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Retrotec
Enclosure Test Form Guide

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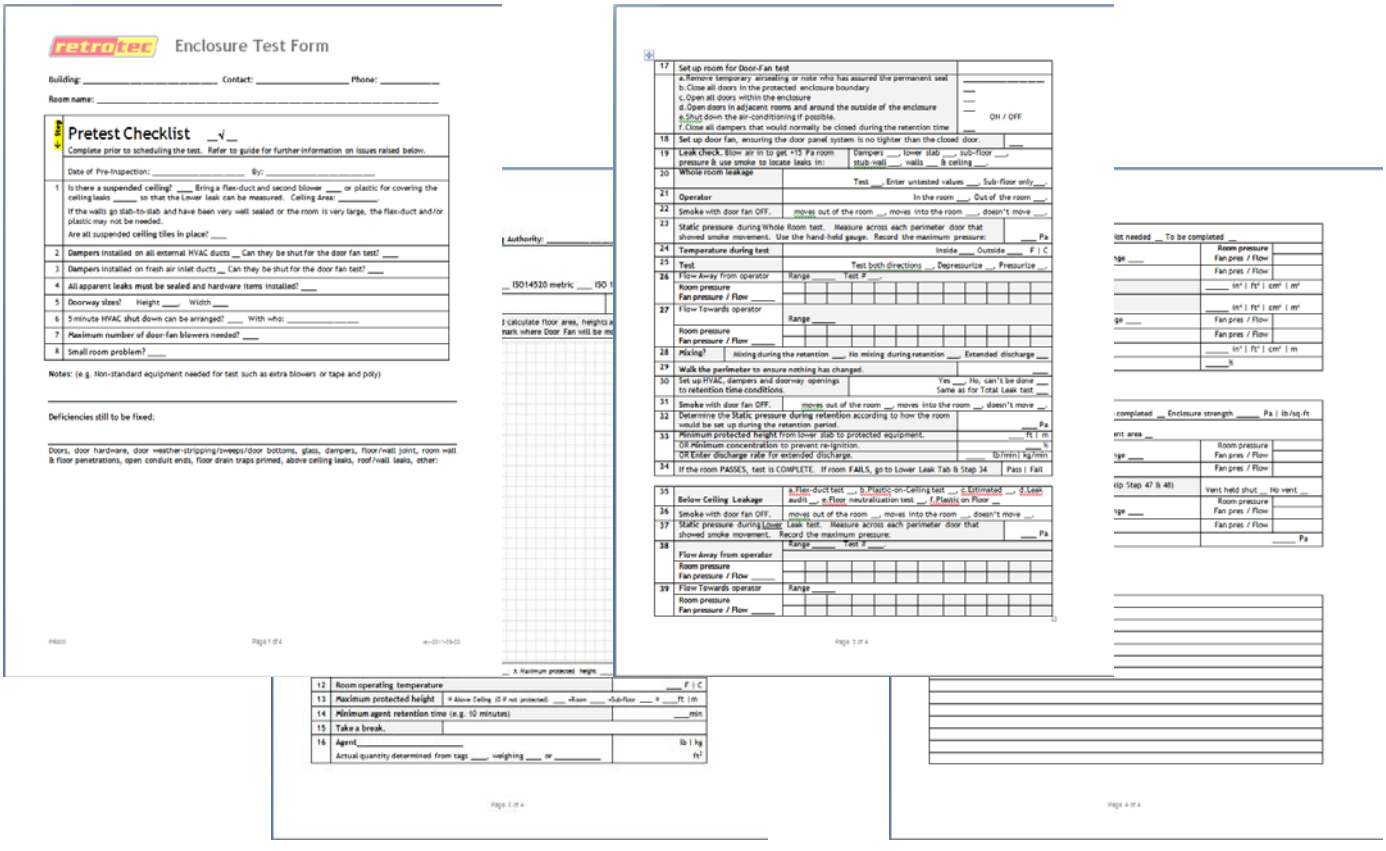
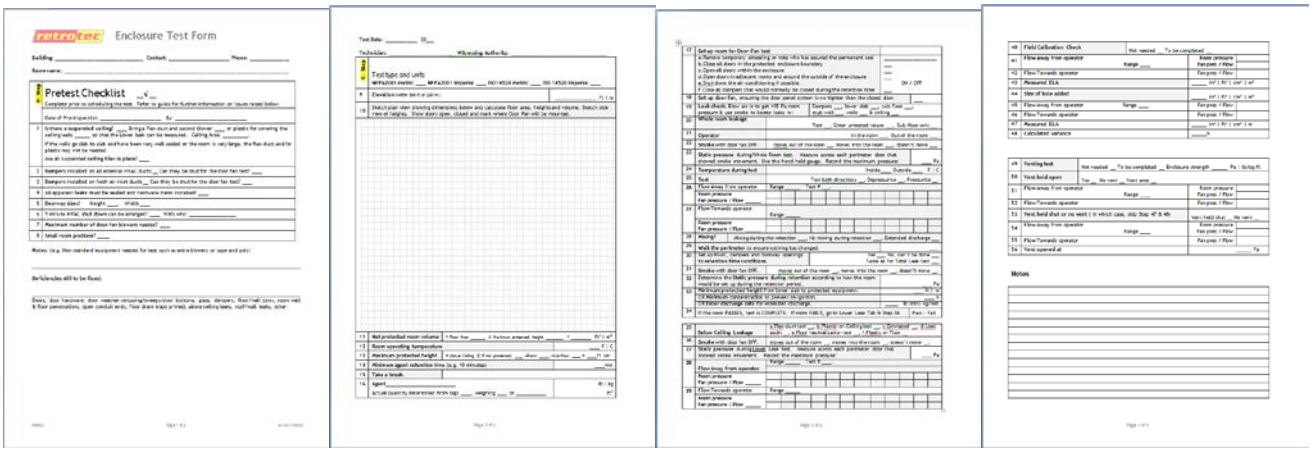


Table of Contents

Using the Enclosure Test Form

This form concisely guides you through the Enclosure Integrity test, from start to finish, so that you don't miss a step, perform the necessary calculations, obtain the required measurements, and have a record of all your test data and notes in one document.



The Enclosure Test Form is available in both PDF and MS-Word formats (To obtain a copy, contact support@retrotec.com).

Note: standards EN15004 and ISO 14520 are essentially identical; For EN15004 test requirements, refer to those specified for ISO 14520 in this Enclosure Test Form Guide.

Pretest Checklist

Before travelling to the test site, ensure you have addressed some of the enclosure's potential issues and packed all the equipment that may be necessary for performing the Enclosure Integrity Test. For the potential issues listed below, you will have to contact your client, or correspond with the building's Facilities Manager directly.

