Department of Energy
Washington, DC 20585

The Honorable A. J. Eggenberger
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW Suite 700
Washington, D.C. 20004-2941

Dear Mr. Chairman:

The Department of Energy (DOE) contract with the operator of the Filter Test Facility (FTF), Air Techniques International (ATI), stipulated that prior to the resumption of High Efficiency Particulate Air (HEPA) filter testing at the newly relocated facility in Baltimore, Maryland, that DOE would conduct a restart audit to verify that the contractor's Quality Assurance (QA) Program meets the applicable requirements of American Society of Mechanical Engineers (ASME) NQA-1-2000, *Quality Assurance Program Requirements for Nuclear Facilities.*

A DOE audit team of QA and technical experts drawn from across the DOE complex conducted a QA audit of the FTF on July 14-15. The results of the audit are presented in the attached report, *Restart Quality Assurance Audit, Air Techniques International Filter Test Facility, Baltimore, Maryland.* The audit team identified certain conditions that needed resolution prior to the start-up of the FTF. This included changes to ATI Quality Program Plan and procedures, documenting eye test results of all testing personnel, recalibration of certain measuring devices and revalidation of certain testing procedures and software. These changes were all accomplished to the satisfaction of the audit team.

The FTF is now fully operational and began testing HEPA filters on August 15. Questions concerning the FTF or the audit report may be directed to me at (202) 586-1772 or Robert Loesch at (301) 903-4443.

Sincerely,

Frank E. Tooper
Acting Deputy Assistant Secretary
Office of Corporate Performance Assessment
Environment, Safety and Health

Attachment

cc w/o attachment:
John Spitaleri Shaw, EH-1

C. Russell Shearer, EH-1
Mark B. Whitaker, DR-1
James McConnell, NA-1
Frank B. Russo, NA-1
Richard H. Lagdon, S-3
Robert M. Loesch, EH-31
Subir K. Sen, EH-31

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RESTART QUALITY ASSURANCE AUDIT OF AIR TECHNIQUES INTERNATIONAL FILTER TEST FACILITY BALTIMORE, MARYLAND

Office of Quality Assurance Programs

Office of Environment, Safety and Health

September, 2005

U.S. Department of Energy

RESTART QUALITY ASSURANCE AUDIT
AIR TECHNIQUES INTERNATIONAL
FILTER TEST FACILITY, BALTIMORE, MARYLAND

Audit Report No.:	DOE-EH-2005-1
Supplier Audited:	Air Techniques International Filter Test Facility 1708 Whitehead Road Baltimore, Maryland 21207
Audit Date (On site):	July 14-15, 2005
Audit Team:	
Audit Team Manager	Subir K. Sen, U.S. Dept. of Energy
Lead Auditor:	Theron K. Cordray, Fluor Hanford
Auditor:	Mark Ryan, Westinghouse Savannah River Co.
Auditor:	Werner Bergman, Lawrence Livermore National Laboratory
Auditor:	James McAndrews. Westinghouse Savannah River Co.
Contract Representative	Richard Frounfelker. U.S. Dept. of Energy

Theron K. Cordray 9/30/05

Lead Auditor: Theron K. Cordray **Date**

9/30/05

Approved by: Subir K. Sen **Date**

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APPENDICES

EXECUTIVE SUMMARY

The audit focused on the inspection and testing of High Efficiency Particulate Air (HEPA) filters and how they conform to the requirements as defined in the Audit scope. Specific areas reviewed included: (1) quality assurance program including implementation, (2) technical capabilities, and (3) equipment operation and calibration. Detailed checklists were used to guide the auditor's questions and lines of inquiry. The audit team identified certain start-up conditions that needed resolution prior to the start-up of the FTF. They included changes to ATI Quality Program Plan and procedures, documenting eye test results of all testing personnel, recalibration of certain measuring devices and revalidation of certain testing procedures and software. These changes were all accomplished subsequent to the audit to the satisfaction of the audit team.. Implementation of the overall QA Program requirements in NQA-1 and the technical requirements in the DOE standards was determined to be satisfactory.

