LA-UR-14-20641

Approved for public release; distribution is unlimited.

Title:	Filter Measurement System for Nuclear Material Storage Canisters- End of Year Report FY 2013
Author(s):	Moore, Murray E. Reeves, Kirk P.
Intended for:	End of year FY2013 report to groups NPI-2 and MET-1.
Issued:	2014-02-03

NOTE: Use these buttons to print or save the form. DO NOT use the browser tool bar. SAVE PRINT

LA-UR-

Approved for public release;
distribution is unlimited.

Title: Filter Measurement System for Nuclear Material Storage Canisters - End of Year Report FY 2013

Author(s): Murray E. Moore, RP-SVS
Kirk P. Reeves, ENV-CP

Intended for: Paul H. Smith, LANL NPI-2
Timothy A. Stone, LANL NPI-2
Douglas K. Veirs, LANL MET-1

Los Alamos NATIONAL LABORATORY EST. 1943

Form 836 (7/06)

SAVE PRINT CLEAR FORM

Filter Measurement System for Nuclear Material Storage Canisters
End of Year Report FY 2013

November 25, 2013

Murray E. Moore, RP-SVS
Kirk Reeves, ENV-ES
Los Alamos National Laboratory
P.O. Box 1663 Los Alamos, NM 87545

Abstract

A test system has been developed at Los Alamos National Laboratory to measure the aerosol collection efficiency of filters in the lids of storage canisters for special nuclear materials. Two FTS (filter test system) devices have been constructed; one will be used in the LANL TA-55 facility with lids from canisters that have stored nuclear material. The other FTS device will be used in TA-3 at the Radiation Protection Division's Aerosol Engineering Facility. The TA-3 system will have an expanded analytical capability, compared to the TA-55 system that will be used for operational performance testing. The LANL FTS is intended to be automatic in operation, with independent instrument checks for each system component. The FTS has been described in a complete P&ID (piping and instrumentation diagram) sketch, included in this report. The TA-3 FTS system is currently in a proof-of-concept status, and TA-55 FTS is a production-quality prototype.

The LANL specification for (Hagan and SAVY) storage canisters requires the filter shall "capture greater than 99.97% of 0.45-micron mean diameter dioctyl phthalate (DOP) aerosol at the rated flow with a DOP concentration of 65±15 micrograms per liter".

The percent penetration (PEN%) and pressure drop (DP) of fifteen (15) Hagan canister lids were measured by NFT Inc (Golden, CO) over a period of time, starting in the year 2002. The Los Alamos FTS measured these quantities on June 21, 2013 and on Oct. 30, 2013. The LANL(6-21-2013) results did not statistically match the NFT Inc data, and the LANL FTS system was re-evaluated, and the aerosol generator was replaced and the air flow measurement method was corrected. The subsequent LANL(10-30-2013) tests indicate that the PEN% results are statistically identical to the NFT Inc results. The LANL(10-30-2013) pressure drop measurements are closer to the NFT Inc data, but future work will be investigated.

An operating procedure for the FTS (filter test system) was written, and future project milestones are on track for completion.

Table of Contents

Contents

Task Status

1 System Process and Instrumentation Diagram (P&ID)………………………………………….... Done

2 Summary list of instruments, model numbers and specifications…………………………………Done

3 List of items that require calibration verification……………………………………………….Done

4 Procedures for calibration verification, component operation and system operation……………. Done

5 List of individual components…………………………………………………………………. Done

6 Software – logic flow description…………………………………………………………….. Done

7 Software – main LabView driver executable file………………………………………………… Done

8 Software – individual instrument drivers………………………………………………………….Done

9 TA-55 system cart specifications…………………………………………………………….... Done

10 TA-3 system specifications………………………………………………………………………97%

List of Figures

Status Summary

At this point in time, the LANL filter test system (FTS) for special nuclear material canisters (SNMC) is **not** producing a complete set of reference results that match the experimental data (5-9-2013) from the NFT Inc company. (See tabular information below, which reflects a paired t-test statistical analysis on that was used to compare the different data sets.)

In between now and the end of the 2013 calendar year, attempts will be made to explain and understand the remaining difference between the LANL and the NFT results since the LANL pressure drop data are (still) statistically different from the NFT. (On a percent error basis, there is an 11.8% difference between the 5-9-2013(NFT) data and the 10-15-2013(LANL) data.)

The LANL filter penetration percent data are statistically the same as the NFT Inc data, since the filter penetration percent is more dependent on the test aerosol size diameter than on the air flow rate (i.e. the filter pressure drop) through the tested filters.

	5-9-2013 NFT dataset	6-21-2013 LANL dataset	10-15-2013 LANL dataset	Is 6-21-2013 LANL data different from NFT 5-9-2013 data? (*p*-value, paired t-test)	Is 10-15-2013 LANL data different from NFT 5-9-2013 data? (*p*-value, paired t-test)
PEN%, filter aerosol penetration percent	0.0091±0.0026	0.0017±0.0021	0.0102±0.0030	Yes (1.2E-06)	No (0.304)
DP (inches WC, water column), filter pressure drop	0.81±0.07	0.58±0.06	0.72±0.08	Yes (7.4E-17)	Yes (7.6E-10)

Introduction

A test system has been developed at Los Alamos National Laboratory to measure the aerosol collection efficiency of filters in the lids of storage canisters for special nuclear materials (Figure 1). Two FTS (filter test system) units have been constructed; one will be at the LANL TA-55 facility, for canisters that have stored nuclear material. The other unit will in TA-3 at the LANL Radiation Protection Division's Aerosol Engineering Facility. The TA-3 system will have an expanded analytical capability, compared to the TA-55 system for operational performance testing. The TA-3 FTS is currently a "proof-of-concept" system, but the TA-55 system is a production-quality prototype.

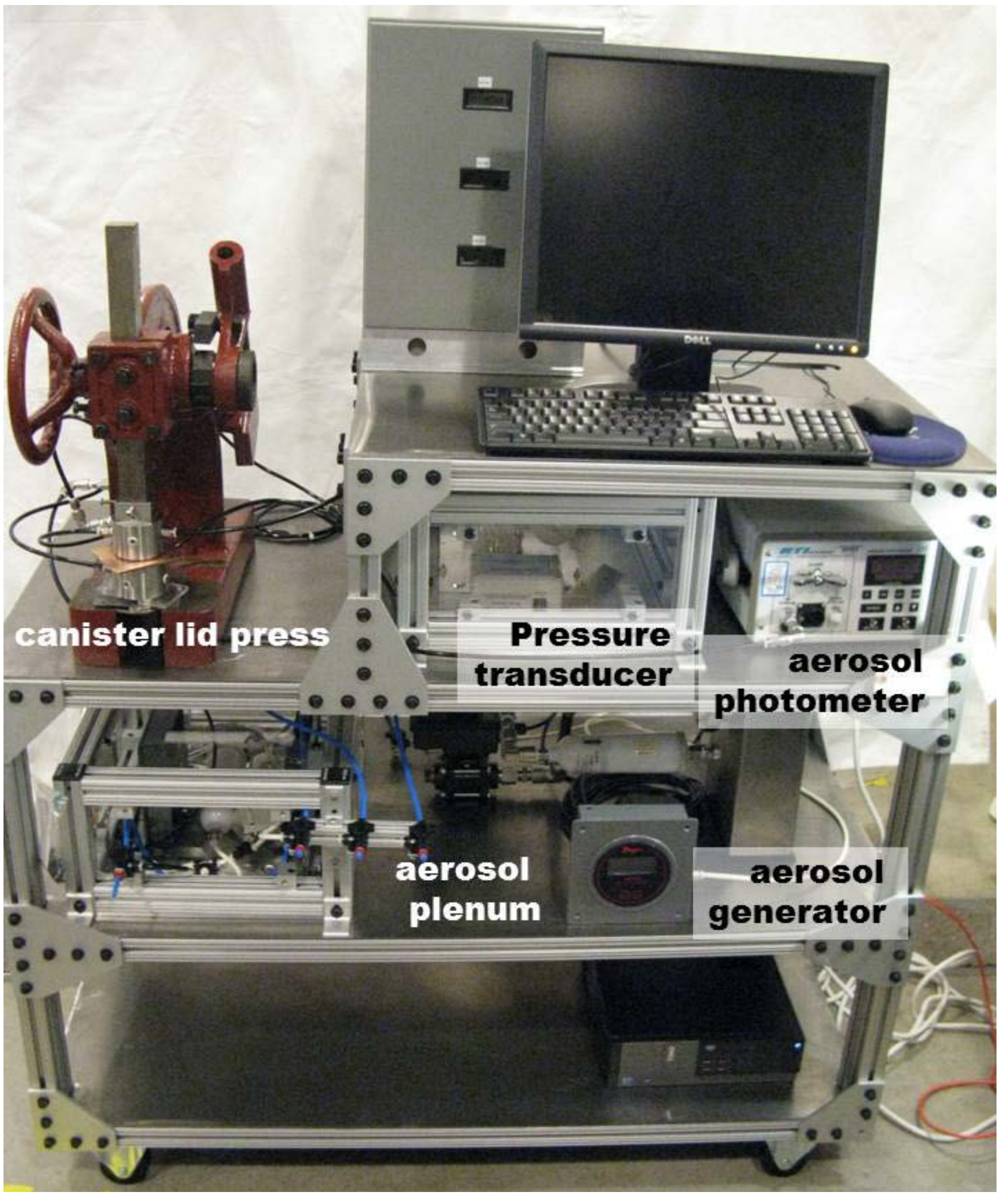

Figure 1. Filter Test System for TA-55 operations.

The TA-55 FTS device was used to measure a set of reference canister filters that are the property of NFT Inc. (Golden, CO). There are fifteen canister lids in this reference set, and all of them are from the older (1980s) Hagan type design. Two physical parameters were measured: the percent penetration and the filter pressure drop.

