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WHY ENCLOSURE INTEGRITY TESTING FOR FIXED FIRE EXTINGUISHING SYSTEMS?

INTRODUCTION

Fixed fire extinguishing systems are designed in accordance with two International Standards:

a) NFPA 2001 (Standard on Clean Agent fixed fire extinguishing systems).
or
b) ISO 14520 (Gaseous fire-extinguishing systems — Physical properties and system design).

South Africa has adopted the ISO standard for the design, installation and testing of fixed fire extinguishing systems (known in South Africa as SANS 14520:2000 Gaseous fire-extinguishing systems — Physical properties and system design).

All of these standards require **Enclosure Integrity Testing** and this article provides some insight into why the test is required.

Many years ago when fixed fire extinguishing systems consisted only of Halon 1301 and CO_2, and fixed system standards were in their infancy, full discharge testing was considered mandatory. However, the 1996 edition of the NFPA 2001 standard went as far as to state, "*a discharge test is generally not recommended*" for the purpose of establishing Enclosure Integrity!

Enclosure Integrity testing is however a **MANDATORY REQUIREMENT** of the SANS/ISO 14520 Standard. The Standard also states that the testing **must** be carried out at least every 12 months to **validate** the enclosure integrity.

All gas system design standards require a certain design concentration of extinguishant be achieved in a pre-defined time. It is the nature of Clean Agent to suppress all flame and fire spread but it cannot in every instance extinguish the initial source of ignition (for instance, severe electrical short circuit). Therefore it is critical that the Clean Agent remain in the protected area for a **minimum** time period (**generally 10 minutes for Clean Agents)** at or above the defined protected height and at the correct design concentration.

AGENT LEAKAGE AND CONCENTRATION DECAY PHYSICS

When agent is discharged into the enclosure, it mixes violently with the air in the enclosure, resulting in a homogeneous mixture.

The mixture then settles down to produce a steady pressure, created by the agent (which is generally considered heavier than air) pressing down upon the floor. This is referred to as the "Column Pressure". This pressure is greatest at the lowest points in the enclosure and induces the agent/air mixture to flow.

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Flow develops whenever a hole has a pressure difference across it. The greater the pressure, the greater the flow, and the larger the hole, the greater the flow. A similar volume of air will flow into the enclosure from leaks at the higher elevations in the enclosure to replace the agent mixture that flowed out.

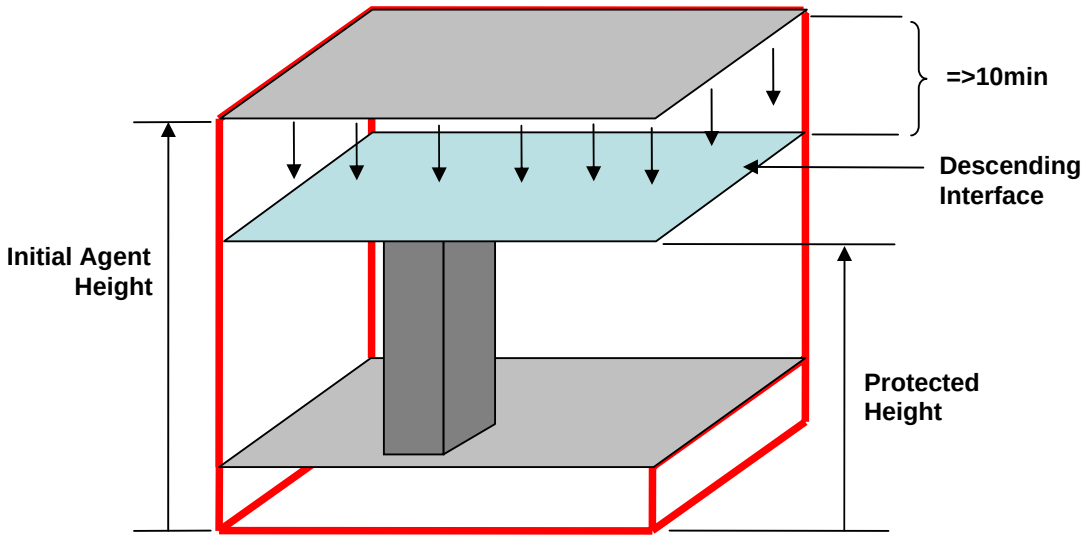
From the above it should be obvious that adding more agent to "fix" the problem will simply result in it leaking out of the enclosure at a faster rate.

The intersection between the pool of agent mixture and clean air above is referred to as the "Agent/Air Interface". This interface drops as agent is lost out of the enclosure through leaks in the floor and lower wall area. Air from outside the enclosure generally replaces agent by infiltrating through the ceiling, and other leaks above the interface. This is called the "Descending Interface".

If air moving equipment in the enclosure is shut off at discharge, the agent mixture will tend to stay separate from the air infiltrating through the upper leaks and the **concentration will remain constant**.

On the other hand, if air moving equipment is left on during the retention period, the infiltrating air will become mixed with the agent. As a result, the average **concentration will decay** throughout the enclosure. The concentration at the floor will decay at the same rate as the concentration near the ceiling.

By measuring the leakage areas and static pressures, retention time can be calculated. This is precisely what the Testing Procedure is designed to do. The model predicts how many minutes it will take for the descending interface to reach the minimum protected height.



Interface must not reach Protected Height in less than 10 minutes.

ENCLOSURE INTEGRITY TEST

The test consists of pressurising the enclosure with calibrated fans that provide specific airflows at specific flow pressures. In addition, the exterior and interior pressures of the enclosure are monitored so as to determine the total air leakage of the enclosure.

The earlier NFPA 2001 standard only requires a single measurement to be performed, while the SANS / ISO standard requires multiple sets of test data to be recorded. The SANS / ISO requirement is therefore

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more accurate and can highlight equipment errors and prevents operator "fudging" of the results, since the minimum correlation factor and allowable standard deviation is specified.

The test result is provided as an equivalent leakage area (ELA) in square metres. This ELA is the sum total of leakage paths in the enclosure.

By utilising a computer model of the gas extinguishing agent properties and knowing the ELA, the gas extinguishing retention times for the minimum design concentration can be determined.

If the retention time is greater than 10 minutes then the enclosure passes, if the retention time is less than 10 minutes then the enclosure fails.

If the enclosure fails it is easy to locate the leakage paths using smoke pencils, seal the leaks and re-test.

It should be noted that enclosure integrity and the fire resistance thereof is also a requirement of SANS 246 (Code of practice for fire protection for electronic equipment installations), this standard is implicitly referred to in SANS 10139 (Fire detection and alarm systems for buildings – System design, installation and servicing).

BENEFITS

Although Enclosure Integrity Testing is a **mandatory requirement** of SANS/ISO 14520 Standard, I believe that from the benefits gained,

"IT IS THE RIGHT THING TO DO!"

SOME BENEFITS ARE:

- Cost effective testing and compliance to the Standard.
- On Site diagnoses of leakage areas. (Smoke Pencil method).
- Quick response time for repair and re-test (same-day).
- Confidence that system will maintain design concentration for specified period.
- Ensures correct over pressurisation venting.
- Improved design for integrity of enclosures.
- The only proven scientific method of establishing Enclosure Integrity.

For additional assistance and related topics, contact:
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About the Author

Casper has been conducting Enclosure Integrity Testing for more than three years in Southern Africa. He has tested over 200 enclosures of various configurations, sizes and locations, thereby gaining valuable experience with the problems (and solutions) within the Fire Industry with respect to testing and qualifying of fixed fire extinguishing systems. He is also a qualified Quality Engineer with over 25 years experience in the Quality Assurance field.

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