1.0 INTRODUCTION

HEPA filters are installed in the Department of Energy (DOE) nuclear facilities to protect against the release of material to the atmosphere and thereby serve to protect workers, the public, and the environment. DOE tests selected HEPA filters at the Filter Test Facility (FTF) that have been identified in the Secretary of Energy Directive issued on June 4, 2001, "100 Percent Quality Assurance Testing of HEPA Filters at The DOE Filter Test Facility", to ensure that the filters meet required specification. These tests are in addition to the tests performed by the filter manufacturers per the requirements specified in the procurement document. HEPA filters are directly shipped to the FTF from the manufacturers for inspection and testing and those that pass are shipped to the DOE facilities.

Due to cleanup activities being conducted at the Oak Ridge site, the FTF has been relocated from its Oak Ridge site to a new location in Baltimore. Air Techniques International (ATI), Inc, the new owner and operator of the FTF, has entered into a contract with DOE to provide independent testing of HEPA filters. In accordance with the contract it is required that, prior to the resumption of HEPA filter testing , DOE will conduct a restart audit to verify that the contractor's Quality Assurance (QA) Program meets the requirements of the applicable sections of American Society of Mechanical Engineers (ASME) NQA-1- 2000.

2.0 AUDIT SCOPE

The scope of the Audit was to verify that ATI has a written QA Program meeting ASME, NQA-1, 2000 Edition, Requirements 1 *Organization* (Paragraphs 100, 200, and 300), 2 *Quality Assurance Programs* (Paragraphs 100, 200, 300, 400 [Inspection Personnel only], and 500), 3 *Design Control* (Paragraphs 100, 400 and 500), 4 *Procurement Document Control* (Paragraph 100), 5 *Instructions, Procedures. and Drawings* (Paragraph 100) , 6 *Document Control* (Paragraphs 100, 200 and 300), 7 *Control of Purchased Items and Services* (Paragraphs 100 and 200), 8 *Identification and Control of Items* (Paragraph 100), 10 *Inspection* (Paragraphs 100,and 200), 11 *Test Control* (Paragraphs 100 and 200), 12 *Control of Measuring & Test Equipment* (Paragraph 100, 300 and 400), 13 *Handling Storage & Shipping* (Paragraphs 100, 200 [Temperature Control only], and 600), 15 *Control of Nonconforming Item* (Paragraph 100), 16 *Corrective Actions* (Paragraph 100), 17 *Quality Assurance Records* (Paragraphs 100, 200, and 300), and 18 *Audits* (Paragraph 100), and that it is being effectively implemented. Also included in the scope of this audit were the technical requirements to ensure the appropriate U.S. Department of Energy (DOE) Standards 3020-97 " Specification For HEPA Filters Used By DOE Contractors", 3022-98 " DOE HEPA Filter Test Program", and 3025-99 "Quality Assurance Inspection and Testing of HEPA Filters" were being addressed and implemented in the ATI procedures.

3.0 OBERVATIONS and START-UP CONDITIONS

The following start-up conditions were identified at the conclusion of the start-up QA audit of the FTF.

3.1 Start-Up Conditions

A. QA program issues. ATI to submit the following to DOE for review and approval:

1. Changes to QPP ATITL-001-QP and any implementing procedures;
2. Changes as a result of the DOE Audit. All documents shall have proper ATI review and approval prior to submittal;
3. Current eye exams for all Test Technicians.