For a list of preparation steps in NFPA 2001 or ISO 14520, refer to Annex C.2.1 or Annex E.2.4 respectively.

1	**Is there a suspended ceiling?** ____ **Bring a flex-duct and second blower** ____ **or plastic for covering the ceiling leaks** _____ **so that the Lower leak can be measured. Ceiling Area:** _____. **If the walls go slab-to-slab and have been very well sealed or the room is very large, the flex-duct and/or plastic may not be needed.** **Are all suspended ceiling tiles in place?** ____

Does the Enclosure you will be testing have a suspended ceiling? If so, there is a chance that your Total Enclosure Leakage test will fail, in which case you will need to perform a "Below the Ceiling Leakage Area" (or "Lower Leaks") test. To perform a Lower Leaks test, you need to bring a Flex Duct and two Door Fans (instead of one), or Plastic Vapor Barrier and tape – refer to the Level 3 Enclosure Integrity Testing training manual for more details on this test procedure.

For a Flex Duct Test, ensure the tiles will be in place when you get there.

If there is a subfloor and there has been a request to measure the sub-floor leakage only, you will need to bring a Sub-floor Test kit.

2	**Dampers** installed on all external HVAC ducts…….. Can they be shut for the door fan test? ….
3	**Dampers** installed on fresh air inlet ducts…….. Can they be shut for the door fan test? ….

Arrange to have the HVAC system turned off for the time you will be performing the Enclosure Integrity test. Bring Grill Mask for sealing dampers on the enclosure envelope.

Ensure dampers actually do work properly.

Fresh air inlets for rooms must be dampered off because it will feed fresh air to a fire

4	All apparent **leaks must be sealed** and hardware items installed? ….

Ensure an inspection and sealing of apparent leaks in the enclosure is performed before you arrive so that time is not wasted with you waiting for preliminary air sealing to be completed; however of course, if the first test fails, they will have to seal those hard to reach places.

5	**Doorway sizes**? Height ……, width ……

Is the doorway too large for your Door Panel to fit into? Is the doorway rectangular-shaped? Make sure the Door Panel for your Door Fan will fit into one of the doors in the enclosure, or you will need to bring other sealing material to contour around it.

Below are the Aluminum Door Frame Dimensions:

Dimensions		**With Extender Kit**
Panel width	29.5 - 41.5 in (75 - 105.4 cm)	30 - 48 in (76 - 122 cm)
Panel height	51.5 - 95 in (131 - 241 cm)	60 - 105 in (152 - 267 cm)
Frame thickness	1.75 in (5.3 cm)	
Frame case	53 x 10 x 4 in (134 x 25 x 10 cm)	
Frame weight	14.2 lbs (6.4 kg)	

6	5 minute **HVAC shut down** can be arranged? With who: ……

Get contact details for appropriate personnel with the authority to turn the HVAC system off. Usually, the client does not realize that we may need only 15 minutes to take our readings. This can be cut down to 5 minutes if required.

7	**Maximum number of door-fan blowers** needed?

You have to ensure your Door Fan will have the maximum capacity to reach your target pressure. Determine this weeks before the test date, since an additional Door Fan rental may be required. A large enclosure size may provide an indication to you that you may need a large amount of flow, but this is not the case for a tight enclosure. If you are unsure of how many fans you need, refer to Retrotec's *Manual-Multi-fan Testing*.

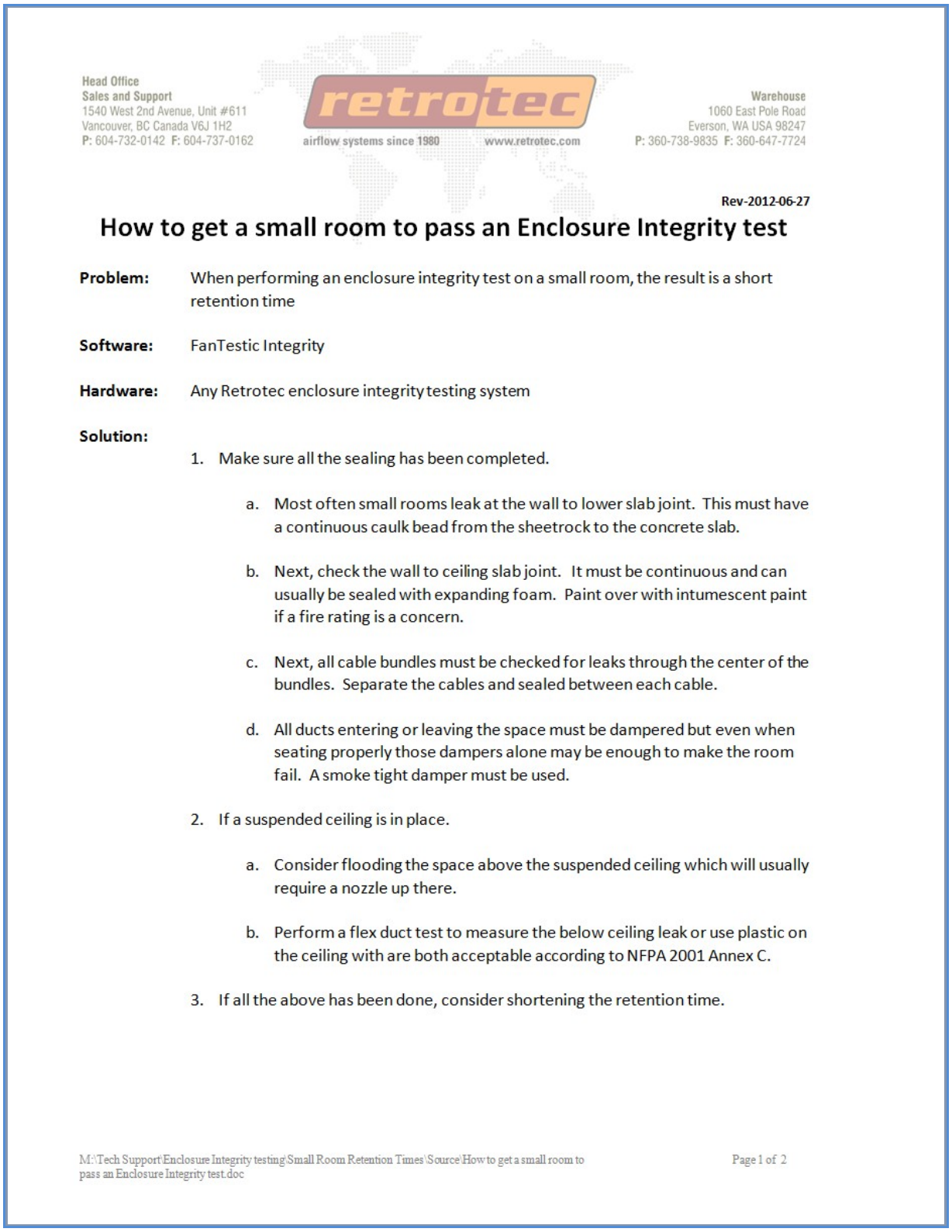
Retrotec has a "Number of Fan Calculator" spreadsheet for estimating how many fans are required. To obtain a copy of this spreadsheet, contact support@retrotec.com.