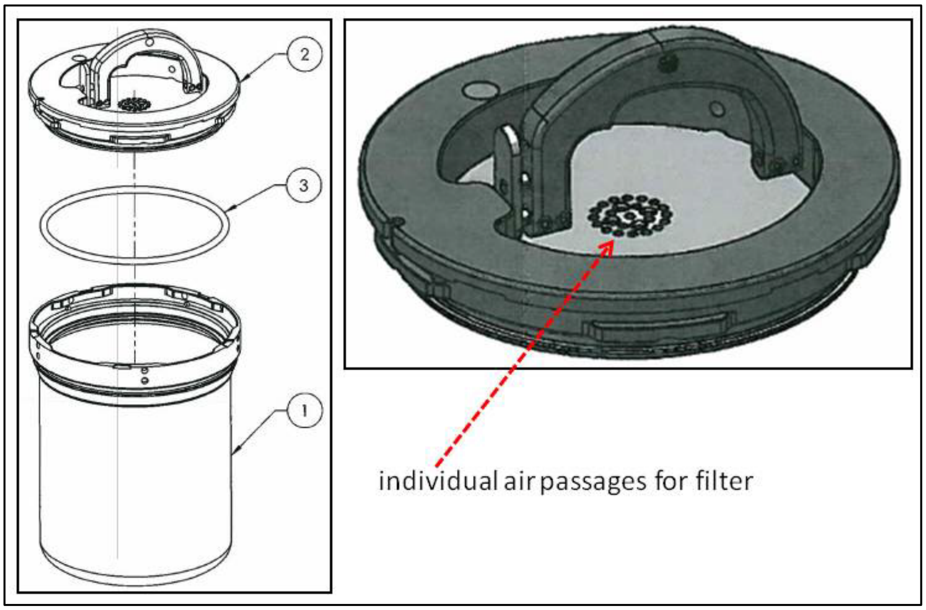

Figure 2. A newer SAVY (2012) type storage canister. (1) Canister (2) Lid. (3) O-ring. Individual holes in the canister lid enable air flow through the integrated filter-lid system.

Figure 3. Hagan type canister lid with hexagonal filter port.

The filter percent penetration is related to the filter collection efficiency (Figure 4), where the efficiency is defined as:

$$E = \text{Filter percent efficiency} = 100\% * (1 - C_D/C_U) \quad (1)$$

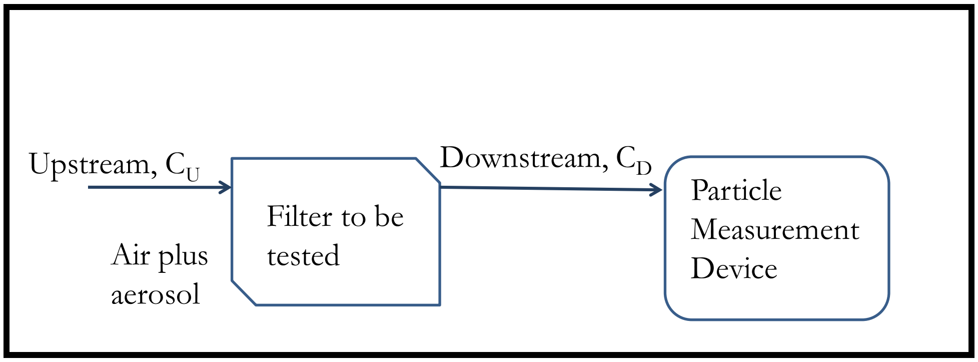

Figure 4. A system sketch illustrates the measurement of filter collection efficiency.

The filter percent penetration, P%, value is defined, where,

$$P = \text{Filter percent penetration} = 100\% * C_D / C_U \text{, or,} \quad (2)$$

$$P\% = 100\% - E\% \quad (3)$$

<u>End-of-Year Status Report</u>

This document provides an overview of the progress and also gives detailed descriptions of the current system setup. The LANL specification for storage canisters requires the filter shall “capture greater than 99.97% of 0.45-micron mean diameter dioctyl phthalate (DOP) aerosol at the rated flow with a DOP concentration of 65 ± 15 micrograms per liter” [1].

The LANL FTS is automatically operated, with independent instrument checks for each system component. The FTS has been described in a complete P&ID (piping and instrumentation diagram) sketch.

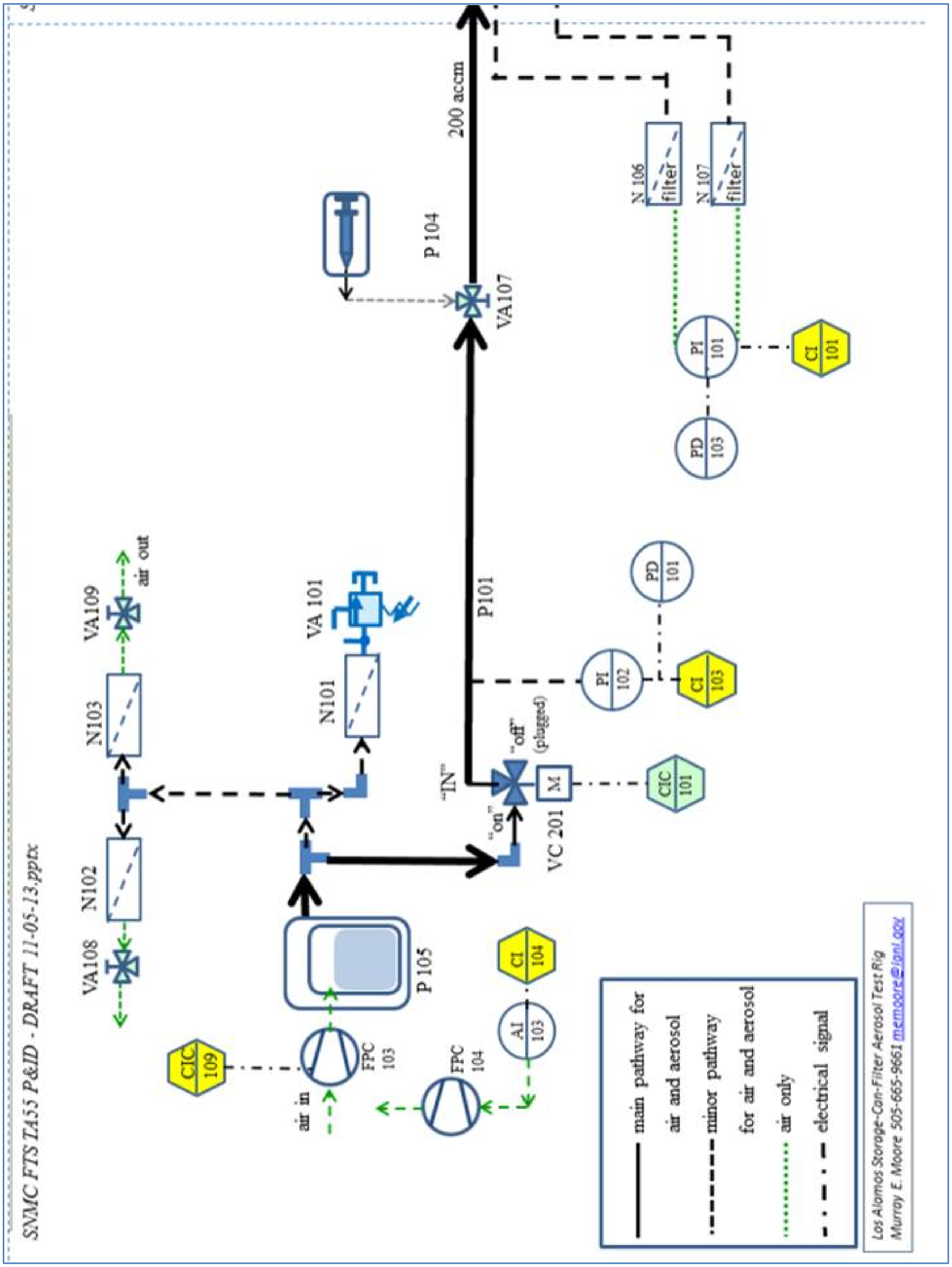

Figure 5. Left hand side of the filter test system P&ID diagram.

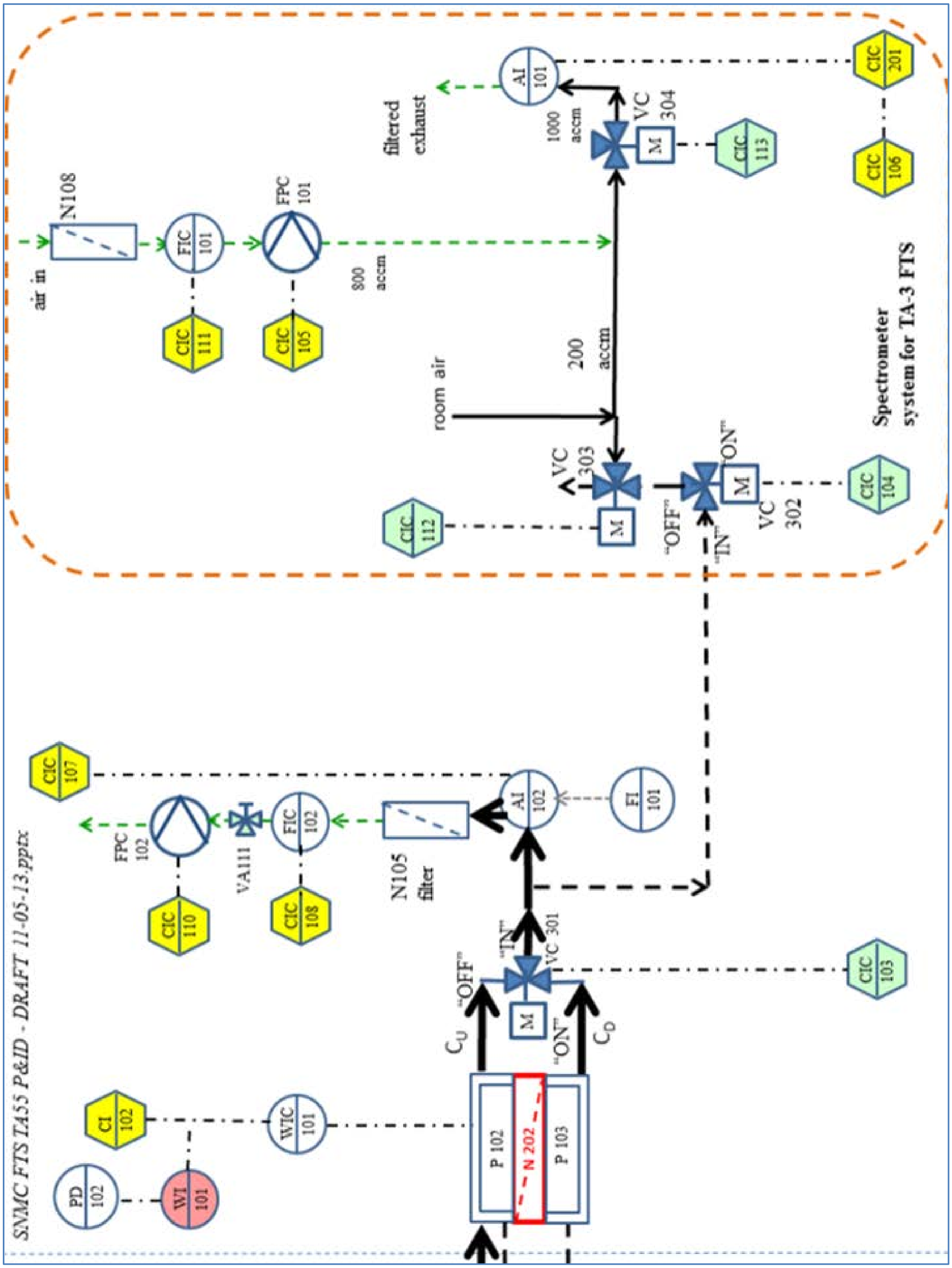

Figure 6. Right hand side of the filter test system P&ID diagram.