B. Technical program issues. ATI to submit the following to DOE for review and approval:

1. Revise ATITL-001-QP, Section 6.1 to indicate discrepancies between the customers P.O./SPEC and DOE STDs will be resolved with the customer by the ATI Test Facility Manager before testing.
2. DOE standards require air flow resistance across HEPA filters be confirmed at the FTF. The FTF cannot meet this requirement for nipple connected filters because the filter manufacturer tests nipple connected filters before the end plates are permanently secured. Once the end plates are permanently secured, the filter cannot meet the required air flow resistance across the filter. ATI will request a waiver from DOE for this requirement until DOE standards are revised to remove this requirement for nipple connected filters.
3. DOE standards require a media velocity not to exceed 5.0 ft/min at filter rated flow to be confirmed by FTF. HEPA Filter media velocity cannot be measured. ATI to request a waiver from DOE for this requirement until DOE standards are revised to remove this requirement.
4. DOE standard 3025 requires a visual inspection of HEPA filters be conducted by the FTF and provides a list of minimum items to be checked. ATI provides a check list in their procedures of items to be visually checked. This check list does not include the minimum items to be checked. ATI to update check list.
5. DOE standard 3022 states that filter that failed penetration or resistance test at the FTF shall not be accepted with waiver, nor shall the FTF attempt to repair damage to the filter media. This requirement was not covered in ATI procedures. ATI to revise their procedures to include this requirement.
6. NQA-1 Level B storage is a minimum of 40 degrees F with a maximum of 140 degrees F or less if stipulated by the manufacturer. ATI procedures that cover storage of HEPA filters at the FTF does not include restricted storage temperature as required by a vendor (120 degrees F). ATI to add requirement in all of their appropriate procedures after checking with other vendors' for similar temperature restrictions.
7. DOE standard 3025 requires filters to be stored at the FTF with temperature and humidity controls. NQA-1 level "B" storage does not require humidity control. ATI has requested a waiver from DOE for this requirement until DOE standards are revised to remove this requirement.
8. DOE Standard 3025 requires FTF verification that the make and model of HEPA filters being tested at the FTF is a DOE approved filter. DOE at this time does not have a

approved list of HEPA filters by make and model. ATI to request a waiver from DOE for this requirement until DOE standards are revised to remove this requirement.

9. National Institute of Standards and Technology (NIST) traceable calibration of the orifice plate 88-S-3 in two configurations (28 holes and 8 holes) used in the flow measurement in Q-76 filter tester.
10. Demonstration of the uniformity of air flow in the Q-107 filter tester for proper measurement of pressure drop across the test filter.
11. Validation of FLOWCAL software used for computing pressure drop across the calibrated orifice plates.
12 Calibration of the diluter used in the HFATS system for the Q-107 filter tester
13 Validation of filter penetration software used in the HFATS system for the Q107 filter tester.

4.0 DEFICIENCIES DISCUSSED/CORRECTED DURING THE AUDIT

A QA desk review was performed of the submitted ATI QA Program and found that some of the ASME NQA-1, 2000 Edition Requirements had not been addressed. The areas not addressed were found in Requirements 1, 2, 3, 5, 10, 11, 13, 17 and 18. Leo Mombay, QA Director for Hamilton Associates, Inc., submitted Hamilton Administrative Procedures and revised the ATI QA Program Plan to ensure all required ASME NQA-1 Requirements were addressed. These were reviewed by the Audit Team and accepted.

A technical desk review of all submitted ATI procedures was conducted against appropriate DOE Standards. This review uncovered editorial comments on ATI procedures that were discussed with ATI personnel. Some editorial comments were considered deficiencies as they alter the meaning of the requirements being addressed. Some of these comments were incorporated by ATI during the audit and were reviewed by the Audit team and accepted.

5.0 AUDIT SUMMARY

Audit was conducted using two checklists. The QA checklist was based on the requirements of ASME, NQA-1, 2000 Edition, as set forth in Section 2.0 of this report. The technical checklist was based on the technical requirements in DOE Standards 3020-97, 3022-98 and 3025-99. Implementation of the overall QA Program requirements in NQA-1 and the technical requirements in the DOE standards, with minor exceptions as noted in Section 3.0 of this report, was determined to be satisfactory.

An audit entrance meeting was held with ATI's Management and Filter Test personnel on July 14, 2005 (see Appendix "A" for a listing of entrance/exit meeting attendees). Discussions concerning the process to be used for performance of the audit and which auditor or subject matter expert would cover specific criteria. The QA criteria audited is covered in "A" below and the technical criteria audited is covered in "B".

