High-Expansion Foam Test Protocol

Comparison of Multiple Standards
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

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

**APSD 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

<table>
<thead>
<tr>
<th>EN1568-2/EN 13565-1</th>
<th>IMO MSC.1/Circ.1384</th>
<th>APSAD Technical Rules (T12)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fire Classes Tested</strong></td>
<td>Class B (Hydrocarbon)</td>
<td>Class B (Hydrocarbon)</td>
</tr>
<tr>
<td><strong>Inside Air Fire Tests</strong></td>
<td>N/A</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Outside Air Fire Tests</strong></td>
<td>Test uses outside air.</td>
<td>Tests can be conducted with outside air at the manufacturer’s discretion.</td>
</tr>
<tr>
<td><strong>Class B Test 1</strong></td>
<td>1.73 m² round pan, Heptane, 60 second pre-burn</td>
<td>Class B Hydrocarbon: Light Diesel Oil, Simulated engine mockup with a combination impinging low pressure (6 bar, 10.4 kg/min) spray fire, 4 m² pan fire below the simulated engine mockup, and 3 m² pan above the simulated engine mockup, 2 minute pre-burn</td>
</tr>
<tr>
<td><strong>Class B Test 2</strong></td>
<td>N/A</td>
<td>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</td>
</tr>
<tr>
<td><strong>Class B Test 3</strong></td>
<td>N/A</td>
<td>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 m² pan positioned on the floor, 2 minute pre-burn</td>
</tr>
<tr>
<td><strong>Class B Test 4</strong></td>
<td>N/A</td>
<td>Class B Hydrocarbon: Heptane, Flowing (0.25 kg/sec) fire from the top of the simulated engine mockup, 15 second pre-burn</td>
</tr>
<tr>
<td><strong>Fire Test Notes</strong></td>
<td>Minimal transit time from the point of foam generation to the fire (Foam is fresh when applied to the fire.)</td>
<td>The fire tests above are conducted twice, once in a 500 m³ (ceiling height 5 m) enclosure and once in an enclosure of at least 1200 m³ and not more than 3500 m³ (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.</td>
</tr>
<tr>
<td><strong>Foam Quality Notes</strong></td>
<td>Fire conducted at a single expansion ratio, whatever the generic test generator produces with the foam concentrate to be tested.</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Test Foam Generator Notes</strong></td>
<td>Generic test foam generator used. Foam quality produced and used for fire testing has no correlation to that produced by full scale equipment.</td>
<td>Generators used for all tests are stock units with no modifications in order to qualify the generator models tested with a specific foam concentrate.</td>
</tr>
</tbody>
</table>
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.
About Johnson Controls’ Building Technologies and Solutions

Johnson Controls’ Building Technologies & Solutions is making the world safer, smarter and more sustainable – one building at a time. Our technology portfolio integrates every aspect of a building – whether security systems, energy management, fire suppression or HVACR – to ensure that we exceed customer expectations at all times.

We operate in more than 150 countries through our unmatched network of branches and distribution channels, helping building owners, operators, engineers and contractors enhance the full lifecycle of any facility. Our arsenal of brands includes some of the most trusted names in the industry, such as SKUM, YORK®, Metasys®, Ruskin®, Frick®, PENN®, Sabroe®, Simplex® and Grinnell®.

For more information, visit www.johnsoncontrols.com or follow @JCI_Buildings on Twitter.