The components in the system (see Figures 7 and 8) must perform the following functions:

(1) Produce oil droplets with an aerosol generator (P105) within defined performance parameters (i.e. aerosol size and concentration),

(2) Control the use of the test aerosol (aerosol plenum P101) without having an accidental release into the room air,

(3) Measure the concentration (aerosol spectrometer AI102) of the aerosol particles upstream of the filter to be tested, verifying the temporal stability of the oil droplet concentration,

(4) Maintain and record the air flowrate through each tested filter at a value of 200 accm (actual cubic centimeters per minute) by flow controller FIC 102. (NOTE: The value of “200 accm” is the volumetric measure of air flowrate at the local altitude, it is not the “standard” flowrate (e.g. 200 sccm), which is the air flowrate corrected to a certain reference temperature and pressure.)

(5) Measure the differential pressure (pressure gauge PI101) across the filter for lifetime extension and surveillance purposes. These values report a fail message if they are outside an acceptable range. The pass or fail values for testing can be changed if criteria were tightened or relaxed.

(6) Regulate and control the process with a LabView™ software application to satisfy the project goals of instrument automation and data acquisition. The program controls and measures aerosol flow through the system. For filter testing, when the aerosol concentration is measured at the upstream location, the program analyzes a rolling average of groups of ten samples, at one second intervals, and calculates the standard deviation to determine a steady state condition. This information provides the conditional logic switch from upstream sampling to downstream sampling, where a similar rolling average defines a standard deviation criterion. Once both upstream and downstream data have been taken, the percent penetration is calculated. The cycle time for the aerosol concentrations to equilibrate from the upstream to the downstream mode will be discussed further in this document. There are several secondary instruments that require measurement and recording for system quality checks and monitoring.

(7) Secure an airtight seal on the tested filter with a clamping force (i.e. 200 pounds) that is applied by an arbor press and measured by a load cell at (WIC 101),

(8) Maintain the state (ON/OFF) of the pump (FPC102) that provides air flow for the photometer (AI 102).

(9) Record the reading of the pressure gauge (PI102) on the aerosol plenum (P101).

(10) Control and record the state of the motorized valves (VC 201 and VC301).

(11) Allow for future modifications of the LabView driver program.

System features and decisions in FY2013.

(A) The TA-3 FTS is more compact than it was at the beginning of FY2013, but the final version of the TA-55 FTS was successfully designed to fit in the required footprint for the available space in TA-55. (i.e. four feet wide and two feet deep).

(B) Aerosol particle counter interlock with the aerosol generator. A small inexpensive aerosol particle counter will monitor the room air aerosol population in the TA-55 lab space where the filter test system will be located. When a baseline aerosol concentration is established for that lab space, a criterion for determining the accidental release of oil droplet aerosol will be used to terminate electrical power to the aerosol generator. This is necessary for operational air quality purposes in the lab room where the TA-55 system will be operated.

(C) The LANL TA-3 system will have a multichannel aerosol spectrometer [2] integrated into its operating profile. (See Figure 6.)

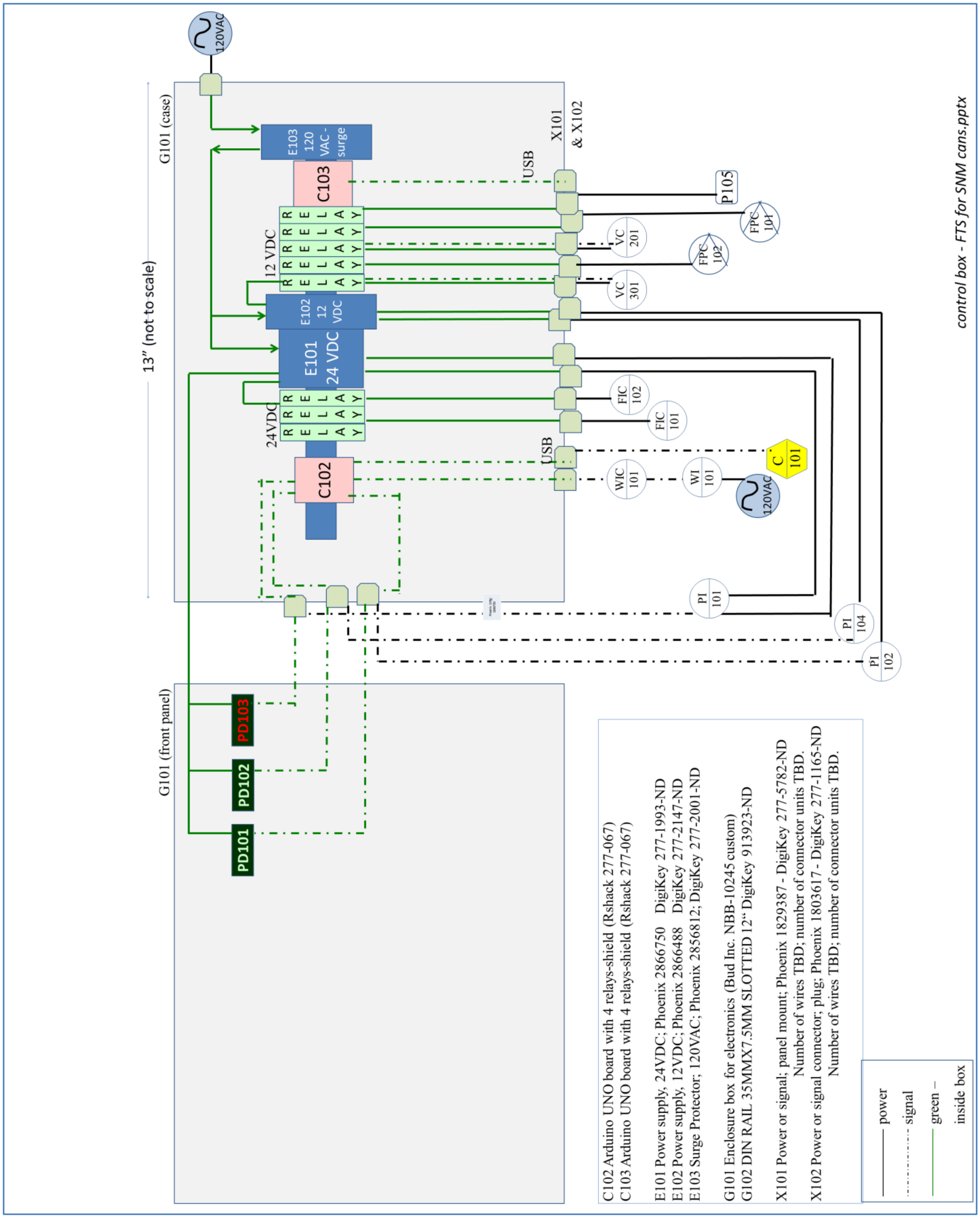

Figure 7. Electrical diagram of the control box for the SNMC FTS.

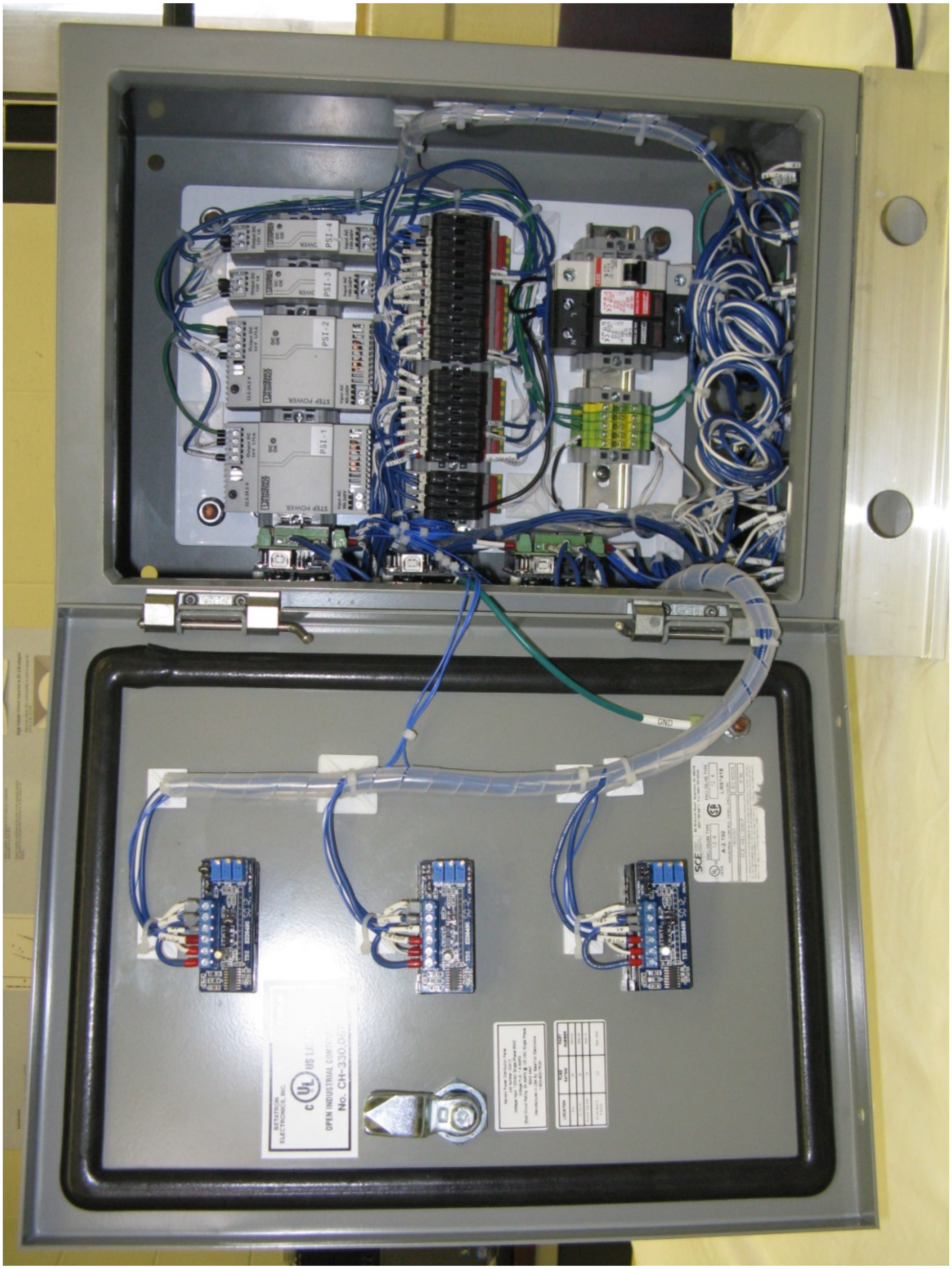

Figure 8. Inner layout of the completed control box.