A. ASME, NQA-1, 2000 Edition Audit Summary
During the meeting, the Audit Team discussed ATI's Quality Performance ratings for the past three (3) years. Ratings were all above average and the only negative comments were in documentation not arriving with the filters. Nonconformances were discussed and the only repetive one was for damage to the blue gel. As it was difficult to identify where the damage occurred, extra care and final inspection before shipping was stressed. The Audit Team did not consider the number of Nonconformance Reports (NCRs) to be significant for a three (3) year period.

Prior to the start of the audit the Audit Team had completed their desk review of the ATI submitted QA System/Program. Deficiencies identified in the written QA System/Program were given to ATI for review and addressing. All deficiencies were corrected (see Section 4.0 above). Upon completion of the entrance meeting, the Audit Team began verification of implementation of the QA System/Program by review of historical data, documentation, and examination of various processes.

The audit found the Hamilton and ATI Organization to be satisfactory for establishing responsibilities, lines of authority and interfacing. An interview with ATI personnel found sufficient organizational freedom, access to management and sufficient authority for performing the work. ATI is comprised of two (2) personnel at this time with support from the Corporate office when required. Review of Indoctrination, Training and Qualification of ATI personnel performing the independent testing and inspection of the HEPA filters found the personnel to have extensive experience in HEPA filter testing and inspection along with documented training and capability demonstration for using the Q-76 and Q-107 machines. Documentation for eye exams was not present during this audit. ATI Management was informed that prior to any testing eye exams would be required and would need to be submitted for review.

Although Design Control was identified in the scope of the audit, the Audit Team decided not to verify design activities at this time. The design activities would not be needed until design changes to the existing machines were needed or new machines were purchased. The ATI Quality Program Plan was revised to add a requirement for submitting the Design Control Procedures to DOE for review and approval prior to the start of any design activities.

Procurement Document Control along with Control of Purchased Items and Services was reviewed and found satisfactory. This is a minimal activity for the Filter Test Facility as the only service procured is calibration services from Davis Calibration Laboratory (Davis) and the procurement of aerosol. A successful on-site audit was accomplished by Hamilton for the purpose of adding Davis to the Approved Vendor List (AVL). Review of the Purchase Order (PO) for the aerosol found all requirements addressed.

Hamilton maintains the Document Control system and at this time only two (2) controlled copies of the Quality System Manual and implementing procedures will be maintained for the ATI Filter Test Facility. One copy will be held by Document Control and the other at the Test Facility. Review of the Document Control system found documents were identified with the owner of the document listed. An approved authority and signature list for the approval of the documents was reviewed and found all documents, including revisions, had the correct approval signatures with the current revision matched against the Document Control Master List. Review of the Procedures that will be used for the testing of the various HEPA filters found that accepance criteria was addressed.

Review of inspection checklists and filter reports associated with Westinghouse Savannah River Company (WRSC) and Hanford Purchase Orders found all inspections and testing to be documented, complete and met the acceptance criteria for applicable sections of the DOE Orders, respective DOE site contractor filter specifications and the applicable ATI procedure's used. Inspection and testing is pre-planned to verify conformance of the filter by using inspection checklists and filter test forms that have been reviewed by DOE site contractor's and accepted. As ATI is an independent filter test facility, both technicians presently at the facility who perform the inspections and tests are independent of the filter manufacturing process.

ATI has an established Material & Testing Equipment (M&TE) Program to ensure calibrations are performed when required, M&TE reviewed was found to be controlled within the specified ranges, calibrated at prescribed intervals, and appropriate calibration certificates are maintained and traceable to NIST. Review of the penetration meters and the 7-day 24-hour recorder found the control process for M&TE satisfactory. ATI is in the process at this time of calibrating various orifice plates and this will be identified in the technical review. ATI through Hamilton Corporate has a system for tagging and segregating out-of-calibrated equipment and evaluating previous inspection or tests performed using the equipment and notification to the customer. These actions have not been required to date. Calibrated equipment is maintained in a clean environment, identification and calibration dates are maintained and records including history are maintained to establish the calibration status and capability of the Measuring & Test equipment.

The ATI storage area is maintained in a very clean and environmentally controlled condition. Storage racks have been built with filters awaiting inspection stored on them with no filters being stacked more than two (2) high. The storage area is being controlled by a 7-day 24-hour recorder for temperature controls; another recorder is planned for the filter testing area.

