High-Expansion Foam Test Protocol

Comparison of Multiple Standards

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INTRODUCTION

High-Expansion foam is used to suppress fire in a variety of applications, from Class A and Class B storage facilities to shipboard machinery spaces to aircraft hangars. Differences in regulatory requirements around the world have led to a confusing collection of high-expansion foam testing protocols. These various protocols set minimum performance standards for high-expansion foam systems and equipment that vary in scope, application, and/or geographical applicability. Given the inconsistency among the various test protocols, it can be challenging to identify the most appropriate test method and 3rd party standard/approvals for a specific high-expansion foam application. Understanding the differences and limitations of the various test protocols will enable a fire protection engineer to select the most applicable performance standard and 3rd party approval for a given project.

This technical bulletin is intended to assist in specifying the most appropriate test protocols, standards, and approvals for a given high-expansion foam system installation. It provides background terminology associated with high-expansion foam systems, and then compares and contrasts the performance criteria of three high-expansion foam test protocols commonly used in Europe:

1. EN 1568-2/EN 13565-1
2. IMO MSC.1/Circ. 1384
3. Technical Rules T12 (Coupling Generator/Foam Agent) of the APSAD R12 Standard

HIGH-EXPANSION FOAM GLOSSARY

APSAD R12: A regulation which defines the minimum requirements for implementation, commissioning, and maintenance of high-expansion foam systems, primarily used in France.

APSAD T12: The technical rules governing the coupling, or joint testing, of high-expansion foam hardware and high-expansion foam equipment. T12 delineates the tests required to validate the performance parameters for the pairing of a specific high-expansion foam generator model with a foam concentrate to meet design requirements of a high-expansion foam system in accordance with APSAD R12.

IMO MSC.1/Circ. 1384: The International Maritime Organization Guidelines for the Testing and Approval of Fixed High-Expansion Foam Systems.

EN1568-2: Part 2 of the European Standard covering Fire Extinguishing Media – Foam Concentrates. Part 2 covers the specifications and testing requirements for high-expansion foam concentrates for use on water-immiscible liquids.

EN13565-2: Part 2 of the European Standard covering Fixed Firefighting Systems – Foam Systems. Part 2 addresses the requirements for design, construction, and maintenance of these systems.

EN13565-1: Part 1 of the European Standard covering Fixed Firefighting Systems – Foam Systems. Part 1 covers the requirements and testing of system components.

Inside Air System: A high-expansion foam system which utilizes air from inside the hazard area for the generation of foam.

Outside Air System: A high-expansion foam system which utilizes air from outside the hazard area for the generation of foam.

Fill Rate: The rate at which a hazard area is flooded with high-expansion foam, usually noted in units of meters/minute.

Fill Time (Submergence Time): A design criteria for high-expansion foam systems defined as the maximum time to completely submerge the tallest hazard in a protected space plus a safety factor, typically defined as some additional height above the hazard (3 meters per EN13565-2). For example, if a 2 meter tall hazard requires a fill time of 2 minutes, the high-expansion foam system must be designed to discharge a minimum of 5 meters of foam in a maximum of 2 minutes (fill rate >= 2.5 m/min).

Expansion Ratio: The ratio of the volume of foam generated to the volume of foam solution required to produce the foam. Example: If one liter of foam is produced from one milliliter of foam solution, the expansion ratio would be 1000 ml foam/1 ml foam solution = 1000:1.

Drainage Time: The time required for a specific percentage of foam solution to drain from the expanded foam blanket and is often used as an indicator of how long the foam blanket will last. For example, 50% drainage time is the total time required for 50% of the volume of liquid consumed in generating the expanded foam to drain from the foam.

Hydrocarbon Fuel A hydrocarbon-based flammable liquid that is immiscible with water. Examples: crude oil, refined gasoline, Jet A.

