FST Digital Enclosure Integrity Tester

and

EIT Quick Test Intl

Manual

Covering the
Model 3 Blower
DG-700 Digital Gauge
EIT Quick Test Intl.

Fire Safety Technology
P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

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FST Digital Enclosure Integrity Test Kit

With the Model 3 Blower and DG-700 Digital Gauge

And

EIT Quick Test Intl

Manual

The blower door testing equipment, software and instruction manuals have been designed, built, calibrated, and written in accordance to the NFPA 2001, 2004/2012 Appendix C Enclosure Integrity Procedure by the The Energy Conservatory and by Fire Safety Technology a division of Worldwide Trade & Services, Inc. The accuracy of the predicted hold time is the responsibility of the publisher of the standard, the National Fire Prevention Association (NFPA). However it is the responsibility of the company (individual) conducting the enclosure integrity test and the authority having jurisdiction supervising the test to assure all tests are conducted in full compliance with the NFPA procedure. Neither The Energy Conservatory nor Fire Safety Technology, assume any responsibility or liability for any errors or omissions nor assume any responsibility or liability for the passage of a discharge test and/or for maintaining the specified concentration for the predicted time in case of an actual emergency.

Fire Safety Technology
P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303
Phone 410-647-8303
FAX 410-647-7066
e-mal: mail@firesafetytech.com
www.firesafetytech.com

(Test kit title page Mod 3 DG-700 rev 9 22 2016.pub)

Notes on using this manual

The material in this manual is based on our experience using enclosure testing equipment since it was first accepted as a NFPA standard in 1989. This experience has been both in conducting actual tests in the field and in training a number of individuals and conducting seminars.

We have tried to make the instructions as complete and as clear as possible. We have incorporated examples which seemed to have been readily understood when used in a face to face training situation. There are check lists which have been developed from our own experience in forgetting something needed or would have been nice to have during a test. And we have used desktop publishing tools to organize and illustrate our manual.

These manuals are an on going project and we welcome your comments, suggestions and questions.

We have included a number of handouts and support material. Most of these are included with your software as .pdf files. Permission is granted for your coping and use of these documents.

All the calculations and procedures are based on the NFPA2001/ 2004, 2012, 2015 code. In our instructional material we have tried to clear up any ambiguities in the code, often based on our experience. We strongly suggest you study the NFPA 2001, Annex C Enclosure Integrity Test Procedure as well as this manual.

If you have questions please contact us by phone, fax or email mail@firesafetytech.com.

Fire Safety Technology
P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

TAB 1

Background and Principles of the Enclosure Integrity Procedure

Background and development of the door fan room leakage procedure

The blower door, also known as a door fan or enclosure integrity tester was first used in Sweden in the late 1970's. The concept was then adopted by researchers at Princeton University in 1979.

This research was in part a due to of one of the early "energy crunches" and the resulting efforts to make homes more energy efficient. The first attempt was to add addition insulation to the test ho
uses. The added insulation did not achieve the predicted results. Investigating further, they discovered certain amount of leaks and cracks in the structure which would allow the infiltration of outside air.

Further investigation showed that in a "leaky" house added insulation would result in only a minimal improvement. But as researchers, they needed to quantify the leakage. It was at this point that the door fan was adopted and test and evaluation procedures were developed.

By the early 1980's there were a number of small bower door manufactures providing test instruments to the researchers, and to a new weatherization industry: testing and sealing of homes to achieve energy savings. (1)

II. Principle of the door fan

The door fan instrument consists of a variable output, calibrated fan; a sealable door panel and a deferential pressure gauge. Depending on the application the differential pressure gauge measures in the range form .050 "WC to .30"WC. A calibrated fan is designed so that the output in CFM (or lt/min) is indicated on an attached gauge.

The purpose of the door fan is to measure the total area of leakage-- originally of a house-- but now for our use, the total area of leakage of a protected zone.

To determine the area of leakage, the door fan is set in an outside door by use of

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P.O. Box 1063
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the sealable door
panel. Once in place, the fan is turned on and increased in output (speed) until the differential pressure inside and outside the house or zone reaches a predetermined pressure. In FM-200 or Halon protected zones this test pressure is close to .050"WC. By reading the gauges we now have two readings, the differential pressure in "WC (pa) and the flow in CFM (Lt/min). By running these two figures thorough an equation the area of the leakage can be calculated.

At first, this sounds like a bit of black magic or hocus pocus. But perhaps an analogy will make it clear. I like to compare the air going into the room with water in a pipe line. If we know the rate of flow in the pipe, that is, the gallons or lt per minute and the pressure we can calculate (or lookup in a table) the cross section area of the pipe (the diameter of the pipe). That is easy to understand and visualize, the larger the pipe the more flow.

By using the calibrated fan we are substituting air for water as a measuring medium. The calibrated fan tells us the rate of flow of air into the zone. Very simply, that air has to be going somewhere, that somewhere is through the leaks and cracks. The area we calculate using the flow and pressure is the total area of the leaks. Obviously, considering that we are usually testing computer rooms, telephone switch gear rooms--our customers much prefer that we use air and not water to make these measurements.

This procedure is covered in the ASTM standard E 779-87.

III. Principles of the Enclosure Integrity Procedure

The Enclosure Integrity Procedure, Annex C of NFPA 2001, is a procedure and calculation which is based on the Door Fan air leakage procedure. The Enclosure Integrity Procedure uses the results of the door fan air leakage procedure, the total leakage area to predict the hold time for a selected 2001 clean agent.

The procedure makes a "worse case" assumption that half of the total leakage is high (ceiling level) and half is low(floor level). For the halon, CO2 and the 2001 gases this is a worse case assumption.

*If all the leakage is a the ceiling, the hold time would be indefinitely long. The gas air mixture is heavier than air and is like water in swimming pool.

*If all the leakage is low, at the floor level, the air/ gas mixture would drain out

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Severna Park, MD 21146 U.S.A.
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FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

but replacement air would have to enter the zone at the same rate as the air gas mixture flowed out. Therefore the effective leakage area would be approximately half of the total leakage. (Like beer out of a bottle, if you turn the bottle com pletely upside down and let the beer drain (heaven forbid), it does not flow smoothly but gurgles as air forces its way into the bottle).

*Therefore, the worst case assumption is that half of the leakage is high and half is low, and as the heavy air/gas mixture flows out of the lower leakage replacement air flows in through the high leaks.

Assuming the area of leakage is half of the total leakage, the procedure calculates the weight of the column height of the air/gas mixture in the room--this is effectively the differential pressure acting on the air/gas mixture against the lower leaks--the force pushing the gas out of the zone.

Knowing the pressure and area of leakage the procedure calculates the rate of flow out of the zone of the air / gas mixture. Based on this rate of flow, the procedure then can calculate how long it would take for the top of the air gas mixture to drop from the ceiling to the minimum protected height. If this time is grater than the hold time required (generally 10 minutes) then the zone has "passed". If not, the leaks need to be found and sealed until the room is tight enough to hold the air / gas mixture for the required time.

(1) Abba Anderson, “The History of the Blower Door,” Home Energy Magazine, November/December 1995

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P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
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www.firesafetytech.com

TAB 2

Conducting a NFPA 2001 Enclosure Integrity Test
Part 1 Preliminary Survey and Review

A. Upon arrival at the room to be tested:

Make sure the suppression gas tanks are disarmed.

Then take time to familiarize yourself with the room. Check and note the following:

1. Obvious sources of leaks in room but particularly above ceiling and under a raised floor: cable trays, conduits and raised floor panels if the lead out of room.

2. Duct work through walls, are dampers present?

3. Air conditioners and air handling systems in room?

4. Location of room in relation to the building (outside wall?) and surrounding rooms.

5. Determine free air passage to and from door that will be used for the test. Do outside doors or stair well doors need to be kept open?

6. Construction of room:

   Sheet rock, is it sealed at floor?
   Block, is it painted?
   Walls, do they go deck to deck or deck to roof?
   are they sealed at overhead deck or roof?
   Doors, do the have wiper or drop seals at floor and are they sealed around jam?
   are the always closed or are they self closing at alarm?
   Widows, are the sealed (silicone caulk recommended)?

7. Review drawings and room specifications, verify with tape floor heights, ceiling height, roof height and room dimensions. Calculate cubic feet of protected volume.

8. Inspect suppression system, determine piping corresponds to the zone to be tested, note and verify total fill weights of cylinders. Are the cylinders disarmed?

9. Review calculations.

B. After the initial inspection, review with the alarm installer and building engineer:

1. Sealing work that has taken place and who is responsible for sealing.

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FAX 410-647-7066
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2. HVAC status at discharge: Self-contained and/or building air handlers shut down?

   Dampers closed?

3. Door status at discharge: Are closers activated?

C. Review with AHJ the minimum required protected height (for a concentration test this would be the height of the highest probe)?

D. At this time install door frame, fan and control module and prepare for test. *Be sure outside air pressure sampling tube is attached to door frame.* While this is taking place the outside doors and/or stairwell doors should be blocked opened. Doors on neighboring rooms should also be opened. The system installer should place the alarm system in discharge mode (make sure system tanks are disarmed) with all dampers closed and air handlers shut down.

E. Now start the door fan test.

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Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
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TAB 3

Conducting a NFPA 2001 Enclosure Integrity Test

Part 2 Using the Model 3 Blower Door and the DG 700 Digital Gauge

Make sure the fire suppression gas tanks are disarmed .

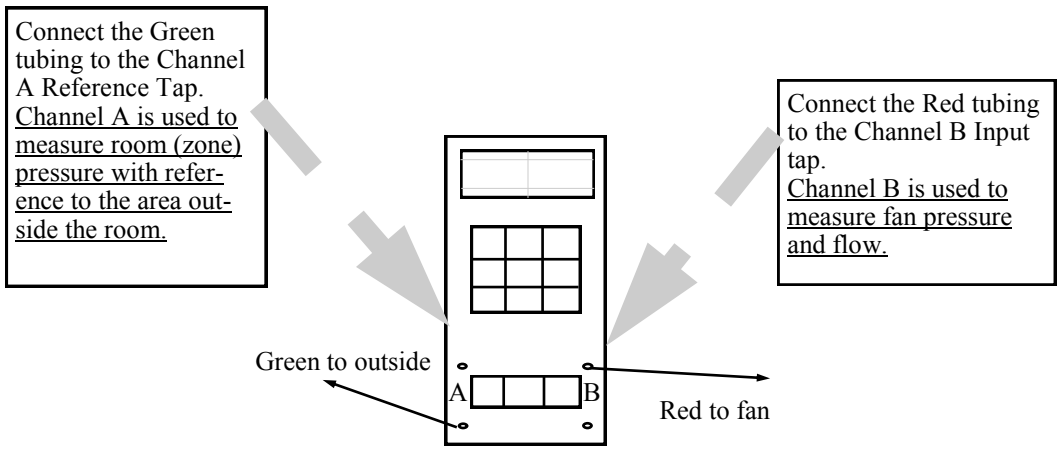
1. Install the Blower Door system (see chapters 2 and 3, pages 7 to 19 in the Minneapolis Blower Door Operation Manual, and *Conducting a Enclosure Integrity Test, A Photo Summary).*

a. Install the aluminum frame and nylon panel in the selected door.

b. Attach the gauge mounting board and fan speed controller to a door or to the aluminum frame gauge hanger bar using the C-clamp on the back of the mounting board.

c. Place the DG-700 pressure gauge onto the mounting board (using the Velcro strips) in front of the "Cheat Sheet" and connect tubing to the DG-700 for the de-pressurization test as shown below.

Note: Normal setup is with the technician inside the protected zone. If you setup outside the protected zone see *Setup Inside or Outside Zone?*



De-pressurization Set Up

d. Run approximately 3 – 5 feet of the remaining end of the Green tubing outside through one of the patches in the bottom corners of the nylon panel. Be sure the outside end of the tubing is well away from the exhaust flow of the Blower Door fan.

Hint: Keep the green tube installed in the nylon panel. It will save time setting up and will remind you to have green tube properly installed.

e. Install the Blower Door fan, with the flow rings and no-flow plate installed, into the large hole in the nylon panel. The exhaust side of the fan should be outside (the side with the chrome grill), and the inlet side of the fan (the side with the flow rings) should be inside facing the operator.

f. Insert the female plug from the fan speed controller into the receptacle located on the fan electrical box. The remaining cord (power cord) should be plugged into a power outlet that is compatible with the voltage and wattage of the fan motor.

g. If the fan is equipped with a fan direction switch be sure it is set to exhaust air out of the zone.

h. The remaining end of the Red tubing should now be connected to the pressure tap on the Blower Door fan electrical box.

2. Prepare for test:

a. Cycle fire suppression control panel through to discharge mode to activate any dampers, HVAC controls, etc. which are controlled by the panel.

b. Be sure to have a free return air path from the outside of all the protected zone walls back to the fan. (Open all doors to connecting closets, offices, etc.)
(Important See *Free Return Air Flow Path)*

c. Turn on computer, start EIT Quick Test 2001 and type in the room and location data. (See *EIT Quick Test Intl. Manual*)

3. Bias (Static) Pressure

a. Using the ON /OFF button, turn on the DG-700. (For more detailed instructions see *Operating Instructions for the DG-700 Pressure and Flow Gauge*)

1. Press the MODE button once to select PR/ FL. Indicating operating in the Pressure / Flow Mode.
2. In the DEVICE window confirm that you are set up for the BD 3 fan. (Later we will use the CONFIG button to change to our selected flow ring.)
3. In the pressure and flow windows confirm you are set up for Pa (Pascals) for pressure and CFM (cubic feet per minute) for flow. If not use the UNITS button to change or to select your preferred test units.
4. In the Time Ave. window confirm you are set up for 1 second time averaging. You may wish to change that later if the readings fluctuate excessively.

c. With all flow rings attached to fan add the blank off plate to completely seal the zone.

d. Measure the bias (static) pressure, the difference between inside and outside the zone.

1. Measure the bias (static) pressure at Discharge Conditions, that is with the doors of any adjacent rooms in their normal conditions.
2. Measure the bias (static) pressure at Test Conditions, that is with any adjacent rooms doors open to give a free return air path. (see *EIT Quick Test Manual, page 18, Special Notes, Bias (Static) Pressure.*)
3. If subfloor is pressurized at discharge (HVAC system on) then measure bias (static) pressure between subfloor and outside the protected zone.

4. Conduct the Enclosure Integrity Test —DE-PRESSURIZATION

a. Remove the No-flow plate and install a trial flow ring. For a large zone try using the open fan (no flow ring), for a very small zone try ring C.

b. Use the CONFIG button to match the flow ring you are using

OPEN Indicates the fan is in the open (no flow plate) configuration.
A1 Indicates the A Ring is installed
B2 Indicates the B Ring is installed
C3 Indicates the C Ring is installed

c. Turn on the Blower Door Fan by slowly turning the fan controller clockwise. As the fan speed increases, room pressure indicated on Channel A should also increase. Increase fan speed until you reach the target pressure as shown in the EIT Quick Test software. The flow gauge will now display the current cfm. Enter the pressure and cfm in the EIT software. To make reading the gauges easier, use the HOLD button to freeze the display. If the readings are fluctuating excessively, use the TIME AVG button to select a longer averaging period.

If you can not reach the target pressure, you must remove a flow ring and using the CONFIG button match the new flow ring.

If the CFM display blinks LO, install the next smaller flow Ring and select the correct setting for the new flow ring.

After entering the test pressure (Pa) and flow (CFM) in the computer, turn off the fan.

*For NFPA 2001/2004 Enclosure Integrity Test Procedure one set of measurements, flow and pressure is take for both De-Pressurization and Pressurization.

*For NFPA 2001/2012 and 2015 Enclosure Integrity Test Procedures two sets of measurements, flow and pressure are taken for both De-Pressurization and Pressurization.

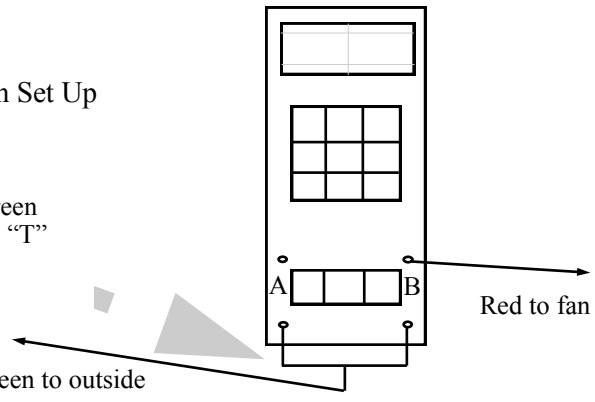
5. Enclosure Integrity Test—PRESSURIZATION.

a. Turn fan around so that the chrome grill is facing you and the fan is blowing into the zone. (Never conduct a pressurization test by reversing the fan using the fan direction switch if so equipped. Any readings displayed with the fan reversed are invalid.)

b. Using the “T” connector and the short tubing connect the green tube to the DG 700 as shown:

Pressurization Set Up

Change the green tube using the “T” connector



c. As in 4c., Turn on the Blower Door Fan by slowly turning the fan controller clockwise. As the fan speed increases, room pressure indicated on Channel A should also increase. Increase fan speed until you reach the target pressure as shown in the EIT Quick Test software. The flow gauge will now display the current cfm. Enter the pressure and cfm in the EIT software.

If you can not reach the target pressure, you must remove a flow ring and using the CONFIG button match the new flow ring.

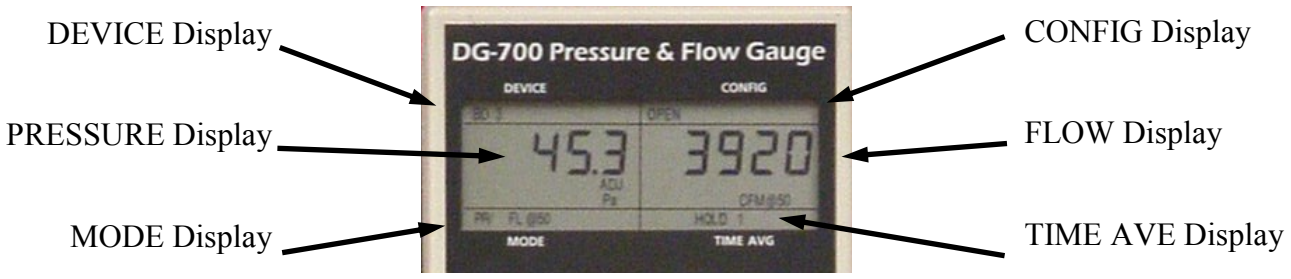
If the CFM display blinks LO, install the next smaller flow Ring and select the correct setting for the new flow ring.

After entering the test pressure (Pa) and flow (CFM) in the computer, turn off the fan.

The EIT Quick Test 2001 software will now indicated the leakage area and the predicted hold time for the zone.

Again,For NFPA 2001/2004 Enclosure Integrity Test Procedure one set of measurements, flow and pressure is take for both De-Pressurization and Pressurization.

For NFPA 2001/2012 and 2015 Enclosure Integrity Test Procedures two sets of measurements, flow and pressure are taken for both De-Pressurization and Pressurization.



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P.O. Box 1063
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FAX 410-647-7066
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TAB 4

Conducting an Enclosure Integrity Test

A Photo Summary

1. Arriving at test site, equipment easily fits in suv or work van.

2. Equipment loaded on hand truck

3. Rolling into test zone

4. First thing—disconnect tank!

5. Unpack door frame

6. Assemble door frame

Conducting an Enclosure Integrity Test

A Photo Summary

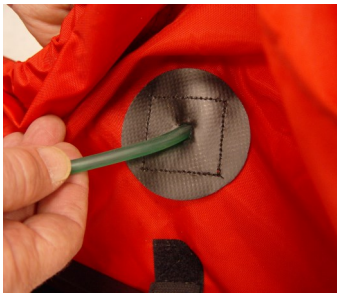
7. Place frame in door for trial fit.

8. If door closer blocks door frame it will have to be removed

9. Drop in cross bars

11. Unpack door panel

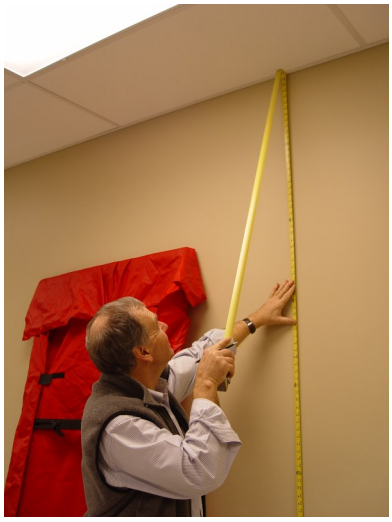
12. Install panel on door frame



13. Install green tubing through patch on door

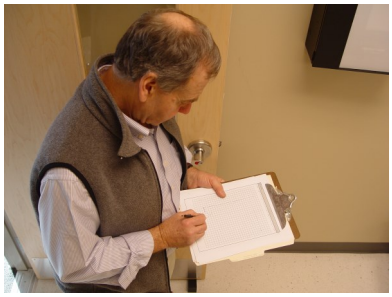
Conducting an Enclosure Integrity Test

A Photo Summary



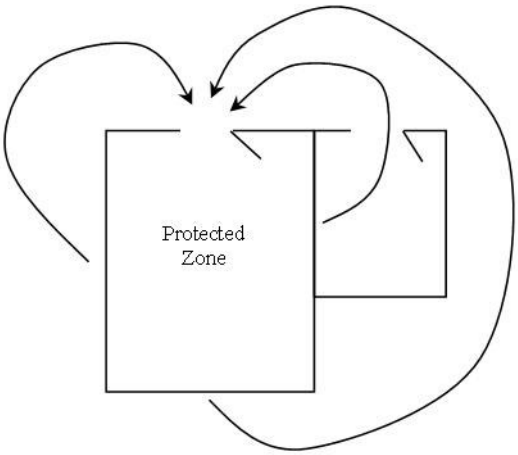
14. Measure the zone, here the maximum protected height

15. Measure height of equipment (hazard), the minimum protected height—also measure length and width of zone



16. Make sketch of zone and record measurements on the test data form

17. Enter zone data and measurements into EIT Quick Test 2001



18. Survey the area surrounding the test zone to assure a free return air path to fan.

Conducting an Enclosure Integrity Test

A Photo Summary

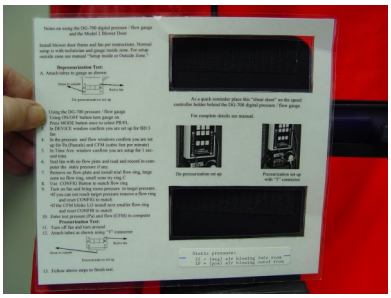
19. Install door frame with panel into the test door

20. Using toggle cams lock frame into the test door

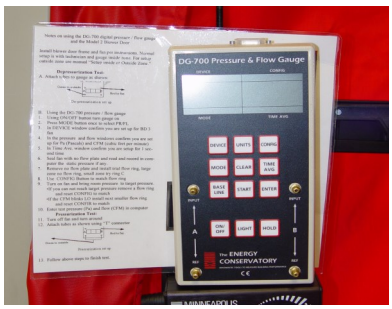
21. Extend green outside air pressure tube away from fan

22. Install fan into frame with white flow rings facing you

23. Clamp speed control board to cross bar



24. Place check list ("cheat sheet") in front of board and hold in place with the DG-700 digital gauge

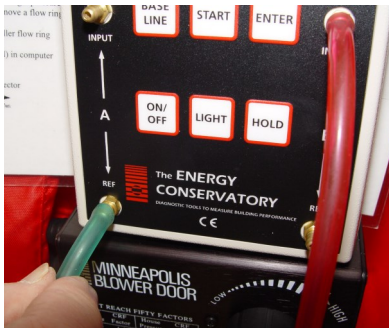


Conducting an Enclosure Integrity Test

A Photo Summary

25. Attach red fan pressure tube to top right nipple on gauge

26. Attach other end of the red fan pressure to nipple on fan



27. Attach green outside pressure tube to lower left nipple

28. Again make sure all tanks are disconnected

29. Have experience alarm technician, call out alarm system, silence building alarm, and cycle panel to activated any HVAC dampers connected to panel

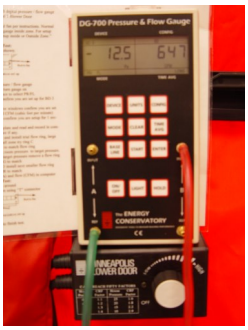
Conducting an Enclosure Integrity Test

A Photo Summary

30. Turn on gauge -see cheat sheet- With fan completely closed and all HVAC dampers closed measure the static (bias) pressure

Note: For detailed instructions for Bias (static) Pressure measurements and for De-Pressurization and Pressurization measurements for NFPA 2001/2004 and NFPA 2001/2012,2015 see *Conducting a NFPA 2001 Enclosure Integrity Test, Part 2* and *EIT Quick Test Manual.*

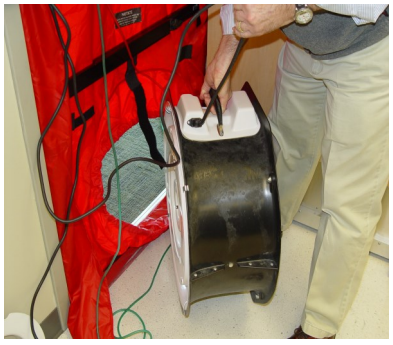
31. Remove blocking plate and flow rings “C”, “B”, “A” as necessary



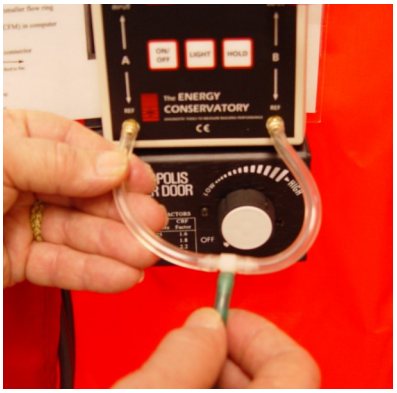
32. Turn on fan and bring up to pressure within the “target pressure range”—record pressure and flow

Note: For NFPA 2001/2004 Enclosure Integrity Test Procedure one set of measurements, flow and pressure are taken for both De-Pressurization and Pressurization.