Results of comparison tests between NFT Inc test system and LANL test system.

The percent penetration (PEN) and pressure drop (DP) of fifteen (15) Hagan canister lids were measured at Los Alamos on June 21, 2013 and on Oct. 30, 2013. These tests were compared to the measurements from NFT Inc, who measured the same fifteen lids over a period of time, starting in the year 2002.

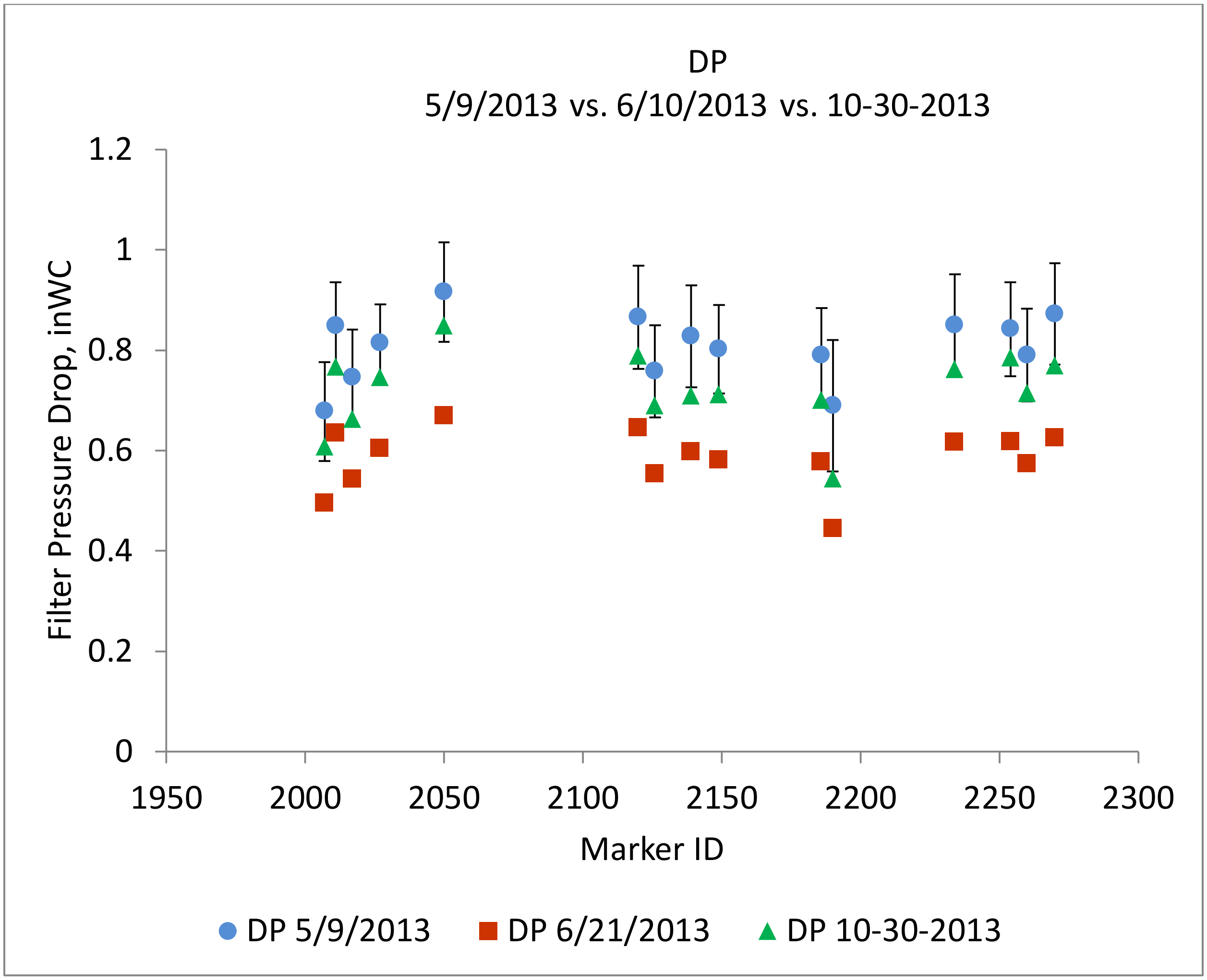

Figure 9. Measured pressure drop across the fifteen reference Hagan filters.

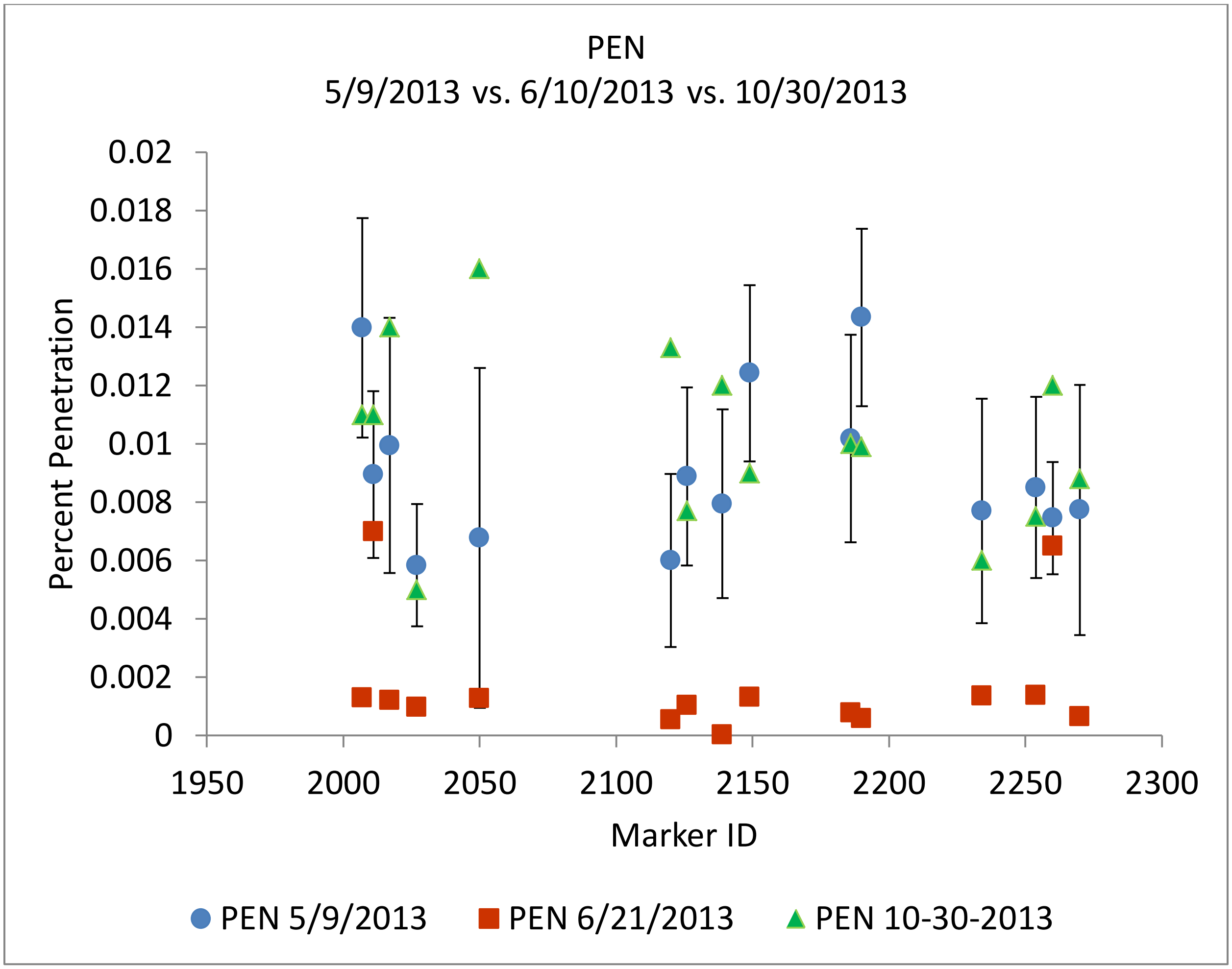

Figure 10. Measured percent penetration across the fifteen reference Hagan filters.

After the LANL 6-21-2013 results were produced, a statistical analysis (paired t-test) was performed on these experimental measurements, and the results are summarized in the table below.

The mean test	p-value	Answer to the mean test
Is PEN% 5/9/2013 greater than PEN% 6/21/2013?	1.2E-06	Yes (because the p-value is virtually zero).
Is DP 5/9/2013 greater than DP 6/21/2013?	7.4E-17	Yes (because the p-value is virtually zero).

Figure 11. Paired t-test comparing the LANL(10-30-2013) results with the NFT(5-9-2013) data.

In short, the LANL 6/21/2013 measurements were statistically **not** the same as the NFT Inc results. In response to these results from the paired t-test, an analysis of the physical components of the FTS device was used to implement two changes: (1) replacing the aerosol generator, and (2) making a correction in the mode of air flow measurement.

In June, an aerosol generator (TSI model 3079) with the correct air flow rate, but with the incorrect aerosol particle size output was being used. (The aerosol generation rate of the aerosol generator that was originally purchased for the filter tester (ATI model TDA-6C) is too large (28.3 m^3/min) for the SNMC test air flow rates (200 cc/min), so the TSI model 3079 was used for the LANL(6-21-2013) tests, in an attempt to provide the correct air flow for the system.

After the LANL(6-21-2013) tests, the ATI TDA-6C aerosol generator was therefore re-engineered by the LANL Aerosol Engineering Facility personnel to operate at a lower air flow rate, while still producing the correct aerosol size distribution.

	TSI model 3079	Original ATI TDA 6C (original purchase for LANL SNMC FTS)	LANL modified ATI TDA 6C (correct operating parameters)
Airflow	5 ALPM	80 ALPM	5 ALPM
Mean diameter of generated aerosol (µm)	2 µm	0.4 µm	0.4 µm

Figure 12. Summary of the operating parameters of the different aerosol generators.