Polar Fuel: A hydrocarbon-based flammable liquid that is miscible with water. Examples: Ethanol, E85, Isopropyl Alcohol (IPA), Methyl Ethyl Ketone (MEK)

Standards Comparison

	EN1568-2/EN 13565-1	IMO MSC.1/Circ.1384	APSAD Technical Rules (T12)
Fire Classes Tested	Class B (Hydrocarbon)	Class B (Hydrocarbon)	Class B (Hydrocarbon and/or Polar, at the manufacturer's discretion)
Inside Air Fire Tests	N/A	Tests can be conducted with inside air at the manufacturer's discretion. For inside air tests, the temperature of the air at the inlet is to be recorded throughout the test. Large scale inside air fire test is defined.	N/A
Outside Air Fire Tests	Test uses outside air.	Tests can be conducted with outside air at the manufacturer's discretion.	Tests must be conducted with outside air per the requirements of the T12 Technical Rules. Air temperature at the generator inlet must be at a temperature between 5 °C and 25 °C.
Class B Test 1	1.73 m^2 round pan, Heptane, 60 second pre-burn	Class B Hydrocarbon: Light Diesel Oil, Simulated engine mockup with a combination impinging low pressure (8 bar, 10.4 kg/min) spray fire, 4 m^2 pan fire below the simulated engine mockup, and 3 m^2 pan above the simulated engine mockup, 2 minute pre-burn	Class B Hydrocarbon: Heptane, fire size to be 10% - 20% of the fire test enclosure floor area, maximum 30 second pre-burn
Class B Test 2	N/A	Class B Hydrocarbon: Light Diesel Oil, High pressure (150 bar, 3.0 kg/min) horizontal spray fire over the top of the simulated engine mockup, 15 second pre-burn	Class B Polar Solvent: Acetone, Fire size to be 20% - 30% of the fire test enclosure floor area, maximum 30 second pre-burn
Class B Test 3	N/A	Class B Hydrocarbon: Light Diesel Oil, Low pressure (8 bar, 10.4 kg/min) concealed (inside the simulated engine mockup) horizontal spray fire with a 0.1 m^2 pan positioned on the floor, 2 minute pre-burn	N/A
Class B Test 4	N/A	Class B Hydrocarbon: Heptane, Flowing (0.25 kg/sec) fire from the top of the simulated engine mockup, 15 second pre-burn	N/A
Fire Test Notes	Minimal transit time from the point of foam generation to the fire (Foam is fresh when applied to the fire.)	The fire tests above are conducted twice, once in a 500 m^3 (ceiling height 5 m) enclosure and once in an enclosure of at least 1200 m^3 and not more than 3500 m^3 (ceiling height exceeding 7.5 m). The intent of using different size compartments is to validate the ability to scale the system being tested to different size compartments during field application. Fill rate of the enclosure shall be per system manufacturer's requirements.	Fill rate of the enclosure shall be 3-4 m/min. The fire test enclosure floor area may be resized with a room divider to bring the fill rate into the required range. The fire tests are used to determine the "Foam Destruction Rate" which is used for system calculation per the requirements of APSAD R12.
Foam Quality Notes	Fire conducted at a single expansion ratio, whatever the generic test generator produces with the foam concentrate to be tested.	Foam quality is taken to be the nominal as specified by the manufacturer. Fill rates for the enclosures are based on the total solution flow and the nominal expansion ratio.	Actual expansion verified by determining the fill time of the fire test enclosure in the absence of a fire. The fill test is repeated twice, and the average expansion rate is recorded for use in APSAD R12 system calculations. 50% drainage time is determined per the method in EN1568-2 and recorded.
Test Foam Generator Notes	Generic test foam generator used. Foam quality produced and used for fire testing has no correlation to that produced by full scale equipment.	Generators used for all tests are stock units with no modifications in order to qualify the generator models tested with a specific foam concentrate.	Generators used for all tests are stock units with no modifications in order to qualify the generator models tested with a specific foam concentrate.

STRENGTHS & WEAKNESSES

EN1568-2/EN13565-1

Strengths:

- Widely recognized foam and foam hardware standards in Europe
- Validates high-expansion foam hardware through a mechanical testing program which typically includes, but is not limited to, assessment of heat resistance, salt spray corrosion, and mechanical vibration

Weaknesses:

- The test protocols do not validate the fire performance of the foam quality produced by full scale equipment
- Laboratory fire test protocols do not simulate a specific hazard
- No validation of fire performance using inside air
- No validation of fire performance on polar solvents

IMO MSC.1/Circ.1384

Strengths:

- Validates the combination of full scale equipment and foam concentrate as a system
- Validates performance of the high-expansion foam system under conditions that mimic changes in inside/ outside air temperatures
- Fire test scenarios and test conditions are representative of real world hazards – obstacles, pool fires, three dimensional fires, and pressure fires
- Multiple test enclosure sizes provide reasonable scalability insight for the high-expansion foam system tested
- Validates high-expansion foam hardware through a mechanical testing program which typically includes, but is not limited to, assessment of heat resistance, salt spray corrosion, and mechanical vibration

Weaknesses:

- Polar solvent fire performance is not validated

APSAD T12 Technical Rules

Strengths:

- Fire tests validate the combination of full scale equipment and foam concentrate as a system
- Fire tests offer the option to validate performance on both hydrocarbon and polar solvent fuels
- Quantification of the “Foam Destruction Rate” allows for a method to account for the effect of the fire on the fill rate of the system

Weaknesses:

- Requirements for the air temperature (5°C – 25°C) at the inlet to the high-expansion foam generator eliminate the possibility of testing under inside air conditions
- APSAD is not widely recognized outside of France

CONCLUSION

Specifying the right high-expansion foam system requires an understanding of the insights and limitations of each test protocol, as well as the intended application of the system. The protocols discussed are designed to evaluate foam system performance in different environments. The IMO test protocols simulate machinery spaces, such as an engine room, where the potential for pool fires, three dimensional fires, and pressure fires is greater and where the likelihood that the high-expansion foam system will have to function using hot and/ or smoky air is high. Alternatively, the T12 Technical Rules protocols measure effectiveness in flammable liquid storage applications where the most likely hazard is a small pool fire. In contrast to the application-specific test protocols of the IMO tests and the T12 Technical Rules, the EN fire test protocol utilizes a laboratory-scale fire test with limited correlation to real world applications for high-expansion foam systems.

Selecting the best test protocol for your given application is a critical first step in selecting the equipment you will rely on to help protect lives and property. For assistance in identifying the most appropriate test protocol and system requirements, contact SKUM Technical Services, info@skum.com.

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For additional information, please visit www.johnsoncontrols.com or follow us @johnsoncontrols on Twitter.

Belgium
Johnson Controls
E19 Business Park
Battelsesteenweg 455 - Gebouw D,
2800 Mechelen
Belgium
Tel: +32 (0)15 285 555
info-be@tyco-bspd.com

Czech Republic
Johnson Controls
Proletárská 447
463 12 Liberec
Czech Republic
Tel: +420 482 736 291
info@skum.com

Germany
Johnson Controls
Niederlassung Ratingen
Am Schimmersfeld 5-7, 40880 Ratingen
Germany
Tel: +49 (0)2102 551 0630
kundenservice-de@tyco-bspd.com

Hungary
Johnson Controls
Etele Ut 59-61
1119 Budapest
Hungary
Tel +36 (0)1481 1383
customerservice-hu@tyco-bspd.com

Italy
Johnson Controls
Via XX Settembre 75
Nerviano, Milano, 20014
Italy
Tel: +39-(0)331583000
ordini-it@tyco-bspd.com

Netherlands
Johnson Controls
Kopersteden 1
7547 TJ Enschede
The Netherlands
Tel: +31 (0)53 428 4444
info-nl@tyco-bspd.com

Norway
Johnson Controls
Kabelgaten 8
580, Oslo
Norway
Tel: +47 67 91 77 00
ordreno@tyco-bspd.com

South Africa
Johnson Controls
Invicta Road, Thandanani Office Park
Halfway Gardens, Midrand, 1685
South Africa
Tel: +27 (0) 11 026 9476
fsp.africa@tyco-bspd.com

Spain
Johnson Controls
C/ Isaac Peral 3
28823 Coslada (Madrid)
Spain
Tel: +34 91 380 7460
order-es@tyco-bspd.com

Sweden
Johnson Controls
Flöjelbergsgatan 20B
SE-431 37 Mölndal
Sweden
Tel: +46 104769901
orderse@tyco-bspd.com

Turkey
Johnson Controls
Balıkhisar Mahallesi
48 Cadde No:14, Akyurt Ankara
Turkey
Tel: +90 312 473 7011
info@skum.com

United Kingdom
Johnson Controls
Grimshaw Lane
Manchester, M40 2WL
United Kingdom
Tel: +44(0)161 259 4000
info-uk@tyco-bspd.com

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