For NFPA 2001/2012, 2015 Enclosure Integrity Test Procedures two sets of measurments, flow and pressure are taken for both De-Pressurization and Pressurization.see *Conducting a NFPA 2001 Enclosure Integrity Test, Part 2* and *EIT Quick Test Manual.*



33. Turn fan around



34. Connect “T” tube to lower nipples and to green outside pressure tube

35. Turn on fan and bring up to target pressure range—record

36. Enter all test data into EIT Quick Test which will calculate the predicted hold time

TAB 5

EIT Quick Test Intl

V 1.0.0.xx

January 2015 Release Notes

1. After a much frustration and effort we are finally releasing our new Enclosure Integrity Test software. This is a new release in that we are looking for comments from our initial users as to possible prob lems or glitches. We have tried to test it thoroughly but new software always seems to have some undiscovered gotchas.

2. We are working on a manual but as it follows the format of EIT Quick Test 2001, you should be able to get started without a manual, call if you have any questions.

3. We are e-mailing a .zip file, to install:
   A. Create a folder for the program and move the .zip to that folder.
   B. Double click on the .zip file, your should have the option to extract the EIT Quick Test Files. Extract them to your new folder.
   C. To run the program, double click on "Integrity Test.exe ". You may also wish to send it to your desktop for easy access.

   This program will run with Windows XP, 7, and 8.1. If you have a problem running the program you may need to download the Microsoft .NET Framework 4.0 plugin. Go to:

   http://www.microsoft.com/en-us/download/confirmation.aspx?id=17851

   D. Once running go to Tools>Preferences and select your folder where you want to save your test files, often the same as the program folder. You may also set your default Standard or Met ric test data. If you wish you may change individual measurements. Once selected click on "Save".

4. Now run the program and explore it. There is a "Demo Test.fst" file, use File>Open to load the file.

5. Printing, as with most Windows programs click on File>Print your should see a print screen that will allow you to print a "hard" copy or a .pdf (button at bottom). If this does not appear you may need to install the Microsoft Report Viewer;
   For Windows XP Service Pack 3, Vista Service Pack 2, & Windows 7: Windows Report Viewer 2010
   http://www.microsoft.com/en-us/download/details.aspx?id=6442
   For Windows Vista Service Pack 2, Windows 7, Windows 8, Windows 8.1: Windows Report Viewer 2012
   http://www.microsoft.com/en-us/download/details.aspx?id=35747

   Or Goggle: Microsoft Report Viewer and pick either 2010 or 2012 version as needed

5. The ISO/ EN 15004-1:2008 are not included in this release, We hope to have them available shortly. If they are important to you please e-mail us and we will put you at the top of the list to receive them when available.

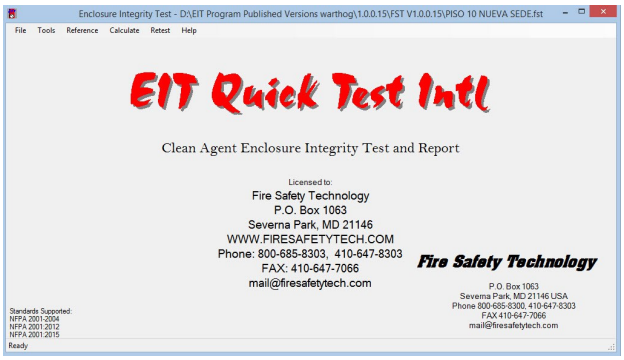
Thank you for your patience. Please notify us of any problems or suggestions for the program.

Fire Safety Technology
P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

EIT Quick Test Intl.

Manual

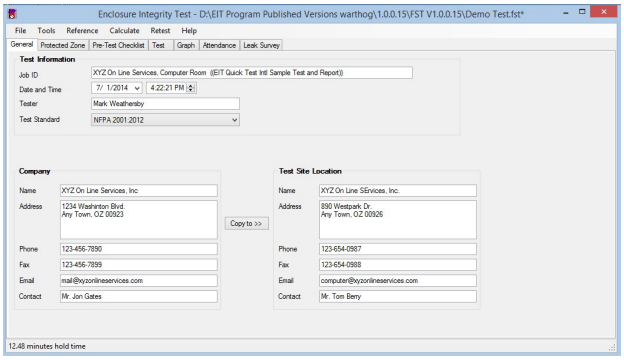
Index Screen By Screen



Opening Screen

EIT Quick Test Intl. our program for enclosure integrity testing per NFPA 2001/ 2004, 2012 and 2015. Standard Windows format, easy to understand, easy to use, designed for quick one step inputting of test data, producing on the spot complete, professional quality test reports.

EIT Quick Test Intl. Leads you through the test procedure step by step, screen by screen

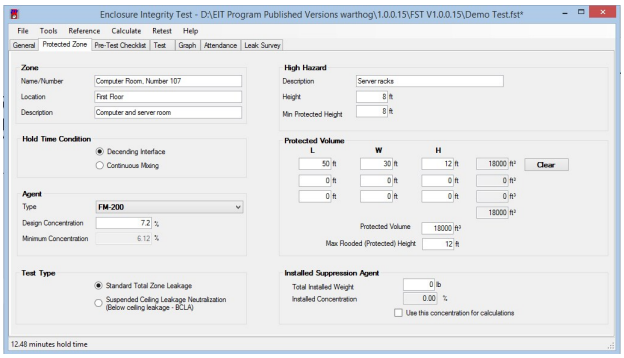


Test file identification
Date, time, technician
Choice of NFPA standard

Customer name and details

Test Site location and contact

Screen 2 General
Test Information
Customer and Test Site



Protected zone details

Hold time conditions

Gas type and concentration

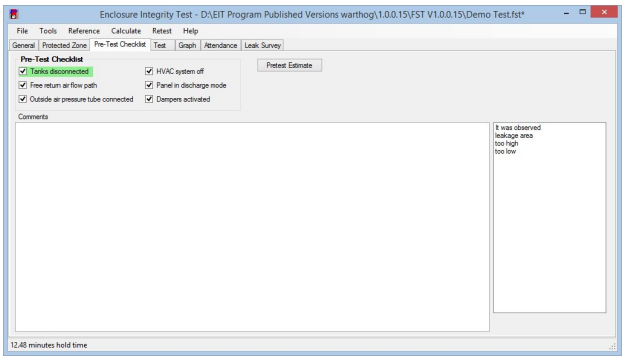
Test type

Screen 3 Protected Zone
Zone Description
Hold time Condition
Clean Agent Selection

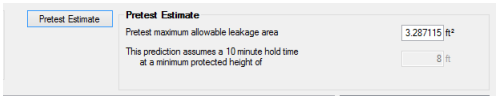
Fire Safety Technology
P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

EIT Quick Test Intl.

Index Screen By Screen



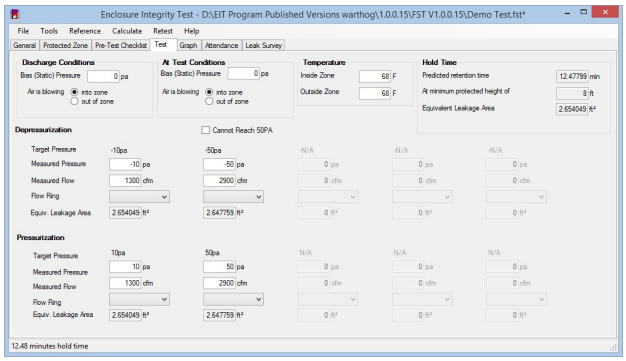
Pre-Test Checklist
Important do not forget items



Pre-Test Estimate
Calculates maximum leakage area

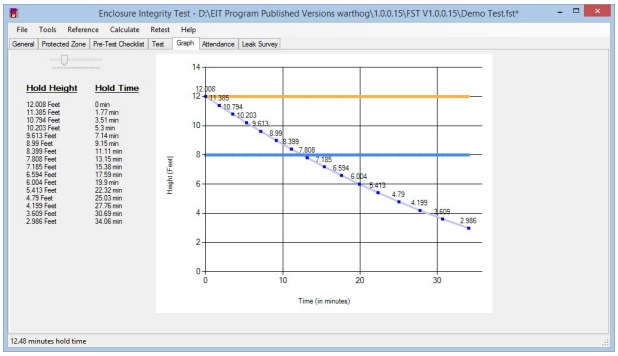
Screen 4, Pre-Test Checklist
Pre-Test Estimate
Comments

Easy to follow "fill in the blanks" leads the technician through the test procedure

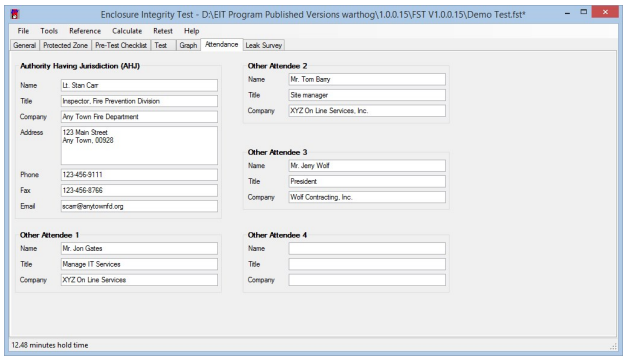


Screen 5, Test
Test Data and Results

Hold time vs. height graph
Easy to understand how the level of the suppression gas decreases over time.



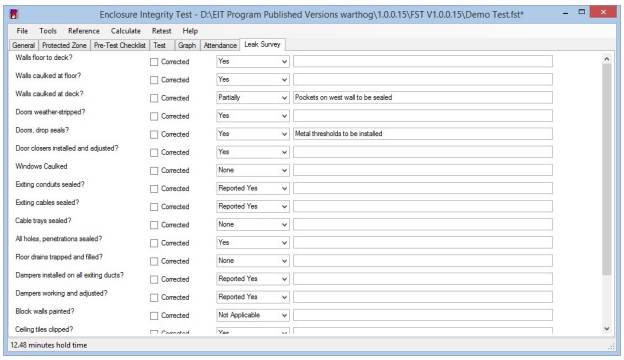
Screen 6, Graph
Graph
Hold Height vs. Time Table



Attendance
Capture, for the record, the names and companies of witnesses to the test including the AHJ if present.

Screen 7, Attendance
Authority Having Jurisdiction
Attendees

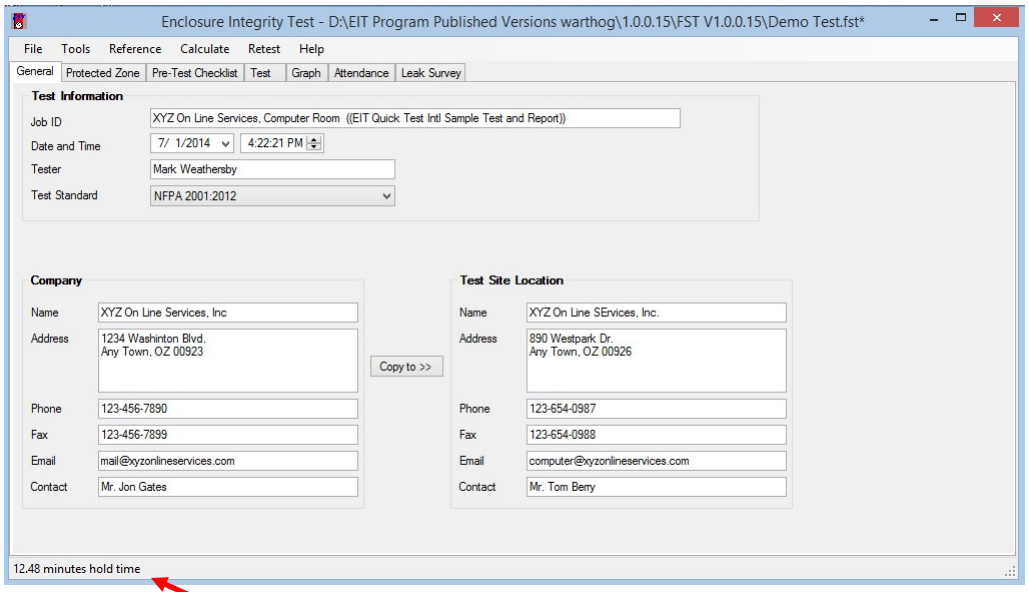
Leak Survey
Should the test fail, the optional leak survey lists the common leakage areas to help guide the customer in sealing the zone. This may or may not be included in the final test report depending on the tester's requirements.



Screen 8, Leak Survey
Optional Leak Survey

EIT Quick Test Intl.

Screen 2, General Test Information



1. **Job ID**: You may use your company filing system name here or other identifying name. This will appear at the top of each page of the report.
2. **Date and Time**: This is taken from your computer however it may be manually changed should the test be delayed after you have logged in to EIT Quick Test Intl.
3. **Tester**: The name of the technician actually conduction the enclosure integrity test.
4. **Test standard**: Here you select the NFPA Test Standard, depending on your local code requirements you have a choice of:

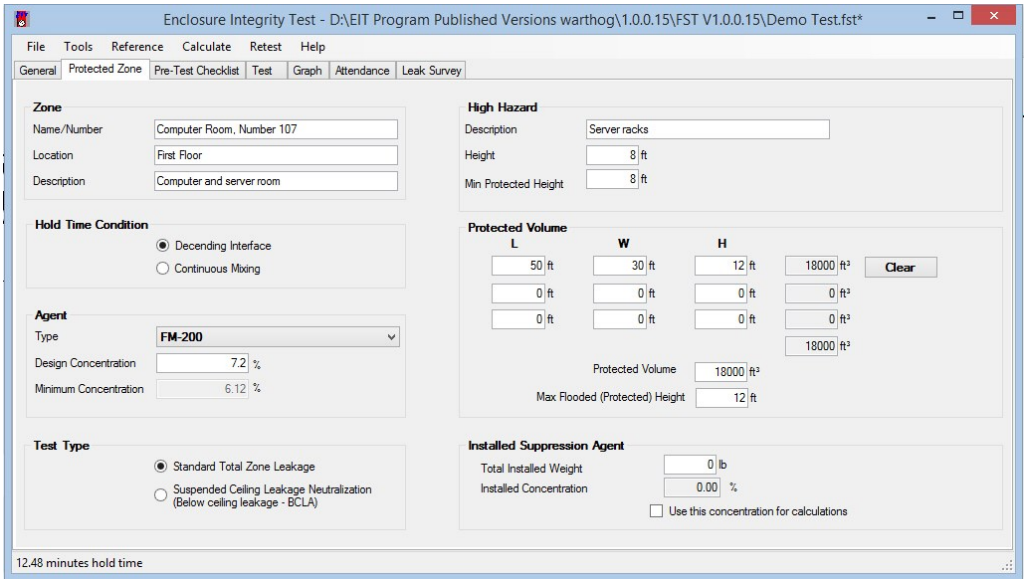
   NFPA 2001/2004
   NFPA 2001/2012
   NFPA 2001/2015

5. **Company**: this is the name, address etc. for your customer.
6. **Job Site Location**: In many cases the company name is the company office but the test site is at a different location: for example your contract may be with Verizon at their local office but the test site is a cell tower at a different location.

If the test site is the same as the company then simply click the "Copy To" button to transfer the data

7. Lower left corner: When the test is completed the hold time will show here on all screens.

Screen 3, Protected Zone



1. **Zone**:

Name/Number: If known use the name and/or used by your customer or as noted on your drawings.

Location: This may be simply “first floor” or “ground floor” but in cases like a large hospital or college campus it may be “3rd Floor West Hall” or “Schaefer Hall Lower Level”

Description: Is the “computer room”, “server room”, “telcon room”, “MRI room” or ?

2. **Hold Time Condition:**

Descending Interface or Continuous Mixing

If all HVAC systems are shut down prior to discharge and there is no moving air in the zone the gas/air mixture will leak out the lower leakage areas and fresh air will enter through the high leakage areas. A layer or interface will form between the gas/air mixture and the fresh air. This interface will drop over time.

If the HVAC systems continue to operate after discharge, the heavy gas/air mixture will leak out of the lower leakage areas and fresh air will enter through the high leakage area. But since the HVAC system continues to operate mixing the room air the concentration of the suppression gas will drop.

See Special Notes, Page 19 Continuous Mixing

3. **Agent**

Type: This is a drop down listing all the NFPA 2001 clean agents (will all trade names), Halon, and CO_2

Concentration: When a gas is selected the nominal concentration is shown here. However it is important to check the drawings or contact the system designer to verify the actual design concentration.

Minimum Concentration: In case of “Continuous Mixing” the NFPA 2001 codes allow a minimum concentration of 85% of the design concentration. This is calculated from the above design concentration and is only active when “Continuous Mixing” is selected.

5. **Test Type**:

Standard Total Zone Leakage / Suspended Ceiling Leakage Neutralization
(Below Ceiling Leakage Area –BCLA)

Standard Total Zone Leakage: The zone during test is in it's normal state with no special covering of the ceiling.

Suspended Ceiling Leakage Neutralization: The ceiling has been covered with sheet plastic to block of leakage through the drop ceiling. A technique which can be used when there is excessive un-sealable leakage area above the drop ceiling or a totally open plenum.

See Special Notes, Page 17

6. **High Hazard**:

Description: What is the hazard or what is being protected with the suppression gas, i.e. server racks, UPS, UPS Batteries, computer, art storage, rare books, or ?

Height: What is the height of the protected item? Height is measured from the lowest point if on the regular floor or slab then from the floor, if on a raised floor then from the slab or floor under the raised floor.

Minimum Protected Height: Normally this is the same as the Height and is automatically filled in. However is some cases the AHJ or owner may want the protected height to be higher than the height of the hazard. This can be changed by typing over. Note: the calculated hold time is based on this Minimum Protected Height.

Important Note:
Minimum Protected Height is the height of the hazard or the protected property.
Maximum Flooded (Protected) Height is the height of the zone.
The minimum height must always be less than the maximum height

6. **Protected Volume**:

For a normal cube shaped zone you may enter the length, width, height of up to three connected areas (all in one zone) and the program will calculate the total volume or you may simply type the total Protected Volume. This will be necessary when the protected volume is a unusual shape and not a cube. It is useful to sketch the zone and divide into squares, triangle or even is some case parts of a circle to calculate total volume. It is strongly recommended to do your own measurements on site and not rely on the submitted drawings as often there can be changes in the zone during or after construction.

7. **Max (Maximum) Flooded (Protected) Height**:

In case of a cube shaped zone this is the over all height of the zone. Note: This Maximum height is always greater than the Minimum Protected Height. If you mistakenly enter a height grater than the minimum protected height you will get an error message.

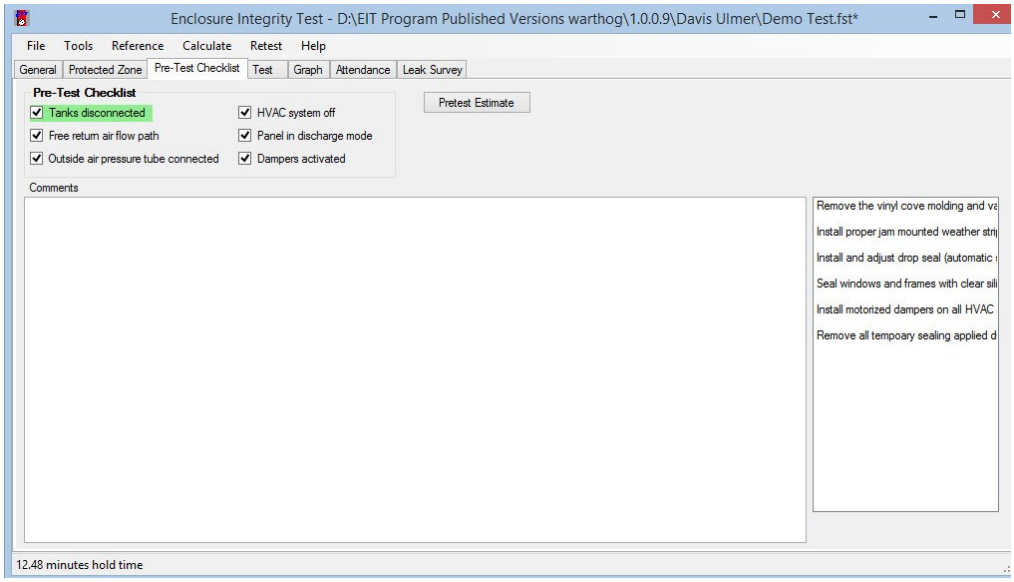
In case of more than one connected rooms (one zone) of different heights the program will calculate an weighted average height of the zone based on the area of each protected room.

8. **Installed Suppression Agent**:

Total Installed Weight: The total weight of the gas in the tank(s) taken off the label of the tank. Only used with the gases such as FM-200 which are measured by weight not the high pressure gasses like nitrogen or Inergen which are measured by volume.

The program calculates the Installed Concentration. You may use this concentration for calculating hold time by checking the box: Use this concentration for calculations.

Screen 4, Pre-Test Checklist, Comments

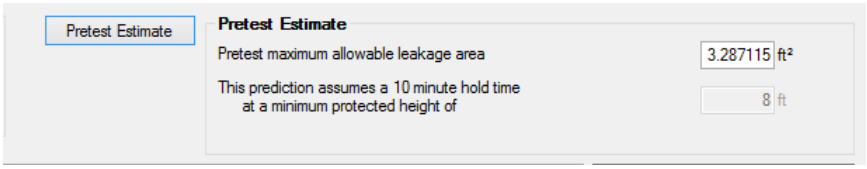


1. Pre-Test Checklist:

This is a reminder list for the testing technician cover a few important items that might be overlooked. This does print in the test report.

2. **Pretest Estimate:**

Clicking on the button will bring up the pretest Estimate showing the maximum allowable leakage area for the zone.



Useful comparing the found leakage area or as guide to the owner or contractor prior to a test.

3. **Comments**:

An open field to type in any special comments on the test which will print in the test report.

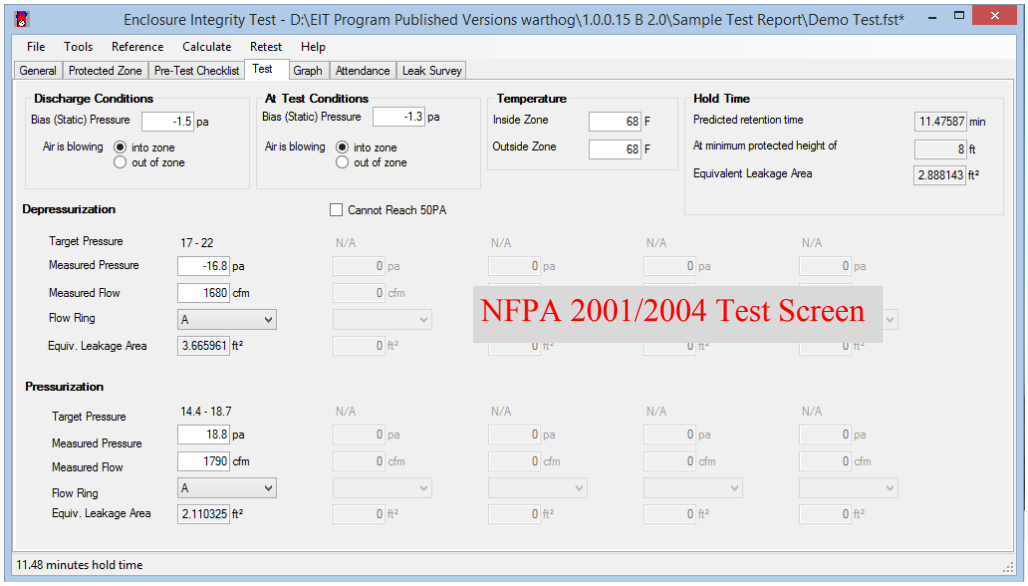
For example: "All areas temporary sealed (such as with duct tape or plastic sheeting) must be permanently sealed prior to final acceptance."

Or "Satisfactory quality weather stripping must be installed on test door prior to final acceptance."

4. **Comment right field:**

We have included a few often used comments. These may be double clicked and added to the comment field and modified as necessary. If your company has standard clauses or disclaimers to be included in each report these may be added to the selection. They are entered in the Tools tab.

Screen 5, Test



1. Bias (Static) Pressure (See "Static (Bias) Pressure Notes" page 18 and "Conducting an Enclosure Integrity Test, A photo Summary Photo 30", and "Conducting a NFPA 2001 Enclosure Integrity Test Part 2")

Discharge Conditions; This is the static (bias) pressure at discharge conditions. If the gauge is properly connected enter the pressure from the gauge including the sign (+/-) the program will set the proper air blowing state which may be difficult to determine visually.

At Test Conditions: This is the static (bias) pressure at test conditions.

2. **Temperature:**

Inside zone: This is the temperature of the protected zone. If this is a computer/server room with special HVAC systems the temperature may be taken off the HVAC control system.

Outside Zone: This is the temperature of the area surrounding the protected zone, often the office area. Not "outside" the building unless the protected zone is something like a cell site control building (box).

3. **Hold Time:**

Will be calculated by the program when the test is completed.

4. **Test Data:**

NFPA 2001/2004 Enclosure Integrity Test

(see "Conducting a Enclosure Integrity Fan Test, a Photo Summary, "The Cheat Sheet" and ?)

The 2004 code requires both a depressurization and pressurization test at one pressure within the Target Pressure range.