8	**Small room problem**

Small Rooms below 2500 ft^3 (70 m^3) are very difficult to pass because there is only a limited volume of agent that can be contained within the enclosure. You can choose to inform the client of this problem before you arrive since extreme care must be taken to air-seal these rooms extra tight to pass.

We recommend that all installers try to educate the Fire Protection Engineers and designers to maximize the volume of these enclosures. Often the volume of the tested zone can be increased by applying agent discharge systems into adjacent rooms and opening the doors between them.

Retrotec has compiled a document that summarizes how to get a small room to pass an Enclosure Integrity Test:



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How to get a small room to pass an Enclosure Integrity test

Problem: When performing an enclosure integrity test on a small room, the result is a short retention time

Software: FanTestic Integrity

Hardware: Any Retrotec enclosure integrity testing system

Solution:

1. Make sure all the sealing has been completed.
    a. Most often small rooms leak at the wall to lower slab joint. This must have a continuous caulk bead from the sheetrock to the concrete slab.
    b. Next, check the wall to ceiling slab joint. It must be continuous and can usually be sealed with expanding foam. Paint over with intumescent paint if a fire rating is a concern.
    c. Next, all cable bundles must be checked for leaks through the center of the bundles. Separate the cables and sealed between each cable.
    d. All ducts entering or leaving the space must be dampered but even when seating properly those dampers alone may be enough to make the room fail. A smoke tight damper must be used.
2. If a suspended ceiling is in place.
    a. Consider flooding the space above the suspended ceiling which will usually require a nozzle up there.
    b. Perform a flex duct test to measure the below ceiling leak or use plastic on the ceiling with are both acceptable according to NFPA 2001 Annex C.
3. If all the above has been done, consider shortening the retention time.

M:\Tech Support\Enclosure Integrity testing\Small Room Retention Times\Source\How to get a small room to pass an Enclosure Integrity test.doc Page 1 of 2

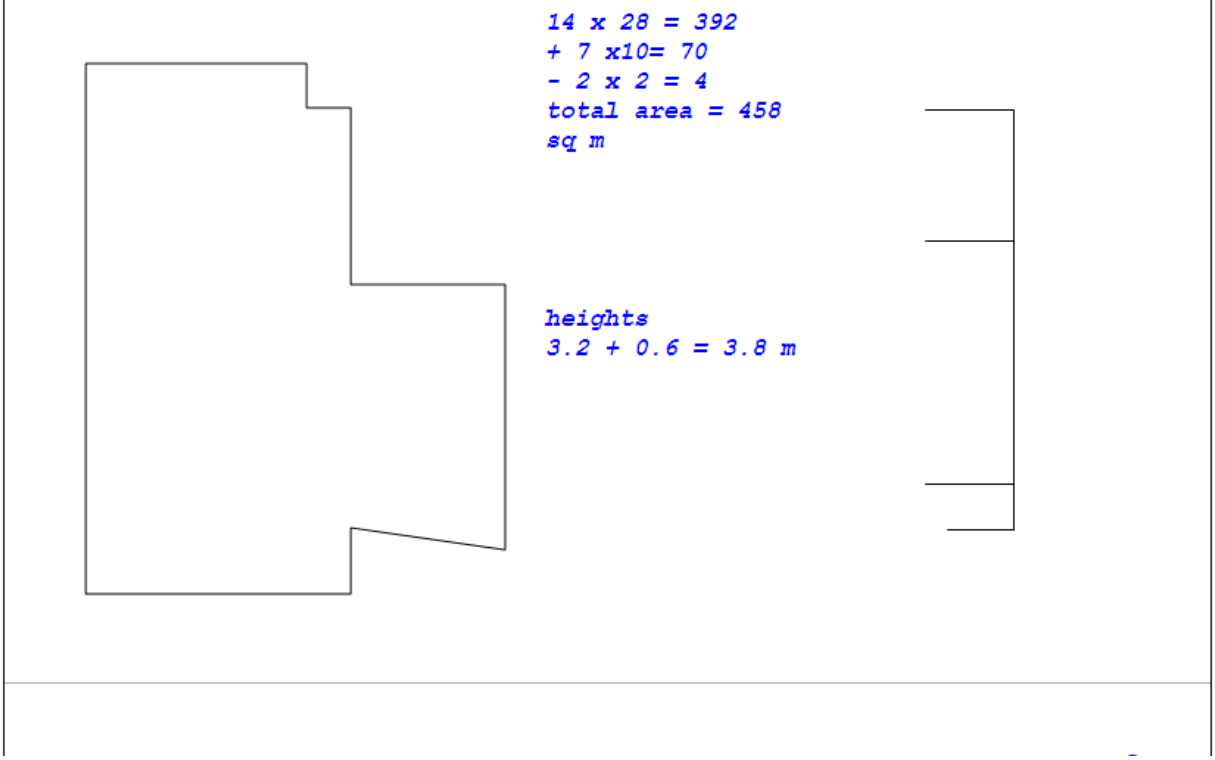
To obtain a copy of this document, contact support@retrotec.com.

Enclosure parameters

← Step	Test type and units NFPA2001 metric ____ NFPA2001 Imperial ____ ISO14520 metric ____ ISO 14520 Imperial ____	
9	**Elevation** (within 600 ft or 200 m):	_____ ft | m

Obtain the elevation of the building from site plans, using an Altimeter, or doing a Google search for the elevation around the building's location.

10	Sketch plan view showing dimensions below and calculate floor area, heights and volume. Sketch side view of heights. Show doors open, closed and mark where Door Fan will be mounted.



Use the large space to sketch of the enclosure and to calculate the enclosure's volume and floor area.

11	**Net protected volume**	= Floor Area _____ X Maximum protected height _____ = _____ ft^3 | m^3

Net protected room volume must be calculated; Using the floor area or volume from a blueprint is not permitted because sometimes they do not account for post-construction modifications or obstructions within the enclosure that can change its volume. Additionally, it is common practice to verify the work of someone else.

