



Property Risk Consulting Guidelines

XL Risk Consulting

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PRC.13.0.5.2

DOOR FAN TESTING FOR ENCLOSURE INTEGRITY

INTRODUCTION

According to a survey conducted by AXA XL Risk Consulting in 1985, 36% of total flooding halon systems failed the first acceptance test. Of these, 69.4% were due to excessive agent leakage. Concern for releasing halon into the environment has led to the use of the door fan test to identify enclosure leaks. The intent of this document is to explain door fan testing for enclosure integrity and to show how it can be used with most gaseous agents.

The door fan procedure was originally developed by the Department of Energy (DOE) to evaluate heat loss of domestic structures during the energy crisis. The test, based on ASTM E799 and CAN2-149.10-M85, requires installing the door fan assembly at an entrance to the enclosure. The assembly is equipped with a variable speed fan. The amount of airflow can be determined based on the air pressure differential across the fan, the size of the fan opening, and the air speed. The equivalent leakage area can be determined using the calculated airflow and the discharge coefficient for a single thin sharp-edged hole. Leaks requiring sealing can be found with a smoke pencil, which discharges a small laminar stream of smoke. The smoke becomes turbulent when moved close to air moving through enclosure cracks.

The Fire Protection Research Foundation (FPRF) took the DOE's test procedure several steps further. Extensive research produced a procedure for measuring extinguishing agent leakage from an enclosure. Additional refinements to the procedures have been made based on work done by committee members and industry representatives to provide more accurate results. This procedure also estimates how long an extinguishing concentration can be retained inside that enclosure without the need to discharge any extinguishing agent. Although the initial work involved halon systems, this technique can be applied to any gaseous extinguishing agent. The test procedure can be found in Appendix B of NFPA 12A and in Appendix C of NFPA 2001.

Door fan testing can also be used to confirm tightness of control rooms and utility enclosures at hazardous process locations, and to evaluate anticipated smoke movement in corridors, stairtowers and atriums. However, these developments are not discussed in this document.

POSITION

AXA XL Risk Consulting strongly supports door fan testing of new enclosures protected by gaseous extinguishing agents. Test existing enclosures using the door fan procedure before the extinguishing systems are installed. Test new enclosures as soon as the enclosures and furnishings are completed.

Thoroughly inspect existing enclosures protected by total flooding extinguishing systems at least every six months. Enclosures such as computer rooms are frequently being remodeled. Construction imperfections and enclosure penetrations can create sources of leakage. Repair them immediately

with materials having the same fire rating as the structures penetrated. After an enclosure has been extensively remodeled or new equipment has been installed, perform a door fan test if the enclosure has been penetrated or extensive leakage is suspected.

DISCUSSION

The door fan test is only one of many tests required for a thorough acceptance test of an extinguishing system. Refer to PRC.13.0.5 for the other tests required for system acceptance.

Enclosure testing of areas protected with carbon dioxide (CO₂) systems is not addressed in NFPA 12. CO₂ systems are more tolerant of leakage than halon or clean agent systems, including the inert gases. The CO₂ concentration can be much greater than the minimum required for extinguishment. Use of the door fan test with CO₂ systems should not be discouraged.

Clean agent systems are designed to tighter tolerances. For inert gas clean agents the design concentration must be high enough for extinguishment, while allowing sufficient oxygen concentration for breathing. The primary concern with inert gases is overpressurizing totally flooded enclosures. This is addressed by designing appropriate venting for nonvented structures. The door fan procedure could confirm both the minimum required leakage to prevent overpressurizing the enclosure and the maximum allowable leakage to prevent depleting the extinguishing concentration.

When an enclosure is pressurized during a door fan test, the door fan exerts uniform air pressure on all the inside surfaces of a room. When an extinguishing agent is discharged, a differential pressure occurs between the ceiling and the floor due to the density of the air/agent mixture. This results in greater leakage of the mixture through the holes and cracks along the lower portion of the enclosure. Therefore, air loss through the ceiling during door fan testing may not necessarily result in agent loss. The NFPA enclosure integrity procedures account for the density of the air/agent mixture and simulates the enclosure pressure expected immediately after the agent completely discharges.

Test Concerns

For the agent retention model to work as simply and as conservatively as possible, three very restrictive assumptions are made:

- The agent/air mixture leaking out of the enclosure is replaced by air at the ceiling.
- Half the door fan air leakage occurs at the bottom level and half at the top. A dense agent will leak out of lower leakage holes while air leaks into the upper part of the enclosure. This creates the greatest leakage rate possible, and is considered the worst case scenario.
- The interface between the air and the agent/air mixture is very thin.

1. The actual flow interface characteristics are much more complex, however the test model procedures are very conservative to ensure that the results of the model provide good correlation to actual discharge test results.

The basic calculation model determines the Total Enclosure Leakage area of the enclosure. The model is based on a steady state condition with no air movement or turbulence in the enclosure. The agent/air mixture and the air leaking into the enclosure create two distinct zones. Everything above the interface between the two zones is air and everything below is a constant homogeneous agent/air mixture. A hole at the lower level of the enclosure will cause the interface to continue to fall until all of the agent has left the enclosure. This model was selected by the NFPA 12A committee as the basis for determining agent retention time. The procedure is described in Appendix B of NFPA 12A and Appendix C of NFPA 2001.

An optional method has been added to provide more accurate calculations. The Suspended Ceiling Leakage Neutralization Method can be used if the area above the suspended ceiling is not protected with clean agent. This method more accurately determines the leakage rate above the ceiling in addition to the total leakage rate for the entire enclosure. This test method is more involved than the Total Enclosure Leakage method, but will generally result in a smaller leakage area. This is due to the fact that the Total Enclosure Leakage area models all of the leakage area for the entire room, but

leakage above the suspended ceiling has a far smaller effect on agent retention than leaks at the lower levels of the enclosure.

Both test methods are only valid in a fairly tight enclosure with no openings to adjoining areas either above suspended ceilings or under raised floors. The outer bounds of the enclosure including the ceiling must be built of appropriate fire retardant materials for the intended hazard. Where suspended ceilings are installed, walls must extend from bottom slab to top slab. Walls that run under corrugated roofing materials should have the void spaces at the corrugation filled with materials having the same fire rating as the wall. Ceiling tiles should be clipped in place to prevent displacement during a system discharge, which can reduce the actual agent retention time.