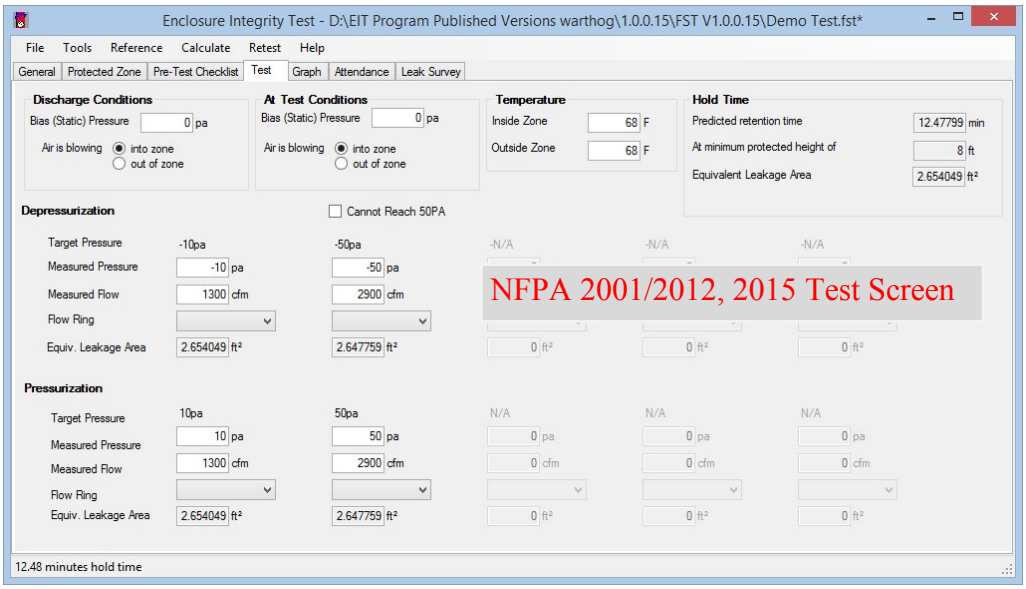
With the fan in the door panel and the gauge properly connected and tester inside the zone

Start by depressurizing the zone, that is with the white flow rings facing you and the fan blowing out. For a small zone that is well sealed start with the C ring, with large zone start with the A ring. Turn fan on and bring up to target pressure range. If you can not reach the target pressure turn fan off and remove one flow ring. If the flow reading flashes LO LO LO, turn fan off and add a flow ring.

When pressure and flow stabilize record **Measured Pressure** and **Measured Flow** readings along with **Flow Ring** which is a drop down selection.

Turn fan around a repeat above steps. Most often the fan flow ring configuration will be the same but sometimes you make have change the flow rings.

Screen 5, Test



NFPA 2001/ 2012, 2015 Enclosure Integrity Test

(see “Conducting a Enclosure Integrity Fan Test, a Photo Summary, “The Cheat Sheet” and “Conducting a NFPA 2001 Enclosure Integrity Test Part 2)

The 2012 and 2015 code requires two depressurization tests and two pressurization tests at 10pa and 50pa.

With the fan in the door panel and the gauge properly connected and tester inside the zone

Start by depressurizing the zone, that is with the white flow rings facing you and the fan blowing out. For a small zone that is well sealed start with the C ring, with large zone start with the A ring. Turn fan on and bring up to 10pa. If you can not reach 10pa turn fan off and remove one flow ring. If the flow reading flashes LO LO LO, turn fan off and add a flow ring.

When pressure and flow stabilize record readings along with flow ring.

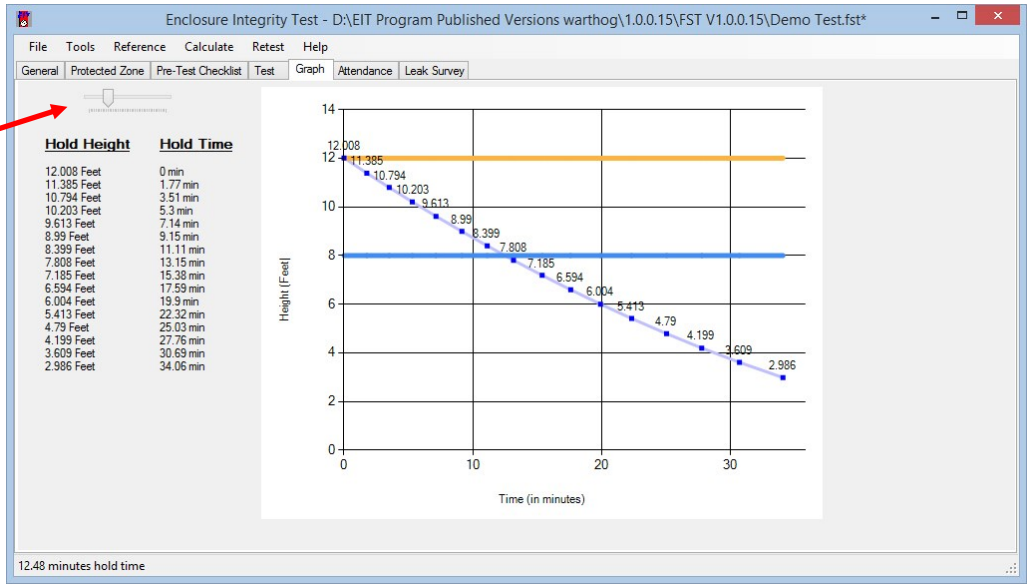
Repeat above step and depressurize to 50pa. Often you may have to change flow rings to reach 50pa.

Turn fan around a repeat above steps. Again you may have to change flow rings to meet the required test pressures.

When both depressurization and pressurization data are entered the calculated hold time will show in the upper right hand corner and the lower left hand corner on all screens.

The NFPA code requires a 10 minute hold time but a lesser time may be approved by the local AHJ depending on several factors.

Screen 6, Graph



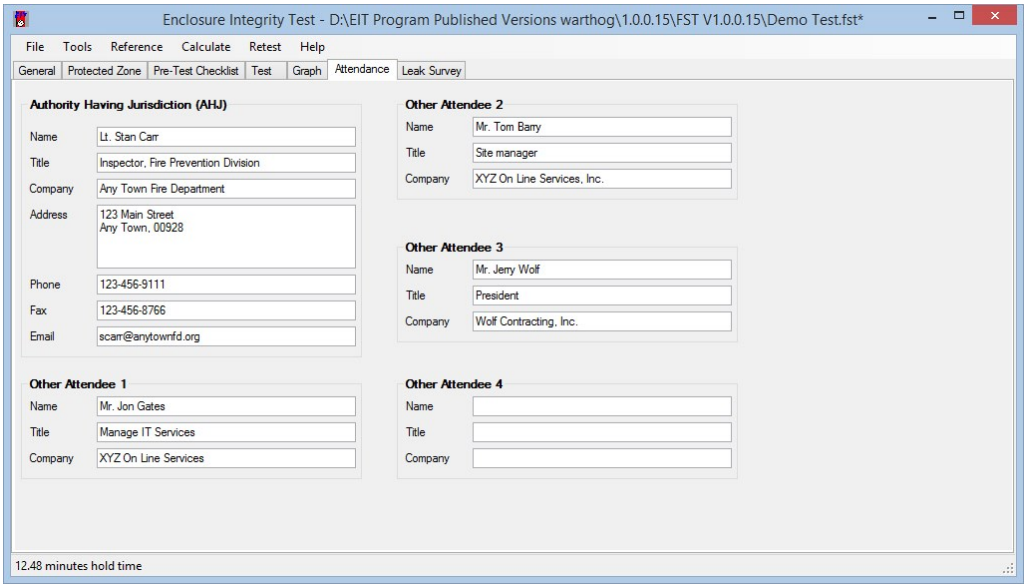
Graph and Hold Height vs. Hold Time Table

When the test is complete the program produces the above graph and table. The graph is very useful to show the rate that the interface is falling in the zone.

By moving the slider 1 the graph may be adjusted to the best presentation of the data.

Note: The graph function only is available for the heavy gases i.e. FM-200.

Screen 7, Attendance



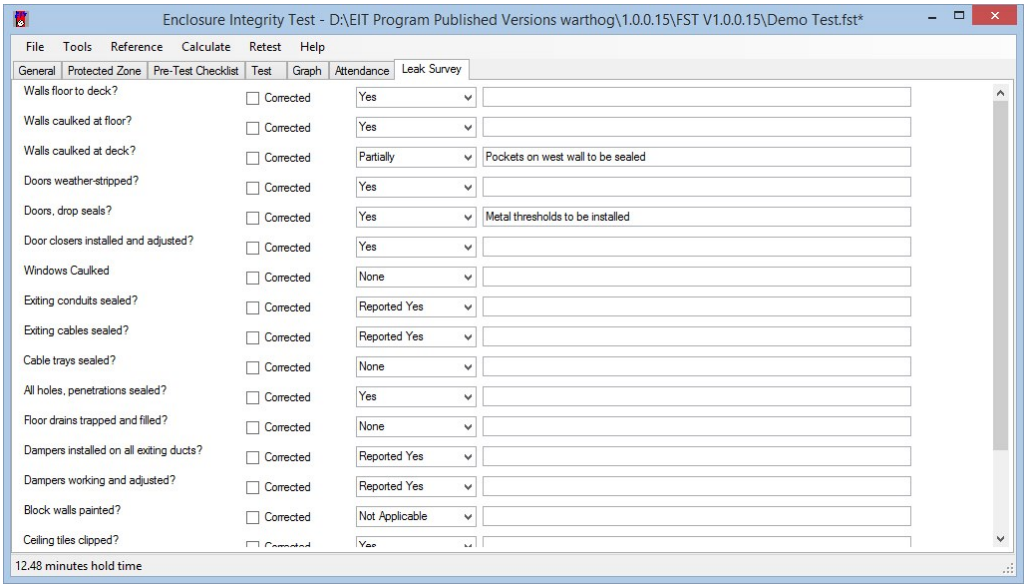
Attendance

Add the names of individuals who are present at the test, including any company employees that may be assisting the testing technician. These names will be printed in the test report.

Note: It is recommended that the Enclosure Integrity Test Data Form is used to make a hard copy of the test data in case there is a computer problem and loss of the test data.

It is easy to pass around the last page of the Data Form and have the individuals fill in their names and company.

Screen 8, Leak Survey



Leak Survey

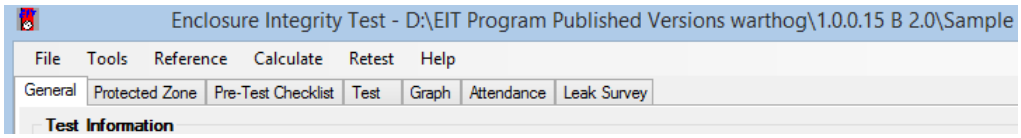
If the zone does not meet the required hold time it is due to too much leakage. The tester can by both observation based on his experience and by using the door fan and smoke help identify the leakage areas.

The survey form list the most common leakage areas with room for comments.

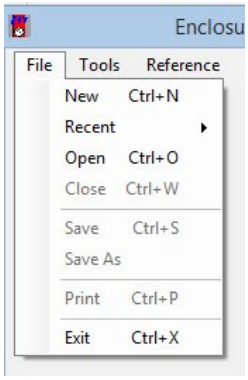
The completed form can be very helpful for the owner and/or contractor.

If the owner and/or contractor has not already received a copy of “Sealing of Rooms for Containment of Fire Suppression Agents” a copy should be included with the test report.

Again it is recommended that the above survey is completed manually on the Test Data Form and copied into the computer form later.

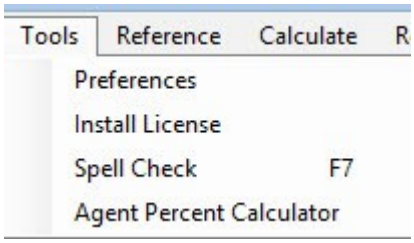


EIT Quick Test Intl. is formatted in the very familiar standard Windows format including a toolbar making it easy to learn and use.



File
The standard Windows functions New, Open, Close, Save, Save As, Print, Exit.

Also included is Recent, useful in quickly finding



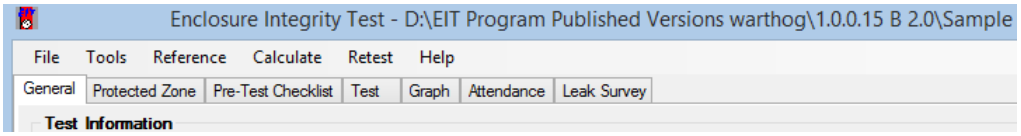
Tools
Preference for setting and locking your desired units and adding standard comments to the comment field.

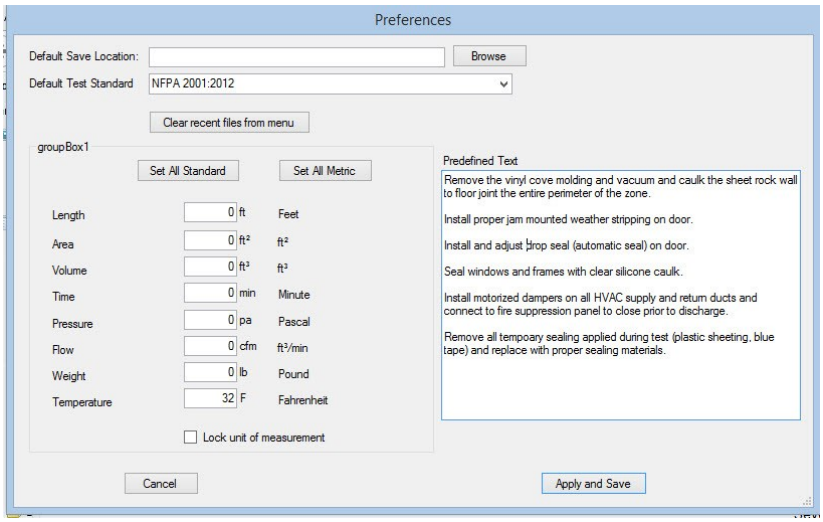
Install License
Only used is moving program from one folder to another or changing computers.

Spell Check
Useful especially when making comments in the comment field.

Agent Percent Calculator
No longer being used

Toolbar Tools>Preferences





Tools>Preferences

Default Save Location: Normally the program will save your test files in the same folder as the program. If you wish to same the test files in a different folder you may select it here.

Default Test Standard: You may set your preferred test standard here. You may always change it for a specific test requirement in the **General** screen.

Clear recent files from the menu: Click this button to clear the files that come up when **Recent** is selected in **File.**

Group Box 1: The program may be run in many different units, metric, standard (also known as Imperial or SAE) or a mix of units depending on your preference. You may Set all Standard or Set all Metric by clicking on the button or you may select or change an individual unit.

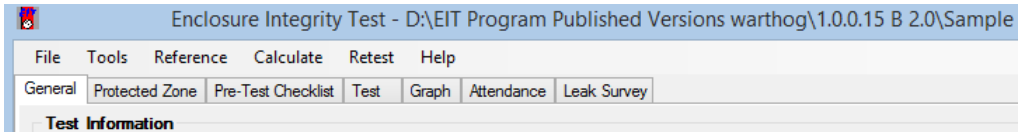
Lock unit of measurement [Important]: Once you have selected your preferred units check this box (or uncheck if you need to change the units). If this is not checked you may inadvertently change the units while working in the program and not realize it.

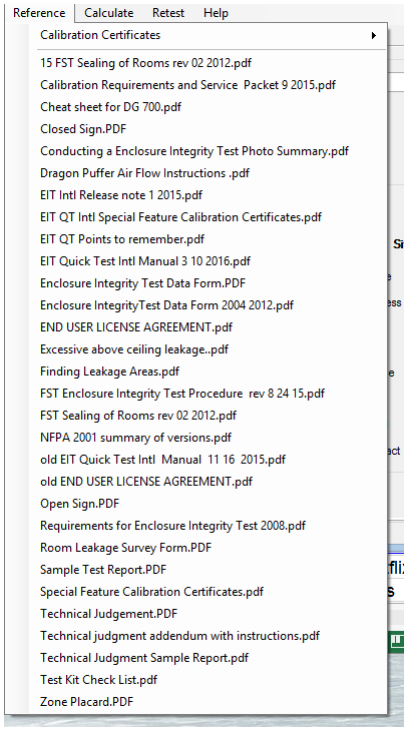
Predefined Text: We have included standard comments which we have often needed to include in the test report. You may add any of these to your report by double clicking on the comment. You may also add your own standard comments (boiler plate) which will appear in Screen 4 and may be double clicked to add them to the comment field.

Apply and Save: Click this button after any changes of units or Predefined Text.

EIT Quick Test Intl.

Toolbar: Reference, Calculate



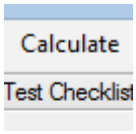


Reference: A collection of our handouts and helpful documents in .pdf format which you are welcome to read, print and give to your customers.

Especially useful for your customers and contractors is our document on sealing a zone "Sealing of Zones"

Useful and recommended for the testing technician is "Enclosure Integrity Test Data Form" for collecting a hard copy of the test data should your have a computer problem and lose the test data.

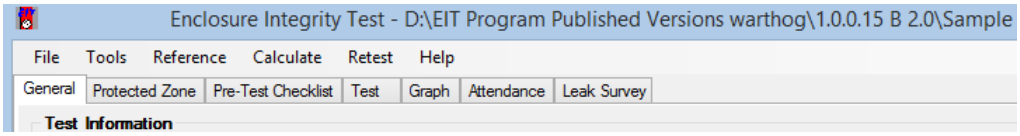
Calibration Certificates: V 1.0.015+ Contains the calibration certificates for your fan and gauge. They will pop up in **Help** should you need to show them to an AHJ. When a gauge is recalibrated, scan the new certificate as a .pdf and add it to this folder.

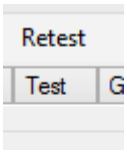


Calculate: Forces a recalculation of the hold time. Whenever there is new data or a change of data entered the program recalculates. However sometimes it may seem that there was no recalculation. Clicking on Calculate forces a recalculation

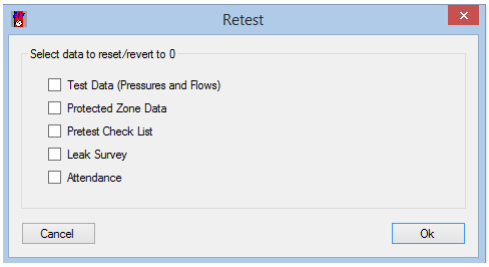
EIT Quick Test Intl.

Toolbar: Retest, Help





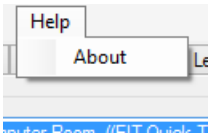
Retest: One of our most useful features. Often you will be retesting a zone, either the same day or later after there is additional sealing. Retest allow you to delete portions of the earlier test so that you do not have start from scratch or manually delete certain data fields and you can select just which fields to delete.

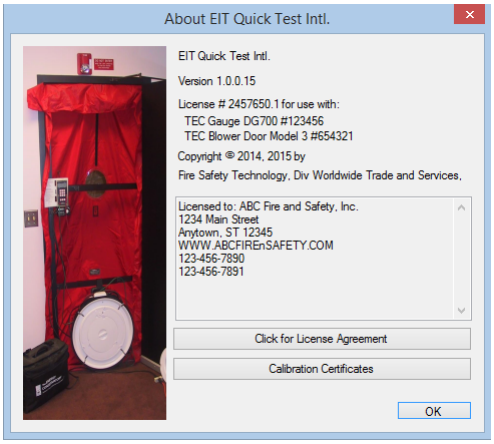


Test Data: Only erases the last test data.

Protected Zone Data: If you are going to test another zone in the same facility at the same date you would check both Test Data and Protected Zone Data and add the Zone Data for the new zone and do a test.

Pretest Check List:
Leak Survey:
Attendance: All function as above.



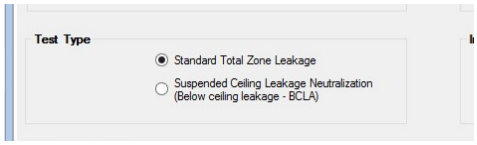


Help>About: Basic data about your copy of EIT Quick Test Intl. including Version, License Number, Gauge and Fan Serial Numbers, and your company details.

Click for License Agreement: Brings up a copy of the license agreement.

Calibration Certificates: Brings up copies of your calibration certificates, and information sheets on calibration requirements and recalibration order forms.

Suspended Ceiling Leakage Neutralization (Below Ceiling Leakage Area-BCLA)



Test Type: In screen 3, Protected Zone , Test Type you have the choice between Standard Total Zone Leakage and Suspended Ceiling Leakage Neutralization (Below Ceiling Leakage Area– BCLA)

Almost all tests are "Standard Total Zone Leakage", that is we test the entire zone high and low for leakage.

The Suspended Ceiling Leakage Neutralization (Below Ceiling Leakage Area– BCLA) test is a special test used in cases where there is excessive above ceiling leakage areas, for example in a case where the side wall do not go to the over head deck and there is an open plenum covering the entire building area or where the walls do go to the overhead deck but are not sealed at the deck and/or there are above ceiling holes in the side walls.

We know that the gases are heavy and leak out of the lower leakage areas. In calculating hold time the standard procedure assumes that half of the found leakage area is high and half is low. The size of the low leakage area and the weight of the gas/air mixture determines the rate of leakage.

However when we test a zone with a drop ceiling and an open plenum the found leakage area is not half high and half low but normally the high leakage area is much greater than the low leakage area.

In order to correct for this difference there is a special test procedure.

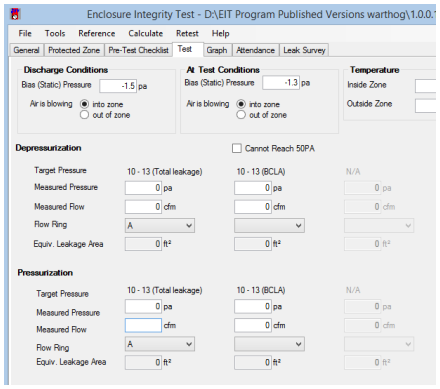
First we test the zone in the normal way with all ceiling tiles in place.

Second we cover the ceiling with plastic sheeting and retest the zone (the BCLA test)

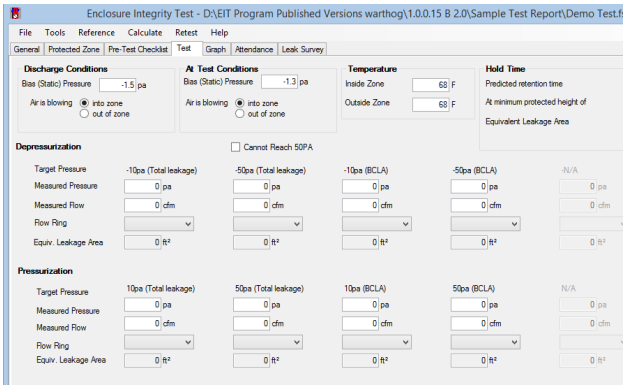
The program then calculates the hold time.

After selecting the Suspended Ceiling Leakage Neutralization (Below Ceiling Leakage Area– BCLA) option when you select the **Test** tab you will see data fields for both tests.

For more information NFPA 2001/ 2004 C.2.6.2 or NFPA 2001/2012, 2015 C.2.7.2



NFPA 2001/2004 BCLA Test



NFPA 2001/2012,2015 BCLA TEST

Bias (Static) Pressure:

The bias or also known as static pressure is the pressure acting on the zone, that is pressure or de-pressure out side the zone. This may be due to building HVAC systems, possibly due to an unbalanced system creating a negative or positive pressure in the area outside the zone, or wind effect on the building, a special lab or kitchen exhaust located near the protected zone or even fluctuations of air pressure due to the elevators.

Excessive bias pressure could shorten the predicted hold time by sucking or forcing out the gas/air mixture at an accelerated rate. By code the bias pressure must not exceed 25% of the pressure created in the zone by the gas/air mixture, the target pressure in NFPA 2001/2004 (and is calculated with warnings in EIT Quick Test Intl for NFPA 2001/2012, 2015).

The NFPA 2001 Enclosure Integrity Test Procedure has always required measurement of the bias pressure. See "Conducting an Enclosure Integrity Test, Photo Summary" photo 30, and "Conducting a NFPA 2001 Enclosure Integrity Test, Part 2"

The test procedure always required the zone and the area to be in the expected discharge condition when the test is conducted. The test is conducted with dampers, HVAC, doors, etc. in the discharge state, but beyond these items it is of course impossible for the tester to accurately predict the state of the zone or surrounding area at the time of an emergency.

The exception to this is in the case where we have opened a normally closed door to an adjoining room in order to obtain a free return air path during the test. Therefore in such case measure the bias pressure with the door closed, then open it for the test.

If the underfloor is pressurized at discharge (HVAC system on) then measure bias (static) pressure between the underfloor and the area outside the protected zone with HVAC on.

NFPA 2001/ 2012 and 2015 require the entry of both the bias pressure at discharge condition and at test condition. Unless there is a situation with an adjoining zone enter the normally measured bias pressure for both the discharge and at test condition.

See below C.2.6.2 from NFPA 2001/2012,2015

C.2.6.2 Bias Pressure Measurement.

C.2.6.2.1 Bias pressures are the background pressures that exist in the enclosure when the fan is stopped and sealed. Bias pressure must be measured or estimated for two different conditions. The first condition (which can always be measured) is the bias pressure present during the actual enclosure integrity test (P_{bt}). The second condition (which may need to be estimated) is the bias pressure expected after discharge, during the hold time (P_{bh}). To measure bias pressure, seal the fan opening with the door fan properly installed but without the fan operating. Observe the room pressure gauge for at least 30 seconds. Look for minor fluctuations in pressure. Determine the flow direction with smoke or other indicating method.

C.2.6.2.2 With the room set up as it would be under hold time conditions, measure the bias pressure P_{bh} across a section of envelope containing the largest quantity of leaks expected to leak clean agent. If the subfloor is pressurized during the hold time, measure the differential between the subfloor and outside the envelope. If the room cannot be set up as would be under discharge conditions, P_{bh} will need to be estimated.

C.2.6.2.3 With the room set up for the room integrity test, measure the bias pressure P_{bt}. If P_{bt} has an absolute value greater than 25 percent of the column pressure calculated in C.2.7.1.4, it must be permanently reduced. Large bias pressures decrease the level of certainty inherent in this procedure. The most common causes of excessive bias pressure are leaky dampers, ducts, and failure to shut down air-handling equipment serving the enclosure.

C.2.6.2.4 Record the position of all doorways, whether open or shut, when the bias pressure P_{bh} is measured.