Requirement 15 *Control of Nonconforming Items* has been removed from the scope of this audit as Requirement 8 *Identification of Items* will control filters that do not meet the inspection/test criteria. The manufacturer or user of the filter will evaluate the deficiency and provide resolution to ATI.

ATI has established a system along with support from the corporate office to identify, document, correct and prevent quality problems. Review of several Corrective Action Reports (CAR) found problem areas have been identified, root cause established, documented closure of the CARs and object evidence for preventing recurrence. Review of findings associated with the 2004 internal audit were also found to be documented, reported to management and closed in a timely manner. Results of all CARs are reported to management.

QA Records were found to be legible and traceable to the filter and applicable PO. QA Records are maintained in fire proof UL rated file cabinets, locked when not in use and the building is locked when not occupied.

Hamilton has an audit program for performing internal audits. Review of previous audits found that they are conducted annually for all aspects of the quality system, using checklists and performed by qualified auditors who have no responsibility in the areas being audited. Audit results were reported to the management. Unsatisfactory conditions were identified and documented and follow up was accomplished to ensure closure and preventive actions addressed. Audits are again reviewed during the Management Assessments. Hamilton will include ATI in the 2005 audit schedule. Hamilton also uses Management Assessments where topics include customer complaints, corrective actions, vendor corrective actions, internal audit findings, preventive actions, continual improvement, customer satisfaction process and quality objectives.

B. Technical Audit Summary, DOE Standards
Reviewed requirements in DOE Standards 3020-97 " Specification For HEPA Filters Used By DOE Contractors", 3022-98 " DOE HEPA Filter Test Program", and 3025-99 "Quality Assurance Inspection and Testing of HEPA Filters" against ATI procedures ATITL-001-QP "ATI Quality Program Plan", ATITL-002 "WI Inspection and Test of High-Efficiency Particulate Air Filters", ATITL-003-WI "Operating The Q-76 Filter Test Penetrometer", ATITL-004-WI "Operating the HFATS Filter Test System", and ATITL-005-WI "Operating the Q-107 Filter Testing Penetrometer". Start-up conditions identified are covered in Section 3.0 of this document.

6.0 EFFECTIVENESS STATEMENT

The Audit Team reviewed numerous documents and process control measures, which established that ATI has both the QA Program Requirements and the Technical ability for the Inspection and Testing of HEPA Filters.

7.0 AUDIT PERSONNEL

Team Member	Organization/Affiliation	Functional Area
Subir K. Sen	DOE Office of Quality Assurance Programs, EH-31 Office of Corporate Performance Assessment	Audit Team Manager, ASME NQA-1, 2000 Edition, DOE Standards 3020, 3022, 3025 & ASME AG-1
Theron K. Cordray	DOE Richland Operations, Fluor Hanford	Lead Auditor, ASME NQA-1, 2000 Edition
Mark W. Ryan	DOE Westinghouse Savannah River Company	Auditor, ASME NQA-1, 2000 Edition
James McAndrews	DOE Westinghouse Savannah River Company	Auditor, DOE Standards 3020, 3022, 3025 & ASME AG-1
Werner Bergman	DOE Lawrence Livermore National Laboratory	Auditor, DOE Standards 3020, 3022, 3025 & ASME AG-1

8.0 PERSONNEL CONTACTED

See Appendix "A".

9.0 DOCUMENTS REVIEWED

See Appendix "B".

10.0 CORRECTIVE ACTION PLAN FROM THE SUPPLIER

Following the on-site audit, ATI took several actions to address the start up conditions listed in Section 3.1 A and 3.1 B, items 1 through 9, which included revising ATI procedures , providing eye test examination results of the test technicians and submitting additional exemption request to DOE for reasons stated there in. Resolution of the start up conditions 3.1 A, items 9 through 13 are detailed in Appendix "C". These actions resolved all the start-up conditions satisfactorily.