Definitions of air flow rates.
Volumetric flow rate – The (volumetric) measure of how much material passes through a defined area in a given time. The measured movement of a physical volume of gas, per unit time, is defined by the temperature and pressure at the local sample location (e.g. this is comparable to some definitions of the "actual flow rate").
Reference (mass) flow rate – The reference (mass) flow rate is the volumetric flow rate corrected to a reference temperature and pressure (e.g. typical units are SLPM "standard liters per minute", where the "standard" temperature and pressure is definition-dependent) Note that various instrument manufacturers and technical societies define different values for their respective "standard" temperature and pressure.)

Figure 13. Definitions of air flow rates.

Based on the paired t-test results, the air flow rate measurement method was also corrected. In summary, if 0.200 ALPM is desired for the volumetric air flow rate into the tested filter, then the reference (mass) flow rate needs to be set at 0.152 SLPM at the Los Alamos elevation (above sea level).

A HyperTerminal™ link to the flow controller (Omega Inc. Model FMA-2605A-V2) is established, following the instructions detailed in the Omega flow controller manual. When this link is established, the air flow setpoint can be transmitted to the flow controller through the desktop computer. The format of the screen display is shown below, with an example data set:

	PSIA	*T(°C)*	*ALPM*	*SLPM*	*SETPOINT(SLPM)*	
A	+008.52	24.01	0.263	0.151	0.152	AIR

Figure 14. An example of the screen output seen through the HyperTerminal™ interface.

In this example, the text shown in *italics* are implicit, since they are not seen directly on the HyperTerminal display screen, rather, they are shown by example in the Omega flow controller (FIC102) manual.

The subject headings in Table 1 correspond to the physical quantities in the P&ID diagram in Figure 7, where,

PSIA = the internal pressure in the flow controller (FIC102),
T(°C) = the internal air temperature measured in the flow controller (FIC102),
ALPM = the measured air flow in FIC102, in units of "actual liters per minute",
SLPM = the measured air flow in FIC102, in units of "standard liters per minute", and,
SETPOINT(SLPM) = the setpoint air flow in FIC102, in units of "standard liters per minute".

Example: To set the actual test flowrate, Q_{TA}, through the tested filter at 0.200 ALPM, the setpoint air flowrate of the flow controller must be determined with respect to the ambient air pressure in the local environment of the test system.

The listing of the definitions of the quantities are given below, where,

Q_{TA} = the test flowrate in terms of "actual" units, ALPM, actual liters per minute (e.g. 0.200 ALPM),
Q_{FS} = the air flowrate in the Omega Inc. flow controller FIC102, in "standard" units, SLPM,
P_A = the "actual" air pressure in the room air of the test system (e.g. 11.2 psia in Los Alamos), it must be emphasized this is not the air pressure inside the flow controller, and,
P_S = the "standard" air pressure at sea level (i.e. 14.7 psia), then by extension,

$Q_{FS} = Q_{TA} * (P_A / P_S)$, or
Q_{FS} = 0.152 SLPM = 0.200 ALPM * (11.2 psia / 14.7 psia),

Therefore, the setpoint of the flow controller needs to be 0.152 SLPM, assuming a desired actual air flowrate of 0.200 ALPM, and a local room air pressure of 11.2 psia.

To verify the calibration of the flow controller, it is necessary to compare the measured "standard" air flowrate of the Omega Inc. flow controller (FIC102) with the measured "standard" air flowrate of the instrument used to verify the air flow calibration (i.e. the current instrument is a Bios Inc. Model 530 Defender).

In regard to the LANL(10-30-2013) data results, the percent penetration data is considered to be a match with the NFT(5-9-2013) data. However, the LANL(10-30-2013) pressure drop measurements are still considered to be statistically different from the NFT Inc(5-9-2013) data.

The mean test	p-value	Answer to the mean test
Is PEN% 5/9/2013 greater than PEN% 10/30/2013?	0.304	**No** (The p-value is 0.304, and a value of 0.500 is considered a "no" answer.)
Is DP 5/9/2013 greater than DP 10/30/2013?	7.6E-10	**Yes** (because the p-value is virtually zero).

Figure 15. Paired t-test comparing the LANL(10-30-2013) results with the NFT(5-9-2013) data.

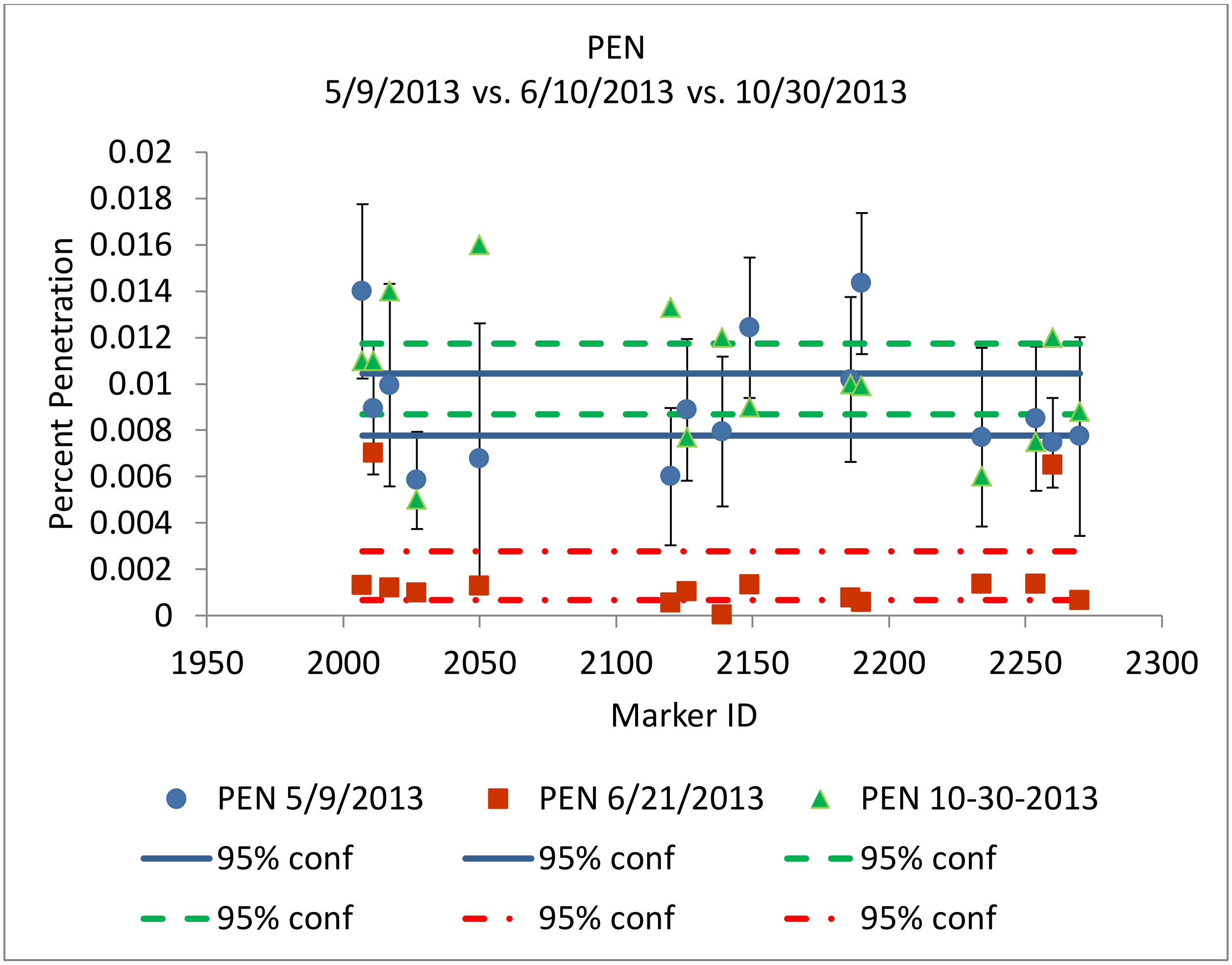

Figure 16. Measured percent penetration across the fifteen reference Hagan filters with 95% confidence intervals indicated.

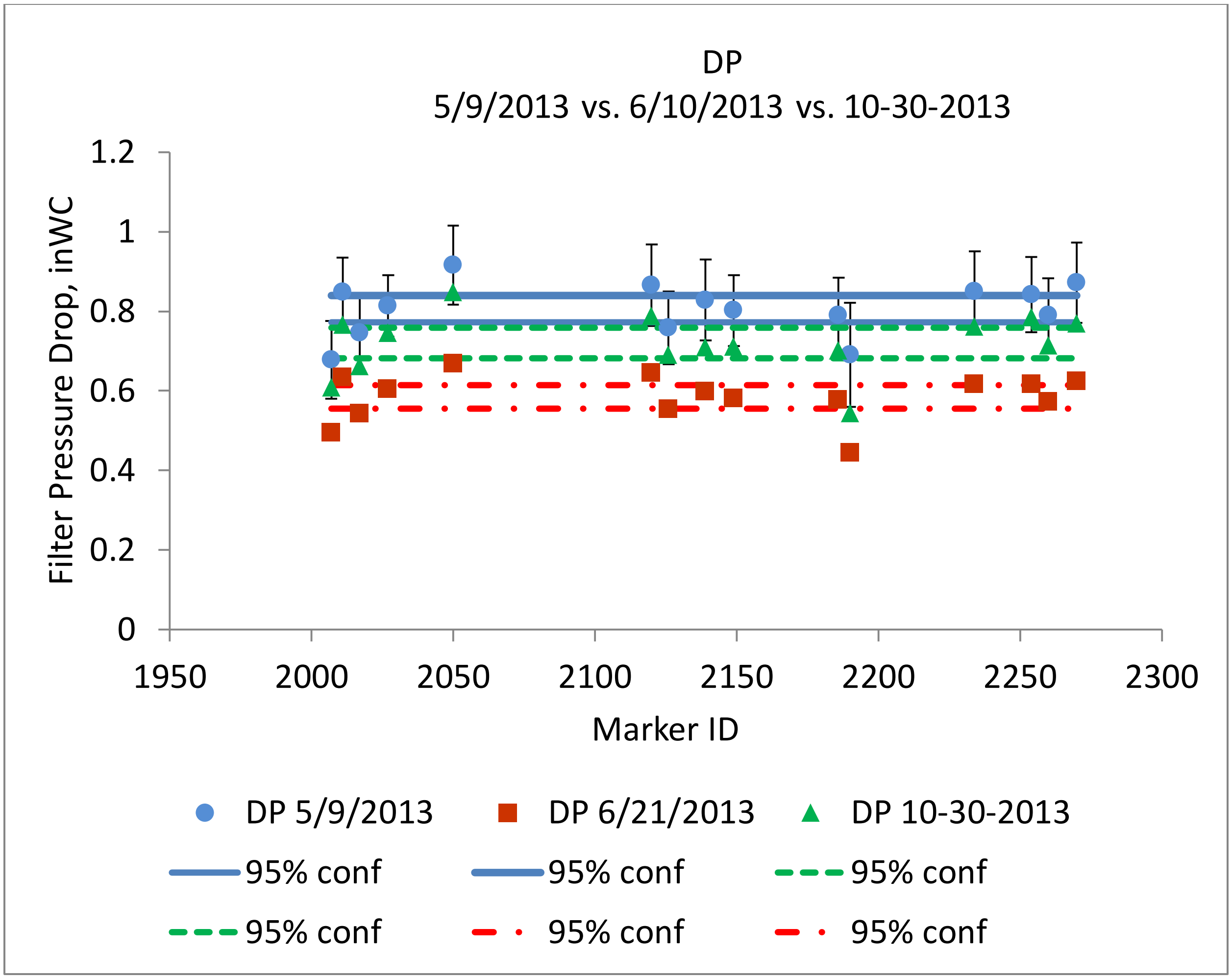

Figure 17. Measured pressure drop across the fifteen reference Hagan filters with 95% confidence intervals indicated.

