NFPA 2001:2012
Clean Agent Enclosure Integrity Test

Conducted by:

Fire Safety Technology

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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

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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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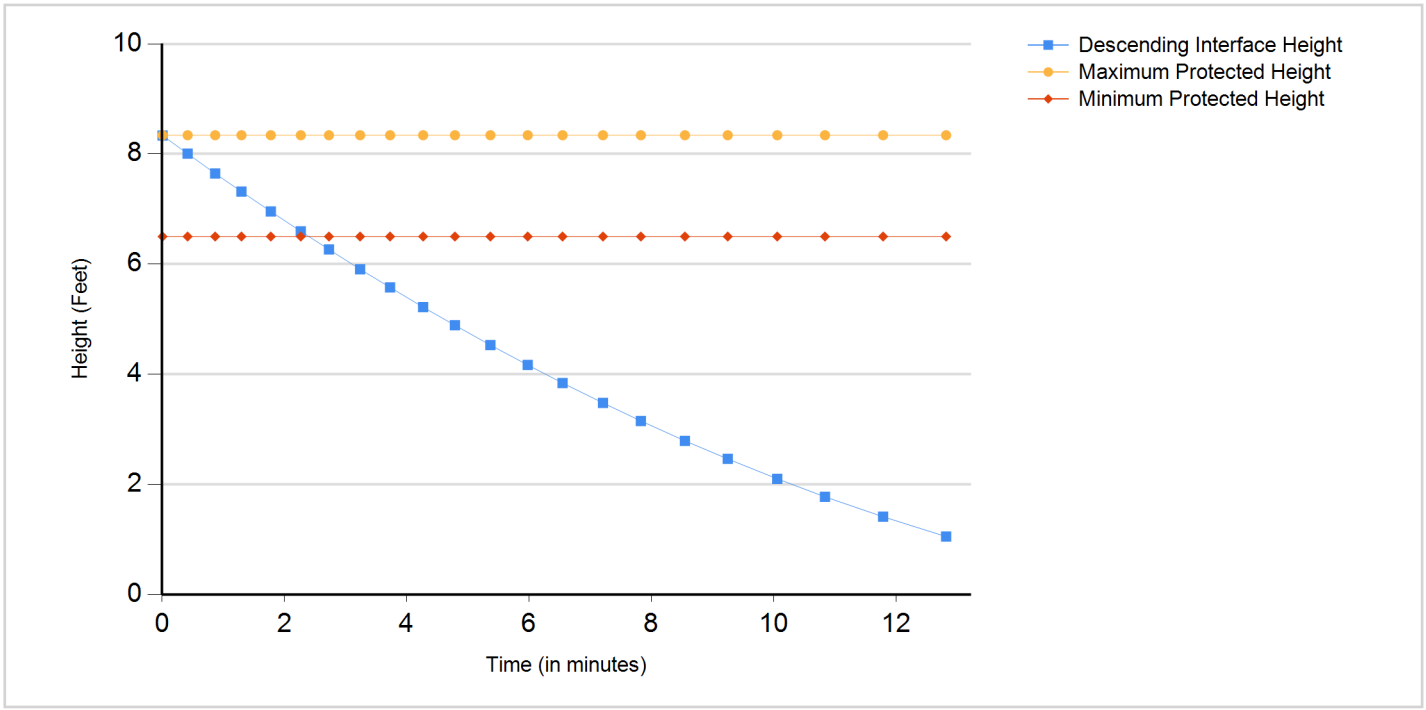

Height (Feet)	Time (minutes)
8.333	0.01
8.005	0.42
7.644	0.87
7.316	1.3
6.955	1.78
6.594	2.27
6.266	2.73
5.906	3.24
5.577	3.73
5.217	4.27
4.888	4.79
4.528	5.37
4.167	5.98
3.839	6.55
3.478	7.21
3.15	7.83
2.789	8.55
2.461	9.25
2.1	10.06
1.772	10.84
1.411	11.79
1.05	12.82

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	

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

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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

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