatment, heating, ventilating, and air conditioning system.

Acceptance Test - - a test to verify system or component design function following initial field installation, an abnormal incident, replacement, repair, or modification affecting a test reference value.

Adsorbent -- a solid having the ability to concentrate other substances on its surface.

Adsorber -- a device or vessel containing adsorbent.

Adsorber Bank or Filter Bank -- one or more filters or adsorbers secured in a single mounting frame, or one or more side by side panels containing poured or packed air treatment media, confined within the perimeter of a duct, plenum, or vault cross section, sometimes referred to as a stage.

Aerosol -- a stable suspension of particles, solid or liquid, in air.

Challenge -- to expose a filter, adsorber, or other air treatment device to an aerosol or gas of known characteristics, under specified conditions, for the purpose of testing.

Challenge Gas -- a gas of known characteristics, under specified conditions, used for the purpose of testing. For in-place testing of adsorbers, the challenge gas is to be Refrigerant-11 or an acceptable substitute.

NOTE: For Challenge Gas Substitution Selection Criteria, refer to Non Mandatory Appendix TA-C.

Challenge Aerosol--poly-disperse droplets of dioctyl phthalate, (di(2-ethyl hexyl) phthalate), used as challenge aerosol for testing HEPA filter banks for leaks. The challenge aerosol for in-place leak testing of HEPA filter systems, in accordance with this section, is poly-disperse DOP liquid aerosol having an approximate light scattering droplet size distribution as follows:

99% less than 3.0 micrometer diameter
50% less than 0.7 micrometer diameter
10% less than 0.4 micrometer diameter

NOTE: The poly-disperse aerosol used for in-place leak testing of systems differs from the 0.3 micrometer mono-disperse DOP aerosol used for efficiency testing of individual HEPA filters by manufacturers.

HEPA Filter -- (High Efficiency Particulate Air) a disposable, extended- media, dry type filter enclosed in a rigid casing, that has a minimum efficiency of 99.97% when tested with an essentially mono-disperse 0.3 micrometer test aerosol.

In-Service Test -- A periodic test to verify that a system or component continues to meet its intended design function after being placed into operation.

Pressure, Maximum Operating -- The maximum pressure the system components will be subjected to while performing their function. The allowable pressure during abnormal operating conditions which will not physically damage the system (e.g. sudden closure of dampers or registers), shall be considered maximum operating pressure.

Pressure, Operating -- the pressure that corresponds to the normal design operating mode of the system. This pressure is less than or equal to the maximum operating pressure.

Pressure, Structural Capability -- the pressure to which the designer specifies the component or system can be safely operated without permanent distortion.

Reference Value -- one or more achieved values or test parameters that are measured, observed, or determined when the equipment or system is known to be operating acceptably within its design basis range.

System -- An assembly of components, including associated instruments and controls, required to perform the safety-related function of a nuclear air treatment, heating, ventilating, and air conditioning system.

Test Boundary -- the physical limits of the component, system, or device being subjected to a specified test.

Test Canister -- a specially designed sample holder containing adsorbent for laboratory tests that can be removed from an adsorber bank, without disturbing the remainder

of the adsorber, to provide representative samples for laboratory testing.

ARTICLE TA-2000
REFERENCE DOCUMENTS

The reference documents listed below shall supplement those listed in AA-2000.

AMERICAN CONFERENCE OF GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH) INDUSTRIAL VENTILATION: A Manual of Recommended Practice.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
ASTM D 3803-1989, Standard Test Method for Nuclear Grade Activated Carbon.

AMERICAN NUCLEAR SOCIETY (ANS)
ANS 3.1 , Selection Qualification and Training of Nuclear Power Plant Personnel. (latest edition)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
ANSI/ASME NQA-1-1989
Quality Assurance Program Requirements for Nuclear Facilities.

ANSI/ASME NQA-2-1989
Quality Assurance Requirements for Nuclear Facility Applications.

SHEET METAL AND AIR-CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC (SMACNA)
HVAC Systems Testing, Adjusting, and Balancing 1983.

ASSOCIATED AIR BALANCE COUNCIL (AABC)
National Standard of Total System Balance 1989.

DEPARTMENT OF ENERGY, DOE Proceedings
16th DOE Nuclear Air Cleaning Conference, page 125, "Size Distribution of Aerosols Produced from Substitute Materials by the Laskin Cold DOP Aerosol Generator", February 1981, NTIS Springfield, VA. (W. Hinds, J. Macher, M. First).

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)
Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems 1991.

(**REFERENCES WILL BE UPDATED TO LATEST ADDITION PRIOR TO PUBLICATION**)

ARTICLE TA-3000
GENERAL INSPECTION AND TEST REQUIREMENTS

TA-3010 General

All inspections and tests shall be conducted in accordance with these requirements and the specific requirements of TA-4000.

NOTE: Activities in this section may involve the use of hazardous materials, operations and equipment. This section does not purport to address all of the safety requirements associated with their use. It is the responsibility of the user of this section to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.

TA-3100 TEST INSTRUMENTS

A calibration program shall be established in accordance with the Owner's Quality Assurance Program. All permanent and temporary test instruments used in the conduct of tests required by TA-4000 shall be in calibration. Instrument accuracy shall meet or exceed the requirements of Table TA-3000-1.

TABLE TA-3000-1
INSTRUMENT ACCURACY REQUIREMENTS

MEASUREMENT	RANGE	ACCURACY
Pressure	>1.0 psig (>7.0 kPa(gage))	+/- 2.0 %
Pressure	from 1.0 in wg to 1.0 psig (0.25 to 7.0 kPa(gage))	+/- 0.1 in wg (+/-0.025 kPa)
Pressure	from 0.1 in wg to 1.0 in wg (2.5 to 250 Pa(gage))	+/- 0.01 in wg (+/-2.5 Pa)
Temperature	variable	+/- 2.0 °F (+/- 1.0 °C)
Temperature*	variable	+/- 0.5 °F (+/- 0.25 °C)
Vibration	variable	Per TA-3141
Flow	variable	+/- 5.0 %
Velocity (airflow)	variable	+/- 3.0 %
Speed	variable	+/- 2.0 %
Time	variable	+/- 1.0 sec
Electrical voltage	variable	+/- 1.0 %
Electrical resistance	variable	+/- 1.0 %
Challenge aerosol concentration		Per TA-3142
Challenge gas concentration		Per TA-3143

* Required for pressure testing in mandatory Appendix TA-III.

TA-3110 Range Requirements

The full scale range of instruments shall be limited as necessary to ensure that

the readings are within the accuracy requirements of Table TA-3000-1.

TA-3120 Instrument Fluctuation

Symmetrical damping devices or averaging techniques may be used to reduce random signal fluctuations. Hydraulic instruments may be damped by using gauge snubbers or by throttling valves in instrument lines.

TA-3130 Evaluation Following Test Instrument Loss, Damage or Calibration Failure

When a test instrument is lost, damaged, or otherwise fails to meet the requirements of Table TA-3000-1 during calibration, all test results obtained using the instrument shall be evaluated, dating back to the time of the previous calibration. If the evaluation does not confirm that the instrument met the acceptance criteria for the test(s) in question, the test(s) shall be repeated with calibrated instruments.

TA-3140 Specific Instrument Accuracy Requirements

TA-3141 Vibration Instrument

Vibration instrument accuracy shall be at least +/- 10%. The minimum frequency response range of the vibration measuring instrument shall be approximately one third of the minimum shaft speed. For rotating components, the maximum frequency response range shall be at least two times the rotational shaft speed of the component being measured. For reciprocating components, the maximum frequency response range shall be at least two times the speed of the crankshaft, times the number of unique planes occupied by a piston throw.

TA-3142 Challenge Aerosol Measuring Instrument

The Challenge Aerosol Measuring Instrument shall be verified to have a linear range of at least 10^5 times the threshold sensitivity of the instrument with an accuracy in accordance with the Facility Project Specifications and Owner's Quality Assurance Program.

TA-3143 Challenge Gas Measuring Instrument

The Challenge Gas Measuring Instrument shall be verified to be capable of distinguishing challenge gas from background and measuring challenge gas over a linear range of at least 10^5 times the threshold sensitivity of the instrument with an accuracy in accordance with the Facility Project Specifications and Owner's Quality Assurance Program.

TA-3200 REFERENCE VALUES

TA-3210 Establishment of Reference Values

Reference values shall be determined from results achieved during acceptance testing (TA-4000), when a component or system is proven to be operating within the acceptable

limits of the Owner's Design Specification. Operating tests and inspections specified in TA-4000 shall be observed, measured, or calculated under conditions readily reproducible during subsequent in-service tests to allow for direct comparison of test results. All test results and associated analyses shall be included in the test procedure documentation (TA-6300).

TA-3300 INSPECTIONS AND TESTS

Acceptance tests shall be conducted following initial component installation but prior to releasing the system for normal operations. Applicable acceptance tests shall also be used to obtain new reference values and verify design function following component replacement, repair, modification, or maintenance. Equipment shall be evaluated as separate components and as functioning parts of an integrated system. The Owner shall define system test boundaries and evaluate system performance with respect to system functional requirements in accordance with the Owners Design Specifications. Field acceptance tests shall be implemented as applicable and in accordance with this section.

Test designations associated with tests required by TA-4000 are listed in Table TA-3000-2. Within the context of TA-4000, when a test is not associated with a Designator it shall be considered a prudent action and not a test requirement.

TABLE TA-3000-2
TEST DESIGNATIONS

TEST	DESIGNATOR
Air-Aerosol mixing test	AA
Airflow distribution test	AD
Differential pressure test	DP
Differential temperature test	DT
Flow rate test	Qf
Functional test*	F
Hydrostatic test	HYD
In-place leak test	IP
Laboratory analysis (adsorbent methyl-iodide penetration)	LAB
Electrical performance test	AMP
Leak test	PL
Structural capability test	PS
Rotational speed test	N
Bearing temperature test	Tb
Vibration test	Vb
Visual inspection	VT

* Functional tests consist of various mechanical actuation and performance verifications and are detailed separately in each test article.