Floor Area = length x width

Enclosure Area = Sum of floor/walls/ceiling area

Volume = length x width x height

According to NFPA 2001:

> ***C.2.4.2 Measurement of Enclosure***
>
> ***C.2.4.2.1.*** *Measure the clean agent protected enclosure volume. Record all dimensions. Deduct the volume of large solid objects to obtain the net volume.*
>
> ***C.2.4.2.2*** *Measure the maximum flooded height*

NFPA allows for the deduction of large solid objects in the room volume, since no agent will occupy those volumes.

NFPA assumes all enclosures are "standard" enclosures, meaning that the horizontal cross section of the room does not change with height. The height is defined as the distance between the floor slab (below a false floor) to the highest point that agent is discharged into. This may or may not include the height of a suspended ceiling.

It is also important to note that the volume of ducts and air handling systems may be included as well:

> ***Section 5.3.5.1*** *If not shut down or closed automatically, the volume of self contained recirculating undampered ventilation system ducts and components mounted below the ceiling height of the protected space shall be considered part of the total hazard volume*

According to ISO 14520:

> ***E.2.6 Measurement of enclosure***
>
> ***E.2.6.1 Standard enclosures without mixing***
> *Standard enclosures are those with a uniform horizontal cross sectional area and horizontal upper and lower boundaries. Measure the protected enclosure as necessary and record the following:*
>
> a. *the overall height of the protected enclosure, H_o;*
> b. *the required protected height, H;*
> c. *the net volume of the protected enclosure, V.*
>
> *Standard enclosures are measured in the exact same way in ISO 14520. The volume of large solid objects in the enclosure should also be deducted (net volume is defined in section 3.10)*
>
> *Also the volume of any self contained air handling system that is not shut down and dampered should also be included as per section 7.4.3*
>
> ***E.2.6.2 Non Standard enclosures without continuous mixing***
>
> *Non-standard enclosures are those with non-uniform horizontal cross sectional area, such as enclosures with non-horizontal upper and/or lower boundaries. Measure the protected enclosure as necessary and record the following:*
>
> a) *The overall height of the protected enclosure from its lowest to its highest point, H_o;*
> b) *The required protected height from the lowest point in the enclosure, H;*
> c) *The net volume of the protected enclosure, V;*

d) *The horizontal cross-sectional area, A, at various heights, sufficient to determine its variation with height so that V_e and dV_e can be evaluated using Equations (E.24) and (E250). See E.2.8.9.3*

e) *Non standard enclosures are anything that does not have straight vertical walls and a flat ceiling and floor. These enclosures are very difficult to predict and often the standard enclosure equations are used anyway.*

For enclosures where the horizontal cross sectional area decreases from the top of the enclosure to the bottom (e.g. a ship's hull or a flat topped and vertical walled room with a cable trench), the standard enclosure equation will underestimate the Hold time in the upper part of the enclosure. Use of the standard enclosure equation is acceptable.

For enclosures where the horizontal cross sectional area increases from the top of the enclosure to the bottom (e.g. enclosures with pitched roofs), the standard enclosure equation will overestimate the Hold time in the upper part of the enclosure. If the non standard enclosure equations must be used, you must determine the horizontal cross sectional area as a function of the height, which can be very difficult. Expert advice should be sought if you are unsure.

E.2.6.3 Enclosures of any shape with continuous mixing

Measure the protected enclosure as necessary and record the following:

a) *The overall height of the protected enclosure from its lowest to its highest point, H_o;*

b) *The net volume of the protected enclosure, V.*

The measurement for enclosures with mixing is the same no matter what, standard or non standard. The height and volume measurements are the same as the standard enclosure measurements.

12	**Operating temperature**	____ F | C

Enter the room operating temperature (at the time of discharge). Room operating temperature within 10F or 5 C is OK. This is one of the factors that affects the initial concentration. A lower temperature means a lower achieved concentration by volume. Both standards refer to this as the "minimum anticipated temperature of the protected volume."

This should be the temperature expected during a discharge and may differ from the temperature at the time of test.

13	**Enclosure height**	= Above Ceiling (0 if not protected) ____ +Room _____ +Sub-floor ____ = _____ft | m

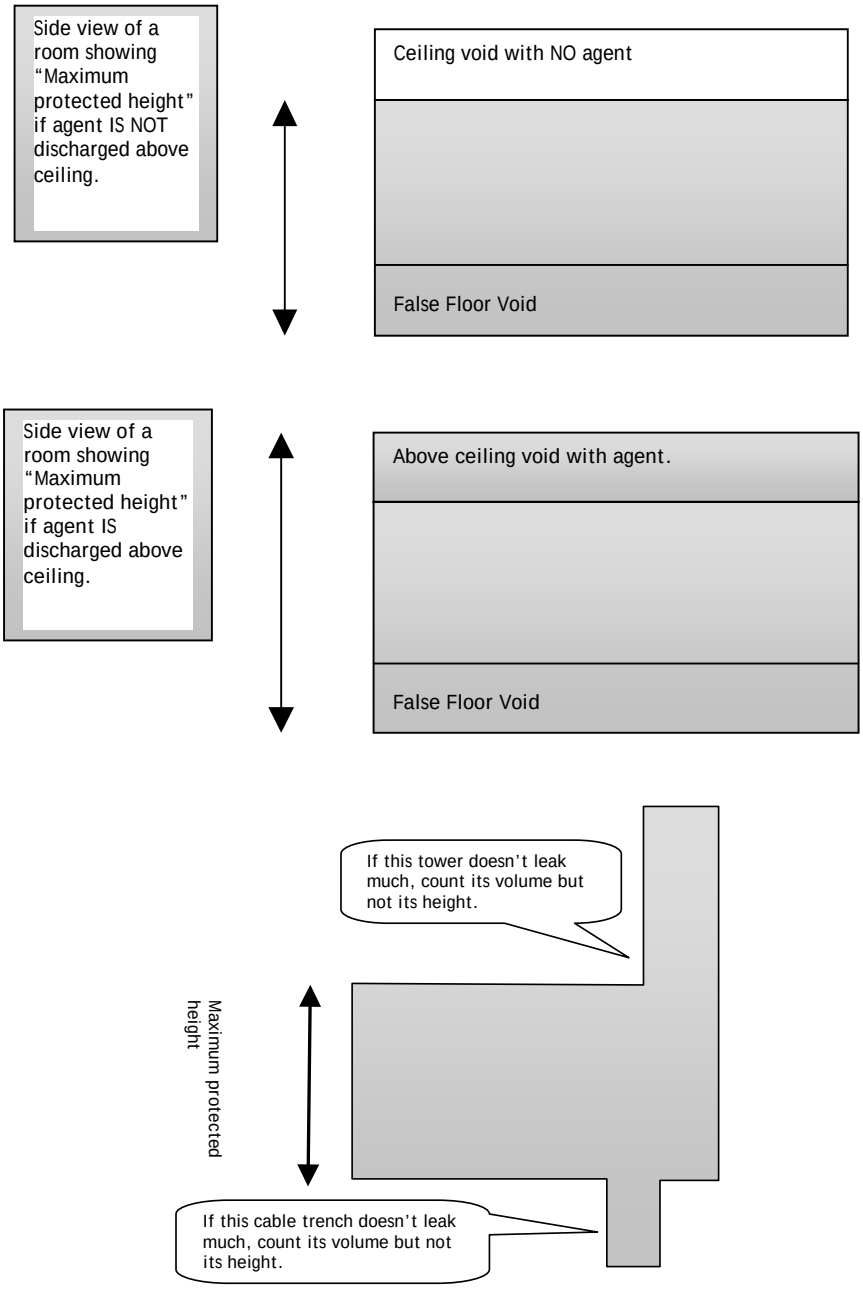
Measure the enclosure height with a measuring tape. The Enclosure height is sometimes called the "Maximum protected height." A common mistake is leaving out the sub-floor and adding in the suspended ceiling space when it is not protected