Marker ID	%pen 10/25/2002	%pen 11/5/2008	%pen 8/11/2009	%pen 3/23/2010	%pen 5/9/2013	%pen 6/21/2013	%pen 10/15/2013		DP 10/25/2002	DP 11/5/2008	DP 8/11/2009	DP 3/23/2010	DP 5/9/2013	DP 6/21/2013	DP 10/15/2013
2007	0.015	0.011	0.013	0.02	0.0109	0.0013	0.011		0.77	0.64	0.53	0.76	0.69	0.495	0.608
2011	0.007	0.011	0.005	0.0118	0.0099	0.007	0.011		0.88	0.88	0.7	0.93	0.85	0.634	0.767
2017	0.009	0.015	0.005	0.0139	0.0068	0.0012	0.014		0.84	0.82	0.6	0.74	0.73	0.542	0.663
2027	0.005	0.008	0.005	0.0032	0.008	0.00098	0.005		0.88	0.84	0.68	0.84	0.83	0.604	0.7452
2050	0.016	0.008	0.005	0.0004	0.0045	0.00127	0.016		1	0.98	0.75	0.91	0.94	0.668	0.848
2120	0.003	0.008	0.004	0.0101	0.0049	0.00054	0.0133		0.96	0.89	0.69	0.89	0.9	0.645	0.789
2126	0.007	0.009	0.005	0.0129	0.0105	0.00103	0.0077		0.88	0.78	0.63	0.72	0.78	0.554	0.69
2139	0.005	0.007	0.005	0.0118	0.0109	0.000027	0.012		0.88	0.87	0.66	0.92	0.81	0.598	0.709
2149	0.011	0.015	0.01	0.0163	0.0098	0.00132	0.009		0.88	0.84	0.65	0.83	0.81	0.581	0.711
2186	0.009	0.009	0.007	0.0163	0.0096	0.00077	0.01		0.88	0.81	0.63	0.83	0.8	0.577	0.701
2190	0.018	0.014	0.01	0.0163	0.0134	0.00058	0.0099		0.77	0.73	0.5	0.83	0.62	0.445	0.544
2234	0.002	0.008	0.007	0.0088	0.0127	0.00135	0.006		0.9	0.89	0.68	0.94	0.84	0.616	0.762
2254	0.007	0.011	0.004	0.0116	0.0089	0.00137	0.0075		0.88	0.92	0.68	0.88	0.85	0.617	0.785
2260	0.007	0.007	0.005	0.0103	0.008	0.0065	0.012		0.88	0.85	0.64	0.79	0.79	0.573	0.714
2270	0.003	0.008	0.005	0.0143	0.0084	0.00066	0.0088		0.92	0.98	0.71	0.86	0.89	0.624	0.769

Figure 18. Tabular information from NFT Inc compared to LANL (6-21-2013 and 10-30-2013) tests.

Summary list of instruments, model numbers and specifications

AI101 Aerosol spectrometer (TSI Inc. #3330). Measures aerosol particle sizes and numbers.

AI102 Aerosol photometer (ATI Inc. #2HN). Single channel aerosol counter.

AI103 Aerosol particle counter TSI model 7501 for ambient room air.

C101 Desktop computer for control and data acquisition.

CI101 Computer indication link to pressure transducer PI101.

CI102 Computer indication link to load cell WIC101.

CI103 Computer indication link to pressure gauge PI102.

CI104 Computer link to ambient room air particle counter. Detects excess aerosol in room air.

CIC101 Computer link for indication and control to valve VC201 through Arduino PLC to Labview.

CIC103 Computer link for indication and control to valve VC301 through Arduino PLC to Labview.

CIC104 Computer link for indication and control to valve VC302 through Arduino PLC to Labview.

CIC105 Computer link for indication and control to pump FPC101.

CIC106 Computer link for indication and control to aerosol spectrometer AI101 through LANL Yellow Network.

CIC107 Computer link for indication and control to aerosol photometer AI102.

CIC108 Computer link for indication and control to flow controller FIC102.

CIC109 Computer link for indication and control to pump FPC103.

CIC110 Computer link for indication and control to pump FPC102.

CIC111 Computer link for indication and control for flow controller FIC101.

CIC112 Computer link for indication and control to valve VC303 through Arduino PLC to Labview.

CIC113 Computer link for indication and control to valve VC304 through Arduino PLC to Labview.

CIC201 Yellow Network - Los Alamos National Laboratory

FI101 Calibrator, air flow, Bios Inc. Model (Defender 530) to verify flowrate through FIC101.

FIC101 Flow, indicator, controller. Connected to pump FPC101.

FIC102 Flow, indicator, controller. Connected to pump FPC102.

FPC101 Pump, Sensidyne Inc. Model 810516 for makeup air to spectrometer AI101.

FPC102 Pump, Sensidyne Inc. Model 810516 to aerosol photometer AI102.

FPC103 Pump for aerosol generator P105. Sensidyne C120CNSNF60PC1, Rev.1, SN 1402.

FPC104 Pump (Gilian sampling pump) for aerosol counter AI103.

N101 Filter, capsule type, Pall Inc. Model 12144; for plenum pressure relief.

N102 Filter, capsule type, Pall Inc. Model 12144; primary filter for plenum.

N103 Filter, capsule type, Pall Inc. Model 12144; secondary filter for plenum.

N104 This place intentionally left blank.

N105 Filter, capsule type; filter for photometer exhaust (supplied by ATI Inc.).

N106 Filter, capsule type; filter for tested filter pressure gauge.

N107 Filter, capsule type; filter for tested filter pressure gauge.

N108 Filter; capsule type; HEPA Pall Model 12144; at FIC103 inlet.

N202 Filter to be tested (integrated into the lid of a SAVY or Hagan canister).

P101 Plenum for air and oil aerosol transport to the filter to be tested.

P102 Pressure fitting (upstream) for the filter to be tested.

P103 Pressure fitting (downstream) for the filter to be tested.

P104 Syringe pressurizes the system (this is a temporary attachment for leak testing).

P105 Aerosol generator, customized from an ATI Test Inc. model TDA-6C.

PD101 Pressure display panel meter for pressure gauge PI102.

PD102 This place intentionally left blank.

PD103 Pressure display panel meter for pressure gauge PI101.

PI101 Pressure gauge for tested filter N202 (inches of water column, in WC). Furness model FCO332.

PI102 Pressure gauge to measure the plenum air pressure.

VA101 Valve, pressure relief.

VA102-VA106 These places intentionally left blank.

VA107 Manual three-way valve for leak testing at filter N104.

VA108 Manual three-way valve for leak testing at filter N102.

VA109 Manual three-way valve for leak testing at filter N103.

VA111 Manual three-way valve for leak testing at flow controller FIC102.

VC201 Valve, two-way, motorized means "M" in the icon, TeeJet Inc. 344BEC-33S-C60, controlled by CIC101.

VC301 Valve, three-way, motorized means "M" in the icon, TeeJet Inc. 344BEC-33S-C60, controlled by CIC103.

VC302 Valve, three-way, motorized means "M" in the icon, TeeJet Inc. 344BEC-33S-C60, controlled by CIC104.

VC303 Valve, three-way, motorized means "M" in the icon, TeeJet Inc. 344BEC-33S-C60, controlled by CIC112.

VC304 Valve, three-way, motorized means "M" in the icon, TeeJet Inc. 344BEC-33S-C60, controlled by CIC113.

WI101 Weight (pound force) indicating panel display. Steel case (standalone) 120VAC plug to power strip.

WIC101 Weight measuring (force) load cell indicating pound force controlled by an arbor press. 5VDC data

Figure 19. AI 101 Aerosol spectrometer (TSI Inc. #3330). (8" wide).

Figure 20. AI 102 Aerosol photometer (ATI Inc. #2HN). Single channel aerosol counter. (12" wide).

Figure 21. AI 103 Aerosol particle counter (TSI Inc. model 7501) for ambient room air. (4.5" long).

Figure 22. FIC101 and FIC102 flow controllers.

Figure 23. FPC101 and FPC102 pumps (Sensidyne Inc. Model 810516).

Figure 24. N101 Filter. Pall Inc. Model 12144

Figure 25. N202 The filter to be tested is integrated into the lid of a SAVY or Hagan canister.

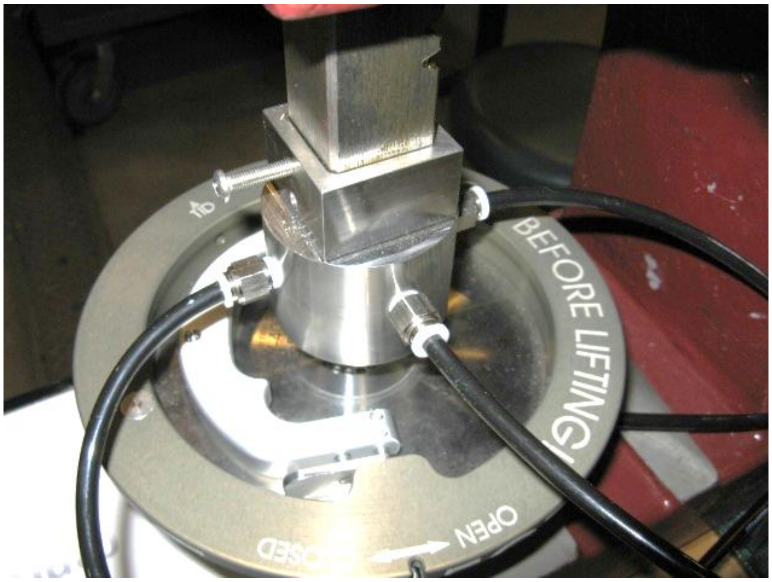

Figure 26. P102 face seal fitting (upstream) and P103 fitting face seal (downstream).