Continuous Mixing:

It is normally recommended that all HVAC systems, computers, UPS equipment, switch gear etc. in the protected zone be shut down (de-powered) prior to discharge of the fire suppression gas. It is easy to understand that in case of a fire emergency shutting down this equipment this would minimize the risk of damage to the equipment and minimize the risk of re-ignition. There have been cases in which the HVAC / air handlers have been the source of smoke setting off the fire suppression system.

However some owners demand that the equipment and in particular the HVAC system is not shut down. In such cases because the air handlers are operating and moving air in the zone one has a situation referred to as "continuous mixing" of the suppression gas / air mixture. This is different from the standard discharge condition where the interface of the gas / air mixture is falling in the zone at a predictable rate. Briefly with "continuous mixing" there is a loss of the gas / air mixture out of the lower leakage areas but due to the mixing action of the air handlers the percentage of the suppression gas in the whole zone decreases. For this condition the calculation of the "hold time" is different from the standard Enclosure Integrity Test Procedure. We actually need to calculate the time lapse, "hold time" until the falling concentration reaches the minimum acceptable concentration.

NFPA 2001 /2012, 2015 5.6 and C.2.8.1.5 requires a minimum of 85% of the design concentration be held in the zone for 10 minutes.

If you have a zone with a continuous mixing then In the Protected Zone Screen, Hold Time Condition click Continuous Mixing. EIT Quick Test Intl. will then calculate the hold time using the Minimum (Allowable) Concentration.

TAB 6

FST Digital Enclosure Integrity Tester

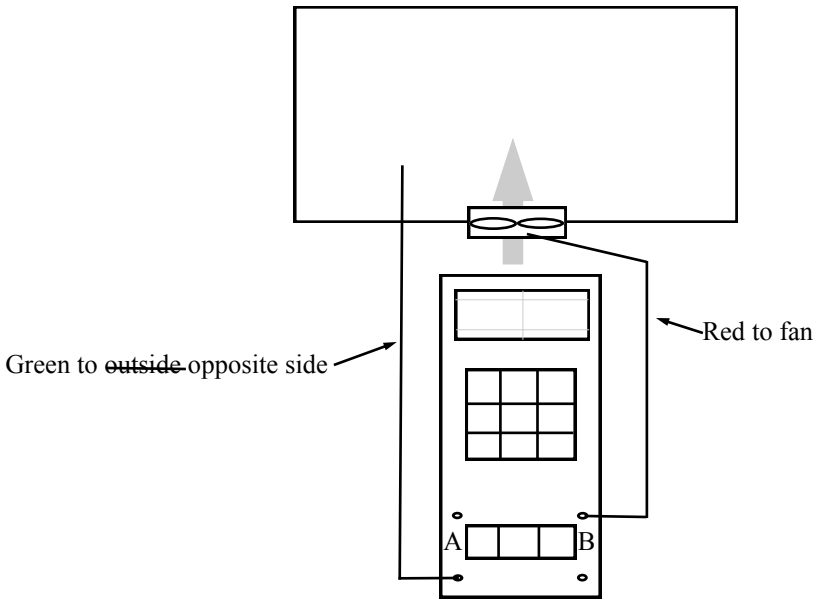
Setup inside or outside zone?

Normal test procedure is to setup the blower door and equipment to test from inside the protected zone. This allows for easy examination of the zone for leaks if it does not pass the enclosure integrity test procedure. Our manual and software has been designed on this basis.

There maybe occasions where it is easier or more desirable to setup up on the outside of the zone. From the standpoint of test results, it does not make any difference however there are a few modifications of the test procedure:

1. When you set up you will have the intake of the fan facing you, i.e. the low flow rings or plate will be facing you and the fan will be set up to pressurize the zone. Therefore:

A. It is necessary to connect the green and red pressure tubes as shown:

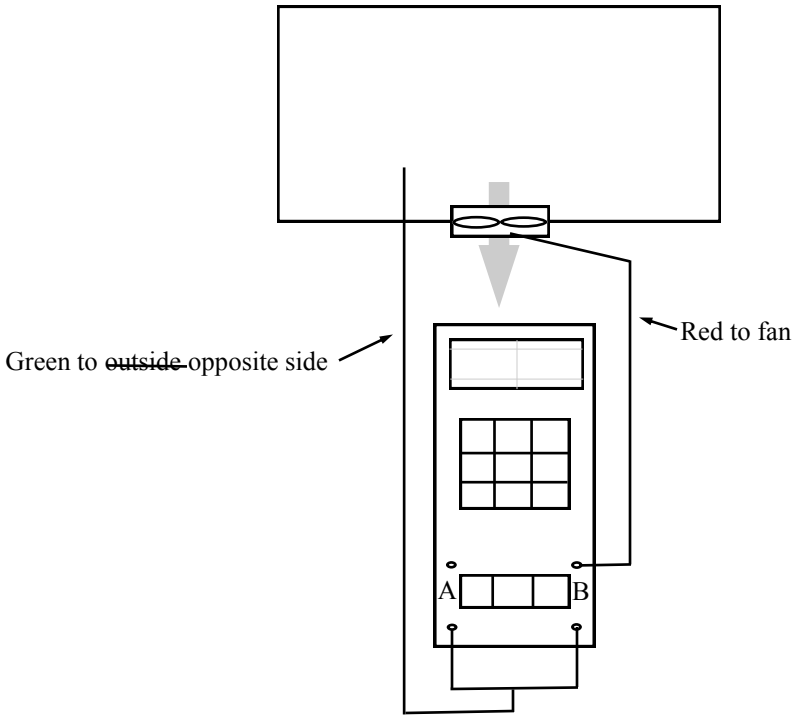


B. For good order sake, enter the room pressure and flows in the pressurization portion of the EIT Quick Test 2001 software.

Setup inside or outside zone?

2. To complete the test procedure, turn the fan around to depressurize the zone.

A. Now connect the tubes as shown:



B. Enter the pressure and flow readings in the depressurization section of the EIT Quick Test 2001 software.

Note that the fan must be turned, never use the reverse switch if you fan is so equipped. The fans are not calibrated in the reverse direction and the readings will not be accurate.

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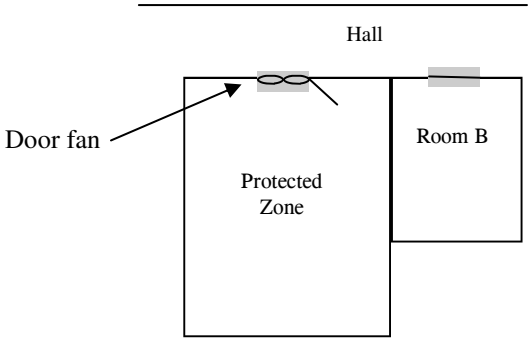
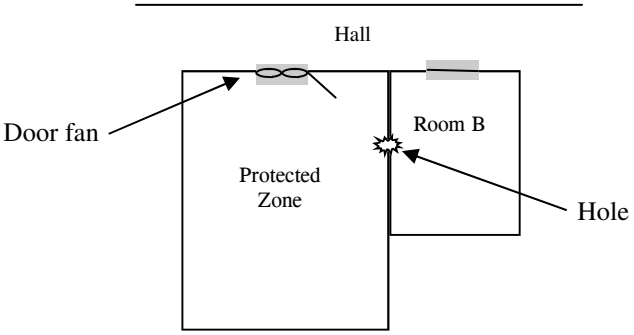
P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

Free Return Air Flow Path

Typically we are testing protected zones such as a computer rooms or telcon rooms which are surrounded by other rooms.

The enclosure integrity test will measure all leakage through the envelop of the zone. However when there are neighboring rooms we must be careful.





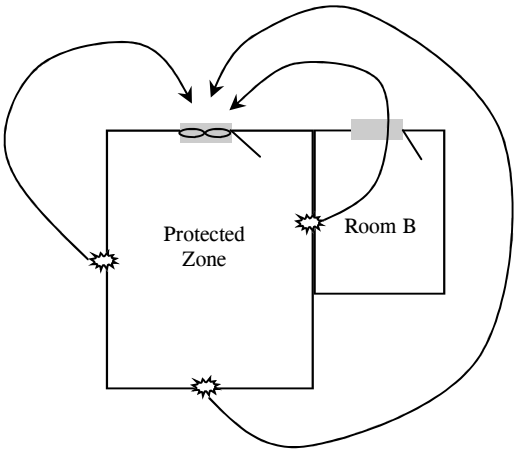
Should there be a hole—a leakage area—through the adjoining wall and the door to the common wall is closed and there is no other openings in room B, the leakage area will not be detected by the door fan

In order to accurately measure all leakage in the zone we must have a *Fred Return Air Flow Path* back to the fan.

In this case the Room B door to the hall must be open.

Prior to setting up the door fan, survey the surrounding rooms and open all doors to assure a *Fred Return Air Flow Path* back to the fan from all sides to the protected zone.

Use the DO NOT CLOSE signs in the manual to assure the doors are not closed during the test.



Free Return Air Flow Paths

Fire Safety Technology
P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

Large, Tall Doors

The FST Special Door Frame included with the FST Digital Enclosure Integrity Test Kit fits openings from 29” to 48” wide and from 51” to 94” high. It was designed to fit most standard commercial door openings that are found in the computer and server rooms that require testing.

However from time to time the openings where we need to set up the blower door are larger than 48” wide or 94” high. A easy answer to this problem is the 2” foam insulation board (usually pink) from your local building supplier (Home Depot, Lowes).

If the door is greater than 94” high, cut a piece of foam to the width of the door and high enough to drop the height to less than 94”. If cut for a close fit, it can be jammed in to place, if need blue non marking masking tape can be used to keep it in place.

Foam insulation board spacer

If the door is a bit wider than 48” the foam could also be used to take up the extra space. The blue masking tape would most likely need to be used to steady the insert.

For larger openings that might be found in special zones i.e. anaerobic chambers, generator rooms, etc.— require more creative solutions. In some cases a special plywood insert has been constructed. If you have such a situation, please call to discuss.

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P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

Multiple Fan Test
using
The Model 3 Blower Door Fan
And
The DG-700 Digital Pressure / Flow Gauge

Do I need more than one fan?

Large zones may require more than one calibrated fan to properly test a suppression gas protect zone. The number of fans that may be required can be determined by using the EIT Quick Test 2001 Software.

Briefly, the technique is to enter the various dimensions of the zone into the software, assume the maximum out put of the Model 3 Blower Door Fan is 5500 cfm at a test pressure within the target pressure range.

If the hold time is greater than 10 minutes, you will need another fan to test the zone, particularly if the zone is border line. You may determine the number of fans by adding 5500 cfm for each fan until a hold time less than 10 minutes is achieved on this “what if” test.

To do the test, single fans may be set up in different doors or using a multiple fan door fan, two or three fans may be set up in one door. The FST Special Door Frame is strong enough to hold the fans as shown,

Assemble the door frame as normal using the double or triple door panel. Place one fan in the lower hole and by suspending the upper fans from the upper cross braces place the other fans in the upper holes. As usual start with the flow rings facing you inside the zone and the fan flowing out. You may place the speed controllers and gauges on the upper cross brace as well.

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P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

Double Fan Test Procedure

The test procedure for a double fan test is similar to the single fan test see *Conducting a NFPA 2001 Enclosure Integrity Test, Part 2 Using the Model 3 Blower Door and the DG 700 digital Gauge*.

It is best to set up to do the test from inside the protected zone. The first test will then de-pressurize the zone, the second test will pressurize the zone. This is convenient if the leakage in the zone is too great, smoke pencils can then be used to help find the leakage areas.

Set up and connect the fans and gauges as shown on pages 3 to 6. Note how the gauges are connected to the fan and to the outside pressure tube.

Depressurize the zone to the target pressure and record the room pressure and the flow through each fan.

VERY IMPORTANT:

1. The fans must be turned around to do the pressurization test. If the fan is equipped with a reversing switch it must NOT be used as the fan in not accurate when used in this manner.

2. When pressurizing the zone the outside (green) tube must be set up as shown on page 4. The double "T" tap must be used to connect both gauges to the outside pressure tap.

Using the EIT Quick Test 2001 Software:

In the NFPA test screen, there is the option for 1, 2, or 3 fans. One test pressure is used and the flow from each fan is entered in the box. If you use more than 3 fans, the flow from the additional fan may be added to one of the fans. The flows are added together to determine the leakage area.

Additional equipment:

To do a multiple fan test in addition to your standard test kit you will need:

1. A second or third fan with speed controller, and an additional DG-700 Digital Pressure / Flow Gauge.
2. A double or triple fan door panel, Velcro fan holder, extra "T" pressure tube connectors

Contact Fire Safety Technology for the additional equipment.

Fire Safety Technology
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Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
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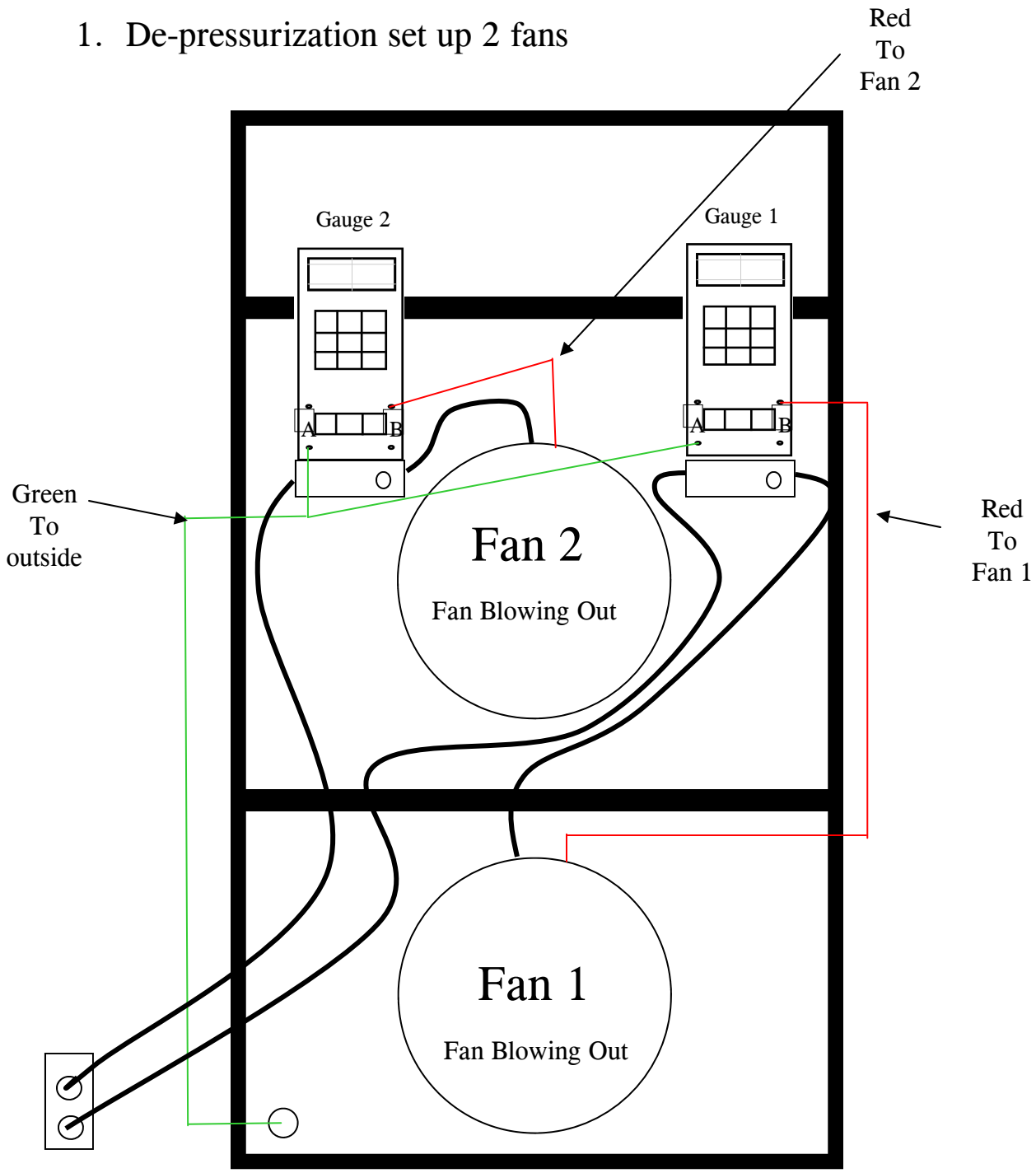
FST

Connecting the speed controllers and gauges:

1. De-pressurization set up 2 fans



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Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
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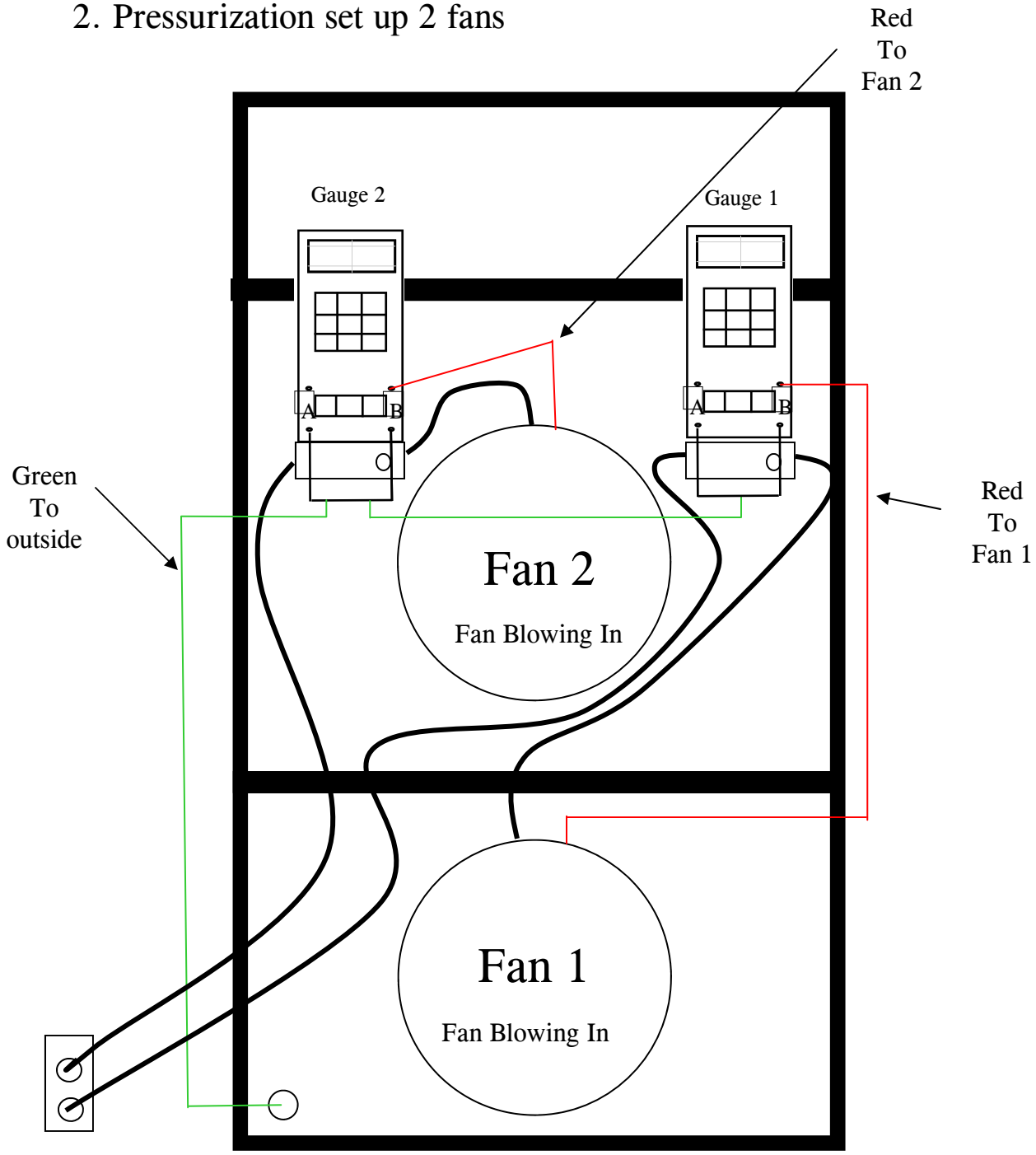
Connecting the speed controllers and gauges:

2. Pressurization set up 2 fans



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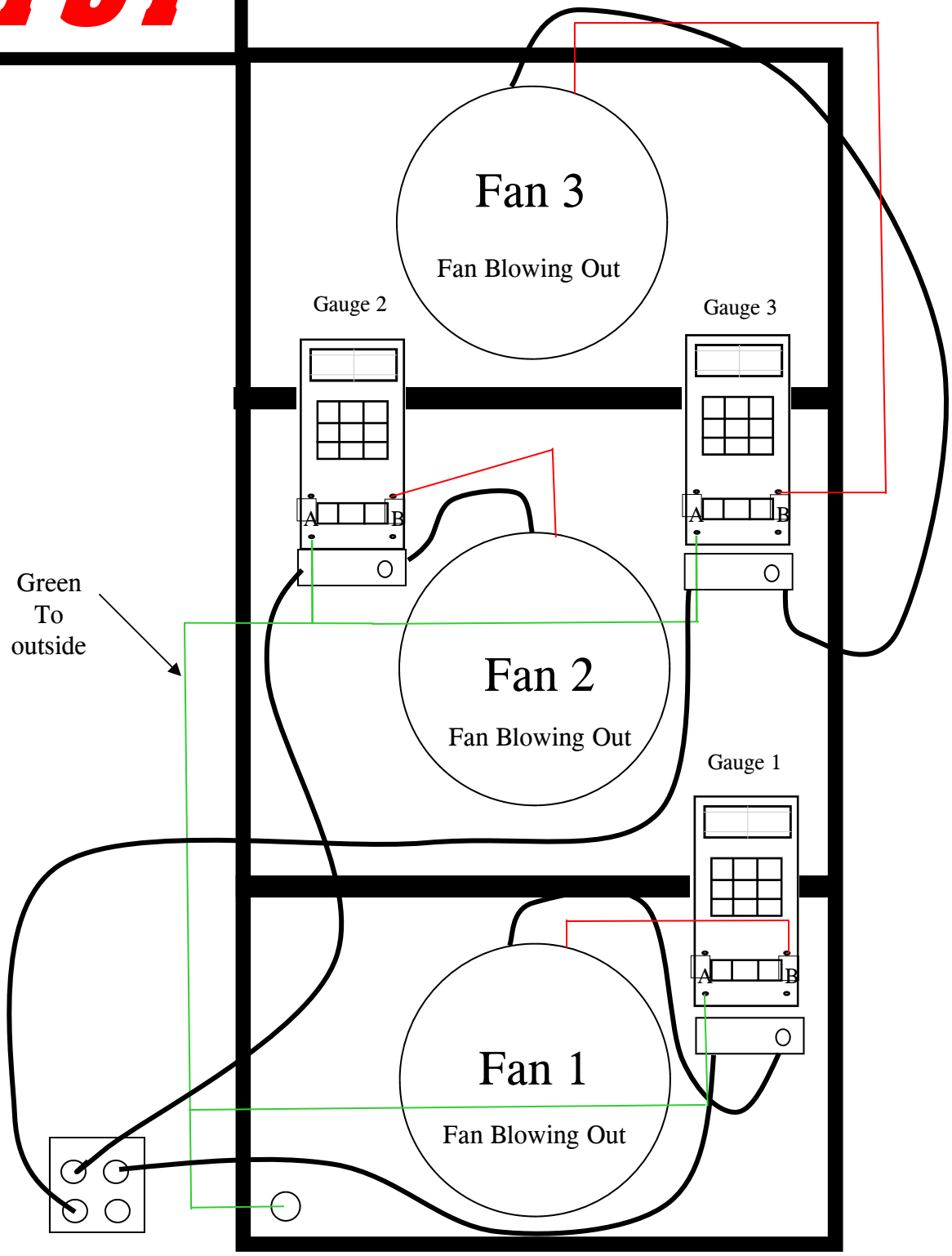
FST

Connecting the speed controllers and gauges:



3. De-pressurization set up 3 fans

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Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
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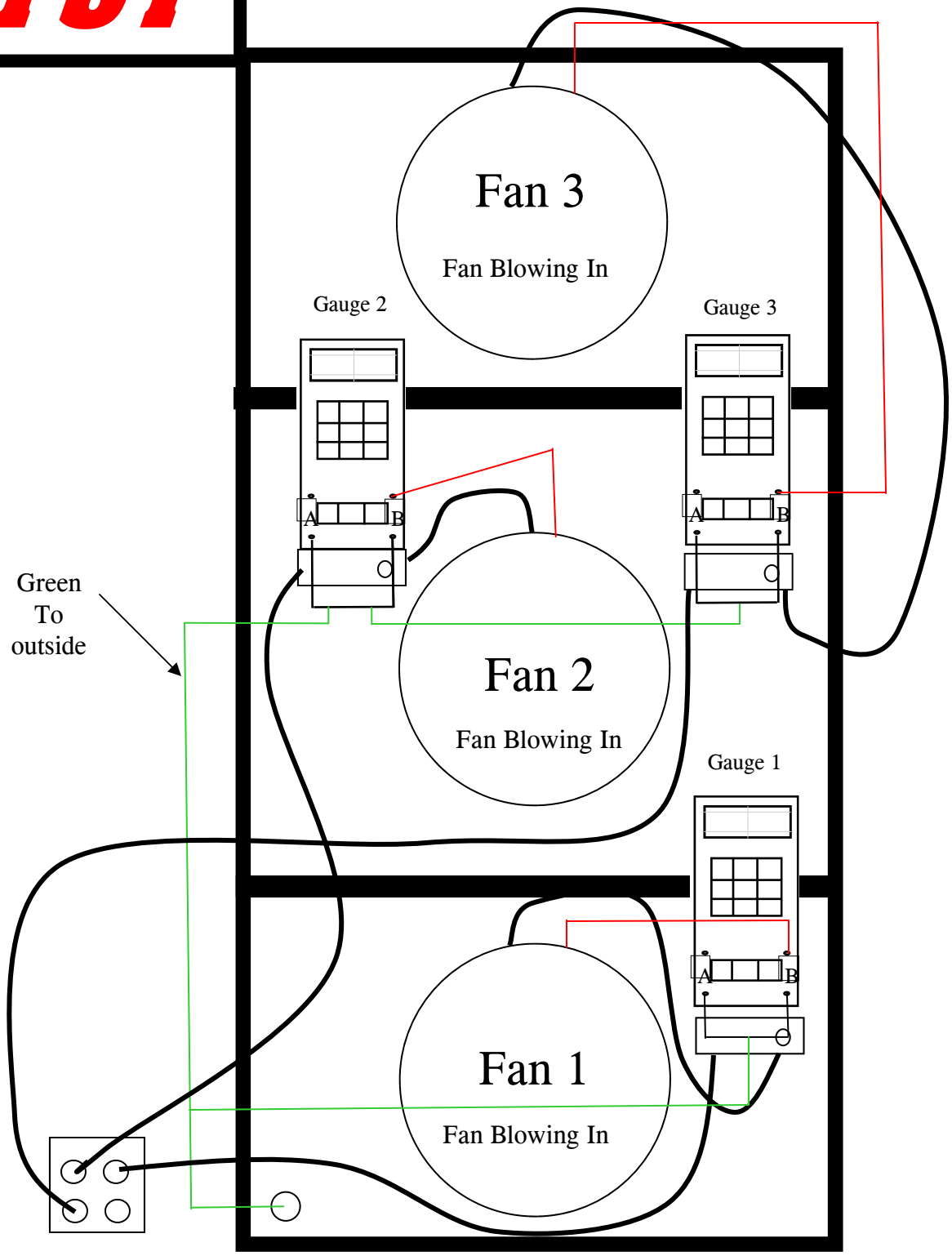
FST

Connecting the speed controllers and gauges:



4. Pressurization set up 3 fans

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Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

Excessive Above Ceiling Leakage

As detailed in our handout *Technical Judgment, Testing Zones with Excessive High Leakage* zones with excessive high leakage will hold the gas concentration longer than the Enclosure Integrity Test Procedure will indicate. The test "sees" all leakage in the zone and assumes that half is high and half is low. If the majority of the leakage is high the Enclosure Test Procedure will predict a shorter than actual hold time and the zone may "fail"; not meet the required hold time.