According to NFPA 2001, this is the

"Maximum flooded height, which is the measured enclosure height"

According to ISO 14520, this is the

"design height of the clean agent column from the floor slab"



14	**Minimum agent Hold time** (e.g. 10 minutes)	____min

Record the Specified Hold time.

According to NFPA 2001,

> **5.6** *for a minimum period of **10 minutes** or for a time period to allow for response by trained personnel.*

According to ISO 14520

> **7.8.2** *the predicted hold time shall be not less than **10 min**, unless otherwise specified by the authority*

Changing the Hold time from 10 minutes must be justified to, and approved by, the AHJ.

- Hold time must be specified to be higher than 10 minutes if there are continuous/hazardous ignition fuel sources.
- The Hold time can be specified to be lower than 10 minutes if the 'Small Room' problem exists or if there is fire safety personnel on-site 24/7.

Recommended Times for Small Rooms:

For room volumes of (ft^3):	2,500	1,250	625	350
Minimum achievable leakage area (in^2):	62	42	32	23
Suggested retention times for inert (minutes):	10	10	8	6
Suggested retention times for halocarbons (minutes):	8	6	4	3

For room volumes of (m^3):	70	35	17.5	10
Minimum achievable leakage area is (cm^2):	400	270	200	150
Suggested hold times for inert (minutes):	10	10	8	6
Suggested hold times for halocarbons (minutes):	8	6	4	3

15	**Take a break.**	
16	**Agent**_____ **Actual quantity determined from tags ____, weighing ____ or _____**	lb | kg ft^3

Record the quantity of agent discharged into the enclosure, in terms of its initial concentration, mass, or volume. Do not obtain on the agent mass from the system specifications or a process & instrumentation diagram; obtain this mass by looking directly on the agent tank.

Total Enclosure Leakage test

17	**Set up room for Door-Fan test**	
	a. Remove temporary airsealing or note who has assured the permanent seal b. Close all doors in the protected enclosure boundary c. Open all doors within the enclosure d. Open doors in adjacent rooms and around the outside of the enclosure e. Shut down the air-conditioning if possible. f. Close all dampers that would normally be closed during the retention time	_____ ___ ___ ___ ON / OFF ___

Setting up an enclosure correctly is critical to ensure accurate and repeatable test results. Refer to your test standard for any specific setup requirements.

- Close all doors in the protected enclosure boundary. Obviously, the leaks can't be measured if the enclosure's doors are open. It is beneficial to have automatic mechanisms that will close the doors whenever a fire is detected.
- Open all doors within the enclosure in order to ensure an even pressure throughout the enclosure.
- Shut down the air-conditioning if possible. This will make the Door Fan reading more accurate.
- Temporarily seal off the dampers if they are designed to close when a fire is detected. Temporary sealing must be removed unless you can get written obligation to assure that work will be done. Or, the report could point out the temporary air sealing where it would be stated that the room was passed on the condition that the temporary air-seal is replaced.

According to NFPA 2001:

> ***C.2.4.3 Preparation***
>
> ***C.2.4.3.1*** *Advise supervisory personnel in the area about the details of the test.*
>
> ***C.2.4.3.2*** *Remove papers and objects likely to be affected by the air currents from the discharge of the Door Fan.*
>
> ***C.2.4.3.3*** *Secure all doorways and openings as for a clean agent discharge. Post personnel to ensure they stay shut/open. Open doorways inside the protected enclosure even though they could be closed upon discharge.*
>
> ***C.2.4.3.4*** *Get the user's personnel and/or the clean agent contractor to set up the room in the same state as when a discharge would occur, that is, HVAC shut down, dampers closed, and so forth. Confirm that all dampers and closable openings are in the discharge-mode position.*

According to ISO 14520:

> ***E.2.7.1*** *Preparation*
>
> ***E.2.7.1.1*** *Advise supervisory personnel in the area of the test.*
>
> ***E.2.7.1.2*** *Remove papers and objects likely to be disturbed by the air stream from the fan.*
>
> ***E.2.7.1.3*** *Block open sufficient doors outside the enclosure envelope to provide an adequate return path for air between the fan unit and the enclosure boundaries while correcting any*

breach of any requirements of the facility, including requirements for security, fire protection and environmental boundaries.

E.2.7.1.4 *Using the sketch plan (see E.2.5) set the enclosure air-handling equipment and extinguishant extraction systems to the state they would be in during the hold time, except that:*

a) *recirculating air-handling equipment without fresh air make-up or exhaust which does not give a bias pressure across the enclosure boundary or otherwise preclude accurate testing, and which would be shut down on extinguishant discharge, may be left operating during the test if this is needed to avoid temperature build-up in equipment such as computers;*

b) *air-handling equipment, with fresh air make up or exhaust, which would continue to operate on extinguishant discharge should be shut down as it may create excessive bias pressure during the integrity test.*

E.2.7.1.5 *Post the appropriate signs on doors (see E.2.2.6).*

E.2.7.1.6 *Open doors and remove floor or ceiling tiles within the extinguishant-protected portions of the enclosure envelope so that the extinguishant-protected volume is treated as one space. Do not remove false ceiling tiles if the volume above the false ceiling is not protected with extinguishant.*

CAUTION — The removal of raised floor tiles creates a serious safety hazard. Appropriate precautions should be taken.