TA-3310 Inspection and Test Parameters

Parameters which need to be observed, calculated and recorded in order to meet the requirements of this section shall be identified for each system based on the functional requirements of the Owner's Design Specification and shall be included in the test procedure documentation (TA-6300).

TA-3320 System Operating Conditions

Operating conditions required for acceptance testing shall be determined for each system. These conditions and acceptance criteria shall be based on the requirements of the Owner's Design Specification and shall be included in the test procedure documentation (TA-6300).

TA-3330 Procedure Requirements

The Owner shall be responsible for the development and implementation of written test procedures that meet the requirements of this section. Each equipment test section consists of generic (TA-3400) and specific (TA-4000) test requirements and acceptance criteria which apply to each of the systems in the facility. The Owner shall document which requirements are applicable in the test procedure documentation (TA-6300).

TA-3340 Test Reports

Test reports shall be prepared in accordance with TA-6300.

TA-3400 GENERIC TESTS

Generic tests as specified in TA-3410 through TA-3433 shall be used in Article TA-4000 where applicable.

TA-3410 Visual Inspection (VT)

Visual inspections shall be conducted in accordance with AA-5000 and the applicable portions of mandatory Appendix TA-I. Field acceptance visual inspections, required in TA-4000, shall include verification of component installation in accordance with the Owner's Design Specification and the applicable sections of this Code. Acceptance inspections shall be conducted prior to releasing the equipment for normal operation.

TA-3420 Pressure Boundary Tests

Pressure boundary tests consist of hydrostatic (or pneumatic) tests for hydronic systems, leak tests for refrigerant systems, and structural capability and leak tests for ducts and housings, including fan and damper housings.

TA-3421 Hydrostatic Tests (HYD)

Hydrostatic tests shall be conducted at the hydrostatic pressure defined by the Owner and shall verify that the component will not rupture, leak or be permanently deformed under design pressure loads. Testing shall be conducted in accordance with the design codes used in the Owner's Design Specification (e.g. ANSI/ASME B31.1). Pneumatic testing may be used in lieu of water where allowed by the applicable codes and in the Owner's Design Specification.

TA-3422 Structural Capability Test (PS)

Structural capability tests shall be conducted at the structural capability pressure defined by the Owner's Design Specification and shall verify that the component will not rupture or be permanently deformed under design pressure loads. Testing shall be conducted in accordance with mandatory Appendix TA-II.

TA-3423 Leak Test, Duct, Housing, and Frames (PL)

Leak tests for duct and housing sections shall be conducted using either the pressure decay method or the constant pressure method to verify that the leak rate for duct or housing does not exceed the allowable limit established for the system. Testing shall be conducted in accordance with mandatory Appendix TA-III. Leak testing performed to satisfy Section SA of this Code may be used to meet these test requirements when the test method is compatible with mandatory Appendix TA-III.

An optional leak test for HEPA filter and adsorber mounting frames is authorized to be conducted in conjunction with the housing leak test by blanking off the frame openings and pressurizing the isolated test boundary. This procedure is useful for detecting small leaks in the mounting frame during acceptance testing. This test is used to verify that there are no defects in a frame that may cause failure of the in-place leak test. Testing should be conducted in accordance with non-mandatory Appendix TA-A.

TA-3424 Leak Test, Refrigerant Piping and Coils (PL)

Leak tests of refrigerant piping and coils shall be conducted in accordance with mandatory Appendix TA-VIII.

TA-3430 Functional Tests (F)

A functional test shall be used to verify mechanical and system performance parameters of equipment. Functional tests include component and system tests as required in Article TA-4000. Component functional tests are used to verify the operational readiness of individual components. Integrated system functional tests are used to verify that all of the system components will operate together under normal operating or simulated conditions and will meet all of the performance requirements of the Owner's Design Specification.

TA-3431 Test Conditions

Equipment shall be tested within the normal operating range specified in the Owner's Design Specification except as otherwise specified in TA-4000.

TA-3432 Restoration of Function Following Testing

Mechanical and electrical equipment status shall be restored as required by plant conditions and according to approved procedures following completion of any test.

TA-3433 Vibration Test (Vb)

Vibration measurements shall be taken on the accessible motor, fan, compressor and pump bearing housings in at least two different orthogonal planes approximately perpendicular to the line of the rotating shaft. When the bearing housing is not accessible, the frame of the component may be used if it will be representative of bearing housing vibration. When portable vibration instruments are used, reference points shall be clearly identified on the component being measured to permit duplication in both location and plane.

TA-3500 ACCEPTANCE CRITERIA

Results of tests described in Article TA-4000 shall be subject to the acceptance criteria in TA-3510 through TA-3530 and to the applicable operating and design criteria specified by the Owner's Design Specification. Test results are considered acceptable if the component or system is not impaired or degraded to the point that it cannot perform its intended function. Acceptance criteria are specified in TA-4000 only when they affect the quality of other tests. When test results do not meet the applicable acceptance criteria, the corrective actions required by TA-5000 shall be initiated.

TA-3510 Visual Inspection

Visual inspections are acceptable when there are no visual indications of improper installation, physical damage, structural distress or degradation that would impair the ability of a component or system to perform its intended function.

TA-3520 Pressure Boundary Tests

Pressure boundary tests are acceptable when there is no permanent structural deformation or leaks in excess of the limits specified in the applicable sections of this Code and the Owner's Design Specification.

TA-3530 Functional Tests

Functional tests are acceptable when they meet the requirements of the applicable sections of this Code and the Owner's Design Specification.

ARTICLE TA-4000
FIELD ACCEPTANCE TESTS

TA-4010 General

Field acceptance tests shall be conducted following initial system installation but prior to releasing the equipment for normal operation. Applicable inspections and tests shall be conducted to verify compliance with the Owner's Design Specifications following equipment replacement, repair, modification, maintenance, or abnormal incident. Within the context of Article TA-4000, a test not associated with a test designator is considered to be a prudent action and not a test requirement.

TA-4100 FAN ACCEPTANCE TESTS

This section provides the field acceptance test requirements for fans, motors, and related accessories. Integrated system testing shall be conducted in accordance with TA-4900.

TA-4101 Acceptance Test Requirements

Acceptance tests shall be conducted with the fan operating at a flow rate within the normal operating range for the system. The tests listed in Table TA-4000-1 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Section BA of this code, and as required in TA-3500 and TA-4150. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison during periodic in-service tests.

TABLE TA-4000-1
FAN ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Structural capability test	PS	*	
Leak tests	PL	*	
System flow balance test	F	*	
Mechanical run test	F		*
Flow rate test	Qf	*	
Differential Pressure test	DP	*	
Electrical test	AMP	*	
Rotational speed test	N	*	
Vibration test	Vb	*	
Bearing temperature test	Tb	*	
Fan performance test	F	*	

TA-4110 Visual Inspection (VT)

A visual inspection of the fan and associated components shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1100).

TA-4120 Pressure Boundary Tests

TA-4121 Structural Capability Test (PS)

When a fan housing is part of the system pressure boundary, a structural capability test shall be conducted to verify structural capability of the fan housing and connections in accordance with TA-3422 and mandatory Appendix TA-II. The fan housing may be tested concurrent with the duct and housing structural capability test specified in TA-4321.

TA-4122 Leak Test, Fan Housing (PL)

When a fan housing is part of the system pressure boundary, a pressure boundary leak test shall be conducted to verify the leak tightness of the fan housing and attached interfaces in accordance with TA-3423 and mandatory Appendix TA-III. The fan housing may be tested concurrent with the duct and housing leak test specified in TA-4322.

TA-4123 Leak Test, Fan Shaft Seal (PL)

When a fan shaft seal is part of the system pressure boundary, a pressure boundary leak test shall be conducted to verify the leak tightness of the shaft seal in accordance with TA-3423 and mandatory Appendix TA-III. The shaft seal may be tested concurrent with the duct and housing leak test specified in TA-4322. However, the shaft seal leakage rate shall be evaluated (qualitatively) independent of the overall system leak rate. The qualitative evaluation of the leakage shall be included in the test report.

TA-4130 Component Functional Tests

The following prerequisites shall be conducted on the fan and motor assemblies prior to the system functional tests specified in TA-4140.

TA-4131 Electrical Prerequisites

Prior to the initial energizing of the fan, the electrical power circuits shall be checked for installation, circuit continuity, voltage capacity and protective relay device settings.

TA-4132 Control System Prerequisites

Prior to the initial energizing of the fan, controls shall be calibrated and verified operational.

TA-4133 Startup Prerequisites

Prior to the initial energizing of the fan, the fan and motor shaft shall be manually rotated to verify moving parts are free of interference. The motor shall be momentarily energized to verify correct rotational direction. The fan shall be restarted and stable operation (no surging) verified. Fan and motor vibration, bearing temperature, motor electrical amperage and phase balance, fan speed, differential pressure, and airflow shall be monitored. Following one hour of operation, or immediately after observation of unusual performance (i.e. unstable performance), the fan shall be secured and a detailed visual inspection for signs of damage or degradation shall be conducted.

TA-4140 System Functional Tests

This section provides the system level field acceptance test requirements for fan systems.

TA-4141 System Flow Balance Test (F)

A system flow balance shall be conducted. Recommended procedures include SMACNA, NEBB, ACGIH, OR AABC (reference TA-2000).

System flow balancing may be conducted using artificial resistance in lieu of filters. However, final component reference values shall be obtained with clean system components installed.

TA-4142 through TA-4149 shall be conducted in the same time frame.