This is often the case in a retrofit zone in an office situation where the side walls do not extend all the way to the overhead deck and there is an open plenum through out the building. Typically these zones will be fitted with a lay-in drop ceiling.

There is also a similar situation where the side walls do go to the overhead deck but are not sealed or have many open pockets where they meet the corrugated decking.

In testing these zones we have several options:

1. Technical Judgment: If the zone is properly constructed and well sealed with minimum penetrations below the drop ceiling, the zone can be surveyed and examined while pressurized with a smoke wand to determine minimal low leakage from the zone. Please refer to our handout *Technical Judgment, Testing Zones with Excessive High Leakage.*

2. Covering the ceiling with plastic sheeting: If the zone is small, the ceiling may be covered from below with plastic sheeting. The sheeting can be held to the "T" bars with large binder clips and sealed around the edges with blue masking tape so as not to damage painted walls. All cables going through the ceiling need to be sealed to the plastic sheeting. Generally you will only be able to do a pressurization test. Enter the pressurization test data for both the pressurization and de-pressurization tests. In evaluating the test results remember: This method is detailed in NFPA 2001/2012, 2015 C.2.7.2.8

3. Above ceiling neutralization with 2 fans: This method is detailed in NFPA 2001/2012, 2015 C.2.7.2.1. It has a number of limitations: It can not be used with large over head leakage areas such as an open plenum situation; or when there is air movement in the zone making it difficult to determine "neutralization" of pressures; or if there are obstructions in the overhead area interfere with flow of the air or limited height above ceiling again making determination of 'Neutralization" difficult. This test procedure also has the disadvantage of requiring additional equipment and specialized operator training. Fire Safety Technology does not endorse this technique due to the added extra cost of equipment (2 fans, gauges, etc.), the limited possible application of the technique (will not work with the most likely open plenum situation), the almost impossible requirement of obtaining equal pressure below and above the drop ceiling, and too many reports of abuse of the technique i.e. over pressurizing the above ceiling volume creating lower flow and apparent below ceiling leakage area.

Important Note:

For options 2 and 3 using EIT Quick Test Intl, Protected Zone Tab, Test Type select Suspended Ceiling Leakage Neutralization (Below Ceiling Leakage Area –BCLA)

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Severna Park, MD 21146 U.S.A.
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FAX 410-647-7066
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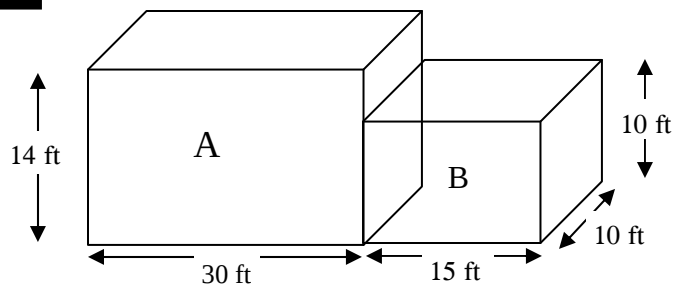
www.firesafetytech.com

Testing Zones with Multiple Heights



At times the technician may be faced with testing zones which have multiple heights. These could be two or more connecting rooms with open door ways that are designed and installed as one zone. Usually in such cases one tank and piping system feeds both (all) rooms and the detectors are crossed zoned so that any two in any of the rooms will alarm and discharge the system.

The question is how to determine the maximum protected height for the sake of the Enclosure Integrity Test calculation (The EIT 2001 Quick Test).

A simplified method is to use a square foot weighted average of the heights.

In the example above: Zone A Measures 30 feet long X 10 feet wide X 14 feet high

Zone B Measures 15 feet long X 10 feet wide X 10 feet high

To determine square foot weighted average height.

1. Calculate total combined volume of the rooms

A		B		
30 X 10 X 14	+	15 X 10 X 10		
4200	+	1500	=	5700 cubic feet

2. Calculate total combined square foot age of the rooms

A		B		
30 X 10	+	15 X 10		
300	+	150	=	450 square feet

3. Now calculate the weighted average height of the rooms by dividing the total cubic feet by the total square footage

5700 / 450 = 12.66 feet average height

Use this height as the maximum protected height
Use the height of the equipment in the zone or the protected hazard as the minimum protected height.

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Phone 800-685-8303, 410-647-8303
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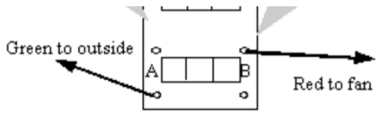
Notes on using the DG-700 digital pressure / flow gauge and the Model 3 Blower Door

Install blower door frame and fan per instructions. Normal setup is with technician and gauge inside zone. For setup outside zone see manual "Setup inside or Outside Zone."

Depressurization Test:

A. Attach tubes to gauge as shown:



De-pressurization set up

B. Using the DG-700 pressure / flow gauge

1. Using ON/OFF button turn gauge on
2. Press MODE button once to select PR/FL
3. In DEVICE window confirm you are set up for BD 3 fan
4. In the pressure and flow windows confirm you are set up for Pa (Pascals) and CFM (cubic feet per minute)
5. In Time Ave. window confirm you are setup for 1 second time
6. Seal fan with no flow plate and read and record in computer the static pressure if any.

When set up as shown and inside zone:

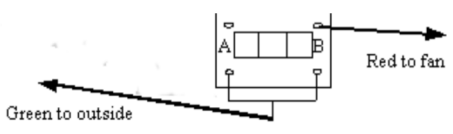
—(neg) static pressure = air blowing into zone

+ (pos) static pressure = air blowing out of zone

7. Remove no flow plate and install trial flow ring, large zone no flow ring, small zone try ring C
8. Use CONFIG Button to match flow ring
9. Turn on fan and bring room pressure to target pressure.
   - •If you can not reach target pressure remove a flow ring and reset CONFIG to match
   - •If the CFM blinks LO install next smaller flow ring and reset CONFIG to match
10. Use TIME AVE Button to select LONG, wait till readings stabilize and record—return to 1 second
11. Enter test pressure (Pa) and flow (CFM) in computer

Pressurization Test:

12. Turn off fan and turn around
13. Attach tubes as shown using "T" connector



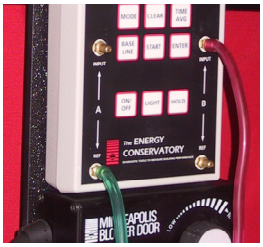
Pressurization set up

14. Follow above steps to finish test.

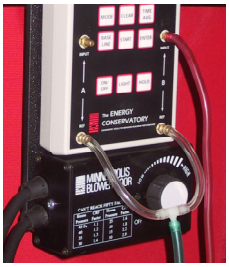
FYI: 1 Pascal (PA) = .004 in wc = .00015 psi

As a quick reminder place this "cheat sheet" on the speed controller holder behind the DG-700 digital pressure / flow gauge.

For complete details see manual.



De-pressurization set up



Pressurization set up with "T" connector

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P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303. FAX 410-647-7066
e-mail: mail@firesafetytech.com www.firesafetytech.com

TAB 7

Test Kit Check List

Review list and equipment before leaving office!

Standard Items included with test kit:

1. Fan in case with:
    a. Extension cord
    b. “A”, “B”, “C” Rings and Closed Plate
2. Door Frame in case with:
    a. Frame cover (red nylon)

3. Accessory case with:
    a. Digital pressure gauge in case with red and green tubes
    b. Speed controller
    c. Instruction manual with back up CD software disk
    d. Smoke tube kit

Additional must have items:

1. Computer with software loaded and 110v power supply
2. Tape measure

Strongly recommended items:

1. Calculator
2. Flashlight with spare batteries
3. Masking tape, duct tape
4. Current copy of NFPA 2001
5. Tool kit including: Screwdrivers, large enough to remove door closers and large channel lock wrench
6. Door stops
7. Signs, “Do Not Close”,”Do Not Open”
8. Clip board
9. Extra test report forms
10. Extra hand outs of “ How to Seal” and ‘Technical Judgment”
11. Power strip or multi plug adaptor with ground
12. Safety glasses, hard hat, safety shoes, ear plugs if needed at site

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Packing the Door Frame

1. Telescope together all pieces to their shortest lengths with the cam lock handle in the down, unlocked position.
2. Nest the two long side pieces together with the rubber sealing material to the outside and place in the top of the case.
3. Place the top piece (with 45° angle ends) next to the side pieces on the left side of the case with the rubber edge towards rear of case.
4. Place one of the cross braces (with hooks on ends) to the right side with the lock handles towards front of case.
5. Place other cross brace to the left with the lock handles towards the rear of the case.
6. Place remaining bottom piece to the right with the rubber seal towards the front of the case.
7. Place the extra from piece or red nylon cover on top and close case.

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Dragon Puffer™
Air Flow Indicator

Introduction

We have been searching for a replacement for the toxic chemical smoke tubes we have been using for leak detection. The Dragon Puffer though originally marketed as a toy has proven to be a useful, safe and economical tool. It provides an instant, harmless, non toxic, non corrosive controlled smoke plume, exactly what is needed in detecting air leakage from the zones we are testing.

The Dragon Puffer uses the same type smoke fluid as used in theatrical smoke generators, primarily distilled water with propylene glycol and glycerin. The fluid is forced through a tiny heated tube creating the instant, harmless smoke plume. (See the MSDS)

In our kits we have included the Dragon Puffer, fluid and batteries. Additional supplies are available as needed.

Instructions

1. Install 6 AA batteries per instructions in battery compartment and 1 AA battery in the Fan body
2. Fill fluid tank about 3/4 full with Super Zero Fluid
3. Turn on blower door fan to pressurize zone
4. Install and turn on blue power nozzle (trim back nozzle if needed to create thicker smoke plume)
4. Press POWER LEVER down gently until blue LED light glows.
5. Hold POWER LEVER down for 6 to 9 seconds to allow smoke generator to heat, then gently squeeze SMOKE LEVER to create a plume of smoke.
6. If the EXCESS FLUID TANK is full, suck out the fluid with the Super Zero Fuel bottle and put it back into the FILL TANK.

Hints

1. Be patient, hold POWER LEVER down longer than shorter.
2. Practice squeezing the SMOKE LEVER slowly to create a plume of smoke, not just one puff.
3. If the quantity of smoke produced seems to decrease, empty the EMPTY TANK and fill the FILL TANK, replace batteries.

Order the ZTS-800 Dragon Puffer Kit with one Dragon Puffer with one fan body, 2 pencil stream cones, 3oz. Bottle Super Zero fluid, seven AA batteries, instructions, MSDS Sheet all in hard case…… $ 59.95

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MSDS Material Safety Data Sheet

Identification

Manufacture:	Zero Toys, Inc. 23 B Bradford St. Concord, MA 01742	Tel: 978-371-3378 Fax: 978-371-3379 E-mail: sales@zerotoys.com

Product Name: Super Zero Fog Fluid

Product Use: Water based fog fluid used in the following products:

Zero blaster
Zero Launcher
Zero Wizard Stick Smoke Wand

Physical Data

Boiling point:	212-480F (100-249C)
Melting point:	Not applicable (N/A)
Specific Gravity:	(H2O = 1) 1.075@ 68F / 20C
Vapor Density:	Air = 1 4.1
Vapor Pressure:	<.025mm Hg
Solubility in Water	Complete
Evaporation rate;	No data
Appearance and odor:	Clear, with slight cherry scent

Fire and explosion hazard data

Flammability:	Nonflammable
Flash Point:	>325.4F (162C)
Flammable limits in air (% by volume)	Not determined
Extinguishing media:	Water, foam, dry chemicals, carbon dioxide
Unusual fire and Explosion hazards:	None

Ingredients

Super Zero Fog Fluid is a mixture of food grade kosher USP ingredients, consisting of glycerine, propylene glycol and distilled water. According to OSHA (1910.1200) this product is non-hazardous

Reactive hazard data

Chemical stability:	Stable, does not polymerize. Also, does not react violently with: air, water, heat.
Incompatibility Materials:	Strong oxidizing agents
Hazardous decomposition Products:	With strong oxidizing agent: acetic acid, aldehydes, ketones, carbon dioxide and / or carbon monoxide.

Toxicological properties

Finding:	The primary ingredients in Super Zero Fog fluid, in small amounts, possess minimal to no toxicity and are commonly used in foods, drugs and cosmetics.
Root of entry:	Ingestion, eyes, skin, inhalation

Effects of overexposure

Ingestion:	No evidence of adverse effect for lose dose.
Eyes:	May cause slight transient eye irritation, seen as slight redness of the conjunctiva.
Skin:	Essentially non-irritating to the skin. May cause minimal irritation of areas exposed to liquid. Skin sensitization—none.
Inhalation:	A single prolonged (hours) exposure is not likely to cause adverse effects. Fog may casue asthmatic reactions in highly sensitive individuals.
Carcinogenicity:	None
Teratogenicity: (Reproductive effects)	None
Mutagenicity:	None

Emergency first aid procedures

Eyes:	Flush with water for several minutes, keeping eyelids open.
Skin:	Rinse with water
Ingestion:	Drink plenty of water
Inhalation:	Bring person to fresh air if discomfort arises.

Preparation information

Date:	May 15, 2003
Prepared by;	Zero Toys, Inc. Information compiled from: Dr. James R. Beall, Ph.D. in Toxicological Services. Independent Report # STR 6121.8623 And MSDS reports from chemical manufactures of similar and/or same ingredients.

Finding Typical Leakage Areas

More times than not the zones we test will fail the initial enclosure integrity test. This happens in spite of our best efforts to inform the owner and/or general contractor the necessity of proper sealing of the zone including furnishing them with copies of our hand out *Sealing of Rooms of Containment of Fire Suppression Agents.* (Still a good idea in spite of the poor success record). This handout covers the typical leakage areas as does the punch list on page 4 of the *Test Data Form.*

The page 4 punch list in *Test Data Form* is design to be used by the technician conducting the test to help locate leakage areas and to assist the owner and/or general contractor in proper preparation of the zone.

Use of the ***Dragon Puffer***, air flow indicator is a reliable and safe way of locating the leakage areas. It also makes a very vivid and un arguable image of the leakage. Review the instructions on use of the ***Dragon Puffer***. Note that the nozzle must be brought very close to the suspected leakage area. You can not hold the ***Dragon Puffer*** in the middle of the zone hoping to follow the smoke to the leakage.

The last phase of the normal test procedure is with the zone pressurized. This makes it easy to turn the fan back on and pressurize the zone which will accelerate the smoke out any leakage areas.

To review the possible leakage areas as listed in the *Test Data Form* punch list:

Walls floor to deck
Walls caulked at floor
Walls caulked at (overhead) deck

In order to retain the suppression gas the entire “envelop” of the zone must be sealed. This means the wall need to go from the lower slab to the upper deck and be sealed and caulked at both joints even in cases where there is a dropped ceiling and the protected zone is only below the dropped ceiling.

The wall floor joint is particularly important as the suppression gasses are heavy and will leak out the lower leakage areas. It is also an area that is often overlooked and not sealed. Use the ***Dragon Puffer*** with the fan pressurizing the zone and apply smoke to the wall floor joint and look for any leakage areas. to properly seal the joint the vinyl cove molding or carpet

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P.O. Box 1063
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Finding Typical Leakage Areas

Similarly the wall to over head deck must be examined for leakage.

Doors weather-stripped
Doors, drop seals
Door closers installed, adjusted

Again using the ***Dragon Puffer*** apply smoke to the edge of the door and especially the bottom of the door. If weather-stripping and a bottom seal has not been installed or properly adjusted you will see the smoke streaming out of the zone. We strongly recommend quality jam mounted weather-stripping (not foam tape) and drop seals (not brush or plastic sweeps) than can be adjusted and will last.

The door where the fan is installed should be examined visually for leakage areas before or after the test. Light coming through the door to jam joint is a sure sign of leakage.

Widows caulked

Use the ***Dragon Puffer*** to apply smoke to the glass-frame joint and around the perimeter of the window frame. Often there is leakage at the corners and the glass-rubber gasket joint leaks.

Exiting conduits sealed
Exiting cables sealed
Cable trays sealed

Use the ***Dragon Puffer*** to apply smoke to these areas. Cable bundles are difficult to seal and may need additional caulk in the core of the bundle.

All holes, penetrations sealed

Obviously—do not need the ***Dragon Puffer*** for this.

Floor drains trapped and filled

Use the *Dragon Puffer* to apply smoke to any floor drains. If the trap has not been filled you will see the smoke pouring down the drain. Fill the trap with vegetable oil which will not evaporate. A floor drain that is used to drain condensation from the HVAC equipment will most likely have enough continuous water to keep the trap filled.

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Severna Park, MD 21146 U.S.A.
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Finding Typical Leakage Areas

Dampers installed on exiting ducts
Dampers working and adjusted

Use the ***Dragon Puffer*** to apply smoke to diffusers or inspection ports to determine if the dampers are working and adjusted. One must be careful however as even small leakage around a closed damper may be enough to create a stream of smoke from the ***Dragon Puffer*** but not enough leakage area to be significant. This can be confirmed by visual inspection of the closed dampers through an inspection port.

Block wall painted

Even though unpainted block walls are a leakage area, there is not enough flow though any singled area to be visually detected by using smoke. However visually one can confirm that block walls, both below and above grade blocks, are porous.

Your software **EIT Quick Test 2001** has an optional punch list in the same style as the punch list in the Test Data Form. The testing technician has the option to include the punch list with the test report.

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Enclosure Integrity Test

Test Data Form

Enclosure Integrity Test					
Date:		Contract:		Job #:	
Customer:					
Address:					
City:		State:		Zip:	
Contact:		Phone:		FAX:	

Site:					
Building:					
Address:					
City:		St:		Zip	
Contact:		Phone:		FAX:	

Zone:	
Room:	
Location:	
Description:	

Suppression gas:					
Trade name:		Concentration:		Weight, volume of gas:	

Heights:					
Raised floor ht.:		Floor to drop ceiling:		Drop ceiling to upper deck:	
Total protected height:					
High hazzard, description:			Height of high hazzard:		
Minimum protected height:			Per (AHJ or ?):		

Volume:			
Overall protected volume:		Volume of solid objects:	
Net Protected volume:		Floor area:	

Note: A .pdf file of this form can be found at the reference tab in your EIT Quick Test 2001 software. Please make as any copies as you need.

EIT Quick Test Intl. ©

Enclosure Integrity Test
Test Data Form

Enclosure Integrity Test					
Date:		Contract:		Job #:	
Customer:					
Address:					
City:		State:		Zip:	
Contact:		Phone:		FAX:	

Site:					
Building:					
Address:					
City:		St:		Zip	
Contact:		Phone:		FAX:	

Zone:							
Test Standard:	NFPA 2001/2004 NFPA 2001/2012						
Room, Location:							
Description:							
Other fire protection:	Sprinklers y / n Type pre-action or ?						
Security:	Zone y / n Type: Cameras? or Building y / n 24/7 y / n Type:						

Suppression gas:							
Trade name:		Concentration:		Weight, volume:		Manufacture:	
Control Panel mfg:				Model:		Installer:	

Heights:					
Raised floor ht.:		Floor to drop ceiling:		Drop ceiling to upper deck:	
Total protected height:					
High hazzard, description:			Height of high hazzard:		
Minimum protected height:			Per (AHJ or ?):		

Volume:			
Overall protected volume:		Volume of solid objects:	
Net Protected volume:		Floor area:	

Temperature:	*Outside temperature is the temperature surounding the zone, not necessairly outside the building*		
Temperature inside zone:		Temperature outside zone:	

Free return air flow path	*Must have open air path from outside zone walls back to fan*
Confirmed:	

Test Set Up Door:	*Weather stripped?*	*Drop seal / door sweep?*	*Door Closer?*

Pretest, Maximum Leakage:	*Based on the zone's specfications, the calculated maximum allowable leakage for a 10 minute hold time (0.00 static pressure)*
Maximum leakage:	

Static air pressure	*Must be less than 25% of target test pressure* *+ Positive if blowing out of zone, - Negative if blowing into zone* **BE SURE OUTSIDE SAMPLING TUBE IS THROUGH DOOR PANEL**	
Static air pressure:	Discharge Condition	Test Condition

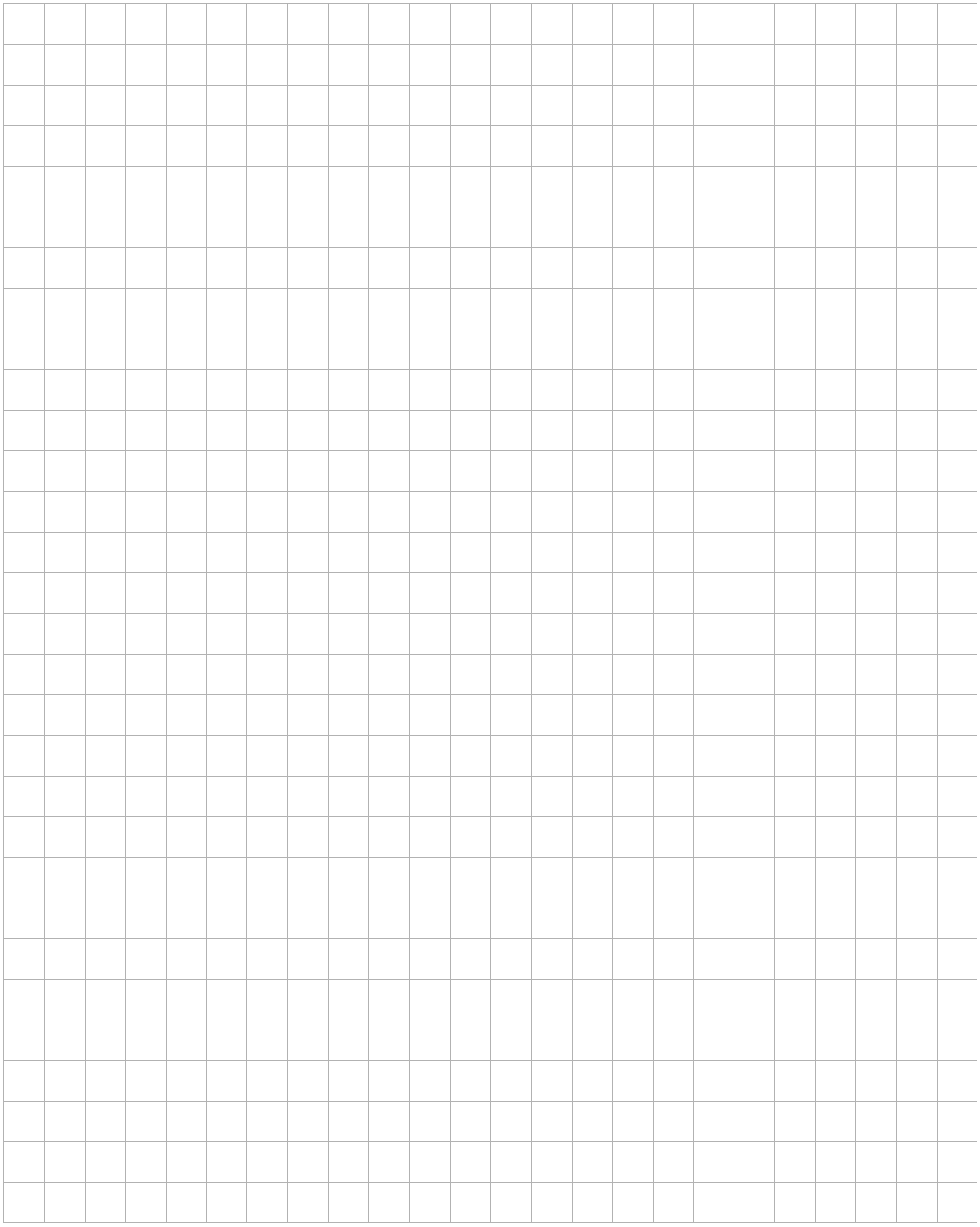
Hold Time Condition:		Test Type	
Descending Interface ☐	Continuous Mixing ☐	Standard Total Zone Leakage ☐	Suspended Ceiling Leakage Neutralization (Below ceiling Leakage BCLA) ☐

Test Data:	NFPA 2001/2004: Use indicated target pressure NFPA 2001/2012: Use 10pa & 50pa, if can not reach 50 pa check box and test at 10 pa						
Depres	Target pressure:			Press:	Target pressure:		
	Test pressure:				Test pressure:		
	Flow:				Flow:		
	Low Flow Plate:				Low Flow Plate:		

Test Results:				
Total leakage	Sq Inches:		Sq Feet:	
Hold time	Height (ft):		Minutes:	
	Height (ft):		Minutes:	
	Height (ft):		Minutes:	
	Height (ft):		Minutes:	

DRAWING:

1” =.083 2” =.166 3” =.25 4” =.333 5” =.416 6” =.50 7” =.583 8” =.666 9” =.75 10” = .833 11” = .9166



Possible leakage areas

Problem area	Y/N (1)	Corrected	Comments
Walls floor to deck			
Walls caulked at floor			
Walls caulked at deck			
Doors weather-stripped			
Doors, drop seals			
Door closers installed, adjusted			
Windows caulked			
Exiting conduits sealed			
Exiting cables sealed			
Cable trays sealed			
All holes, penetrations sealed			
Floor drains trapped and filled			
Dampers installed on all exiting ducts			
Dampers working and adjusted			
Block walls painted			
Ceiling tiles clipped			
HVAC shut down			
Halon exhaust dampered			
Halon exhaust damper closed			

1. Y—yes
N— No
R—-Reported
?—-Unknown
N/A—Not Applicable
I/A—-Inaccessible

Attendance at test:	
Name	Company / Department

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P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
Cell 443-928-8567
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

TAB 8

SEALING OF ROOMS FOR CONTAINMENT OF FIRE SUPPRESSION AGENTS

This bulletin has been prepared to assist anyone who must seal a room for a fire suppression gas system. Suppression gas systems are designed to suppress all flame and fire spread, but cannot in every instance extinguish the initial source of ignition (for instance, severe electrical short circuit). Therefore it is critical that the suppression gas remain in the protected area until emergency personnel have a chance to deal with a possible continuing source of ignition.