11.0 LIST OF APPENDICES

Appendix A - Personnel Contacted During The Audit
Appendix B - Documents Reviewed During The Audit
Appendix C - Audit Start Up Conditions and Resolutions

Appendix A
Entrance/Exit Meeting
Attendees'/Interviewees'

Name	Organization	Entrance	Exit	Interviewed
S. K. Sen	DOE/ Office of Quality Assurance Programs	X	X	
T. K. Cordray	FH QA/Audit Lead	X	X	
M. Ryan	WRSC, Auditor	X	X	
J. McAndrews	WRSC, Auditor	X	X	
W. Bergman	Lawrence Livermore, Auditor	X	X	
R. E. Frounfelker	DOE, EM ORO	X	X	
E. Hanson	Hamilton/ATI, President	X	X	X
L. Mombay	Hamilton/ATI, Director CQS	X	X	X
D. Crosby	ATI, Laboratory Manager	X	X	X
J. Fretthold	ATI, Techician	X	X	X

Appendix B
Documents Reviewed During Audit

ATI Documents used for written QA program compliance:
Hamilton Quality Management System Manual, Revision: January 02, 2004
ATI Quality Program Plan ATITL-001-QP, Revision: B, dated July XXXX , 2005

- **Procedures**:

ATITL-002	WI Inspection and Test of High-Efficiency Particulate Air Filters
ATITL-003	WI Operating The Q-76 Filter Test Penetrometer
ATITL-004	WI Operating the HFATS Filter Test System
ATITL-005	WI Operating the Q-107 Filter Testing Penetrometer
MTR-000	Executive Management Quality System Review
MTR-001	LI Executive Management List
DOC-000	The Document Control System & Data Management
DOC-002	GL Document Category
DOC-003	LI Personnel Authorized to Approve & Sign Documents
DOC-004	LI Document Master List- Electronic List
DOC-006	FC Entry, Processing & Distribution of QMS Controlled Documents
DOC-007	FC Revision, Removal & Distribution of QMS Controlled Documents
PRG-000	Purchasing
PRG-001	FM Purchase Order Form
PRG-002	GL Guidelines of Purchasing requisitions
PRG-005	LI Approved Vendors List- Electronic List
PRG-006	FC Vendor Verification requirements
PRG-009	GL Guidelines for Approval of New or Removal of Existing Vendors from the
CAL-000	Management of Test & Calibration Equipment
CAL-001	LI Calibrated Equipment List- Electronic List
CAR-000	Corrective & Preventive Action
CAR-001	FC Handling & Management of Customer Complaints
CAR-002	FC The Internal Corrective Action Requirement Process
CAR-003	FC Vendor Corrective Action requirement
CAR-004	FC Escalation of Corrective Action Resolution & Close Out
CAR-005	FM Corrective Action Request Form
REC-000	Records Management
IQA-000	Internal Audit
IQA-001	LI List of Internal audit Team members
IQA-002	SC Internal audit Schedule
IQA-004	FM Internal Audit Report
IQA-005	CL21 Internal audit schedule

HRD-000	Training
HRD-003	MX Training requirement Identification
HRD-004	FC Training Implementation
HRD-005	GL Training Assessment

- **Indoctrination and Training files:**
  D. Crosby
  L. Mombay
  J. Fretthold

- **Qualification/Certification files:**
  L. Mombay (Lead Auditor)
  D. Crosby (Filter Technician)
  J. Fretthold (Filter Techician)

- **Audit Report(s):**
  2002
  2003
  2004

- **Corrective Actions**
  04-01 Customer Complaint
  04-02 Vendor CAR
  04-03 Internal CAR
  04-04 Internal CAR

- **Approved Supplier File(s):**
  Davis Calibration Laboratory

- **Purchase Orders/Test Reports/Inspection**
  20057684
  AC45273A
  AC45276A
  AC44289A
  AC45278A
  25273
  26134
  25871
  26001

- **M&TE with current NIST traceable calibration(s):**
- Penetrometer Meter 4599
- Penetrometer Meter 4947