TA-4142 Mechanical Run Test (F)

Prior to conducting the tests specified in TA-4143 through TA-4149, the fan shall be operated at the design flow rate for at least 15 minutes and stable system operation (no surging) verified.

TA-4143 Flow Rate Test (Qf)

The fan flow rate shall be measured. Recommended procedures include ACGIH "Industrial Ventilation" or equivalent.

TA-4144 Static Pressure Test (DP)

The fan inlet and outlet static pressure and velocity pressure shall be measured and the overall fan static pressure determined.

TA-4145 Electrical Tests (AMP)

The fan motor supply voltage and amperage shall be measured for each phase.

TA-4146 Rotational Speed Test (N)

The rotational speed of the fan shall be measured.

TA-4147 Vibration Test (Vb)

The vibration of each fan and motor bearing shall be measured in accordance with TA-3433.

TA-4148 Bearing Temperature Test (Tb)

Following bearing temperature stabilization, the fan and motor bearing temperatures shall be measured. Stabilization occurs when temperature changes are less than or equal to +/- 3 °F (1.5 °C) in a 10 minute period.

TA-4149 Fan Performance Test (F)

For systems with filter or adsorber banks, the fan performance shall be measured under maximum design dirty filter conditions. This may be done by increasing the system resistance to the design dirty filter differential pressure, (design basis maximum dirty filter condition), using artificial resistance. The measurement procedures in TA-4142 through TA-4148 shall be used.

TA-4150 Acceptance Criteria

The following acceptance criteria are in addition to the requirements of TA-3500.

TA-4151 Airflow Capacity Test Acceptance Criteria

Airflow capacity shall be within +/- 10% of design when tested in the normal clean and maximum dirty filter conditions.

TA-4152 Fan Performance Acceptance Criteria

Fan performance (flow, static pressure, horsepower) shall meet the specifications of the manufacturer's fan performance curve and the Owner's Design Specification.

TA-4200 DAMPER ACCEPTANCE TESTS

This section provides the field acceptance test requirements for dampers and related accessories. Integrated system testing shall be conducted in accordance with TA-4900.

TA-4201 Acceptance Test Requirements

Acceptance tests shall be conducted with the dampers installed in the system. The tests listed in Table TA-4000-2 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Section DA of this code, and as required in TA-3500. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TA-4210 Visual Inspection (VT)

A visual inspection of the damper and associated components shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1200).

TABLE TA-4000-2
DAMPER ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Structural capability tests	PS	*	
Leak tests	PL	*	
Position indication test	F	*	
Exercise test	F		*
Static timing test	F	*	
Flow Control test	F		*
Fire Damper test	F		*
Dynamic time test	F	*	
Interlock Test	F		*

TA-4220 Pressure Boundary Tests.

TA-4221 Structural Capability Test, Damper Housing (PS)

When the damper housing and actuator shaft seal are part of the system pressure boundary, a structural capability test shall be conducted to verify the structural capability of the damper housing, shaft seal, and interfaces in accordance with TA-3422 and mandatory Appendix TA-II. The damper housing may be tested concurrent with the duct and housing structural capability test specified in TA-4321.

TA-4222 Structural Capability Test, Damper Blades (PS)

Isolation dampers shall be tested to verify the structural capability of the damper blade and seat in accordance with TA-3422 and mandatory Appendix TA-II. The damper blades and seat may be tested concurrent with the duct and housing structural capability test specified in TA-4321.

TA-4223 Leak Test, Damper Housing (PL)

When a damper housing is part of the system pressure boundary, a pressure boundary leak test shall be conducted to verify leak tightness of the damper housing and interfaces in accordance with TA-3423 and mandatory Appendix TA-III. The damper housing may be tested concurrent with the duct and housing leak test specified in TA-4322.

TA-4224 Leak Test, Damper Shaft Seal (PL)

When a damper shaft seal is part of the system pressure boundary, a pressure boundary leak test shall be conducted to verify leak tightness of the shaft seal in accordance with TA-3423 and mandatory Appendix TA-III. The shaft seal may be tested concurrent with the duct and housing leak test specified in TA-4322. However, the shaft seal leak rate shall be evaluated (qualitative) independently of the overall system leak rate. The qualitative evaluation of the leakage shall be included in the test report.

TA-4225 Leak Test, Damper Seat (PL)

When dampers have seat leakage limits, a leak test shall be conducted in the direction the damper is expected to function, in accordance with TA-3423 and mandatory Appendix TA-III. The seat leak rate shall be tested by blanking off or otherwise isolating a duct section upstream of the damper. The leak test shall be performed with the damper cycled closed using its normal closing mechanism (without any additional manual assistance).

TA-4230 Component Functional Tests

Component functional tests shall verify that the damper is operational prior to conducting the system functional tests specified in TA-4240.

TA-4231 Electrical Prerequisites

Prior to the initial energizing of the damper operator, the electrical circuits shall be checked for proper installation, circuit continuity, voltage capacity and protective relay device settings.

TA-4232 Pneumatic Prerequisites

Prior to the initial pressurizing of the damper control system, pneumatic systems shall be checked for proper installation and leak tightness.

TA-4233 Control System Prerequisites

Prior to the initial energizing of the damper operator, control instrumentation shall be calibrated and verified to be operational.

TA-4234 Position Indication Test (F)

Dampers having remote position indicators shall be observed during operation to verify that the mechanical damper position corresponds to the remote indication.

TA-4235 Exercise Test (F)

Power operated dampers shall be fully cycled using a control switch or other actuating device to verify operation. Manual dampers, including balancing dampers, shall

be fully cycled to verify operation. Fire Dampers shall be tested in accordance with TA-4242.

TA-4236 Static Timing Test (F)

Power operated dampers (electrical or pneumatic), that are required to operate within a specified time limit, shall be tested by measuring time for the damper to fully open or fully close (as required by the Owner's Design Specification).

TA-4240 System Functional Tests

TA-4241 Flow Control Damper Functional Test (F)

Power operated dampers that control air flow shall be observed under throttled (throughout its anticipated operating range) flow conditions to verify free movement and stable operation.

TA-4242 Fire Damper Test (F)

Fire dampers shall be tested, using a normal or simulated actuation signal, to verify activation under design airflow conditions.

TA-4243 Dynamic Timing Test (F)

Isolation dampers having a required actuation response time shall be timed to the fully open or fully closed position (as required by the Owners Design Specification) under design airflow conditions.

TA-4244 Interlock Test (F)

Dampers that have an opening or closing function interlocked with other components (e.g. fans, other dampers) shall be tested to verify interlock action.

TA-4300 DUCT, HOUSING, AND MOUNTING FRAME ACCEPTANCE TESTS

This section provides the field acceptance test requirements for ducts, housings and mounting frames.

TA-4301 Acceptance Test Requirements

Acceptance tests shall be conducted with the ducts, housings and mounting frames installed in the system. The tests listed in Table TA-4000-3 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Section SA of this Code, and as required in TA-3500. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TA-4310 Visual Inspection (VT)

A visual inspection of ducts, housings, and mounting frames, shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1300).

TABLE TA-4000-3
DUCT, HOUSING AND FRAME ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Structural capability test	PS	*	
Leak tests	PL	*	

TA-4320 Pressure Boundary Tests

Pressure boundary tests apply to all ducts, housings and interface connections that are parts of the system. Individual components may be tested at separate times provided that all system pressure boundaries are ultimately tested prior to the system being placed into service.

TA-4321 Structural Capability Test, Duct and Housing (PS)

A structural capability test shall be conducted to verify structural capability of ducts and housings in accordance with TA-3422 and mandatory Appendix TA-II.

TA-4322 Leak Test, Duct and Housing (PL)

A pressure boundary leak test shall be conducted to verify leak tightness of the ducts and housings in accordance with TA-3423 and mandatory Appendix TA-III.

TA-4323 Leak Test, Mounting Frame (optional) (PL)

A mounting frame pressure leak test may be used to detect leaks in the HEPA filter and adsorber mounting frames that could affect the results of the in-place leak tests in TA-4600 and TA-4700. This test is optional and may be conducted in accordance with non-mandatory Appendix TA-A.

TA-4400 REFRIGERATION EQUIPMENT ACCEPTANCE TESTS

This section provides the field acceptance test requirements for refrigeration equipment. Integrated system testing shall be conducted in accordance with TA-4900.

TA-4401 Acceptance Test Requirements

Acceptance tests shall be conducted with the refrigeration equipment in service

under normal operating conditions. The tests listed in Table TA-4000-4 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, applicable portions of Section RA of this Code, and as required in TA-3500. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TA-4410 Visual Inspection (VT)

A visual inspection of the refrigeration equipment components shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1400).

TA-4420 Pressure Boundary Tests

TA-4421 Leak Test, Refrigerant Piping and Coil (PL)

Refrigeration systems, including piping, coils, and pressure vessels, shall have a pressure test conducted to verify structural integrity and leak tightness. Testing shall be conducted in accordance with TA-3424 and mandatory Appendix TA-VIII.

TABLE TA-4000-4
REFRIGERATION EQUIPMENT ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Leak test	PL		*
Hydrostatic test	HYD		*
Valve position indication test	F		*
Valve exercise test	F		*
Valve timing test	F	*	
Flow Control valve test	F		*
Mechanical run test	F		*
Performance test	F	*	
Electrical test	AMP	*	
Rotational speed test	N	*	
Vibration test	Vb	*	
Bearing temperature test	Tb	*	

TA-4422 Hydrostatic Test, Hydronic Piping and Coils (HYD)

Hydronic piping, coils and pressure vessels, shall have a hydrostatic test conducted to verify structural integrity and leak tightness. Testing shall be conducted in accordance with TA-3421.

TA-4430 Component Functional Tests

The following component functional tests and prerequisites shall be conducted to verify that the refrigeration system equipment is operating acceptably prior to conducting the system functional tests specified in TA-4440. Fans shall be tested in accordance with TA-4100.