1. **ALL DOORS** leading from the protected areas or into another protected zone shall have drop seals (1) on the bottoms, weather-stripping(2) around the jams, latching mechanisms and door closer hardware. In addition, double doors shall have a weather-stripped astragal(2) to prevent leakage between doors and a coordinator to assure proper sequence of closure. In general, doors shall be treated as though they are being weatherproofed for outside use with no light possible passing around all sides. Doors, which for any reason cannot be kept normally closed, shall be equipped with electromagnets designed to release on alarm.

2. **ALL WINDOWS** in the zone shall be caulked with silicone around the frame and at the glass-rubber gasket. Particular attention shall be given to the area

SEALING OF ROOMS

FOR CONTAINMENT OF FIRE SUPPRESSION AGENTS

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2. **ALL WINDOWS** in the zone shall be caulked with silicone around the frame and at the glass-rubber gasket. Particular attention shall be given to the area under the window sill which often has large leakage areas.

3. **ALL DUCTWORK** not in service, leading from or into a protected area shall be permanently sealed off, air tight, with metal plates caulked and screwed in place. Ductwork left in service from the building air handling unit shall have blade type dampers installed with elastomer blade tip and side seals. Dampers shall be spring loaded or motor operated to provide 100% air shut-off.(5) Dampers shall be located at the wall line where the ducts enter and exit the zone. The ducts shall be fitted with inspection ports to allow inspection of the damper blades. It is further recommended that the building air handling units be shut down prior to discharge to prevent the spread of smoke and fire byproducts into other areas of the building and excessive static pressure on the protected zone.

4. **ALL CONDUITS** leading from or into a protected zone shall be sealed with a rated duct seal. All electrical switch boxes and receptacles, including computer LAN connections shall be sealed to prevent leakage from the zone.

5. **SELF-CONTAINED AIR HANDLING UNITS** within the protected zone may be left in service. However subfloor pressurization may accelerate leakage through the subfloor and one must consider the possibility that the air handling unit could be the source of the fire. It is strongly recommended that the air handlers be shut down prior to

discharge and in particular, systems not manned 24 hours a day should be shutdown.

6. **PROTECTED AREAS** shall be enclosed with wall partitions which extend slab-to-slab. All walls shall be caulked around the inside perimeter of the room where the walls rest on the floor slab and where the walls intersect with the ceiling slab above. Sealing shall take place on the inside surface of the zone to avoid leakage into the partition wall void. Particular attention shall be given to a wall which meets a corrugated overhead pan. The pockets shall be sealed with a properly rated material(3), fiberglass covered with sheet rock mud is an economical method. Unrated, canned foam is not acceptable. Drop ceiling tiles shall be clipped in place within 4 feet of any discharge nozzle.

7. **ALL HOLES, CRACKS OR PENETRATIONS** leading into or out of the protected area shall be sealed. This includes pipe chases, wire troughs and expansion joints. It is recommended that ***wire troughs*** **and** ***cable trays*** be sealed with reusable, intumescent, rated sealbags ***not canned foam***.(4).

8. **IF A RAISED FLOOR** continues out of the protected area into adjoining rooms, bulkheads shall be installed under the floor directly under above-floor border partitions. These bulkheads must be caulked top and bottom. If the bottom of the floor tiles are "waffled" or perforated allowing leakage through the tile, caulked sheet metal may be attached to provide a seal between the bulkhead and the bottom of the tile. If the adjoining rooms share the same underfloor air handlers, then the bulkheads shall have dampers installed the same as required for ductwork. See Item #2.

9. **ALL FLOOR DRAINS** shall have traps and the traps should be designed to have water in them at all times or shall be filled with a non evaporating, approved liquid.

10. **POROUS BLOCK WALLS** must be sealed slab-to-slab to prevent gas from passing through the block. Two or three coats of paint are normally required. Unpainted block walls are totally unacceptable. If an unpainted block wall is covered by sheetrock which stops just above a dropped ceiling, the exposed block wall above the ceiling must be painted and the joint between the sheetrock and wall sealed.

11. **QUALITY OF MATERIALS,** all materials used to seal the zone shall have proper fire rating and must be of a lasting quality. Canned foam generally does not have proper fire rating and is subject to special AHJ approval per NFPA 2001.

12. **IN GENERAL,** the basic intent is to make the protected areas as air tight as possible during and after discharge. The suppression gases are heavier than air and therefore, openings below floors are usually more critical than those above a ceiling. Small zones with high protected equipment are much harder to seal than large zones with low protected equipment. See attached chart.

13. **ONCE THE GAS IS DISCHARGE,** in most jurisdictions, it must remain in the room at its designed concentration and height for ten minutes. The length of time that the gas will remain is directly proportional to the "air tightness," "integrity" of the room.

14. If INERGEN is used as the suppression gas, please contact the supplier of INERGEN for pressure relief recommendations.

The above points are based on our testing, observations and experience. However, sealing of these leakage areas does not guarantee "passing" of an enclosure integrity test. A subsequent enclosure integrity test may determine that there are additional leakage areas which prevent "passing" of the test. In some cases it may be impossible to determine the actual location of leakage.

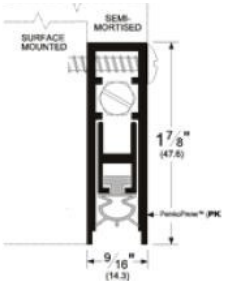
In all cases, Fire Safety Technology a division of Worldwide Trade & Services, Inc. assumes no responsibility for "passing" of an enclosure integrity test, retention of the suppression gas during an emergency or approval of the zone by the authority having jurisdiction.

Code references:
From NFPA 2001, 2004 Edition Annex C, Enclosure Integrity Procedure:

C.2.8.2 Leakage Alteration.
C.2.8.2.1 Procedure.
C.2.8.2.1.1 Protected areas should be enclosed with wall partitions that extend from the floor slab to ceiling slab or floor slab to roof.
C.2.8.2.1.2 If a raised floor continues out of the protected area into adjoining rooms, partitions should be installed under the floor directly under above-floor border partitions. These partitions should be caulked top and bottom. If the adjoining rooms share the same under-floor air handlers, then the partitions should have dampers installed the same as required for ductwork.
C.2.8.2.1.3 Any holes, cracks, or penetrations leading into or out of the protected area should be sealed. This includes pipe chases and wire troughs. All walls should be caulked around the inside perimeter of the room where the walls rest on the floor slab and where the walls intersect with the ceiling slab or roof above.
C.2.8.2.1.4 Porous block walls should be sealed slab-to-slab to prevent gas from passing through the block. Multiple coats of paint could be required.
C.2.8.2.1.5 All doors should have door sweeps or drop seals on the bottoms, and weather stripping around the jambs, latching mechanisms, and door closer hardware. In addition, double doors should have a weather-stripped astragal to prevent leakage between doors and a coordinator to ensure proper sequence of closure.
C.2.8.2.1.6 Windows should have solid weather stripping around all joints.
C.2.8.2.1.7 All unused and out-of-service ductwork leading into or from a protected area should be permanently sealed off (airtight) with metal plates caulked and screwed in place. Ductwork still in service with the building air-handling unit should have butterfly blade-type dampers installed with neoprene seals. Dampers should be spring-loaded or motor operated to provide 100-percent air shutoff. Alterations to air conditioning, heating, ventilating ductwork, and related equipment should be in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, or NFPA90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, as applicable.
C.2.8.2.1.8 All floor drains should have traps, and the traps should be designed to have water or other compatible liquid in them at all times.
C.2.8.2.2 Materials.
C.2.8.2.2.1 All materials used in altering leaks on enclosure envelope boundaries, including walls, floors, partitions, finish, acoustical treatment, raised floors, suspended ceilings, and other construction, should have a flame spread rating that is compatible with the flame spread requirements of the enclosure.
C.2.8.2.2.2 Exposed cellular plastics should not be used for altering leakage unless considered acceptable by the authority having jurisdiction.

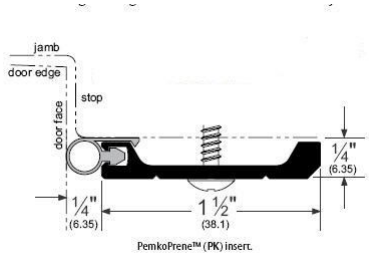
Additional References:
1.Drop seals or automatic door bottoms such as PEMCO 4301CPKL with UBC 7.2 rating or equal, from PEMCO, P.O. Box 18966, Memphis, TN 38181 Phone 901-3656-2160, 800-824-3018, FAX 901-365-1354 Available from your local commercial door hardware supplier; they are also stocked by McMaster-Carr, phone 404-346-7000 or www.mcmaster.com listed as "Automatic-Sealing Door Bottoms" see stock number 8403A56 or "google" Pemco 4301CPKL for internet supplier.

Functioning of an automatic door bottom

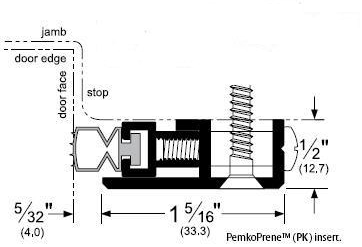


Cross section

2. Rigid jamb mounted weatherstripping such as PEMCO 290APK or even better the adjustable rigid jamb mounted weatherstripping PEMCO 379CPK is recommended for durability and adjustability. Special sealing products for double door astragals also available from PEMCO or others.



Rigid jamb mounted weatherstrip-



Adjustable, rigid jamb mounted weather-

3. Fiberglass or mineral wool backing can be sprayed or painted with a fire rated product such as 3M Fire Dam Spray from 3M Fire Protection Products, 800-328-1687 or equal[www.3m.com/firestop].

See also McMaster-Carr item numbers 93455K46, 9340K11 and Grainger item 4MM44. www.grainger.com

4. Fire rated, intumesce Sealbags from International Protective Coatings phone 800-334-8796, 215-362-9020, FAX 888-531-5192 or equal. Also 3M Fire Barrier Pillows and McMaster-Carr stock number 9359K51

5. Fire & smoke dampers with appropriate UL 555S fire rating and AMCA Standard 500-89 Class I leakage rating or better such as Ruskin fire and smoke dampers, Ruskin, 39000 Dr. Graves Rd., Kansas City, MO 64030, 816-761-7476 FAX 816-761-0521 www.ruskin.com or Johnson Controls VD-1330 Class 1 Control Dampers, www.johnsoncontrols.com

Zone Size, Height of Protected Equipment VS. Allowable Leakage Area
Small zones with high protected equipment are more difficult to meet sealing requirements

Example	Square Footage of Zone	Height of Zone	Height of Protected Equipment	Allowable Leakage Area
A(1)	300 sq. ft.	10 ft	6 ft.	108 sq. inches .75 sq feet
A(2)	300 sq. ft.	10 ft.	8 ft.	50 sq. inches .35 sq. feet
B(1)	1210 sq. ft.	10 ft.	6 ft.	436 sq. inches 3 sq. feet
B(2)	1210 sq. ft.	10 ft.	8 ft.	204 sq. inches 1.42 sq. feet
C(1)	6000 sq. ft.	10 ft.	6 ft.	1083 sq. inches 7.52 sq. feet
C (2)	6000 sq. ft.	10 ft.	8 ft.	507 sq. inches 3.52 sq. feet

FM-200, 7% concentration, 68° inside and outside zone

Fire Safety Technology
P.O. Box 1063
Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

Technical Judgment,

Testing Zones with Excessive High Leakage

Gaseous fire suppression systems are designed to control fires in the protected zone. In order to be effective the gaseous agent must be retained in the zone after discharged per- must be eliminated room the for an extended- riod. A protected zone constructed and finished to any loss of the agent after discharge zone.

Presently, the accepted method of testing these zones for leakage is by use of the Enclosure Integrity Procedure as outlined in the appendix C of the NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems.

The enclosure integrity procedure has many advantageous: eliminates need and expense of a discharge test of the system and enclosure, tests can be conducted with minimal impact on the occupants or use of zone, the tests are easily repeatable and results are comparable from test to test: i.e. the zone can be tested and tested from year to year to assure the integrity of the zone has been maintained.

Unfortunately, the Enclosure Integrity Procedure also has an disadvantage over a discharge test. The procedure measures all leakage in the protected zone. This means all leakage areas through the walls, floors and the overhead roof or deck; the entire “envelope” of the

Technical Judgment,

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Unfortunately, the Enclosure Integrity Procedure also has an disadvantage over a discharge test. The procedure measures all leakage in the protected zone. This means all leakage areas through the walls, floors and the overhead roof or deck; the entire "envelope" of the zone. In zones where there is a dropped ceiling, this includes the portion of the envelop above the dropped ceiling.

All the Clean agents listed in NFPA 2001 as well as CO2 and Halon produce a gas air mixture which is heavier than air. Normal concentrations of Halon and FM-200 produce a mixture which is significantly heaver than air. Normal concentration of Inergen produces a mixture only slightly heavier than air. Due to the weight of the mixture after discharge, the loss of the suppression gas mixture will be through the low leaks in the zone.

Prior to 1989 the usual test procedure for halon protected zones was a discharge test to confirm that the Halon concentration would be retained in the zone. This test utilized a three channel chart recording concentration meter. One channel measured the concentration at the ceiling, one at the minimum protected height and one at the floor (sub floor) level. From the concentration charts one could see the level of the suppression gas mixture fall in the zone over a period of time, confirming that the loss was through the low leakage areas.

It was common practice at that time to install halon suppression gas systems in zones in which there was considerable high leakage; such as partition walls that extended only slightly above the dropped ceiling. In these zones if the lower portion of the zone was properly sealed the zone would contain the suppression gas mixture for the required time.

Due to environmental and costs reasons, discharge testing is no longer used to con-

firm the holding time of the suppression gas mixture. However the physical principles have not changed and zones with large areas of leakage in the upper area of the zone but no lower leakage will retain the suppression gas mixture. However, these zones will "fail" a standard enclosure integrity procedure test.

This problem has been recognized in the NFPA 2001 Standard 2004 on Clean Agent Fire Extinguishing Systems, Appendix C, Enclosure Integrity Procedure, Section C-1.2.2.(5) Page 92: (NFPA 2001/2008 C.1.2.2 (5) page 106, NFPA 2001/2012 C.1.2.2 (5) page 105)

> *Technical Judgment.* Enclosures with large overhead leaks but no significant leaks in the floor slab and walls will yield unrealistically short retention time predictions. Experience has shown that enclosures of this type can be capable of retaining clean agent for prolonged periods. However, in such cases the authority having jurisdiction might waive the quantitative results in favor of a detailed witnessed leak inspection of all floors and walls with a door fan and smoke pencil.

Which means that with proper inspection and testing and with the approval of the authority having jurisdiction such zones may be accepted.

In order to assure that the zones will retain the suppression gas mixture the following points should be considered:

1. A standard enclosure test should be completed even when there is known excessive high leakage in the zone. This test will show the following:

a. Static pressure on the zone, if any. It is important that the static pressure be eliminated at discharge to avoid the accelerated loss of the suppression gas mixture. An excessive level of static pressure could cause to loss of the suppression gas through even the high leakage areas, especially the lighter gases such as Inergen. Eliminating static pressure may mean the shutting down of local or building HVAC systems prior to discharge of the suppression gas.

b. The maximum allowable leakage in the zone. The maximum allowable leakage is the total leakage from the zone which would pass a standard enclosure integrity test. The procedure assumes that half of the maximum allowable leakage is high in the zone and half is low. In evaluating a zone which has known high leakage, one must consider that the total low leakage can not exceed one half of the maximum allowable leakage.

c. The actual leakage in the zone and the predicted hold time. Unless the high leakage is so great that the test can not be completed, the test will produce an indicator of the

leakage from the zone and the predicted worse case hold time. This information will be useful in making a technical judgment.

2. As stated in the NFPA standard referenced above, a door fan should be used to pressurize the zone and smoke pencils used to test all suspect areas for possible leakage. Properly used, smoke pencils can dramatically identify leakage areas. They need to be applied directly next to the suspect areas. The smoke pencils should also be used with caution as the smoke produced is typically very corrosive and should not be inhaled or used directly next to sensitive equipment.

3. The condition of the zone must allow for a complete and thorough examination of the "envelope" (all surface areas) below the drop ceiling or required minimum hold height. This includes the area below the raised floor if any. If this area is obstructed or full of cables a complete examination may not be possible will eliminate the application of the technical judgment paragraph. Likewise hidden areas or inaccessible areas behind HVAC units, in closets would also eliminate the application of a technical judgment. The room survey report which is part of the EIT 2001 Quick Report enclosure integrity test procedure software may be used as a guide for common (but not all) possible leakage areas.

Finally in all cases and particularly in zones which have been accepted on the basis of a technical judgment the protected zones need to be tested and/or examined on a periodic bases for leakage. NFPA 2001 Standard on clean Agent Fire Extinguishing Systems, 2000 Edition Chapter 4 Inspection, Maintenance, Testing and Training Paragraph 4 -4: states:

> Enclosure Inspection: At least every 12 months, the enclosure protected by the clean agent shall be thoroughly inspected to determine if penetrations or other changes have occurred that could adversely affect agent leakage or change volume of hazard or both. Where the inspection indicates conditions that could result in inability to maintain the clean agent concentration, they shall be corrected. If uncertainty still exists, the enclosures shall be retested for integrity in accordance with 4-7.2.3.
> *Exception: An enclosure inspection is not required every 12 months if a documented administrative control program exists that addresses barrier integrity.*
>
> and
>
> Paragraph 4-7.2.3
> **Review Enclosure Integrity.** All total flooding systems shall have the enclosure examined and tested to locate and then effectively seal any significant air leaks that could result in a failure of the enclosure to hold the specified agent concentration level for the specified holding period. The currently preferred method is using a blower door fan unit and smoke pen-

cil. Quantitative results shall be obtained and recorded to indicate that the specified agent concentration for the specified duration of protection is in compliance with Section 3-6, using an approved blower fan unit or other means as approved by the authority having jurisdiction. *(For guidance, see Appendix B.)*

References:

1. NFPA 2001 Standard on clean Agent Fire Extinguishing Systems: 2000, 2004, 2008, 2012 Editions
2. EIT 2001 Quick Test, NFPA 2001 Clean Agent Enclosure Integrity Test and Report Software, Fire Safety Technology, P.O. Box 1063, Severna park, Md 21146 800-685-8303
3. Sealing of Rooms for Proper Containment of Suppression Gas, Fire Safety Technology, P.O. Box 1063, Severna park, Md 21146 800-685-8303

Fire Safety Technology
P. O. Box 1063
Severna Park, Md 21146 U.S.A.
Phone 800-685-8303 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com www.firesafetytech.com

Fire Safety Technology
Division of
Worldwide Trade and Services, Inc.

P. O. Box 1063
Severna Park, MD 21146
U.S.A.
PHONE 410-647-8303
FAX 410-647-7066
e-mail:
mail@firesafetytech.com

NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems Enclosure Integrity Testing Procedure 2004, 2008, 2012 Editions A Summary

NFPA 2001 2004 Enclosure Integrity Testing Procedure

The procedure and calculations as presented in NFPA 2001 2004 edition were virtually unchanged from the previous editions and were the same calculations as were published in the NFPA 12A Halon 1301 Fire Extinguishing Systems 1989, 1993 editions. The NFPA 2001 procedure added the constants for the new clean agents which were used in place of the Halon 1301 constant. This was a single point test for both pressurizing and depressurizing the protected zone.

NFPA 2001 2008 Enclosure Integrity Testing Procedure

The revised procedure as presented in the NFPA 2001 2008 edition incorporated a multipoint test procedure. This test would have required 5 test points for both pressurization and depressurization of the protected zone. This is similar to the ISO 14520 and the EN 15004 test procedure. The purpose of the change was to make the procedure less conservative, in other words to increase the predicted hold time for a given zone. Unfortunately, the calculations as published were erroneous and did not calculate and there were no published revisions of the calculations.(1) Therefore the NFPA 2001 2008 procedure was not and could not be adopted by local authorities.

NFPA 2001 2012 Enclosure Integrity Testing Procedure

The NFPA 2001 2012 procedure incorporates a 2 point test procedure for both the pressurization and depressurization tests of the zone. Again the purpose of the change is to make the procedure less conservative. This procedure was finally published in late 2012. I know of no local authorities in this country that have at this time adopted the 2012 standard.

NFPA 2001 2004 vs. NFPA 2001 2012 Enclosure Integrity Testing Procedure

When a zone is tested using both the NFPA 2001 2004 and the NFPA 2001 2012 procedure the NFPA 2001 2004 predicted hold time will be shorter than the predicted hold time calculated by the NFPA 2001 2012 procedure. In other words the NFPA 2001 2004 is the most conservative procedure and offers the greatest margin of protection for the zone and the protected equipment.

(1).Colin Genge, President of Retrotec has for many years been a contributor to the NFPA 2001 committee and has helped develop the calculations and procedures including the ones published in NFPA 2001/2008 version. He recently (2/25/2013) wrote “The 2012 test procedure was required by the 2008 version but it had so many typos that it was unusable.”

The problems with the 2008 version were earlier confirmed in a direct conversation with Jeffery L. Harrington Chairman of the NFPA 2001 committee and Barry D. Chase the NFPA Staff Liaison.

NFPA 2001 Clean Agents

Trade Name	Gas Producer	Equipment Producer	2001 Name	Formula	Molecular Wt.	Vapor density at 21C (kg/m^3) per NFPA 2001,pg 46	Extinguishing Concentration minimum (nominal) TF= Total Flooding LA= Local Application	Nominal lbs/f^3 factor at 60F
Argon			IG-01	Ar	39.9	1,70 kg/m^3		
Argonite			IG-55	N_2 Ar	34.0	1.41 kg/m^3		
CEA-410	3M		FC-3-1-10	C_4 F_{10}	238.03	9.85 kg/ m^3	(7%?) TF	0.0472(7% 60F)
FM-100	Great Lakes		HBFC-22B1	CHF_2Br	130.92	5.54 kg/m^3	3.9% LA	
NAF-SIII	North American Fire Guardian		HCFC Blend A	$CHCL_2CF_3$ $CHCLF_2$ $CHCLFCF_3$	92.9	3.84 kg/m^3	(8.6-9.9%) TF	.0272 (10% 60F)
Halotron 1	American Pacific	Amerx Badger Buckey Kidde	HCFC Blend B				LA	
FE-241	DuPont		HFC-124	$CHCLFCF_3$	136.5	5.83 kg/m^3	LA	
FE-25 Ecaro 25	DuPont	Fike	HFC-125	CHF_2CF_3	120.02	5.06 kg/m^3	(8-9%) TF	.0318 (9% 60F)
FE-36	DuPont		HFC-236fc	$CF_3CH_2CF_2$	152		LA	

FM-200 DuPont FE227	Great Lakes DuPont	Fike Kidde Fenwal Chemetron Cerberus- Pyrotronics	HFC-227ea	CF_3CHFCF_3	170.03	7.26 kg/m^3	5.8% (7%) (6.25%) TF	0.0348 (7% 60F)
FE13	DuPont	Kidde (GX40)	HFC-23	CHF_3	70.01	2.915 kg/m^3	(18%) TF	.0408 (18% 60F)
Inergen	Ansul/ Wormald	Ansul	IG-541	N_2--52% Ar- 40% CO_2-8%	34	1.43 kg/m^3	(37 - 50%) TF	
Novec 1230 Sapphire	3M	Chemetron Ansul	FK-5-1-12	$CF_2CF_2C(O)CF(CF_3)_2$	316.04	13.66 kg/m^3	4%-6% TF	.0564 (6% 60F)
Nitrogen	various		IG-100	N_2	28			
Triodide	Pacific Scientific		FIC-1311	CF_3I	195.1	8.051 kg/m^3	5%-7% TF, LA unoccupied spaces	
Halon 1301	various	various	not listed	$CBrF_3$	148.93	6.283 kg/m^3 (pg 58, NFPA 12A--1992)	3.5% TF (6%)	0.0254 (6% 60F)
CO_2	various	Kidde Figgie		CO_2	44		(32 -34%) TF,LA (50%) unoccupied spaces	

The data above was complied from various sources including NFPA 2001 / 2004 and manufacture's literature. Please advise of any corrections or additions.