- **Miscellaneous:**
- Management Assessment for 2003 & 2004
- DOE Order 3025

- DOE Contract with ATI no. DE-AC05-05OR23197 (as amended), dated March 29, 2005
- Certificates of Calibration from Colorado Engineering Experiment Station, dated July 28 &29, 2005 and April 28, 1998.
- Los Alamos National Laboratory Final Report LA-10748, Evaluation of Methods, Instrumentation, and Materials Pertinent to Quality Assurance Filter Penetration Testing, January 1987 by R.C. Scripsick and S.C. Soderholm.
- Los Alamos National Laboratory Summary Report, Technology Transfer of the Department of Energy Filter Test Facilities High Flow Alternative Test System, July 9, 1991 by J.A. McIntyre and R.J. Beckman.
- Operational Evaluation of the High Flow Alternative Filter Test System, by R.C. Scripsick, R.L. Smitherman, and S.A. McNabb, 19th DOE/NRC Nuclear Air Cleaning Conference.
- FTF Flow Calibration Program by R.C. Scripsick and Edited by D.L. Monroe, September 28, 1994.

Appendix C
Audit Start Up Conditions and Resolutions

Item 1. ATI did not have NIST traceable calibration data for small orifice plates 88-S-3 (28 Holes) and 88-S-3 (8 Holes).

Significance of Item 1: The orifice plates are used in the Q-76 filter tester to establish the proper air flow for filter testing. The air flow is an important experimental parameter that affects the accuracy of the HEPA filter pressure drop and efficiency measurement.

Resolution 1. ATI sent the orifice plates to the Colorado Engineering Experiment Station in Nunn, Colorado for calibration. The plates were satisfactorily calibrated on July 28 and 29, 2005.

Item 2. The air flow in the Q-107 filter tester makes a 90 degree bend immediately prior to passing through the test HEPA filter or calibration plate. The sharp bend may result in a non-uniform air flow distribution across the face of the test filter or calibration plate. This design feature was unchanged since the first Q-107 tester was developed by the US Army. A screen placed prior to the filter test section to mitigate the non-uniform air flow distribution. No data was available to determine the uniformity of the air flow in the test section of the Q-107.

Significance of item 2: A non-uniform air flow across the HEPA filter or the orifice plate can introduce a significant error in the relationship between the pressure drop and flow. This error is understood in the ASME Standards N509 and N510 which state the flow must be within plus and minus 20% of the average in filter banks. Although not stated in the DOE HEPA filter standard 3020, a uniform air flow is critical to ensure accurate measurements of pressure drop and efficiency. Most other filter test standards have explicit statements on the tolerance of flow uniformity.

Resolution 2: ATI personnel measured the air flow distribution across the face of the filter test section at 500, 1000 and 2000 cfm and found the flow uniformity had a standard deviation of less than 15% of the mean velocity. This variation is acceptable.

Item 3. The Filter Test Facility uses a computer program (FLOWCAL) to compute the pressure drop across the calibrated orifice plates that corresponds to a desired air flow in ACFM. There is no supporting documentation that shows what equations are used in the computer code to relate the pressure drop to the flow. The FLOWCAL code uses an iterative scheme in its computations that differs from standard ASME flow equations. In addition, the FLOWCAL code is not validated.

Significance of item 3: The setting of the air flows using the orifice calibration plates and the FLOWCAL code is an important task in the filter test procedure and has a direct impact on the accuracy of the pressure drop and aerosol penetration measurements. The use of an undocumented and un-validated computer code introduces an unknown error into the values of pressure drop and aerosol penetration.

Resolution 3. The audit team conducted an independent analysis of the use of the orifice calibration plates in computing the differential pressure across the orifice plate for a desired air flow rate in ACFM. The analysis, "Application of Orifice Plates for Flow Calibrations at ATI Filter Test Facility", consisted of identifying the equations used by CEESI to establish the differential pressure versus air flow for measured temperature and pressure conditions. The flow equations are obtained from the ASME-MFC report on the "Measurement of fluid flow in pipes using orifice, nozzle, and venturi". The agreement between the CEESI example data and the ASME flow equations is within +/-0.01%.

Empirical equations were then generated for each of the calibration plates using the ASME flow equations. Using these equations, the error in the individual CESSI measurements for the two large plates is +/- 1.5% and for the small plate with 12 and 24 holes is +/-4% and +/-2% respectively.