TA-4431 Electrical Prerequisites

Prior to the initial energizing of the refrigeration system components, the electrical circuits shall be checked for installation, circuit continuity, voltage capacity, and protective relay device settings.

TA-4432 Control System Prerequisites

Prior to the initial energizing of the refrigeration system components, the system controls shall be calibrated and verified operational.

TA-4433 Valve Position Indication Test (F)

Valves having remote position indicators shall be observed during valve full stroke operation to verify that the valve position corresponds to the remote indication.

TA-4434 Valve Exercise Test (F)

Power operated valves shall be fully cycled using a control switch or other actuating device to verify operation. Manual valves shall be fully cycled to verify operation.

TA-4435 Valve Timing Test (F)

Power operated valves that are required to operate within a specified time limit shall be tested by measuring the time to fully cycle.

TA-4436 Startup Prerequisites

The compressor motor shall be momentarily energized and correct direction of rotation verified. restart the compressor motor,verify stable operation and monitor the compressor motor electrical supply voltage, amperage and phase balance, vibration, bearing temperatures, and rotational speed, as applicable. Following one hour of operation, or immediately after observation of unusual performance (unstable operation), the equipment shall be secured and a detailed visual inspection conducted for signs of damage or degradation.

TA-4440 System Functional Tests

The refrigeration equipment shall be tested to verify mechanical component integrity and design cooling function. TA-4441 through TA-4447 shall be conducted in the same time frame.

TA-4441 Flow Control Valve Test (F)

Power operated valves, controlled by flow instrumentation, shall be observed under throttled (throughout its anticipated operating range) flow conditions to verify freedom of movement, stable operation, and ability to maintain required flow.

TA-4442 Mechanical Run Test (F)

The refrigeration compressor shall be operated with the system in the normal heat load range for at least 15 minutes and stable system operation verified.

TA-4443 Performance Test (F)

The refrigeration compressor inlet and outlet pressure and temperature shall be measured with the equipment operating at achievable load points.

TA-4444 Electrical Test (AMP)

The compressor motor electrical supply voltage and amperage shall be measured for each phase.

TA-4445 Rotational Speed Test (N)

The rotational speed of the compressor shall be measured when accessible.

TA-4446 Vibration Test (Vb)

The vibration of each accessible bearing on the compressor and compressor motor shall be measured in accordance with TA-3433.

TA-4447 Bearing Temperature Test (Tb)

Following compressor and compressor motor bearing temperature stabilization, the accessible bearing temperatures shall be measured. Stabilization occurs when temperature changes are less than or equal to +/- 3 °F (1.5 °C) in a 10 minute period.

TA-4500 CONDITIONING EQUIPMENT ACCEPTANCE TESTS

This section provides the field acceptance test requirements for forced circulation air cooling and heating coils, air washers, evaporative coolers, and electric heating coils. Integrated system testing shall be conducted in accordance with TA-4900.

TA-4501 Acceptance Test Requirements

Acceptance tests shall be conducted with the conditioning equipment in service under normal operating conditions for the system . The tests listed in Table TA-4000-5 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Section CA of this Code, and as required in TA-3500 and TA-4560. These test results shall be documented

in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TABLE TA-4000-5
CONDITIONING EQUIPMENT ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Hydrostatic test	HYD		*
Electric heater step controller test	F		*
Electric heater coil resistance test	F	*	
Electric heater resistance to ground test	F	*	
Valve performance tests	F	*	*
Performance test	F	*	
Electrical test	AMP	*	
Rotational speed test	N	*	
Vibration test	Vb	*	
Bearing temperature test	Tb	*	
Electric heater performance test	F	*	
Hydronic system flow balance	F	*	
Hydronic system heater and coil performance test	F	*	
Air washer, evaporative cooler performance test	F	*	

TA-4510 Visual Inspection (VT)

A visual inspection of the conditioning equipment components shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1500).

TA-4520 Pressure Boundary Tests

TA-4521 Hydrostatic Test, Hydronic Piping and Coils (HYD)

Hydronic piping, coils and pressure vessels shall have a hydrostatic test conducted to verify structural integrity and leak tightness. Testing shall be conducted in accordance with TA-3421.

TA-4530 Component Functional Tests

The following component functional prerequisites and tests shall be conducted to verify that the conditioning system equipment is operating acceptably prior to conducting the system functional tests specified in TA-4540. Fans shall be tested

in accordance with TA-4100. Refrigeration components shall be tested in accordance with TA-4400.

TA-4531 Electrical Prerequisites

Prior to the initial energizing of the conditioning system equipment, the electric circuits shall be checked for proper installation, circuit continuity, voltage capacity, and protective relay device settings.

TA-4532 Control System Prerequisites

Prior to the initial energizing of the conditioning system components, the controls shall be calibrated and verified operational.

TA-4533 Electric Heater Step Controller Test (F)

Electric heater step controllers shall be tested by initiating a simulated demand signal to verify the heater circuit step controller is operational.

TA-4534 Electric Heater Coil Resistance Test (F)

The electrical resistance shall be measured across each heater circuit in accordance with CA-5440.

TA-4535 Electric Heater Resistance To Ground Test (F)

The electrical resistance to ground shall be measured on each heater circuit.

TA-4536 Valve Performance Tests (F)

Conditioning system valves shall be tested in accordance with TA-4433, TA-4434, and TA-4435.

TA-4537 Startup Prerequisites

Prior to starting the conditioning system pumps, the pump shaft shall be manually rotated to verify freedom of movement. The motor shall be momentarily energized and the correct direction of rotation verified. restart the pump motor and verify stable operation and monitor the pump motor electrical supply voltage, amperage and phase balance, bearing vibration, bearing temperatures, rotational speed, pump differential pressure, and fluid system flow rate, as applicable. Following one hour of operation, or immediately after observation of unusual performance (unstable operation), the pump shall be secured and a detailed visual inspection for signs of damage or degradation conducted.

TA-4540 System Functional Tests

The conditioning equipment shall be tested in conjunction with the system to verify mechanical component integrity and design cooling or heating function. TA-4541

through TA-4546 shall be conducted in the same time frame.

TA-4541 Hydronic System Flow Balance Test (F)

A hydronic system flow balance shall be conducted. Recommended procedures include SMACNA, NEBB, or AABC (reference TA-2000).

TA-4542 Flow Control Valve Test (F)

Power operated valves, controlled by flow control instrumentation, shall be observed under throttled (throughout its anticipated operating range) flow conditions to verify freedom of movement, stable operation, and the ability to maintain required flow.

TA-4543 Mechanical Run Test (F)

The conditioning system pumps shall be operated with the system operating in the normal operating range for at least 15 minutes and stable system operation (no surging) verified.

TA-4544 Performance Test (F)

The conditioning system pump differential pressure and flow rate shall be measured with the pump operating at achievable flow rates.

TA-4545 Electrical Tests (AMP)

The conditioning system pump supply voltage and amperage shall be measured for each phase.

TA-4546 Rotational Speed Test (N)

The rotational speed of the pump shaft shall be measured.

TA-4547 Vibration Test (Vb)

The vibration of each bearing on the pump and motor shall be measured in accordance with TA-3433.

TA-4548 Bearing Temperature Test (Tb)

Following pump and motor bearing temperature stabilization, the bearing temperature shall be measured. Stabilization occurs when temperature changes are less than or equal to +/- 3 °F (1.5 °C) in a 10 minute period.

TA-4549 Electric Heater Performance Test (F)

With design airflow (+/- 10%) through the heater bank, the electrical supply voltage, amperage, and phase balance of each heater circuit, and differential temperature

and air flow across the heater bank shall be measured. Following one hour of continuous operation, the heater shall be secured and a detailed visual inspection shall be conducted for signs of damage or degradation.

TA-4550 Hydronic System Heating and Cooling Performance Test (F)

With the conditioning system operating at design airflow (+/- 10%) and design hydronic flow (+/- 10%) and at achievable heat load conditions, the air-side flow, differential temperature and differential pressure, and the hydronic side flow, differential temperature and differential pressure shall be measured.

TA-4551 Air Washer, Evaporative Cooler Performance Test (F)

A performance test for the conditioning system air washers and evaporative coolers shall be conducted in accordance with CA-5000, Appendix CA-II.

TA-4560 Acceptance Criteria

The following acceptance criteria are in addition to TA-3500.

TA-4561 Electrical Heater Ground Resistance Acceptance Criteria

Conditioning system electric heater resistance to ground shall be greater than 50,000 Ohms.

TA-4600 MOISTURE SEPARATOR, PRE-FILTER, HEPA FILTER BANK ACCEPTANCE TESTS

This section provides the field acceptance test requirements for installed moisture separator, pre-filter and HEPA filter banks.

TA-4601 Acceptance Test Requirements

Acceptance tests shall be conducted with clean moisture separator, pre-filter and HEPA filter banks installed in the system. The tests in Table TA-4000-6 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Sections FA, FB and FC of this Code and as required in TA-3500 and TA-4630. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TABLE TA-4000-6
MOISTURE SEPARATOR, PREFILTER AND HEPA FILTER
ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Differential pressure test	DP	*	
Airflow distribution test	AD	*	
Air-aerosol mixing test	AA	*	
In-place leak test [@]	IP	*	

[@] In-place leak tests are not required on systems used for 100% recirculation (e.g. Reactor containment cleanup units) unless the atmospheric cleanup rate is time dependent.

TA-4610 Visual Inspection (VT)

A visual inspection of the installed moisture separator, prefilter and HEPA filter banks shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1600).

TA-4620 System Functional Tests

TA-4621 Differential Pressure Test (DP)

With the system operating at design flow rate (+/- 10%), the differential pressure across each moisture separator, pre-filter, and HEPA filter bank shall be measured.