2001 Clean Agent Table rev 1.wpd

Fire Safety Technology

P. O. Box 1063
Severna Park, Md 21146
Phone 800-685-8303 FAX 410-647-7066
Www.firesafetytech.com E-mail:mail@firesafetytech.com

TAB 9

NFPA 2001:2012
Clean Agent Enclosure Integrity Test

Conducted by:

Fire Safety Technology

P. O. Box 1063
Severna Park, MD 21146

Phone	**800-685-8303, 410-647-8303**
Fascimile	**410-647-7066**
E-mail	**mail@firesafetytech.com**
Website	**www.firesafetytech.com**

Wednesday, August 20, 2014 6:44 AM

Jones Fire Protection ABC Washington DC

Enclosure Integrity Test Report

Jones Fire Protection ABC Washington DC

General

Test Date	**8/20/2014 6:44:16 AM**
Tested by	**Fred Musser**
Job ID	**Jones Fire Protection ABC Washington DC**

Company

Name	**Jones Fire Protection**
Address	**2300 Madison St** **Baltimore, MD 21224**
Contact	**Dave Jones**
Phone	**410-555-1212**
Fascimile	
E-mail	**dave@jonesfire.com**

Location

Name	**ABC**
Address	**1200 New York Ave NW** **Washington, DC 20003**
Contact	
Phone	
Fascimile	
E-mail	

Protected Zone

Name/Number	**Server Room**
Location	
Description	**Server / Telcon Room**

High Hazard

Description	**Server Racks**
Height	**6.5 Feet**

Enclosure Integrity Test Report

Jones Fire Protection ABC Washington DC

General

Protected Volume	**2629.100**	**ft³**
Maximum Protected Height	**8.340**	**Feet**
Minimum Protected Height	**6.500**	**Feet**
Temperature Inside Zone	**68.0**	**Fahrenheit**
Temperature Outside Zone	**72.0**	**Fahrenheit**
Static Pressure (test)	**0.600**	**Pascal**
Static Pressure (discharge)	**0.600**	**Pascal**

Test Standard

Name	**NFPA 2001:2012**
Hold Time Condition	**Descending Interface**
Test Type	**Total Zone Leakage**

Supression Agent

Name	**FM-200 (HFC-227ea)**
Gas Design Concentration	**7 %**

Depressurization

Target	-10pa	-50pa
Pressure	-9.8 Pascal	-50.5 Pascal
Flow	770 ft³/min	1772 ft³/min
Leakage Area	1.278 ft²	1.457 ft²

Pressurization

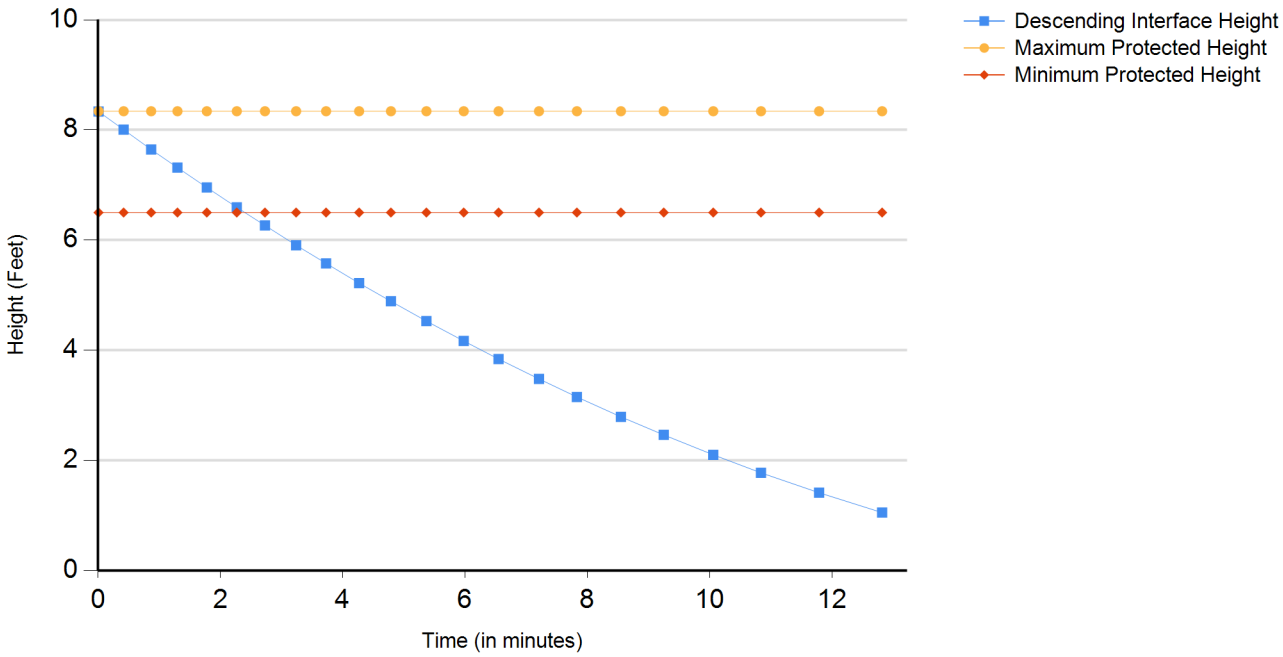
Target	10pa	50pa
Pressure	10.8 Pascal	50.1 Pascal
Flow	760 ft³/min	1700 ft³/min
Leakage Area	1.946 ft²	1.735 ft²

NFPA 2001, 2012 edition, Annex C, Enclosure Integrity Procedure Enclosure Integrity Procedure Calcuations

Predicted Hold Time at 6.5 Feet	2.4 Minutes

Enclosure Integrity Test Report

Jones Fire Protection ABC Washington DC



Height (Feet)	Time (minutes)
8.333	0.01
8.005	0.42
7.644	0.87
7.316	1.3
6.955	1.78
6.594	2.27
6.266	2.73
5.906	3.24
5.577	3.73
5.217	4.27
4.888	4.79
4.528	5.37
4.167	5.98
3.839	6.55
3.478	7.21
3.15	7.83
2.789	8.55
2.461	9.25
2.1	10.06
1.772	10.84
1.411	11.79
1.05	12.82

Authority Having Jurisdiction

Name	
Contact	
Address	
Phone	
Fascimile	
E-mail	

Other Attendees

Name	Justin Flagg
Title	
Company	Jones Fire Protection
Name	Brian Meridith
Title	
Company	Jones Fire Protection
Name	
Title	
Company	
Name	
Title	
Company	

Enclosure Integrity Test Report

Jones Fire Protection ABC Washington DC

Pretest Checklist

Tanks disconnected:	Yes	HVAC system off:	Yes
Free return of air flow path:	Yes	Panel in discharge mode:	Yes
Outside air pressure tube connected:	Yes	Dampers activated:	Yes

Comments

Except for minor leakage areas in zone (see "Leak Survey") all detected leakage is out of the zone above the drop ceiling.

With corrections as listed in Leak Survey, the actual hold time of the heavy gas/air mixture would be significantly longer than the calculated hold time.

See attached "Technical Judgment Amendment" and "Technical Judgment, Testing Zones with Excessive High Leakage"

Conditions

This test is a calculated prediction of the hold time and is based on the NFPA 2001:2012 Edition, Annex C, Enclosure Integrity Procedure and on the condition of the zone at the time of the test. This test was conducted in accordance with the NFPA procedure.

The software was produced by the Fire Safety Technology division of Worldwide Trade & Services, Inc. and is based on the equations and calculations as published in the above cited NFPA standard. The accuracy of the predicted hold time is totally the responsibility of the publisher of the standards, NFPA.

The Fire Safety Technology division nor Worldwide Trade & Services, Inc., assumes no responsibility or liability for the passage of a subsequent discharge test or from maintaining the concentration of the suppression gas for the predicted time in case of an actual fire emergency.

The sealing integrity of this zone must be maintained to assure the effectiveness of the fire suppression agent in case of an actual fire emergency. NFPA 2001:2012 Edition, Section 7.4 requires an annual inspection and possible retesting of this zone. Next inspection is due one year from the date of the test.

Test conducted by:

Fred Musser

Fire Safety Technology

ATTENTION

This room is protected with a clean agent gaseous fire extinguishing system.

To be effective in a fire emergency, the fire supression agent must be retained in the room.

Upon installation of this system, all doors were equipped with automatic closers, weather stripping and floor seals; all cables and conduits leading in or out of the room were sealed (including those above the ceiling or under the raised floor); and all leaks or cracks were seals. As required per NFPA 2001, 2012 edition, Annex C, Enclosure Integrity Procedure to assure it was properly sealed to retain the fire suppression agent.

For the safety of the occupants and equiptment in this room:

1. Doors must not be blocked open.
2. All weather stripping and seals must be maintained in good operating condition
3. Any new cables or conduits leading in or out of the room must be caulked and sealed.
4. Any holes or penetrations through the walls must be repaired and sealed.

To assure the sealing integrity of this room, NFPA 2001, 2012 edition, Section 7.4 requires an annual inspection and possible retesting of this room. Next inspection due one year from Test Date.

Test Results:

Test Date	**8/20/2014 6:44:16 AM**
Minimum Protected Height	**6.500 Feet**
Hold Time:	**2.40 Minutes**

For more information or to schedule an inspection contact:

Fire Safety Technology

P. O. Box 1063
Severna Park, MD 21146

Phone	**800-685-8303, 410-647-8303**
Fascimile	**410-647-7066**
E-mail	**mail@firesafetytech.com**
Website	**www.firesafetytech.com**

ENCLOSSURE INTEGRITY TEST REPORT

Jones Fire Protection ABC Washington DC

Technical Judgment Addendum

The NFPA 2001 Appendix C Enclosure Integrity Test predicted hold time for this zone is 2.4 minutes at the minimum protected height of 6.5 feet. However by examination and use of a smoke generator no significant low leakage was found in the zone. In accordance with the 2004 edition of NFPA 2001 Standard on Clean Agent Extinguishing Systems, Appendix C, Enclosure Integrity Procedure Section C-1.2.2(5) Technical Judgment it is the opinion of the tester that this zone would retain the concentration of the suppression gas at the minimum protected height for a significant time greater than the calculated predicted hold time. See attachment *Technical Judgment, Testing Zones with Excessive High Leakage.*

Test conducted by:

x_____

Fred Musser

Fire Safety Technology

Date: August 20, 2014

Technical Judgment,

Testing Zones with Excessive High Leakage

Gaseous fire suppression systems are designed to control fires in the protected zone. In order to be effective the gaseous agent must be retained in the zone after discharge for an extended period. A protected zone must be constructed and finished to eliminate any loss of the agent after discharge room the zone.

Presently, the accepted method of testing these zones for leakage is by use of the Enclosure Integrity Procedure as outlined in the appendix C of the NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems.

The enclosure integrity procedure has many advantageous: eliminates need and expense of a discharge test of the system and enclosure, tests can be conducted with minimal impact on the occupants or use of zone, the tests are easily repeatable and results are comparable from test to test: i.e. the zone can be tested and tested from year to year to assure the integrity of the zone has been maintained.

Unfortunately, the Enclosure Integrity Procedure also has an disadvantage over a discharge test. The procedure measures all leakage in the protected zone. This means all leakage areas through the walls, floors and the overhead roof or deck; the entire “envelope” of the zone. In zones where there is a dropped ceiling, this includes the portion of the envelop above the dropped ceiling.

All the Clean agents listed in NFPA 2001 as well as CO2 and Halon produce a gas air mixture which is heavier than air. Normal concentrations of Halon and FM-200 produce a mixture which is significantly heaver than air. Normal concentration of Inergen produces a mixture only slightly heavier than air. Due to the weight of the mixture after discharge, the loss of the suppression gas mixture will be through the low leaks in the zone.

Prior to 1989 the usual test procedure for halon protected zones was a discharge test to confirm that the Halon concentration would be retained in the zone. This test utilized a three channel chart recording concentration meter. One channel measured the concentration at the ceiling, one at the minimum protected height and one at the floor (sub floor) level. From the concentration charts one could see the level of the suppression gas mixture fall in the zone over a period of time, confirming that the loss was through the low leakage areas.

It was common practice at that time to install halon suppression gas systems in zones in which there was considerable high leakage; such as partition walls that extended only slightly above the dropped ceiling. In these zones if the lower portion of the zone was

properly sealed the zone would contain the suppression gas mixture for the required time.

Due to environmental and costs reasons, discharge testing is no longer used to confirm the holding time of the suppression gas mixture. However the physical principles have not changed and zones with large areas of leakage in the upper area of the zone but no lower leakage will retain the suppression gas mixture. However, these zones will "fail" a standard enclosure integrity procedure test.

This problem has been recognized in the NFPA 2001 Standard 2004 on Clean Agent Fire Extinguishing Systems, Appendix C, Enclosure Integrity Procedure, Section C-1.2.2.(5) Page 92: (NFPA 2001/2008 C.1.2.2 (5) page 106, NFPA 2001/2012 C.1.2.2 (5) page 105)

> *Technical Judgment.* Enclosures with large overhead leaks but no significant leaks in the floor slab and walls will yield unrealistically short retention time predictions. Experience has shown that enclosures of this type can be capable of retaining clean agent for prolonged periods. However, in such cases the authority having jurisdiction might waive the quantitative results in favor of a detailed witnessed leak inspection of all floors and walls with a door fan and smoke pencil.

Which means that with proper inspection and testing and with the approval of the authority having jurisdiction such zones may be accepted.

In order to assure that the zones will retain the suppression gas mixture the following points should be considered:

1. A standard enclosure test should be completed even when there is known excessive high leakage in the zone. This test will show the following:

a. Static pressure on the zone, if any. It is important that the static pressure be eliminated at discharge to avoid the accelerated loss of the suppression gas mixture. An excessive level of static pressure could cause to loss of the suppression gas through even the high leakage areas, especially the lighter gases such as Inergen. Eliminating static pressure may mean the shutting down of local or building HVAC systems prior to discharge of the suppression gas.

b. The maximum allowable leakage in the zone. The maximum allowable leakage is the total leakage from the zone which would pass a standard enclosure integrity test. The

procedure assumes that half of the maximum allowable leakage is high in the zone and half is low. In evaluating a zone which has known high leakage, one must consider that the total low leakage can not exceed one half of the maximum allowable leakage.

c. The actual leakage in the zone and the predicted hold time. Unless the high leakage is so great that the test can not be completed, the test will produce an indicator of the leakage from the zone and the predicted worse case hold time. This information will be useful in making a technical judgment.

2. As stated in the NFPA standard referenced above, a door fan should be used to pressurize the zone and smoke pencils used to test all suspect areas for possible leakage. Properly used, smoke pencils can dramatically identify leakage areas. They need to be applied directly next to the suspect areas. The smoke pencils should also be used with caution as the smoke produced is typically very corrosive and should not be inhaled or used directly next to sensitive equipment.

3. The condition of the zone must allow for a complete and thorough examination of the "envelope" (all surface areas) below the drop ceiling or required minimum hold height. This includes the area below the raised floor if any. If this area is obstructed or full of cables a complete examination may not be possible will eliminate the application of the technical judgment paragraph. Likewise hidden areas or inaccessible areas behind HVAC units, in closets would also eliminate the application of a technical judgment. The room survey report which is part of the EIT 2001 Quick Report enclosure integrity test procedure software may be used as a guide for common (but not all) possible leakage areas.

Finally in all cases and particularly in zones which have been accepted on the basis of a technical judgment the protected zones need to be tested and/or examined on a periodic bases for leakage. NFPA 2001 Standard on clean Agent Fire Extinguishing Systems, 2000 Edition Chapter 4 Inspection, Maintenance, Testing and Training Paragraph 4 -4: states:

> Enclosure Inspection: At least every 12 months, the enclosure protected by the clean agent shall be thoroughly inspected to determine if penetrations or other changes have occurred that could adversely affect agent leakage or change volume of hazard or both. Where the inspection indicates conditions that could result in inability to maintain the clean agent concentration, they shall be corrected. If uncertainty still exists, the enclosures shall be retested for integrity in accordance with 4-7.2.3.
> *Exception: An enclosure inspection is not required every 12 months if a documented administrative control program exists that addresses barrier integrity.*

and

Paragraph 4-7.2.3
Review Enclosure Integrity. All total flooding systems shall have the enclosure examined and tested to locate and then effectively seal any significant air leaks that could result in a failure of the enclosure to hold the specified agent concentration level for the specified holding period. The currently preferred method is using a blower door fan unit and smoke pencil. Quantitative results shall be obtained and recorded to indicate that the specified agent concentration for the specified duration of protection is in compliance with Section 3-6, using an approved blower fan unit or other means as approved by the authority having jurisdiction. *(For guidance, see Appendix B.)*

References:

1. NFPA 2001 Standard on clean Agent Fire Extinguishing Systems: 2000, 2004, 2008, 2012 Editions
2. EIT 2001 Quick Test, NFPA 2001 Clean Agent Enclosure Integrity Test and Report Software, Fire Safety Technology, P.O. Box 1063, Severna park, Md 21146 800-685-8303
3. Sealing of Rooms for Proper Containment of Suppression Gas, Fire Safety Technology, P.O. Box 1063, Severna park, Md 21146 800-685-8303

Fire Safety Technology
P. O. Box 1063
Severna Park, Md 21146 U.S.A.
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FAX 410-647-7066
e-mail: mail@firesafetytech.com www.firesafetytech.com

TAB 10

PLEASE KEEP THIS DOOR

OPEN

DOOR FAN TEST IN PROGRESS
DOOR WILL BE CLOSED UPON
COMPLETION OF TEST

Thank You...

PLEASE KEEP THIS DOOR

CLOSED

DOOR FAN TEST IN PROGRESS
DOOR WILL BE OPENED UPON
COMPLETION OF TEST

Thank You...

TAB 11

Calibration Requirements And Service

NFPA 2001 Requires calibration of door fan systems as follows:

"C-2.2.1.4 The accuracy of airflow measurement should be +/-5% of the measured flow rate."

"C-2.2.1.5 The room pressure gauge should be capable of measuring pressure differences form 0 Pa to at least 50 Pa. It should have an accuracy of +/- 1 Pa and divisions of 2 Pa or less. Inclined oil-filled manometers are considered to be traceable to a primary standard and need not be calibrated. All other pressure-measurement apparatus (for example, electronic transducer or magnehelic) should be calibrated at least yearly."

"C-2.2.1.6 Door fan systems should be checked for calibration every 5 years under controlled conditions, and a certificate should be available for inspection at all integrity tests. The calibration should be performed according to manufacture's specifications.

The certificate should include the following:

(1) Description of calibration facility and responsible technician.

(2) Date of calibration and serial number of door fan.

(3) Room pressure gauge error estimates at 8, 10, 12, 15, 20 and 40 PA measured by both ascending and descending pressures (minimum).

(4) Fan calibration at a minimum of 3 leakage areas (approximate): 0.5, 0.25, and 0.05 sq m measured at a pressure of 10 Pa." (1)

Calibration Service:

All calibration of the gauge and fan is done by the manufacture The Energy Conservatory in Minneapolis, MN. Please see the Calibration / Service form for instructions.

Gauge Calibration Service:

Calibration of digital pressure gauge, Models DG-3 and DG-700 against traceable standard and general check out of gauge. Parts and repairs are not included and will be billed separately if needed. A calibration seal will be affixed to gauge. (Required yearly per C-2.2.1.5) Includes return shipping via UPS ground.

$ 125.00 (2)

FST Fan Calibration Service:

Calibration of fan. Parts and labor for repair if necessary are not included and will be billed separately if needed. A calibration seal will be affixed to gauge and full calibration certificate will be issued. (Required every five years per C-2.2.1.6) (Return shipping not included)

$ 250.00 (2)

Please use the attached service form from The Energy Conservatory

(1) NFPA 2001 2004 page 2004-94
(2) As of November 2016, please call for current charges

Prices and specifications subject to change

Fire Safety Technology
P.O. Box 1063
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Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com

The Energy Conservatory

Equipment Service Form: Calibration and Repair

TEC Customer Number (if known) _____ **Date** _____

Contact Name _____

Company _____

Billing Address ☐ Address change

_____

_____

_____

Office Phone _____

Fax _____

Shipping Address (If different from billing)

_____

_____

_____

Cell Phone _____

Email _____

Where was your equipment purchased? Fire Safety Technology

Return shipping: All equipment will be shipped back using UPS Ground Service (UPS Standard to Canada) unless indicated below. If you need expedited return shipping, check the appropriate box below. (**Note:** Additional shipping charges will be added to the invoice.)

U.S.	☐ Ground	☐ 3-day Select	☐ 2nd Day Air	☐ Next Day Air
Canada	☐ Standard		☐ Worldwide Expedited	☐ Worldwide Saver

Please package your equipment carefully to eliminate shipping damage. If shipping a blower door fan, we recommend using an original shipping box, along with the original packing (if possible). *Please do not use packing peanuts or shredded paper.*

Ship all equipment, along with this completed form, to:

The Energy Conservatory
Attn: Calibration/Repair
2801 21st Ave S, Suite 160
Minneapolis, MN 55407

Payment Information

☐ Send invoice: Use purchase order number _____

(Invoice option only available if customer has account established with Net 30 Day terms.)

☐ Check enclosed

☐ Credit Card _____ Expiration _____

Repair Policy

In order to expedite return of equipment, TEC assumes that for all items sent in for repair (i.e. **Repair** box checked on second page), you are authorizing repairs of up to $200 per item, ***without*** contacting you for approval. **All** digital pressure gauges sent in for repair will be recalibrated for quality assurance purposes (additional calibration fee applies).

Customers in Canada

Non-warranty repairs are dutiable and GST applies to the value of the repair only. Brokerage fees apply to shipments sent UPS Standard to Canada.

The Energy Conservatory

Repair Policy

By checking the Repair box below, you are authorizing TEC to make repairs of up to $200 per item, without contacting you for approval. All digital pressure gauges sent in for repair will be recalibrated for quality assurance purposes (additional calibration fee applies).

☐ **Repairs authorized on *ALL* equipment**

Product(s) being returned _____ **Quantity** _____

Serial number (if applicable) _____

Reason for return ☐ Calibration

If repair, please describe problems or symptoms _____

_____

_____

Product(s) being returned _____ **Quantity** _____

Serial number (if applicable) _____

Reason for return ☐ Calibration

If repair, please describe problems or symptoms _____

_____

_____

Product(s) being returned _____ **Quantity** _____

Serial number (if applicable) _____

Reason for return ☐ Calibration

If repair, please describe problems or symptoms _____

_____

_____

Additional Comments

_____

_____

_____

_____

_____

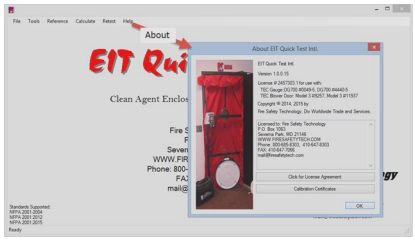
The Energy Conservatory | 2801 21st Ave S, Suite 160 | Minneapolis, MN | 55407
Phone: (612) 827-1117 | **Fax:** (612) 827-1051 | **Website:** www.energyconservatory.com

EIT Quick Test Intl

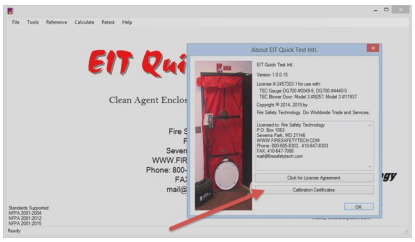
Special Features

Calibration Certificates:

We have included a way to have your calibration certificates easily available in case you are questioned while on a test site.

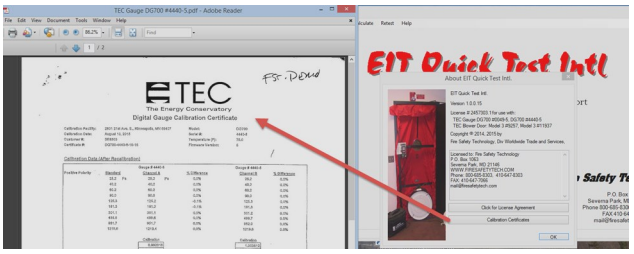


Click on the “Help” tab , then “About”

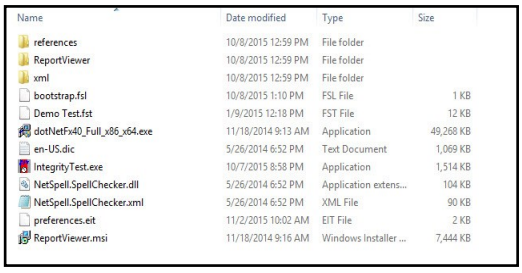


Then click on the “Calibration Certificates” button

This will bring up your calibration certificates, and “Calibration Requirements and Service” along with the TEC Equipment Service Form for recalibration of your equipment..



When you have your gauge or fan recalibrated, scan the certificates as a .pdf and place them in the “calibration certificates” folder which is located in the “references” folder which is located on your hard drive where you installed the program.



Name	Date modified	Type	Size
references	10/8/2015 12:59 PM	File folder	
ReportViewer	10/8/2015 12:59 PM	File folder	
xml	10/8/2015 12:59 PM	File folder	
bootstrap.fsl	10/8/2015 1:10 PM	FSL File	1 KB
Demo Test.fst	1/9/2015 12:18 PM	FST File	12 KB
dotNetFx40_Full_x86_x64.exe	11/18/2014 9:13 AM	Application	49,268 KB
en-US.dic	5/26/2014 6:52 PM	Text Document	1,069 KB
IntegrityTest.exe	10/7/2015 8:58 PM	Application	1,514 KB
NetSpell.SpellChecker.dll	5/26/2014 6:52 PM	Application extens...	104 KB
NetSpell.SpellChecker.xml	5/26/2014 6:52 PM	XML File	90 KB
preferences.eit	11/2/2015 10:02 AM	EIT File	2 KB
ReportViewer.msi	11/18/2014 9:16 AM	Windows Installer ...	7,444 KB

If you have questions about the NFPA calibration requirements please review the “Calibration Requirements and Service” page.