E.2.7.1.7 *Set all doors and windows and other openings in the enclosure envelope to the state they would be during the hold time.*

E.2.7.1.8 *Check that liquid traps in the floor and sink drains are sealed with liquid.*

E.2.7.1.9 *Record the conditions (enclosure, surroundings and services) during the fan test.*

18	**Set up Door Fan**, ensuring the door panel system is no tighter than the closed door.	___

Set up the Door Fan system. (For detailed instruction on how to do so, refer to Retrotec's *Manual-Door Fan Operation* or *QuickGuide-Blower Door.)*

19	**Leak check**. Blow air in to get +15 Pa room pressure & use smoke to locate leaks in:	Dampers ___, lower slab ___, sub-floor ___, stub-wall ___, walls ___ & ceiling ___.

Pressurize the room (to 15 Pa) to check for leaks with an Air Current Tester. The positive pressure will cause the smoke to flow OUT of the room. 15 Pa is a convenient pressure to look for leaks; larger pressures magnify leaks too much and smaller pressure makes them harder to find. Always use the same pressure so you will come to recognize big from small leaks.

According to NFPA 2001:

C.2.6.1 Pressure Run-up Inspection

C.2.5.1.1 *Activate the blower and adjust the enclosure pressure to +15 Pa so that smoke used for air current direction moves out of the enclosure.*

C.2.5.1.2 *Inspect all dampers with smoke to ensure they are closing properly. Record problems and notify individuals responsible for the enclosure of the problems.*

C.2.5.1.3 *Inspect doors and hatches to ensure correct closure. Record problems and notify individuals responsible for the enclosure of the problems.*

C.2.5.1.4 *Inspect the wall perimeter (above and below the false floor) and the floor slab for major leaks. Note location and size of major leaks. Track down major air flow currents.*

20	**Total Enclosure Leakage**	Test ___, Enter untested values ___, Sub-floor only___.

To perform the Total Enclosure Leakage test, you can either perform a Door Fan test so that FanTestic Integrity software can calculate the Equivalent Leakage Area

You can also enter an "untested" Equivalent Leakage Area value directly if you just want to get an idea of what the result would be if this number were true; this is used if you want to experiment with different leakage sizes just to see how the results vary.

The Sub-floor only test is for testing sub-floor spaces where they alone are protected (i.e. agent is discharged into the sub-floor; In this case you would mount your Door-Fan flat on the floor and test the sub-floor space as if it's a small room.

21	Operator	In the room ___, Out of the room ___.
22	Smoke with Door Fan OFF.	moves out of the room __, moves into the room ___, doesn't move ___.

Specify where you are standing when you are testing the Enclosure – inside or outside. This needs to be selected in FanTestic Integrity software so that it can differentiate if you are depressurizing or pressurizing the enclosure.

23	**Bias pressure** during Total Enclosure Leakage test. Measure across each perimeter door that showed smoke movement. Use the hand-held gauge. Record the maximum pressure:	____ Pa

Measure the bias pressure for 30 seconds with the Door Fan turned off. Use the **[Baseline]** function on the gauge, but make sure to clear the Baseline before taking induced pressure readings.

Do not confuse this "bias pressure taken during fan test" with the "bias pressure during Hold time", which is not tested here.

- According to section C.2.7.1.2 (6) of NFPA 2001, the bias pressure taken during fan test **must be less than 5 Pa**.
- According to ISO 14520, the bias pressure taken during fan test **must be less than 3 Pa**.

24	**Temperature during test**	Inside ____ Outside ____ F | C

The inside and outside temperatures during the test only needs to be taken if you are complying with ISO 14520 (i.e. not for complying with NFPA 2001), which accounts for air flow measurement changes

due to a slight density change. These temperatures are taken during the test. If the temperature is fluctuating during the test, record your best estimate within 5 C or 10 F.

Do not confuse the temperature during the test with the "Operating temperature," which is the temperature in the room during the actual discharge.

25	Test	Test both directions __, Depressurize __, Pressurize __.

Perform the Total Enclosure Leakage test in both directions, depressurization and pressurization; testing in both directions is required by NFPA 2001 and ISO 14520. The table below summarizes the test requirements for NFPA 2001 and ISO 14520:

Standard	Region	Test both Directions?	test Readings per direction	lowest test Pressure (Pa)	highest test Pressure (Pa)
NFPA 2001	North America	Yes	2	10 (± 5% in other direction)	50 (± 5% in other direction)
ISO 14520 / EN 15004	Global	Yes	5	10 OR 10*(ΔP, bias) whichever is greater	60

ISO 14520 **requires** at least **5** test Readings per direction. Readings are usually split evenly between 10 to 60 Pa, which yields target pressure Readings around **10**, **22.5**, **35**, **47.5**, and **60 Pa**.

NFPA 2001 **recommends 2** test target pressure Readings per direction at **10 and 50 Pa**. However, section C.2.7.1.7 states that

> *"If the door fan is not capable of achieving a test pressure, P_2, of 50 Pa, then the test can be performed at 10 Pa only. In this case, the exponent, n, must be set at 0.5 and can result in a much more conservative retention time and venting areas."*

26	Flow Away from operator	Range _____ Test # ___.										
	Room pressure											
	Fan pressure / Flow _____											
27	Flow Towards operator	Range _____										
	Room pressure											
	Fan pressure / Flow _____											

The first table provides space to record data for the Door Fan test in one direction, and the second table provides space to record data for the Door Fan test in the other direction.

On the first row of the table, record the enclosure's induced pressure (Channel A from the gauge, in Pa), once the pressures have been stabilized. Press **[Hold]** on the gauge to freeze this reading for the next step.

On the second row of the table, record the air flow rate through the fan ("Flow" from the gauge, in units of CFM, m^3/h, m^3/s, or l/s). If you record the air flow rate, you do not need to record the Range Configuration unless you want to for future reference.

Alternatively, you can record the Fan Pressure on the second row of the table – In this case, you must also record which Range Configuration is installed on the Door Fan for the test; if it is changed during the test, you need to make note of what it has been changed to.

Repeat the procedure above for the remaining target pressures. Then, turn the fan around to achieve the same target pressures in the other direction and fill out the second table.

28	Mixing?	a. No mixing (descending interface) ___, b. Mixing _|__, c. Extended discharge ___

What type of fire suppression system is installed? There are three types, and we define these according to how the agent behaves after a discharge in the enclosure.

Descending Interface:

Agent is discharged at near-ceiling level into the enclosure. An 'interface' with a constant concentration (known as the Initial Concentration) descends from the discharge level as gas leaves the enclosure through leaks. The time it takes for this 'interface' to reach the Minimum protected height is defined as the Hold time.