TA-4622 Airflow Distribution Test (AD)

With the system operating at design flow rate (+/- 10%), the airflow distribution shall be measured downstream of each moisture separator, prefilter, and HEPA filter bank in accordance with mandatory Appendix TA-IV.

TA-4623 Air-Aerosol Mixing Test (AA)

With the system operating at design flow rate (+/- 10%), the air-aerosol mixing upstream of each HEPA filter bank shall be measured in accordance with mandatory Appendix TA-V.

TA-4624 In-Place Leak Test (IP)

With the system operating at design flow rate (+/- 10%), the challenge aerosol leak rate of each HEPA filter bank shall be measured in accordance with mandatory Appendix TA-VI.

TA-4630 Acceptance Criteria

The following acceptance criteria are in addition to the requirements of TA-3500.

TA-4631 Airflow Distribution Test Acceptance Criteria

With the system operating within +/-10% of design flow rate, the variation in velocity measurements across the HEPA filter banks shall be limited to +/-20% of the average, when measured in accordance with mandatory Appendix TA-IV. Airflow distribution across the moisture separator and prefilter banks shall be in accordance with the Owner's Design Specification.

TA-4632 Air-Aerosol Mixing Test Acceptance Criteria

With the system operating within +/-10% of design flow rate, the variation in concentration of the air-aerosol mixture immediately upstream of the HEPA filter bank shall be limited to +/-20% of the average when measured in accordance with mandatory Appendix TA-V.

TA-4700 TYPE II and TYPE III ADSORBER BANK ACCEPTANCE TESTS

This section provides the field acceptance test requirements for installed type II and III adsorber banks.

TA-4701 Acceptance Test Requirements

Acceptance tests shall be conducted with the adsorbent media installed and in service under normal operating conditions for the system. The tests listed in Table TA-4000-7 shall be conducted and test results verified to be within the acceptance limits of the Owner's Design Specification, the applicable portions of Sections FD and FE of this code, and as required in TA-3500 and TA-4730. These test results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TABLE TA-4000-7
TYPE II AND TYPE III ADSORBER BANK ACCEPTANCE TESTS

TEST	DESIGNATOR	MEASURE	OBSERVE
Visual inspection	VT		*
Differential pressure test	DP	*	
Airflow distribution test	AD	*	
Air-aerosol mixing test	AA	*	
In-place leak test @	IP	*	
Test canister flow rate test	Qf	*	
Air heater performance test	F	*	

@ In-place leak tests are not required on systems used for 100% recirculation (e.g. Reactor containment cleanup units) unless the atmospheric cleanup rate is time dependent.

TA-4710 Visual Inspection (VT)

A visual inspection of the type II and type III adsorber banks shall be conducted in accordance with TA-3410 and mandatory Appendix TA-I (I-1700).

TA-4720 Component Functional Tests

TA-4721 Electric Heater Step Controller Test (F)

Electric heater step controllers shall be tested by initiating a simulated demand signal to verify the heater circuit step controller is operational.

TA-4722 Electric Heater Coil Resistance Test (F)

The electrical resistance shall be measured across each heater circuit in accordance with CA-5440.

TA-4723 Electric Heater Resistance To Ground Test (F)

The electrical resistance to ground shall be measured on each heater circuit.

TA-4730 System Functional Tests

TA-4731 Differential Pressure Test (DP)

With the system operating at design flow rate (+/- 10%), the differential pressure across each adsorber bank shall be measured.

TA-4732 Airflow Distribution Test (AD)

With the system operating at design flow rate (+/- 10%), the airflow distribution across each adsorber bank shall be measured in accordance with mandatory Appendix TA-IV.

TA-4733 Air-Aerosol Mixing Test (AA)

With the system operating at design flow rate (+/- 10%), the air-aerosol mixing immediately upstream of each adsorber bank shall be measured in accordance with mandatory Appendix TA-V. This test is not required when it can be determined that the air-aerosol test conducted on a HEPA bank immediately upstream of the adsorber bank also provides equivalent challenge to the adsorber bank.

TA-4734 In-Place Leak Test (IP)

With the system operating at design flow rate (+/- 10%), the challenge gas leak rate of each adsorber bank shall be measured in accordance with mandatory Appendix TA-VII.

TA-4735 Test Canister Flow Rate Test (Qf)

When the system is equipped with test canisters used for obtaining adsorbent samples for laboratory analysis, the velocity through each test canister shall be measured (or calculated from flow measurements) with the system operating at design airflow rate. Alternatively, when access is limited and measurements cannot be performed, the design documentation shall be verified to assure that the installed canisters meet the performance requirements, (differential pressure / flow rate), of canisters used during shop testing of the test canister sampling system.

TA-4736 Electric Heater Performance Test (F)

With design airflow (+/- 10%) through the heater bank, the electrical supply voltage, amperage, and phase balance of each heater circuit, and differential temperature and air flow across the heater bank shall be measured. Following one hour of continuous operation, the heater shall be secured and a detailed visual inspection shall be conducted for signs of damage or degradation.

TA-4740 Acceptance Criteria

The following acceptance criteria are in addition to the requirements of TA-3500.

TA-4741 Airflow Distribution Test Acceptance Criteria

With the system operating within +/- 10% of design flow rate, the variation in velocity measurements across the face of the adsorber banks shall be limited to +/-20% of the average, when measured in accordance with mandatory Appendix TA-IV.

TA-4742 Air-Aerosol Mixing Test Acceptance Criteria

With the system operating within +/-10% of design flow rate, the variation in the challenge gas or aerosol concentration readings immediately upstream of each adsorber bank shall be limited to +/-20% of the average when measured in accordance with mandatory Appendix TA-V.

TA-4743 Test Canister Flow Rate Test Acceptance Criteria

The test canister velocity shall be within +/- 10% of the average adsorber design velocity as specified by the Owner's Design Specification.

TA-4800 ADSORBENT ACCEPTANCE TESTS

This section provides the Laboratory acceptance test requirements for radioactive iodine penetration of the adsorbent used in adsorber systems.

TA-4801 Acceptance Test Requirements

A laboratory acceptance test shall be conducted using representative samples of adsorbent from the adsorber system. This test measures the radioiodine penetration of the adsorbent. Laboratory test results shall be evaluated to the acceptance limits of the Owner's Design Specification. Sample locations shall be documented to ensure they are not reused in periodic in-service testing. Test Results shall be documented in accordance with TA-6300 and shall be retained as reference values for comparison to periodic in-service test results.

TA-4810 Laboratory Analysis of Adsorbent (LAB)

New adsorbent installed in the adsorber banks shall be certified in accordance with the manufacturers test data for radioiodine penetration (ref. FF-5000). Adsorbent stored more than 50 percent of manufacturer's assigned shelf life shall have a laboratory test conducted in accordance with ASTM D-3803-89 prior to installation. The test bed depth, air temperature, humidity, and flow rate, used in the laboratory test, shall be the same as adsorber bank conditions required by the Owner's Design Specification. Adsorbent installed in the adsorber bank shall be sampled and tested in accordance with the procedures in ASTM D-3803-89 prior to system operation.

TA-4900 INTEGRATED SYSTEM TESTS

Each system shall be tested to verify the functional performance at achievable design operating conditions. Integrated system tests shall be conducted to challenge all integrated control functions including interlocks and manual or automatic actuation circuits, (damper position changes, fan starts and stops, compressor and pump starts or stops, valve position changes, heater energization or de-energization). Actuations can be from a number of different sources including radiation sensors, temperature sensors, chlorine sensors, pressure sensors, manual controls and emergency safeguard signals. Sensor operation shall be verified in addition to control circuitry. Integrated testing shall also include an overall system leak test to verify that there are no unacceptable bypasses of the HEPA filter or adsorber banks. Integrated system testing shall verify that the intended design function of the system is achieved in accordance with the Owner's Design Specification. Test results shall be documented in accordance with TA-6300.

TA-4910 Fan Integrated System Test Requirements (F)

Fans designed to respond automatically to a process or emergency actuation signal shall be tested. Sequencing of starts, stops and speed changes shall be conducted utilizing an actual or simulated actuation signal.

TA-4920 Damper Integrated System Test Requirements (F)

Dampers designed to respond automatically to a process or emergency actuation signal shall be tested. Sequencing of damper position changes shall be conducted utilizing an actual or simulated actuation signal.

TA-4930 Refrigeration and Conditioning Integrated System Test Requirements(F)

Refrigeration and Conditioning equipment designed to respond automatically to a process or emergency actuation signal shall be tested. Sequencing of equipment operation (starts, stops, speed changes, valve operations or isolation, heater operation) shall be conducted utilizing an actual or simulated actuation signal.

TA-4940 HEPA and Adsorber Bank Integrated System Test Requirements (F)

All potential HEPA filter and adsorber bank bypass flow paths shall be challenged to verify that leak rates are within the Owner's Design Specification. Bypass flow paths may be challenged during the in-place leak test specified in TA-4624 and TA-4734, by ensuring that the challenge aerosol or gas injection and sample ports encompass all potential bypass flow paths (reference mandatory appendix TA-V, step V-1100). If a potential bypass flow path within the system is not challenged during these in-place tests, a separate test shall be performed using mandatory appendix TA-VI or TA-VII to verify that the HEPA or adsorber banks are not being bypassed in excess of the limits specified in the Owner's Design Specification.

ARTICLE TA-5000
CORRECTIVE ACTION REQUIREMENTS

Corrective action is required when test results do not meet the acceptance criteria specified in the applicable section or in the Owner's Design Specifications. For equipment that is replaced, modified, repaired, or has undergone maintenance, such that reference values may change, a new set of reference values shall be obtained in accordance with the requirements of Article TA-3200. Additional guidance for corrective actions is included in non-mandatory Appendix TA-B.