Figure 27. P104 syringe (without the needle) pressurizes the system for leak testing.

Figure 28. P105 aerosol generator ATI Inc. (LANL customized).

Figure 29. PD101 Pressure display panel meter for pressure gauge PI102.

Figure 30. PI 101 pressure gauge measures the tested filter (inches of water column, in WC). Furness Inc model #FCO332 has integrated pressure transducer and panel display.

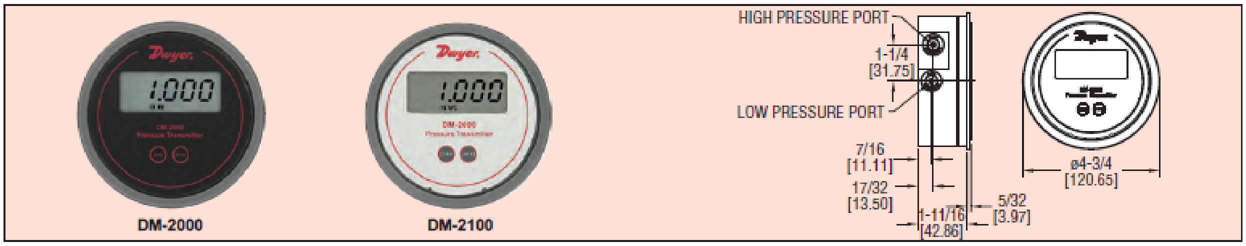

Figure 31. PI 102 Pressure gauge to measure the plenum tank air pressure.

Figure 32. VA 101 Valve, pressure relief

Figure 33. VA 102 Valve, manual, three-way for pressure relief during leak test procedure

Figure 34. VC 201 motorized two-way valve. TeeJet Inc. 344BEC-33S-C60.

Figure 35. WI 101 Weight (pound force) indicating panel display.

Figure 36. WIC 101 Load cell indicates the clamping force controlled by an arbor press.

List of items that require calibration verification

AI101 Spectrometer

AI102 Photometer – size output

AI102 Photometer – mass concentration

FIC101 flow controller

FIC102 flow controller

P105 aerosol generator – size output

PI101 pressure transducer

PI102 pressure gauge

PI103 pressure gauge on panel display

PI104 pressure gauge

WI101 and WIC101 load cell

Procedures for calibration verification, component operation and system operation

SNMC Filter test rig component list 4-10-2013.xlsx

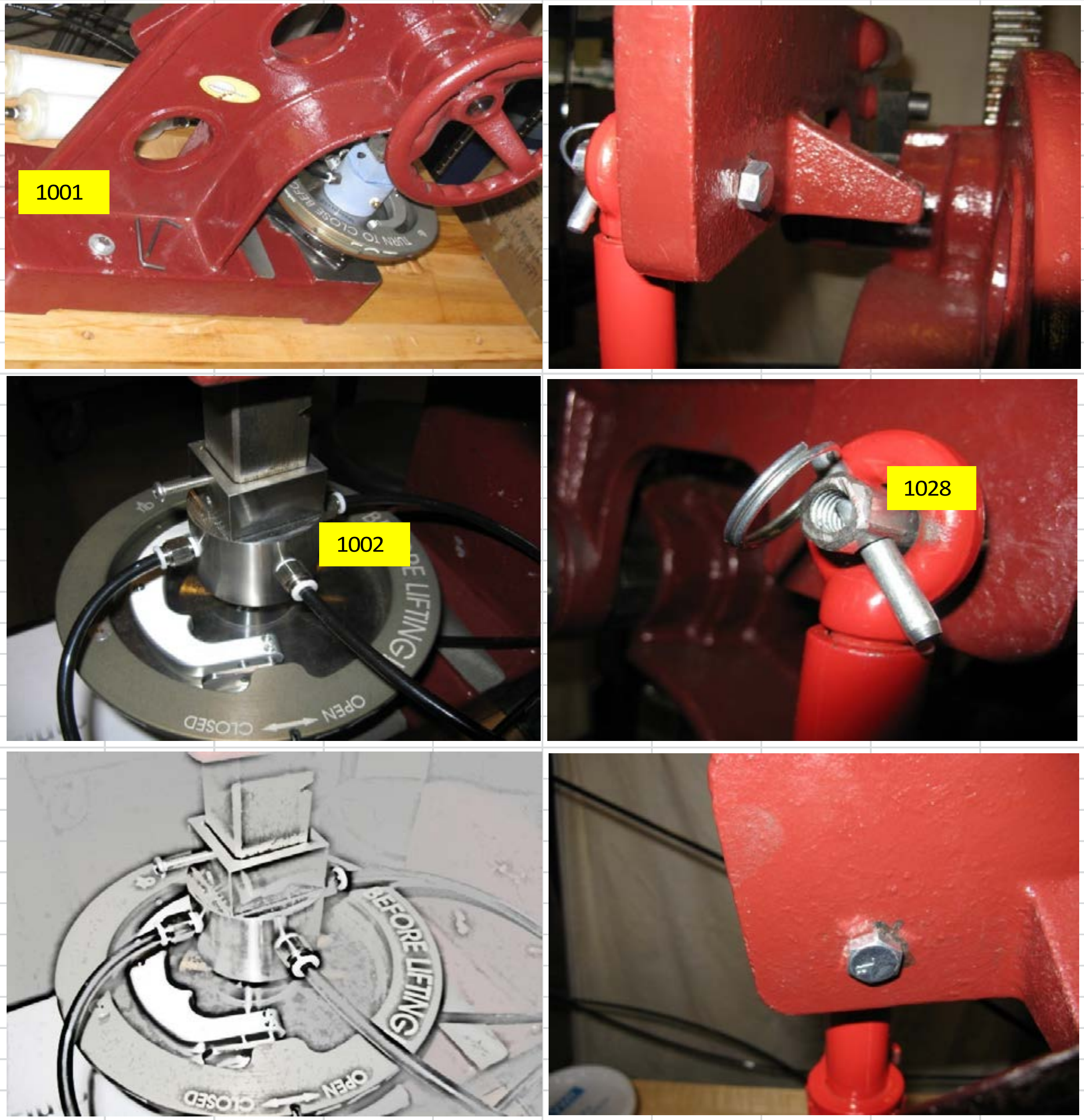

Figure 37. Closeup photos of the arbor press for clamping the filter lid (N202) to be tested.

Software – logic flow description

This is a summary of the overall logic flow for the main operating software for the FTS (filter test system). This procedure assumes that the system instruments are initialized, powered up, and that the aerosol generator is producing oil droplet particulates. The system operator first loads a canister lid into the arbor press and exerts a clamping force to provide an air tight seal (measured by gauge WIC101).When the program is run, the operator will be able to start the aerosol generation and when it enters into the system. Once the upstream concentration is within the specified value range, the operator will click a button and the system will take the needed data automatically. When the upstream and downstream aerosol concentrations achieve a predetermined stability criterion, then valid measures can be performed of those values. Those measures are the basis of the filter penetration determination. The system also measures and records the air flowrate through the tested filter and the pressure drop across that filter.

(1) If WIC 101 > 200lbs allow start
(2) (3) Open aerosol to system VC 201
(4) Count aerosol concentration up stream of the filter
(5) If count has COV < 20% then switch valve VC 301
(6) Measure Pressure drop across the filter.
(7) If delta P > 1.0” W.C. show error “Pressure drop outside limits”
(8) Count aerosol concentration downstream of filter
(9) If count has COV < 20% then calculate filter penetration
(10) If penetration > .003% show error “Filter penetration outside limits”
(11) Save data as txt file
(12) Close VC 201 and switch VC301 back to upstream position
(13) Allow purge of aerosol in system (time TBD)

Software – main LabView driver executable file

Software – individual instrument drivers

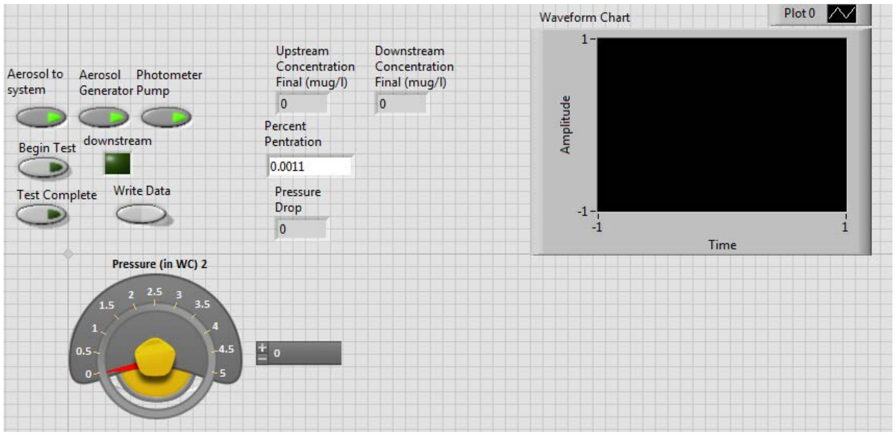

Figure 38. Current main panel display for the LabView control program.

TA-55 and TA-3 system cart specifications

Cart Parts		
Item	Size	Amount
8020 1530	45 inch	6
8020 1530	18 inch	9
8020 1530	41 inch	2
8020 1530	27 inch	2
8020 1530	30 inch	2
8020 1530	11 inch	2
Bottom Shelf	1/8" plate	1
2nd Shelf	1/8" plate	1
3rd Shelf	1/8" plate	1
Top Shelf	1/8" plate	1
4" Swivel Caster w/ 7/16-14 stem 8020 part # 2310		4
1.5" x 3" Base Plate w/ 7/16-14 center hole 8020 part# 2138		4
5/16-18 x .75" BHSCS 8020 part# 3114		16
Joining Plate 4351		20
Joining Plate 4312		16
5/16 - 18 x 3/4 Econ. T-Slot Stud,Washer, Hex Nut		212

Figure 39. List of structural parts for the system cart design from the 8020 Inc. catalog.