Continual Mixing:

Agent is discharged at near-ceiling level into the enclosure. Fans circulate gas throughout the room, resulting in a uniform agent concentration. This concentration begins at Initial Concentration and lowers until it eventually reaches a specified Minimum Concentration. The time it takes for the Initial Concentration to reach the Minimum Concentration is defined as the Hold time.

There is no definite quantitative criterion to classify a system as a "Mixing" type system. However, it is important for you to use good judgment on your part: How many fans are in the room? Will the fan(s) generate enough flow across the room to mix the entire room's gas? Will the agent disperse within the room, creating uniform agent concentration within it? If the fans do not, it cannot be classified as a "Mixing" type system. A Mixing system typically involves multiple fans on different parts of the room to thoroughly mix the agent around its entire volume. Sometimes, large in-room air conditioners that discharge into a subfloor causing convection upwards will generate enough flow. Note that even small computer fans or small air-conditioner units can be powerful enough to mix all the agent in the entire room. You can try using smoke around the room, from a Retrotec Air Current Tester or Dragon Puffers, and see where and how far it travels across the room. Ultimately, you must justify a mixing system to the authority having jurisdiction (AHJ).

Extended Discharge:

Typically extended discharges consist of an initial discharge for 10 to 60 seconds to get the concentration up to the design concentration. Then the extended discharge will continue at a far lesser rate. The intention is for the extended discharge to replace the agent that leaks out of the room. It is assumed that the extended discharge will create enough turbulence to create a continual mixing situation throughout the extended discharge period. At the end of the extended discharge there will typically be another interval that will be either mixed or not depending on the criteria in the previous paragraphs. If the calculated "Required rate" (or

Agent loss rate) is less than or equal to the existing extended discharge rate, then the system will maintain the design concentration for the duration of the extended discharge.

29	**Walk the perimeter** to ensure nothing has changed.	____

Walk the perimeter to ensure nothing has changed. Check to see if the doors inside and outside the enclosure are set the way they were at the start of the test. It is very common for other people to close or open doors even if they have signs posted on them not to touch them.

30	Set up HVAC, dampers and doorway openings to **Hold time conditions.**	Yes ___, No, can't be done ___ Same as for Total Enclosure Leakage test ___
31	**Smoke** with Door Fan OFF.	moves out of the room __, moves into the room __, doesn't move __.
32	Determine the **Bias pressure during Hold time** according to how the room would be set up during the agent retention period.	____ Pa

Set the enclosure to discharge conditions and measure the bias pressure for 30 seconds. The bias pressure measured under these conditions will be the "Bias pressure during Hold time."

Often the enclosure in discharge conditions is the same condition it is in when you perform the Total Enclosure Leakage test, and so, the best prediction that can be made for the "Bias pressure during Hold time" would be the same as the measurement for "Bias pressure during Total Enclosure Leakage test."

If the bias pressure during Hold time is greater than 25% of the Column Pressure, the source of the excessive bias pressure should be discovered and permanently reduced.

According to NFPA 2001:

> **C.2.6.2.3** [*If* the bias pressure during Hold time] *has an absolute value greater than 25 percent of the column pressure calculated in C.2.7.1.4, it must be permanently reduced.*
>
> **C.2.6.2.4** *Record the position of all doorways, whether open or shut, when the bias pressure P_{bh}, is measured.*
>
> **C.2.6.2.2** *If the room cannot be set up as would be during discharge conditions, P_{bh} will need to be estimated.*
>
> In this case you can estimate the bias pressure during Hold time by using the same bias pressure during fan test.

According to ISO 14520:

> **E.2.7.6.5** *If the bias pressure P_{bh}, has a numerical value greater than 25% of the initial extinguishant/ air column pressure then the hold time is likely to be low and the enclosure may not hold the specified extinguishant concentration. The source of the excessive bias pressure should be identified (traced using inert smoke) and if possible permanently reduced.*

33	a. **Minimum protected height** from lower slab to protected equipment.	OR	____ ft | m
	b. **Minimum concentration** to prevent re-ignition. 85% of Design %	OR	____ %
	c. **Enter discharge rate** for extended discharge.		_____ lb/min | kg/min

The specification that you're required to record depends on what type of agent discharge system is installed. For the following system types, record the corresponding specification:

Descending Interface:

> **Minimum protected height** - The height from the floor slab (or bottom of the subfloor, if there is one) to the highest level of combustibles or equipment that needs to be protected. In a Descending Interface type system, this is that height at which the agent is allowed to fall during the Hold time. Measure this height with a measuring tape.

Continual Mixing and Extended Discharge:

> **Minimum concentration** – The minimum allowable agent concentration to prevent re-ignition. This concentration is often the same value as the initial discharge concentration but there must be some allowance for a drop in concentration if "mixing" is chosen. Typically there must be an allowance for a minimum drop of one quarter the initial concentration. For example, if the initial concentration is 40%, then the minimum concentration must be about 30%. Obtain the minimum concentration from the design specifications of the fire suppression system.

Extended Discharge:

> **Extended discharge rate** – The required minimum agent flow rate required to maintain design concentration. This will yield a pass if the enclosure will lose less than this amount and a fail if it will lose more than that. Obtain the extended discharge rate from the design specifications of the fire suppression system.

34	If the room **PASSES**, test is COMPLETE. If room **FAILS**, go to Step 35	Pass | Fail

The Enclosure Integrity Test for the enclosure passes if for the following system types, the following result must be met:

Descending Interface and Continual Mixing:

> The calculated Hold time from the test results is greater than the Specified Hold time (usually 10 minutes, but could be longer if the authority having jurisdiction specifies that it takes longer for the fire department personnel to arrive onsite)

Extended Discharge:

> The Extended discharge rate (actual) is greater than the Extended discharge rate (required).

Below Ceiling Leakage Area (Lower Leaks) test

35	Below Ceiling Leakage	a.Flex-duct test __, b.Plastic-on-Ceiling test __, c.Estimated __, d.Leak audit __, e.Floor neutralization test __, f.Plastic on Floor __										
36	Smoke with door fan OFF.	moves out of the room __, moves into the room __, doesn't move __.										
37	Static pressure during Lower Leak test. Measure across each perimeter door that showed smoke movement. Record the maximum pressure:	____ Pa										
38	Flow Away from operator	Range _____ Test # ____.										
	Room pressure Fan pressure / Flow _____											
39	Flow Towards operator	Range _____										
	Room pressure Fan pressure / Flow _____											

Refer to Level 3, Enclosure Integrity Training for Below Ceiling Leakage Area (also known as Lower Leaks) tests, on how to set up a Flex Duct or Plastic-on-the-Ceiling. Once it is set up, perform the Flex Duct Test or Plastic-on-the-Ceiling test and record the information similar to that of a Total Enclosure Leakage test.