ARTICLE TA-6000
QUALITY ASSURANCE

TA-6100 General

Field testing of nuclear air treatment, heating, ventilating, and air conditioning systems shall be conducted in accordance with the quality assurance requirements of Article AA-8000, ANSI/ASME NQA-1, and ANSI/ASME NQA-2.

TA-6200 Personnel

Tests shall be conducted by personnel who have demonstrated competence to perform the specific tests, as evidenced by documented experience and training. Personnel shall be certified in accordance with ANSI/ASME NQA-1 or ANS 3.1, and in accordance with the Owner's Requirements.

TA-6300 Documentation

TA-6310 Procedures

Written acceptance test procedures shall document the field acceptance testing performed and test results obtained as specified in Article TA-4000. These records shall be maintained for the life of the facility.

TA-6320 Reports

A written report shall be provided to document the acceptance testing performed in accordance with Article TA-4000. The report shall contain the following as a minimum:

(a) The system name, test/inspection procedure(s) used, date of test results and the test performer's signature;
(b) Identification of instruments, equipment, tools and documents to the extent that they or their equivalents can be identified for future examinations;
(c) Observations and dimensional checks specified by the respective test data and reports developed during inspection and testing;
(d) Conclusions and recommendations by visual examination and testing personnel;
(e) Reference to previous reports if this report is for reinspection and testing.

APPENDIX TA-I
MANDATORY
VISUAL INSPECTION CHECKLIST

I-1000 General

A specific inspection checklist for each component in the system shall be included in the acceptance test procedures. This Appendix lists typical items for each component that need to be inspected visually in Article TA-4000 (Acceptance tests). As a minimum, the lists of items indicated below shall be checked for compliance with the Owner's Specifications. The inspection shall be conducted in accordance with TA-3410. The acceptance criteria for these inspections shall be in accordance with TA-3500 and TA-3510.

I-1100 Fan Inspection Checklist

a. Housing and duct interface
b. Fan belt and shaft guards
c. Interferences with moving parts
d. Fan shaft seal
e. Belt adjustment and condition
f. Lubricant levels
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Control system components
l. Pneumatic connections
m. As built configuration in accordance with design drawings
n. Fan nameplate
o. Access for tests and maintenance

I-1200 Damper Inspection Checklist

a. Housing and duct interface
b. Actuator linkage, motor, controller
c. Interferences with moving parts
d. Damper shaft seal
e. Blade edge seals, damper seat
f. Limit switches
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Pneumatic connections
l. As built configuration in accordance with design drawings
m. Damper nameplate
n. Access for tests and maintenance

I-1300 **Duct, Housing and Mounting Frame Inspection Checklist**

a. Housing and duct connections (no caulking)
b. Provision for opening access doors from both inside and outside
c. Access door seals, gaskets
d. Access door latches
e. Housing internal access ladders and platforms
f. Sample and injection ports, location and caps
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation, connections
j. Electrical connections
k. Housing/duct penetration seals
l. Loop seals (water level), drain connections
m. Lighting conduits, socket housing seals (flush mounted)
n. HEPA/adsorber mounting frame continuous seal welds
o. Mounting frame penetrations seal welded
p. Mounting frame seating surface (weld splatter, flatness, scratches)
q. Sample canister installation
r. Mounting frame clamping devices
s. As built configuration in accordance with design drawings
t. Access for tests and maintenance
u. Lighting for test and maintenance available

I-1400 **Refrigeration Equipment Inspection Checklist**

a. Housing or duct interface with refrigeration equipment
b. Fan, pump, compressor belt and coupling guards
c. Interferences with moving parts
d. Belt adjustment and condition
e. Fluid leaks
f. Lubricant levels
g. Supports and attachments
h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Control system components
l. Pneumatic connections and tubing (No crimping)
m. As built configuration in accordance with design drawings
n. Fan, pump, compressor nameplate
o. Access for tests and maintenance

I-1500 **Conditioning Equipment Inspection Checklist**

a. Housing or duct interface with conditioning equipment
b. Belt and coupling guards
c. Interferences with moving parts
d. Belt tightness
e. Fluid leaks
f. Lubricant levels
g. Supports and attachments

h. Bolting and fasteners
i. Instrumentation
j. Electrical connections
k. Control system components
l. Pneumatic connections and tubing (No crimping)
m. Drains and spray nozzles not plugged
n. As built configuration in accordance with design drawings
o. Fan, pump, compressor nameplate
p. Access for tests and maintenance

I-1600 **Moisture Separator Bank, Prefilter Bank, HEPA Filter Bank Inspection Checklist**

a. Moisture separator media, frame, clamps and gaskets
b. Moisture separator water collection system and drains
c. Prefilter media, frame, clamps and gaskets
d. HEPA filter media, frame, clamps and gaskets
e. Sealant or caulking (none allowed)
f. Moisture separator, prefilter, HEPA orientation (vertical)
g. Bolting and fasteners.
h. As built configuration in accordance with design drawings
i. HEPA filter nameplate
j. Access for tests and maintenance

I-1700 **Type II, Type III Adsorber Bank Inspection Checklist**

a. Type II media, frame, screen, clamps and gaskets
b. Sealant or caulking (none allowed)
c. Type III media, screens, frame
d. Test canisters
e. Bulk loading equipment
f. Fire protection system piping, nozzles, instrumentation
g. Bolting and fasteners
h. As built configuration in accordance with design drawings
i. Adsorber nameplate
j. Access for tests and maintenance

APPENDIX TA-II
MANDATORY
STRUCTURAL CAPABILITY TEST PROCEDURE

II-1000 General

This procedure is used to test the structural capability of ducts and housings.

II-1100 Summary of Method

Ducts, and housings which form the pressure boundary of the system shall be pressure tested, with air, to the structural capability pressure to verify that there is no breach of integrity or unacceptable distortion. Fans, dampers and other components which form parts of the pressure boundary shall be installed and tested with the ducts and housings to verify the interface connection integrity.

NOTE: This test procedure is written as if the operating pressure were positive, but it would be identical for negative pressure systems with appropriate signs used in data collection and calculations.

II-2000 Prerequisites

Construction, modifications or repairs affecting the test boundary shall be complete and inlet and discharge openings of the duct or housing sealed before the test is started. Electrical, piping, and instrument connections shall be complete and all permanent seals installed before the test is started.

II-3000 Test Equipment

a. Pressurization source

b. Covers to seal test boundaries.

c. Pressure indicating device accurate to +/- 0.1 in.w.g. (0.025 kPa(gage)).

II-4000 Procedure

a. Connect the pressurization source to the duct or housing.

b. Install instrumentation to indicate the pressure inside the duct or housing being tested.

c. Start the pressurization source and operate until the structural capability pressure is achieved. Maintain pressure for the duration of the inspection.

d. Inspect the test boundary for breach of integrity or distortion.

e. Release pressure and inspect for permanent distortion.

II-5000 **Acceptance Criteria**

All distortion shall be measured and compared to the acceptance limits of the Owner's Design Specification.

APPENDIX TA-III
MANDATORY
DUCT AND HOUSING LEAK TEST PROCEDURE

III-1000 General

This procedure is used to test the leak tightness of the ducts and housings including installed fan housings, damper housings and fan and damper shaft seals.

III-1100 Summary of Method

Ducts and housings that form the pressure boundary of the system shall be leak tested, with air, using one of the methods listed in this procedure. Either method may be used and will produce a similar test result. The constant pressure method is useful for testing small volumes and is conducted at the maximum operating pressure for the system. The pressure decay method is useful in testing large volumes and is conducted by pressurizing to 1.25 times the maximum operating pressure, then allowing the pressure to decay for a fixed period of time, or until the pressure decreases to 80% of the maximum operating pressure, whichever occurs first. Fans, dampers, and other components that are part of the pressure boundary shall be installed and tested with the pressure boundary to verify interface connection leak tightness. If the measured leak rate is in excess of the acceptance criteria, the leaks shall be located by one of the methods listed in this procedure. After leaks are repaired, the duct and housing shall be re-tested to verify leak tightness.

NOTE: This test procedure is written as if the operating pressure were positive, but it would be identical for negative pressure systems with appropriate change in signs used in the data collection and calculations.

III-2000 Prerequisites

Construction, modifications and repairs affecting the test boundary shall be complete and the inlet and discharge openings of the duct or housing sealed before the test is started. All electrical, piping, and instrument connections shall be complete and all permanent seals shall be installed before the test is started. For pressure decay testing, the volume of the pressure test boundary must be calculated.

III-3000 Test Equipment

a. Pressurization source

b. Covers to seal test boundaries.

c. Clock or timer accurate to +/- 1.0 second.

d. Pressure indicating device accurate to +/- 0.1 in.w.g. (0.025 kPa(gage)).

e. Flowmeter or Totalizing Gas Volume meter accurate to +/-5% (constant pressure method).

f. Temperature indicating device accurate to +/- 0.5 °F (0.25°C).

g. Bubble solution for detecting air leaks (bubble method).

h. Optional portable electronic sound detection equipment (audible leak method).

i. Barometer

III-4000 **Procedure**

III-4100 **Constant Pressure Test**

a. Connect the pressurization source to the duct or housing.

b. Connect the flowmeter or totalizing gas volume meter between the pressurization source and the housing (downstream of the throttling valve, if used).

c. Install temperature and pressure indicating devices so that they will indicate representative temperature and pressure inside the duct or housing being tested.

d. Seal test boundaries and close access doors in the normal manner. Do not use temporary sealants, duct tape, or similar temporary materials except for sealing the temporary blank-off panels.

e. Start the pressurization source and operate it until the maximum operating pressure is achieved. Maintain pressure constant with the flow control device until temperature remains constant within +/- 0.5 °F (0.25 °C) for a minimum of 10 minutes. Record the initial stabilized pressure, temperature, and barometric pressure.

f. Measure the flow rate of the air being added to or removed from the duct or housing while maintaining the maximum operating pressure within +/- 0.1 in. w. g. (0.025 kPa(gage)). When using the flow meter, record flow readings once a minute for a 5 minute continuous period and average the readings to calculate the measured leak rate. When using a totalizing gas volume meter, measure the total volume of air for a 10 minute continuous period and divide the measured volume by time (10 minutes) to calculate the measured leak rate. Record final pressure, temperature and barometric pressure.

g. Convert the final calculated leak rate to standard cubic feet per minute (cubic meters per second) in accordance with the method illustrated in "Industrial Ventilation" (ref. TA-2000).