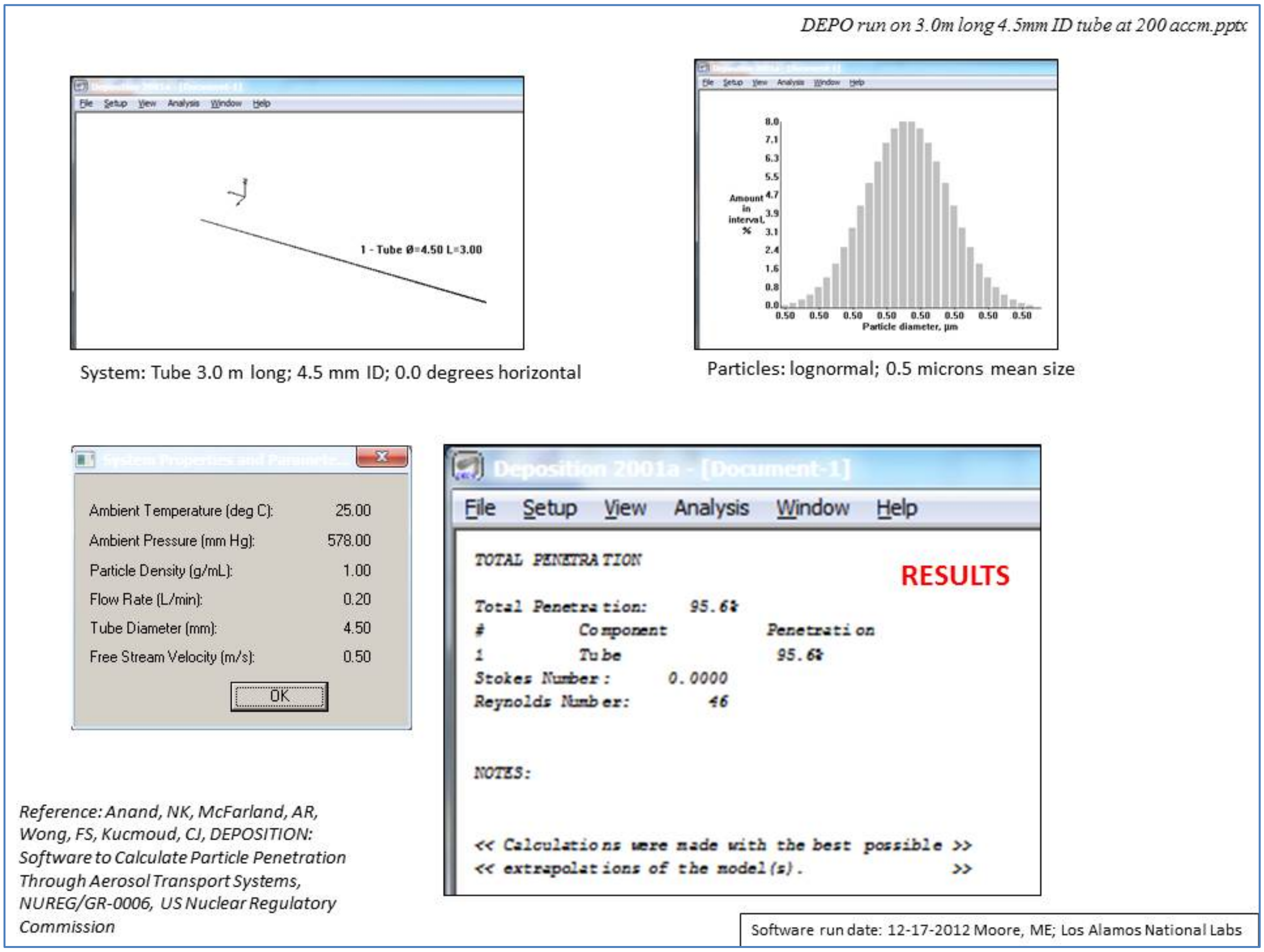

Figure 40. A calculation of the percent penetration of oil droplet aerosol through 3.0 meters of 4.5 mm ID tubing. For an air flowrate of 200 accm, with a mean aerosol diameter of 0.5 microns, the calculated penetration is 96%.

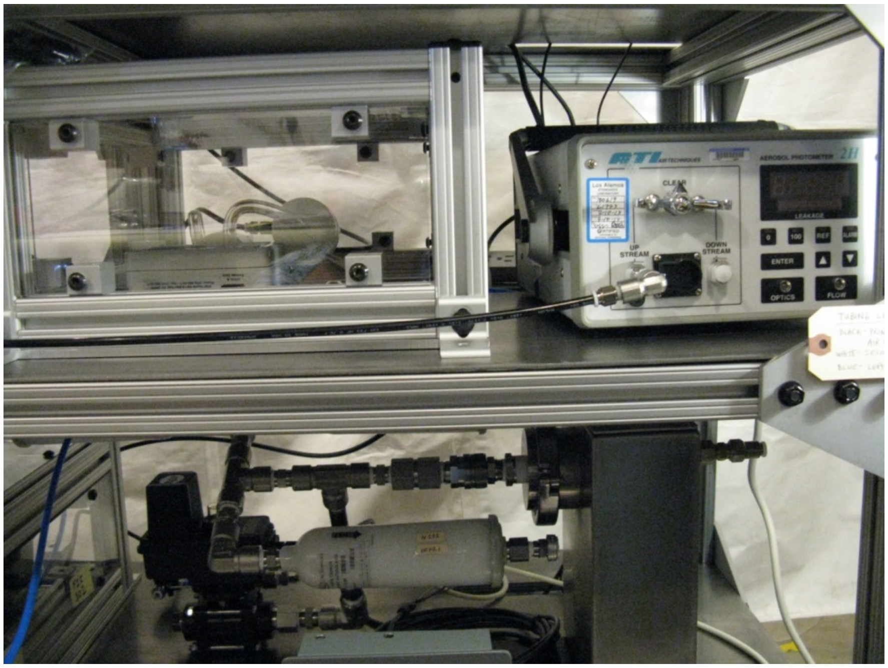

Figure 41. Clockwise from top left: the pressure transducer for the tested filter, the aerosol photometer and the aerosol generator.

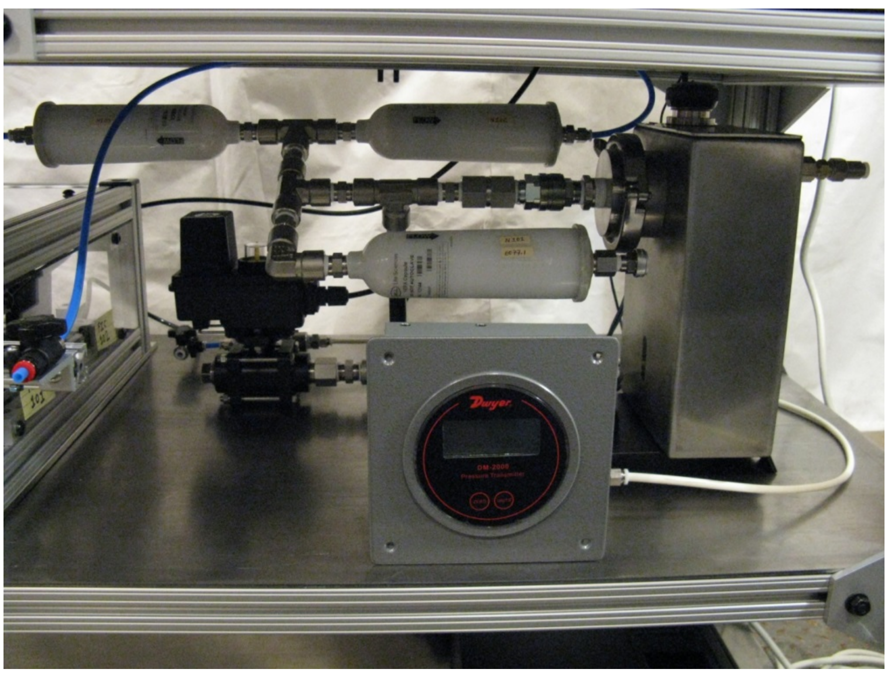

Figure 42. The aerosol generator injects oil droplet spray into a distribution plenum.

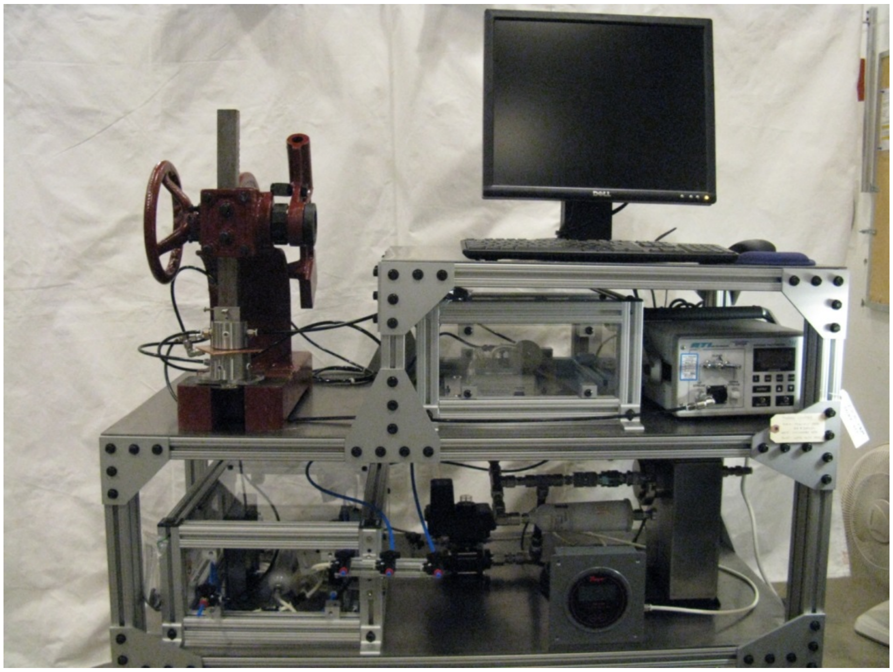

Figure 43. A view of the completed TA-55 FTS (the control box is not shown in this photo).

References

[1] Anderson, LL, MW Blair, EJ Hamilton, EJ Kelly, ME Moore, PH Smith, TA Stone, JG Teague, DK Veirs, E Weis and TF Yarbro, "Safety Analysis Report for the SAVY 4000 Container Series", Los Alamos National Laboratory Publication, LA-CP-12-00204, 2012.

[2] Moore, ME, Veirs, DK, Evaluation of Filter Suitability for Nuclear Material Storage Canisters at Los Alamos National Laboratory, Los Alamos National Laboratory, Los Alamos Unclassified Report LAUR-12-10245

This document:

Moore Reeves FY2013-report - FTS-SNMC.docx