The empirical equations were then used to compute the differential pressure across the orifice plate corresponding to specific flow rates in ACFM and were compared to the FLOCAL results. The comparisons show the Q-76 plates with 24 holes and 8 holes yield 4-7% and 2-6% higher flows respectively with the FLOWCAL than with the values obtained with the flow calibration equations based on the CESSI data. Correction tables (see Tables S-1 and S-2) were prepared for these two plates to have good agreement between the FLOWCAL values and the flow equations. Comparisons of the three plates for the Q-107 filter tester showed the FLOWCAL code gave 0.2-0.5% higher flows for the 77 hole plate and 1-2% lower flows fro the 24 and 12 hole plates.

The analysis and corrections provide an independent validation of the FLOWCAL code.

Item 4. The diluter calibration used by the FTS in the HFATS system for the Q-107 tester has an unknown uncertainty and is subject to change over time due to particle deposits in the diluter filter and in the capillary. The diluter calibration is performed using the HFATS filter penetration measurement and a supplemental capillary diluter with unknown dilution.

Significance of Item 4. The accuracy of the diluter calibration has a direct effect on the accuracy of the filter penetration when using the HFATS system in the Q-107 tester.

Resolution 4. A new procedure was developed using only the primary diluter capillary and 200 nm latex spheres. The dilution is determined directly from the latex sphere concentration measurements before and after the capillary diluter. The new method is a direct and primary measurement and does not rely on the HFATS program to operate. The method also incorporates particle deposit effects and thus does not have inherent uncertainties.

Item 5. The HFATS system and computer program used in the FTS has not been validated since the initial installation in 1986 when penetration measurements using the HFATS system were compared with penetration measurements using the Q-107 system of photometer and OWL. The correlation between the two systems was reported in the 19th Nuclear Air Cleaning Conference and in the LANL report on the HFATS dated July 9, 1991 that was used to request formal DOE approval of the HFATS for the filter test stations.

Significance of Item 5. The accuracy of the HEPA filter penetration measurements in the Q-107 tester using the HFATS system and computer code is dependent on the system and computer code performing their intended functions. Changes in the HFATS system (e.g. diluter) and in the HFATS computer code have occurred but have not been documented or analyzed. These changes may cause errors in the penetration measurements.

Resolution 5. The HFATS system and computer program were analyzed to determine what changes were made and the potential impact on the resulting penetration measurement. The HFATS system was found to be essentially the same as that used in the 1986 validation study except for the diluter calibration as discussed in Item **4**. The HFATS computer code used by the FTS was compared line-by-line to the computer code used in the 1986 validation. Most of the changes in the current HFATS code are due to added comment statements and the passing of parameter values through the subroutine parameter list. The only substantive change in the code is the explicit setting of the dilution ratios in the AUTOST subroutine in the current code. The dilution ratio for the 0.3 μm particles is 250. The code used in 1986 did not use fixed values of the dilution ratio. The experimental dilution ratio is set at 250 by adjusting the pressure drop across the orifice to be 3.0 inches of water. With these changes , the HFATS computer code is shown to be essentially the same as the code used in the 1986 validation study. Thus the 1986 validation study is still valid for the slightly modified HFATS system and code.

Table S-1. Modified flow data to be entered into FLOCAL for calibration plate 88-S-3 (28 Holes).

Actual Flow (ACFM)	Modified Flow (ACFM)
275	260.4
250	236.7
225	213.1
200	189.4
175	165.7
150	142.0
125	118.4
100	94.7

Note: $Q_{modified} = Q_{actual} / 1.056$

Table S-2. Modified flow data to be entered into FLOCAL for calibration plate 88-S-3 (8 Holes);

Actual Flow (ACFM)	Modified Flow (ACFM)
75	70.6
60	56.4
50	48.3
40	38.6
35	33.8
30	29.0

Note: $Q_{modified} = Q_{actual} / 1.035$ **for flows 50 cfm and less.**

$Q_{modified} = Q_{actual} / 1.063$ for flows greater than 50 cfm