III-4200 **Pressure Decay Test**

a. Connect the pressurization source (with a leak tight shutoff

valve) to the duct or housing.

b. Install the temperature and pressure indicating devices where they will indicate representative temperature and pressure inside the duct or housing being tested.

c. Seal test boundaries and close access doors in the normal manner. Do not use temporary sealants, duct tape, or similar temporary materials except for sealing the temporary blank-off panels.

d. Start the pressurization source and operate until the pressure is 1.25 times the maximum operating pressure (but not to exceed the structural capability pressure). Maintain this pressure constant with a flow control device until temperature remains constant within +/- 0.5 °F (0.25 °C) for a minimum of 10 minutes. Close shutoff valve.

NOTE(1): If the structural capability pressure for the duct or housing is less than 1.25 times the maximum operating pressure, the final test pressure shall be calculated as follows to achieve an average test pressure equal to the maximum operating pressure:

$$Pf = 0.8(OP_{max}) + (1.25(OP_{max}) - SCP)$$

where: Pf = final test pressure
OP_{max} = maximum operating pressure
SCP = structural capability pressure

e. Record the initial time, pressure, temperature, and barometric pressure.

f. Record pressure readings once a minute until pressure decays to 80% of the maximum operating pressure, or for a minimum of 15 minutes (see NOTE(1) in step d above).

h. Record final time, pressure, temperature, and barometric pressure.

i. Calculate leak rate from the following equation in English Units:

$$Q_{ave} = \left(\frac{Pi}{Ti} - \frac{Pf}{Tf} \right) * \frac{V}{R*\Delta t*0.075}$$

Metric Units:

$$Q_{ave} = (1.39 * 10^{-5}) * \left(\frac{Pi}{Ti} - \frac{Pf}{Tf} \right) * \frac{V}{R*\Delta t}$$

where:
Q_{ave}= Average leak rate, scfm (sm^3/s). (air density 0.075 lb/ft3)
V = Volume within test boundary, ft^3 (m^3).

P_i = Initial pressure within test boundary, lb/ft^2 ABS (Pa(absolute)).
P_f = Final pressure within test boundary, lb/ft^2 ABS (Pa(absolute).

T_i = Absolute Temperature at start of test, °R (°K).
T_f = Absolute Temperature at end of test, °R (°K).
Δt = $t_i - t_f$ Time difference (minutes).
t_i = Time at start of test (minutes).
t_f = Time at end of test (minutes).
R = Gas Constant for Air; 53.35 $\frac{ft\text{-}lb}{lb\text{-}°R}$, (0.286 $\frac{kJ}{kg\text{-}°K}$)

III-4300 Acceptance Criteria

If the calculated leak rate exceeds the Owner's acceptance criteria, locate leaks in accordance with one of the techniques outlined in III-4400 or III-4500.

III-4400 Bubble Leak Location Method

a. Pressurize the test boundary to the maximum operating pressure for the system.

b. With the test boundary under continuous pressure, apply bubble solution to areas to be tested. Identify places where bubbles are found and perform corrective actions.

c. Following corrective actions, retest in accordance with III-4100 or III-4200.

III-4500 Audible Leak Location Method

a. Pressurize the test boundary to the maximum operating pressure for the system.

b. With the test boundary continuously pressurized, locate audible leaks (electronic sound detection equipment optional) and perform corrective actions.

c. Following corrective action, retest in accordance with III-4100 or III-4200.

APPENDIX TA-IV
MANDATORY
AIRFLOW DISTRIBUTION TEST PROCEDURE

IV-1000 General

This procedure is used to measure the air flow distribution across the face of moisture separator, prefilter, HEPA filter, and adsorber banks. Uniform air velocity distribution ensures maximum air treatment efficiency and uniform loading of air treatment components.

IV-1100 Summary of Method

The system is operated at design flow rate. Airflow velocity readings are measured downstream of each moisture separator, prefilter, and HEPA filter in the bank. For adsorbers, readings shall be taken in line with the flow slots. Each reading is compared to the average for the bank.

IV-2000 Prerequisites

System operating within +/- 10% design flow rate.

IV-3000 Test Equipment

Rotating vane, heated wire or heated thermocouple anemometer, pitot tube, or other suitable air velocity measuring device as appropriate for the anticipated velocities.

IV-4000 Procedure

a. For each moisture separator, prefilter, and HEPA filter, measure the air velocity at the approximate centers of equal areas with at least one measurement per each moisture separator, prefilter and HEPA filter, and a minimum of 9 measurements per bank. Adsorber velocity measurements shall be made in the approximate center of the flow slots. For flow slots greater than 24 inches long (60 cm), measurements shall be nominally every 12 inches (30 cm) along the length of the slot.

b. Calculate the average velocity (V_{ave}) using the following formula:

$$V_{ave} = \frac{\sum_1^n V_i}{n}$$

where:

$\sum_1^n$ = sum of readings from 1 to n

V_i = individual velocity readings
n = number of readings

c. Identify the highest and lowest velocity readings and calculate the percentage they vary from the average calculated above.

APPENDIX TA-V
MANDATORY
AIR-AEROSOL MIXING TEST PROCEDURE

V-1000 General

This procedure is used to ensure that the challenge aerosol or gas injection ports, used for the in-place leak tests of mandatory Appendix TA-VI and TA-VII, provide a uniform challenge across the entire face of the HEPA filter or adsorber banks. Uniform air-aerosol mixing ensures that all areas of the bank are challenged during these in-place tests. Once an injection port is qualified by this procedure, it shall be used in all subsequent in-place leak tests as outlined in the acceptance tests of TA-4600 and TA-4700.

V-1100 System Test

Injection and sample port location shall be located so that the entire system is challenged for inadvertent bypass flow paths around the HEPA filter or adsorber banks. If this cannot be accomplished, an integrated system test shall be included in addition to the bank tests outlined in appendix TA-VI, TA-VII and TA-4940.

V-1200 Summary of Method

The system is operated at design flow rate. Challenge aerosol or gas is injected through an injection port upstream of the bank. Challenge aerosol or gas concentration readings are obtained at equal cross-sectional areas in front of the HEPA filter or adsorber bank. Each reading is then compared to the average for the bank. DOP aerosol is the preferred challenge agent for this test. However, use of a challenge gas may be useful in some cases.

V-1300 Injection Port Selection Criteria

Injection ports should be located upstream of a flow disturbance to maximize mixing. The challenge gas will pass through the HEPA bank and challenge the adsorber bank. For systems with two or more HEPA filter banks in series, or two or more adsorber banks in series, separate injection ports must be qualified for each bank. Use of injection manifolds may be necessary when there is insufficient room between banks to provide adequate mixing.

V-2000 Prerequisites

The system is operating within +/- 10% of design flow rate. The airflow distribution has been verified in accordance with Appendix TA-IV.

V-3000 Test Equipment

a. Challenge aerosol or gas generator.

b. Challenge aerosol or gas measuring instrument.

V-4000 **Procedure**

a. Connect challenge aerosol or gas generator to the injection port to be tested.

b. Place the challenge aerosol or gas measuring instrument sample probe upstream of the bank to be tested with adequate hose length to reach all areas of the bank.

c. Start the challenge aerosol or gas injection and establish a constant injection rate.

d. Take a concentration reading upstream of and at the approximate centers of equal areas, with at least one reading per HEPA filter and a minimum of 9 readings per HEPA bank. For type II and type III adsorbers, readings shall be taken upstream of and in the approximate center of each flow slot. For flow slots greater than 24 inches (60 cm) in length, a reading shall be taken nominally every 12 inches (30 cm) along the length of the slot.

e. Calculate the average concentration (C_{ave}) readings using the following formula;

$$C_{ave} = \frac{\sum_1^n C_i}{n}$$

where:

$\sum_1^n$ = sum of readings from 1 to n

C_i = individual readings.
n = number of readings.

f. Identify the highest and lowest concentration readings and calculate the percentage it varies from the average above.

APPENDIX TA-VI
MANDATORY
HEPA FILTER BANK IN-PLACE LEAK TEST PROCEDURE

VI-1000 General

This procedure is used to leak test HEPA banks.

VI-1100 Summary of Method

The system is operated at design flow rate. Challenge aerosol is injected upstream of each bank through injection ports qualified in Appendix TA-V. The concentration of the challenge aerosol is measured upstream and downstream of the HEPA bank. The ratio of the downstream and upstream concentrations represents the HEPA filter bank leak rate.

VI-2000 Prerequisites

Airflow distribution shall be verified in accordance with Appendix TA-IV. The injection port shall be qualified to provide uniform air-aerosol mixing in accordance with Appendix TA-V.

VI-3000 Test Equipment

a. Challenge aerosol generator.

b. Challenge aerosol measuring instrument.

c. Flow measuring device.