Note if a Plastic on the Ceiling test is to be performed, that the bias pressure for the BCLA/Lower Leaks test must be measured after sealing has been completed.

Field Calibration Check

40	Field Calibration Check	Not needed __ To be completed __

A Field Calibration Check of your Door Fan system equipment may be requested by the authority having jurisdiction, to indicate the accuracy of its measurements. It can also be performed to confirm its accuracy to yourself or other witnesses.

41	Flow Away from operator Range ____	Room pressure Fan pres / Flow	
42	Flow Towards operator	Fan pres / Flow	
43	Measured ELA	_____ in^2 | ft^2 | cm^2 | m^2	

The Field Calibration Check procedure is detailed in section 8.2 of Retrotec's *Manual-Door Fan Operation*, section C.2.3 of NFPA 2001, or section E.2.7.5 of ISO 14520.

In summary, the procedure involves creating a Field Calibration Plate by cutting an opening into a thin piece of material (e.g. cardboard). This Field Calibration Plate, with an opening of a known size, is installed on the enclosure envelope (e.g. upper part of doorway with the rest of the doorway sealed) to create a leakage area in the enclosure. Equivalent Leakage Areas (EqLA) are then measured by performing Door Fan tests on the enclosure with the opening sealed off (or not installed) and with the opening present. Subtracting these two EqLA value gives you the EqLA that the Door Fan system 'sees' for the Field Calibration Plate. This area is compared with the actual area of the Field Calibration Plate's opening.

Remember to seal off any HVAC registers or grilles before performing the Door Fan tests.

In the table above, record the flow and EqLA of the Door Fan test with the no Field Calibration Plate opening (i.e. Field Calibration Plate not installed, or sealed)

According to NFPA2001:

> ***C.2.3.4*** *Ensure that the door fan flow measurement system is turned on to properly measure* ***pressurization or depressurization*** *and operate the fan to achieve the convenient pressure differential* ***preferably 10 Pa****.*

According to ISO14520:

> ***E.2.7.5.4*** *Calculate the equivalent leakage area (average of* ***pressurization and depressurization****) of the enclosure with the orifice at a reference pressure differential of* ***10 Pa***

44	**Size of hole added**	_____ in^2 | ft^2 | cm^2 | m^2

According to NFPA2001:

> ***C.2.3.3*** *Install a piece of rigid material* ***less than 1/8 in. (3mm)***
>
> ***C.2.3.6*** *Create a sharp-edged* ***round or square*** *opening in the rigid material. The area of this opening should be* ***at least 33 percent*** *of the initial EqLA measured.*

According to ISO14520:

> ***E.2.7.5.2*** *In a sheet of rigid material,* ***less than 3 mm thick*** *and free of any penetrations cut a sharp-edged* ***circular*** *check orifice… A geometrical area about* ***50%*** *of the enclosures equivalent leakage area is likely to be suitable.*

45	**Flow Away from operator**	Range ____	Fan pres / Flow	
46	**Flow Towards operator**		Fan pres / Flow	
47	**Measured ELA**		_____ in^2 | ft^2 | cm^2 | m	

Obtain the EqLA and flow measurements with the Field Calibration Plate. In the table above, record the flow and EqLA of the Door Fan test with the Field Calibration Plate opening present (i.e. not sealed)

48	**Calculated variance**	_____%

Calculate the percent difference between the Equivalent Leakage Areas (EqLA) measurements from the Door Fan tests on the enclosure with the Field Calibration Plate opening sealed off or not installed, and with opening present.

First test	ELA@10Pa =	310 in^2
Second test	ELA@10Pa =	470 in^2
Difference		160 in^2
Added hole		155 in^2
Difference		| 5 | in^2
	(5/155) x 100 =	3.2 %

According to NFPA2001:

> ***C.2.3.7*** *Field calibration is acceptable if the difference between the first and second* ***EqLA value is within +15 percent*** *of the hole area cut in the rigid material. If the difference in EqLA values is greater than +15 percent, the door fan apparatus should be recalibrated according to the manufacturer's specifications and to ASTM E 779, ASTM E 1258, or CGSB 149.10.*

According to ISO 14520:

> ***E.2.7.5.6*** *The field calibration check is acceptable if the measured* ***equivalent leakage area of the orifice is within ±15%*** *of its geometrical area. If the difference is greater than 15%, the fan unit should be recalibrated*

Venting and Peak Pressure Analysis

49	**Venting test**	Not needed ___ To be completed ___ Enclosure strength _____ Pa | lb/sq-ft

According to NFPA 2001:

> ***5.3.7*** *…enclosure shall have the structural strength and integrity necessary to contain the agent discharge. If the developed pressures present a threat to the structural strength of the enclosure, venting shall be provided to prevent excessive pressures.*

According to ISO14520:

> ***7.4.1*** *The protected enclosure shall have sufficient structural strength and integrity to contain the extinguishant discharge. Venting shall be provided to prevent excessive over- or under-pressurization of the enclosure.*

50	**Vent installed?**	Yes ____ No ____ (if no, go to step 56)
	Vent opens under: Positive pressure ___, Negative pressure ___, Both ____.	
51	Single direction vent___ or dual direction vent ___ (if single direction vent, skip either step 54 or 55)	

Indicate if there is a venting system installed. If not, then the total room leakage will be used for venting and the vent test can be skipped. If there is a gravity vent, confirm whether it will open in one direction or both directions. If it opens in both directions, a test must be done for both the positive venting configuration and the negative venting configuration.

52	Pressurize until vent is fully open or 125Pa (whichever is less) or skip if vent opens under negative only ____.	Vent opened at ____ Pa, Didn't open___, Partially open___
53	Lock the vent in place (either fully open or whatever position it was in at 125 Pa)	

The idea is to establish a pressure that should open any gravity vent, and lock the vent in place at that pressure – with tape or a piece of cardboard. Vents that are not fully open at 125Pa will be assumed to not open any further during a discharge. Electronic and pneumatic vents that are actuated to be fully open or fully closed can just be forced all the way open and tested as such.

54	Pressurize direction - Fan range ____	Room pressure Fan pressure/Flow___					
	Depressurize until vent is fully open or 125Pa (whichever is less) or skip if vent opens under positive only ___ .						
55	Depressurize direction - Fan range ____	Room pressure Fan pressure/Flow___					

Once the vents are set up in the same configuration that they would be in to relieve peak pressure (either fully or partially open), run a standard door fan test just like you would for a total leakage test. Record the data into FanTestic Integrity.

56	System discharge time ____sec	Relative humidity range ____ to ____%

Enter system discharge time.

Record expected humidity range throughout the year (only relevant for halocarbon agents).