If your gauge or fan needs calibration fill out the “TEC Equipment Service Form” and send them directly to The Energy Conservatory in Minneapolis.

Fire Safety Technology
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Severna Park, MD 21146 U.S.A.
Phone 800-685-8303, 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com
www.firesafetytech.com

TAB 12

Testing Small Zones
&
Technical Judgment

Today many of the zones that are being protected with Clean Agent suppression gasses are small zones. Often these are computer or server rooms that the customer has set up in an extra office, storage room or even a closet. The customer wants to have the protection for his computers and data offered by a suppression system. And as a fire suppression dealer you can offer him early detection of a fire emergency and legitimate, safe protection with a properly designed and installed suppression system.

However to achieve a properly designed, installed and approved suppression system requires an understanding of the total scope of the project and a willingness to address all of the elements with the customer, the contractor, the system designer, the installers and the AHJ.

As we know, for a gaseous fire suppression system to be effective the suppression gas / air mixture must be retained in the zone until the fire department arrives and can address the problem.

Small retro fitted zones such as above have special problems.

First, because they are small the allowable leakage are is very small

Second, they have a drop ceiling and an open plenum above the drop ceiling.

Such zones will never pass a standard Enclosure Integrity Test.

However, if there is no leakage areas below the ceiling—like a swimming pool—they will retain the suppression gas mixture. With the fan pressurizing the zone, If we carefully survey the it using smoke—the Dragon Puffer—and determine there is no low leakage—we can state that the zone will hold the suppression gas longer that the standard predicted hold time. This is know as Technical Judgment and is cover in the NFPA 2001 code. See the reference *Technical Judgment.*

To make a test report in the case of Technical Judgment:

1. In the comment space on the Zone screen type:
   SEE THE ATTACHED TECHNICAL JUDGMENT ADDENDUM.
2. Complete the .pdf Technical Judgment addendum and attach it to the report
3. Also attach a copy of the reference Technical Judgment
4. Hand write on the report page 2 next to the “Predicted hold time at_ft is __minutes, the statement—”see attached Technical judgment Addendum”

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www.firesafetytech.com

Job ID

ENCLOSURE INTEGRITY TEST REPORT

Predicted Hold Time

Minimum hold height

Technical Judgment Addendum

The NFPA 2001 Appendix C Enclosure Integrity Test predicted hold time for this zone is minutes at the minimum protected height of feet. However by examination and use of a smoke generator no significant low leakage was found in the zone. In accordance with the 2004 edition of NFPA 2001 Standard on Clean Agent Extinguishing Systems, Appendix C, Enclosure Integrity Procedure Section C-1.2.2(5) Technical Judgment it is the opinion of the tester that this zone would retain the concentration of the suppression gas at the minimum protected height for a significant time greater than the calculated predicted hold time. See attachment *Technical Judgment, Testing Zones with Excessive High Leakage.*

Tester Signature

Test conducted by:

x_____

Tester

Company:

Company

Date:

Date

NOTE:
1. In comment field in Zone Screen, type in "See Technical Judgment Addendum".
2. Be sure to attach to report a copy of the .pdf "Technical Judgment, Testing Zones with Excessive High Leakage"

Technical Judgment,

Testing Zones with Excessive High Leakage

Gaseous fire suppression systems are designed to control fires in the protected zone. In order to be effective the gaseous agent must be retained in the zone after discharge for an extended period. A protected zone must be constructed and finished to eliminate any loss of the agent after discharge room the zone.

Presently, the accepted method of testing these zones for leakage is by use of the Enclosure Integrity Procedure as outlined in the appendix C of the NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems.

The enclosure integrity procedure has many advantageous: eliminates need and expense of a discharge test of the system and enclosure, tests can be conducted with minimal impact on the occupants or use of zone, the tests are easily repeatable and results are comparable from test to test: i.e. the zone can be tested and tested from year to year to assure the integrity of the zone has been maintained.

Unfortunately, the Enclosure Integrity Procedure also has an disadvantage over a discharge test. The procedure measures all leakage in the protected zone. This means all leakage areas through the walls, floors and the overhead roof or deck; the entire “envelope” of the zone. In zones where there is a dropped ceiling, this includes the portion of the envelop above the dropped ceiling.

All the Clean agents listed in NFPA 2001 as well as CO2 and Halon produce a gas air mixture which is heavier than air. Normal concentrations of Halon and FM-200 produce a mixture which is significantly heaver than air. Normal concentration of Inergen produces a mixture only slightly heavier than air. Due to the weight of the mixture after discharge, the loss of the suppression gas mixture will be through the low leaks in the zone.

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It was common practice at that time to install halon suppression gas systems in zones in which there was considerable high leakage; such as partition walls that extended only slightly above the dropped ceiling. In these zones if the lower portion of the zone was

properly sealed the zone would contain the suppression gas mixture for the required time.

Due to environmental and costs reasons, discharge testing is no longer used to confirm the holding time of the suppression gas mixture. However the physical principles have not changed and zones with large areas of leakage in the upper area of the zone but no lower leakage will retain the suppression gas mixture. However, these zones will "fail" a standard enclosure integrity procedure test.

This problem has been recognized in the NFPA 2001 Standard 2004 on Clean Agent Fire Extinguishing Systems, Appendix C, Enclosure Integrity Procedure, Section C-1.2.2.(5) Page 92: (NFPA 2001/2008 C.1.2.2 (5) page 106, NFPA 2001/2012 C.1.2.2 (5) page 105)

> *Technical Judgment.* Enclosures with large overhead leaks but no significant leaks in the floor slab and walls will yield unrealistically short retention time predictions. Experience has shown that enclosures of this type can be capable of retaining clean agent for prolonged periods. However, in such cases the authority having jurisdiction might waive the quantitative results in favor of a detailed witnessed leak inspection of all floors and walls with a door fan and smoke pencil.

Which means that with proper inspection and testing and with the approval of the authority having jurisdiction such zones may be accepted.

In order to assure that the zones will retain the suppression gas mixture the following points should be considered:

1. A standard enclosure test should be completed even when there is known excessive high leakage in the zone. This test will show the following:

a. Static pressure on the zone, if any. It is important that the static pressure be eliminated at discharge to avoid the accelerated loss of the suppression gas mixture. An excessive level of static pressure could cause to loss of the suppression gas through even the high leakage areas, especially the lighter gases such as Inergen. Eliminating static pressure may mean the shutting down of local or building HVAC systems prior to discharge of the suppression gas.

b. The maximum allowable leakage in the zone. The maximum allowable leakage is the total leakage from the zone which would pass a standard enclosure integrity test. The

procedure assumes that half of the maximum allowable leakage is high in the zone and half is low. In evaluating a zone which has known high leakage, one must consider that the total low leakage can not exceed one half of the maximum allowable leakage.

c. The actual leakage in the zone and the predicted hold time. Unless the high leakage is so great that the test can not be completed, the test will produce an indicator of the leakage from the zone and the predicted worse case hold time. This information will be useful in making a technical judgment.

2. As stated in the NFPA standard referenced above, a door fan should be used to pressurize the zone and smoke pencils used to test all suspect areas for possible leakage. Properly used, smoke pencils can dramatically identify leakage areas. They need to be applied directly next to the suspect areas. The smoke pencils should also be used with caution as the smoke produced is typically very corrosive and should not be inhaled or used directly next to sensitive equipment.

3. The condition of the zone must allow for a complete and thorough examination of the "envelope" (all surface areas) below the drop ceiling or required minimum hold height. This includes the area below the raised floor if any. If this area is obstructed or full of cables a complete examination may not be possible will eliminate the application of the technical judgment paragraph. Likewise hidden areas or inaccessible areas behind HVAC units, in closets would also eliminate the application of a technical judgment. The room survey report which is part of the EIT 2001 Quick Report enclosure integrity test procedure software may be used as a guide for common (but not all) possible leakage areas.

Finally in all cases and particularly in zones which have been accepted on the basis of a technical judgment the protected zones need to be tested and/or examined on a periodic bases for leakage. NFPA 2001 Standard on clean Agent Fire Extinguishing Systems, 2000 Edition Chapter 4 Inspection, Maintenance, Testing and Training Paragraph 4 -4: states:

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> *Exception: An enclosure inspection is not required every 12 months if a documented administrative control program exists that addresses barrier integrity.*

and

Paragraph 4-7.2.3
Review Enclosure Integrity. All total flooding systems shall have the enclosure examined and tested to locate and then effectively seal any significant air leaks that could result in a failure of the enclosure to hold the specified agent concentration level for the specified holding period. The currently preferred method is using a blower door fan unit and smoke pencil. Quantitative results shall be obtained and recorded to indicate that the specified agent concentration for the specified duration of protection is in compliance with Section 3-6, using an approved blower fan unit or other means as approved by the authority having jurisdiction. *(For guidance, see Appendix B.)*

References:

1. NFPA 2001 Standard on clean Agent Fire Extinguishing Systems: 2000, 2004, 2008, 2012 Editions
2. EIT 2001 Quick Test, NFPA 2001 Clean Agent Enclosure Integrity Test and Report Software, Fire Safety Technology, P.O. Box 1063, Severna park, Md 21146 800-685-8303
3. Sealing of Rooms for Proper Containment of Suppression Gas, Fire Safety Technology, P.O. Box 1063, Severna park, Md 21146 800-685-8303

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NFPA 2001:2012
Clean Agent Enclosure Integrity Test

Conducted by:

Fire Safety Technology

P. O. Box 1063
Severna Park, MD 21146

Phone	**800-685-8303, 410-647-8303**
Fascimile	**410-647-7066**
E-mail	**mail@firesafetytech.com**
Website	**www.firesafetytech.com**

Wednesday, August 20, 2014 6:44 AM

Jones Fire Protection ABC Washington DC

Enclosure Integrity Test Report

Jones Fire Protection ABC Washington DC

General

Test Date	**8/20/2014 6:44:16 AM**
Tested by	**Fred Musser**
Job ID	**Jones Fire Protection ABC Washington DC**

Company

Name	**Jones Fire Protection**
Address	**2300 Madison St** **Baltimore, MD 21224**
Contact	**Dave Jones**
Phone	**410-555-1212**
Fascimile	
E-mail	**dave@jonesfire.com**

Location

Name	**ABC**
Address	**1200 New York Ave NW** **Washington, DC 20003**
Contact	
Phone	
Fascimile	
E-mail	

Protected Zone

Name/Number	**Server Room**
Location	
Description	**Server / Telcon Room**

High Hazard

Description	**Server Racks**
Height	**6.5 Feet**

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General

Protected Volume	**2629.100**	**ft³**
Maximum Protected Height	**8.340**	**Feet**
Minimum Protected Height	**6.500**	**Feet**
Temperature Inside Zone	**68.0**	**Fahrenheit**
Temperature Outside Zone	**72.0**	**Fahrenheit**
Static Pressure (test)	**0.600**	**Pascal**
Static Pressure (discharge)	**0.600**	**Pascal**

Test Standard

Name	**NFPA 2001:2012**
Hold Time Condition	**Descending Interface**
Test Type	**Total Zone Leakage**

Supression Agent

Name	**FM-200 (HFC-227ea)**
Gas Design Concentration	**7 %**

Depressurization

Target	-10pa	-50pa
Pressure	-9.8 Pascal	-50.5 Pascal
Flow	770 ft³/min	1772 ft³/min
Leakage Area	1.278 ft²	1.457 ft²

Pressurization

Target	10pa	50pa
Pressure	10.8 Pascal	50.1 Pascal
Flow	760 ft³/min	1700 ft³/min
Leakage Area	1.946 ft²	1.735 ft²

NFPA 2001, 2012 edition, Annex C, Enclosure Integrity Procedure Enclosure Integrity Procedure Calcuations

Predicted Hold Time at 6.5 Feet	2.4 Minutes

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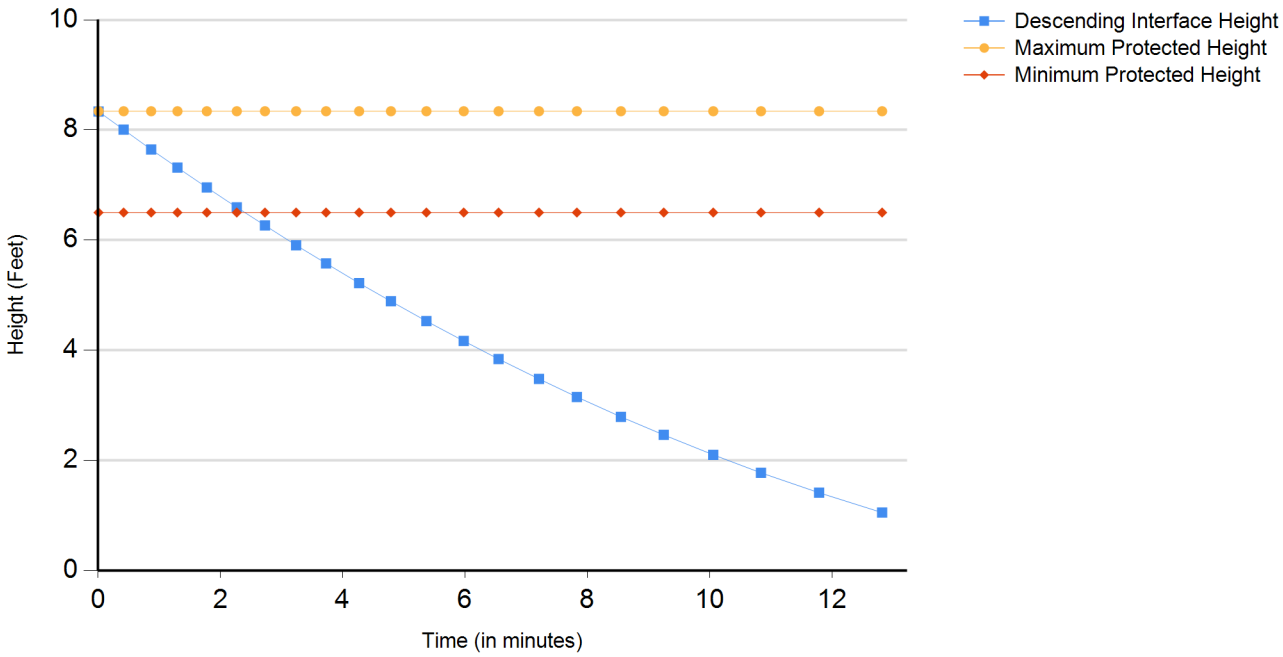

Height (Feet)	Time (minutes)
8.333	0.01
8.005	0.42
7.644	0.87
7.316	1.3
6.955	1.78
6.594	2.27
6.266	2.73
5.906	3.24
5.577	3.73
5.217	4.27
4.888	4.79
4.528	5.37
4.167	5.98
3.839	6.55
3.478	7.21
3.15	7.83
2.789	8.55
2.461	9.25
2.1	10.06
1.772	10.84
1.411	11.79
1.05	12.82

Authority Having Jurisdiction

Name	
Contact	
Address	
Phone	
Fascimile	
E-mail	

Other Attendees

Name	Justin Flagg
Title	
Company	Jones Fire Protection
Name	Brian Meridith
Title	
Company	Jones Fire Protection
Name	
Title	
Company	
Name	
Title	
Company	

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Pretest Checklist

Tanks disconnected:	Yes	HVAC system off:	Yes
Free return of air flow path:	Yes	Panel in discharge mode:	Yes
Outside air pressure tube connected:	Yes	Dampers activated:	Yes

Comments

Except for minor leakage areas in zone (see "Leak Survey") all detected leakage is out of the zone above the drop ceiling.

With corrections as listed in Leak Survey, the actual hold time of the heavy gas/air mixture would be significantly longer than the calculated hold time.

See attached "Technical Judgment Amendment" and "Technical Judgment, Testing Zones with Excessive High Leakage"

Conditions

This test is a calculated prediction of the hold time and is based on the NFPA 2001:2012 Edition, Annex C, Enclosure Integrity Procedure and on the condition of the zone at the time of the test. This test was conducted in accordance with the NFPA procedure.

The software was produced by the Fire Safety Technology division of Worldwide Trade & Services, Inc. and is based on the equations and calculations as published in the above cited NFPA standard. The accuracy of the predicted hold time is totally the responsibility of the publisher of the standards, NFPA.

The Fire Safety Technology division nor Worldwide Trade & Services, Inc., assumes no responsibility or liability for the passage of a subsequent discharge test or from maintaining the concentration of the suppression gas for the predicted time in case of an actual fire emergency.

The sealing integrity of this zone must be maintained to assure the effectiveness of the fire suppression agent in case of an actual fire emergency. NFPA 2001:2012 Edition, Section 7.4 requires an annual inspection and possible retesting of this zone. Next inspection is due one year from the date of the test.

Test conducted by:

Fred Musser

Fire Safety Technology

ATTENTION

This room is protected with a clean agent gaseous fire extinguishing system.

To be effective in a fire emergency, the fire supression agent must be retained in the room.

Upon installation of this system, all doors were equipped with automatic closers, weather stripping and floor seals; all cables and conduits leading in or out of the room were sealed (including those above the ceiling or under the raised floor); and all leaks or cracks were seals. As required per NFPA 2001, 2012 edition, Annex C, Enclosure Integrity Procedure to assure it was properly sealed to retain the fire suppression agent.

For the safety of the occupants and equiptment in this room:

1. Doors must not be blocked open.
2. All weather stripping and seals must be maintained in good operating condition
3. Any new cables or conduits leading in or out of the room must be caulked and sealed.
4. Any holes or penetrations through the walls must be repaired and sealed.

To assure the sealing integrity of this room, NFPA 2001, 2012 edition, Section 7.4 requires an annual inspection and possible retesting of this room. Next inspection due one year from Test Date.

Test Results:

Test Date	**8/20/2014 6:44:16 AM**
Minimum Protected Height	**6.500 Feet**
Hold Time:	**2.40 Minutes**

For more information or to schedule an inspection contact:

Fire Safety Technology

P. O. Box 1063
Severna Park, MD 21146

Phone	**800-685-8303, 410-647-8303**
Fascimile	**410-647-7066**
E-mail	**mail@firesafetytech.com**
Website	**www.firesafetytech.com**

ENCLOSSURE INTEGRITY TEST REPORT

Jones Fire Protection ABC Washington DC

Technical Judgment Addendum

The NFPA 2001 Appendix C Enclosure Integrity Test predicted hold time for this zone is 2.4 minutes at the minimum protected height of 6.5 feet. However by examination and use of a smoke generator no significant low leakage was found in the zone. In accordance with the 2004 edition of NFPA 2001 Standard on Clean Agent Extinguishing Systems, Appendix C, Enclosure Integrity Procedure Section C-1.2.2(5) Technical Judgment it is the opinion of the tester that this zone would retain the concentration of the suppression gas at the minimum protected height for a significant time greater than the calculated predicted hold time. See attachment *Technical Judgment, Testing Zones with Excessive High Leakage.*

Test conducted by:

x_____

Fred Musser

Fire Safety Technology

Date: August 20, 2014

Technical Judgment,

Testing Zones with Excessive High Leakage

Gaseous fire suppression systems are designed to control fires in the protected zone. In order to be effective the gaseous agent must be retained in the zone after discharge for an extended period. A protected zone must be constructed and finished to eliminate any loss of the agent after discharge room the zone.

Presently, the accepted method of testing these zones for leakage is by use of the Enclosure Integrity Procedure as outlined in the appendix C of the NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems.

The enclosure integrity procedure has many advantageous: eliminates need and expense of a discharge test of the system and enclosure, tests can be conducted with minimal impact on the occupants or use of zone, the tests are easily repeatable and results are comparable from test to test: i.e. the zone can be tested and tested from year to year to assure the integrity of the zone has been maintained.

Unfortunately, the Enclosure Integrity Procedure also has an disadvantage over a discharge test. The procedure measures all leakage in the protected zone. This means all leakage areas through the walls, floors and the overhead roof or deck; the entire “envelope” of the zone. In zones where there is a dropped ceiling, this includes the portion of the envelop above the dropped ceiling.

All the Clean agents listed in NFPA 2001 as well as CO2 and Halon produce a gas air mixture which is heavier than air. Normal concentrations of Halon and FM-200 produce a mixture which is significantly heaver than air. Normal concentration of Inergen produces a mixture only slightly heavier than air. Due to the weight of the mixture after discharge, the loss of the suppression gas mixture will be through the low leaks in the zone.

Prior to 1989 the usual test procedure for halon protected zones was a discharge test to confirm that the Halon concentration would be retained in the zone. This test utilized a three channel chart recording concentration meter. One channel measured the concentration at the ceiling, one at the minimum protected height and one at the floor (sub floor) level. From the concentration charts one could see the level of the suppression gas mixture fall in the zone over a period of time, confirming that the loss was through the low leakage areas.

It was common practice at that time to install halon suppression gas systems in zones in which there was considerable high leakage; such as partition walls that extended only slightly above the dropped ceiling. In these zones if the lower portion of the zone was

properly sealed the zone would contain the suppression gas mixture for the required time.

Due to environmental and costs reasons, discharge testing is no longer used to confirm the holding time of the suppression gas mixture. However the physical principles have not changed and zones with large areas of leakage in the upper area of the zone but no lower leakage will retain the suppression gas mixture. However, these zones will "fail" a standard enclosure integrity procedure test.

This problem has been recognized in the NFPA 2001 Standard 2004 on Clean Agent Fire Extinguishing Systems, Appendix C, Enclosure Integrity Procedure, Section C-1.2.2.(5) Page 92: (NFPA 2001/2008 C.1.2.2 (5) page 106, NFPA 2001/2012 C.1.2.2 (5) page 105)

> *Technical Judgment.* Enclosures with large overhead leaks but no significant leaks in the floor slab and walls will yield unrealistically short retention time predictions. Experience has shown that enclosures of this type can be capable of retaining clean agent for prolonged periods. However, in such cases the authority having jurisdiction might waive the quantitative results in favor of a detailed witnessed leak inspection of all floors and walls with a door fan and smoke pencil.

Which means that with proper inspection and testing and with the approval of the authority having jurisdiction such zones may be accepted.

In order to assure that the zones will retain the suppression gas mixture the following points should be considered:

1. A standard enclosure test should be completed even when there is known excessive high leakage in the zone. This test will show the following:

a. Static pressure on the zone, if any. It is important that the static pressure be eliminated at discharge to avoid the accelerated loss of the suppression gas mixture. An excessive level of static pressure could cause to loss of the suppression gas through even the high leakage areas, especially the lighter gases such as Inergen. Eliminating static pressure may mean the shutting down of local or building HVAC systems prior to discharge of the suppression gas.

b. The maximum allowable leakage in the zone. The maximum allowable leakage is the total leakage from the zone which would pass a standard enclosure integrity test. The

procedure assumes that half of the maximum allowable leakage is high in the zone and half is low. In evaluating a zone which has known high leakage, one must consider that the total low leakage can not exceed one half of the maximum allowable leakage.

c. The actual leakage in the zone and the predicted hold time. Unless the high leakage is so great that the test can not be completed, the test will produce an indicator of the leakage from the zone and the predicted worse case hold time. This information will be useful in making a technical judgment.

2. As stated in the NFPA standard referenced above, a door fan should be used to pressurize the zone and smoke pencils used to test all suspect areas for possible leakage. Properly used, smoke pencils can dramatically identify leakage areas. They need to be applied directly next to the suspect areas. The smoke pencils should also be used with caution as the smoke produced is typically very corrosive and should not be inhaled or used directly next to sensitive equipment.

3. The condition of the zone must allow for a complete and thorough examination of the "envelope" (all surface areas) below the drop ceiling or required minimum hold height. This includes the area below the raised floor if any. If this area is obstructed or full of cables a complete examination may not be possible will eliminate the application of the technical judgment paragraph. Likewise hidden areas or inaccessible areas behind HVAC units, in closets would also eliminate the application of a technical judgment. The room survey report which is part of the EIT 2001 Quick Report enclosure integrity test procedure software may be used as a guide for common (but not all) possible leakage areas.

Finally in all cases and particularly in zones which have been accepted on the basis of a technical judgment the protected zones need to be tested and/or examined on a periodic bases for leakage. NFPA 2001 Standard on clean Agent Fire Extinguishing Systems, 2000 Edition Chapter 4 Inspection, Maintenance, Testing and Training Paragraph 4 -4: states:

> Enclosure Inspection: At least every 12 months, the enclosure protected by the clean agent shall be thoroughly inspected to determine if penetrations or other changes have occurred that could adversely affect agent leakage or change volume of hazard or both. Where the inspection indicates conditions that could result in inability to maintain the clean agent concentration, they shall be corrected. If uncertainty still exists, the enclosures shall be retested for integrity in accordance with 4-7.2.3.
> *Exception: An enclosure inspection is not required every 12 months if a documented administrative control program exists that addresses barrier integrity.*

and

Paragraph 4-7.2.3
Review Enclosure Integrity. All total flooding systems shall have the enclosure examined and tested to locate and then effectively seal any significant air leaks that could result in a failure of the enclosure to hold the specified agent concentration level for the specified holding period. The currently preferred method is using a blower door fan unit and smoke pencil. Quantitative results shall be obtained and recorded to indicate that the specified agent concentration for the specified duration of protection is in compliance with Section 3-6, using an approved blower fan unit or other means as approved by the authority having jurisdiction. *(For guidance, see Appendix B.)*

References:

1. NFPA 2001 Standard on clean Agent Fire Extinguishing Systems: 2000, 2004, 2008, 2012 Editions
2. EIT 2001 Quick Test, NFPA 2001 Clean Agent Enclosure Integrity Test and Report Software, Fire Safety Technology, P.O. Box 1063, Severna park, Md 21146 800-685-8303
3. Sealing of Rooms for Proper Containment of Suppression Gas, Fire Safety Technology, P.O. Box 1063, Severna park, Md 21146 800-685-8303

Fire Safety Technology
P. O. Box 1063
Severna Park, Md 21146 U.S.A.
Phone 800-685-8303 410-647-8303
FAX 410-647-7066
e-mail: mail@firesafetytech.com www.firesafetytech.com