VI-4000 Procedure

a. Connect challenge aerosol generator to the qualified injection port.

b. Place the challenge aerosol measuring instrument sample probes upstream and downstream of the bank to be tested. The sample tubing shall be of equal bore and approximately equal lengths and as short as possible to minimize the measuring instrument response time. The upstream sample probe shall be located in approximately the center of the bank. The downstream sample probe shall be located in a downstream sample manifold or downstream of a mixing source such as a turbulent fan discharge.

c. Start the system and verify stable flow rate within +/-10% of design flow rate.

d. Measure the upstream and downstream aerosol background concentration. The pre-injection background levels shall be stable to ensure correct instrument response and shall not interfere with the detector's ability to detect leaks in excess of the maximum allowed by the acceptance criteria.

e. Start the challenge aerosol injection.

f. Record the upstream and downstream concentrations. Repeat until at least three of the readings are stable.

g. Stop the injection.

h. Using the final set of readings meeting the stability and tolerance criteria, calculate the bank leak rate using the formula below:

$$L = (100)\frac{C_d}{C_u}$$

L = % Leak
C_d = Downstream concentration
C_u = Upstream concentration

APPENDIX TA-VII
MANDATORY
ADSORBER BANK IN-PLACE LEAK TEST PROCEDURE

VII-1000 General

This procedure is used to leak test adsorber banks.

VII-1100 Summary of Method

The system is operated at design flow rate. Challenge gas is injected upstream of each bank through the injection port qualified in Appendix TA-V. The concentration of challenge gas is measured upstream and downstream of the bank. The ratio of the downstream and upstream concentrations represents the bank leak rate.

VII-2000 Prerequisites

Airflow distribution shall be verified in accordance with Appendix TA-IV. The injection port shall be qualified to provide uniform air-aerosol mixing in accordance with Appendix TA-V.

VII-3000 Test Equipment

a. Challenge gas generator.

b. Challenge gas measuring instrument.

c. Flow measuring device.

VII-4000 Procedure

a. Connect challenge gas generator to the qualified injection port.

b. Place the challenge gas measuring instrument sample probes upstream and downstream of the bank to be tested. The sample tubing shall be of equal bore and approximately equal lengths and as short as possible to minimize the measuring instrument response time. The upstream sample probe shall be located in approximately the center of the bank. The downstream sample probe shall be located in a downstream sample manifold or downstream of a mixing source such as a turbulent fan discharge.

c. Start the system and verify stable flow rate and within +/-10% of design flow rate.

d. Measure the upstream and downstream challenge gas background concentration. The pre-injection background levels shall be stable to ensure correct instrument response and shall not interfere with the detector's ability to detect challenge gas leaks less than the maximum allowed by the acceptance criteria.

e. Start the challenge gas injection.

f. Record the upstream and downstream concentrations, as rapidly as instrument response time allows, until sufficient data have been recorded to allow calculation of adsorber bank leak rate. Care must be taken to obtain sufficient readings quickly after injection.

g. Terminate challenge gas injection.

h. Using the upstream and downstream concentration data, calculate the adsorber bank leak rate using the formula below.

$$L = (100)\ \frac{C_d}{C_u}$$

L = % Leak
C_d = Downstream concentration
C_u = Upstream concentration

APPENDIX TA-VIII
MANDATORY
REFRIGERANT PIPING AND COIL SYSTEM LEAK TEST PROCEDURE

VIII-1000 General

This procedure is used to test the leak tightness of refrigerant system piping and coils. The system will be pressurized with a test mixture to identify any leaks. After all identified leaks are repaired a vacuum will be drawn on the system to prove that there are no remaining leaks and to remove any contaminants from the system.

VIII-1100 Summary of Method

The pressure method consists of admitting a test gas, which is usually a mixture of refrigerant and inert gas, into the pressure vessel, coils and piping system and checking for leaks. The vacuum method consists of drawing a vacuum in the closed system and watching for a rise in pressure on a pressure indicator.

VIII-2000 Prerequisites

a. All flare, flange, solder, braze, weld or thread fittings mechanically tight.

b. All seals, packing glands and service valve packing nuts mechanically tight.

c. All service, purge and charging valves closed to the atmosphere.

d. Wire brush and wipe flux and oxides from all heated joints.

VIII-3000 Test Equipment

a. Refrigerant gas.

b. Inert gas (Nitrogen or carbon dioxide).

c. Pressure indicating device.

d. Pressure regulating device with relief valve.

e. Electronic refrigerant leak detector.

f. Leak detection bubble solution.

g. Vacuum Pump.

h. Vacuum indicating device (thermocouple vacuum indicator or other

suitable vacuum indicating device).

VIII-4000 Procedure

VIII-4100 Leak Test Procedure

a. Open all interconnecting manual system valves, solenoid and expansion valves to ensure access to the complete system volume. CAUTION: Do not exceed the safe test pressure limits established by the unit manufacturer.

NOTE: It is advantageous and less costly to use an inert gas (Nitrogen or carbon dioxide), to back up the refrigerant vapor pressure. Only about 5 to 10% of the total mixture need be refrigerant vapor for this method to work.

b. Pressurize the entire system to the manufacturers recommended test pressure with the test mixture.

NOTE: Allow time for the refrigerant and inert gas to mix before checking for leaks.

c. Leak test the entire system, including factory joints, seals, and insulated lines with an electronic leak detector. Usually a one inch (2.5 cm) per second movement of the detector probe is sufficient to pick up leaks. Soap solution may also be used to locate leaks.

d. Mark or identify any leaks located.

CAUTION: Use appropriate reclaim equipment to prevent release of refrigerant gas to the atmosphere.

e. Leak testing is complete when all leaks have been repaired and the system has been re-pressurized and retested to verify that there are no leaks.

VIII-4200 Evacuation and Dehydration Procedure

Evacuate and dehydrate after leak testing per step VIII-4100. Proper evacuation and dehydration prove system tightness, expel non-condensables, and assure a dry system before charging with refrigerant.

VIII-4210 Deep Vacuum Method

a. Vent all system pressure.

CAUTION: Use appropriate reclaim equipment to prevent release of refrigerant gas to the atmosphere.

b. Connect a temporary connection between the system high and low pressure sides. Connect the vacuum pump, vacuum indicator, and refrigerant cylinder to the system.

c. Open the vacuum pump suction and start the evacuation.

d. When the system reaches less than 500 micrometers (Hg) absolute, it is isolated from the vacuum pump.

e. When the system holds 500 micrometer (Hg) absolute for at least 15 minutes, with the vacuum source isolated, the system is free of moisture and leaks and the vacuum should be released by charging with refrigerant.

APPENDIX TA-A
NON-MANDATORY
MOUNTING FRAME PRESSURE LEAK TEST PROCEDURE

A-1000 General

This optional test is used to identify leaks through seal welds of the HEPA filter or adsorber mounting frames. The presence of these leaks may be evident when conducting the in-place leak tests on the HEPA filter and adsorber banks. A good visual verification per Appendix TA-I, steps I-1600 and I-1700, is usually adequate. This procedure is provided for use when the frame leaks need to be located.

A-1100 Summary of Method

Temporary blanks, with gaskets, are installed in place of the HEPA filters or adsorbers on the mounting frame in the system. The pressure boundary is then secured by blanking off upstream of the mounting frame in the housing or associated ducts. This modified pressure boundary is then pressurized using the techniques outlined in Appendix TA-III and any leaks in the mounting frame welded interface is detected using the techniques in Appendix TA-III, steps III-4400 or III-4500.

A-2000 Prerequisites

Construction, modifications, and repairs affecting the test boundary shall be completed and temporary blanks (with gaskets) installed on the gasket side of the mounting frame. The opening of the duct or housing upstream of the mounting frame shall be blanked off to form a modified pressure boundary.

A-3000 Test Equipment

a. Pressurization source.

b. Covers to seal test boundaries.

c. Pressure indicating device accurate to +/- 0.1 in. w.g. (0.025 kPa(gage)).

A-4000 Procedure

a. Connect the pressurization source to the duct or housing pressure boundary.

b. Install pressure indicating device so that it will indicate the pressure inside the duct or housing being tested.

c. Close access doors.

d. Start the fan and operate until the pressure is greater than

or equal to the maximum operating differential pressure for the filter bank (not to exceed the structural capability pressure for the duct and housing assembly). Maintain pressure for the duration of the inspection.

e. Inspect the mounting frame welds and attachments for leaks using the methods outlined in Appendix TA-III, steps III-4400 or III-4500.

APPENDIX TA-B
NON-MANDATORY
CORRECTIVE ACTION GUIDANCE

Corrective action may consist of replacement, repair, modification, maintenance, or analysis to demonstrate that the equipment will fulfill its design function. A revised set of reference values, as described in TA-3200, should be established after the corrective action has been taken.

Results of a failed test should not be resolved simply by a successful repetition of the test. A successful repetition of the test should be preceded by corrective action.

If the cause of the test failure cannot be determined by inspection or analysis, corrective action may consist of re-calibration of test instruments and subsequent re-testing. If it is determined that the test failure is due to an equipment malfunction, instead of difficulties with the test equipment, or test procedure, the equipment should be declared unavailable for service until the specific cause has been determined and the condition corrected.

APPENDIX TA-C
NON-MANDATORY
CHALLENGE GAS SUBSTITUTE SELECTION CRITERIA

Alternative test agents (challenge gas) may be used to perform In-Place Leak Testing of Adsorbers, as required in Mandatory Appendix TA-VII, when their selection is based on meeting the following characteristics:

1. The test agent gives the same In-Place Leak Test results as one of the following: R-11, R-12, R-112 or R-112a.

2. The test agent has similar retention times on activated carbons, at the same concentration levels, as one of the following: R-11, R-12, R-112 or R-112a.

3. The test agent has similar lower detection limit sensitivity and precision in the concentration range of use as one of the following: R-11, R-12, R-112 or R-112a.

4. The test agent exhibits chemical and radiological stability under the test conditions.

5. The test agent causes no degradation of the carbon and its impregnant(s) or of the other Nuclear Air Treatment System components under the test conditions.

6. The test agent is listed in the Environmental Protection Agency "Toxic Substance Control Act" (TSCA) inventory for commercial use.