Application of BS 8489 to the Protection of Generator Enclosures

IWMA, BRE
22nd March 2017
Dr Tim Nichols CPhys FIFireE
Agenda

Generator Enclosure Characteristics

Generator Fire Characteristics

Machinery Space – Definition

BS 8489-1 Fire Test Protocols

FM 5560 Fire Test Protocol

BS 8489-1 Detection, Actuation and Control

BS 8489-1 System Design

BS 8489-1 Commissioning
Generator Enclosure Characteristics

20’ Container
Payload: 48,600lbs
Tare Weight: 5,015lbs
Cubic Capacity 1,164cu.ft

Exterior Dimensions
L: 20”
W: 8”
H: 8’6”

40’ Container
Payload: 80,350lbs
Tare Weight: 8,337lbs
Cubic Capacity 2,376cu.ft

Exterior Dimensions
L: 40”
W: 8”
H: 8’6”
Generator Enclosure Characteristics

- Class B flammable or combustible liquids
- Flammable liquids under pressure
- Presence of hot surfaces
- Non-tight enclosures
- Ventilated enclosures
- Controlled Access
Generator Fire Characteristics

- Pool and spray fire
- Fast growing fire
- High heat release
Generator Fire Characteristics

// Class B
// Hydro-Carbon, high heat release
// Open Nozzles
// All nozzles discharge simultaneously
// Enclosure design area
// Enclosure volume and ventilation key design variables
Machinery Spaces - Definition

Machinery Spaces:
• Rooms with machinery such as oil pumps, oil tanks, fuel filters, generators, transformers vaults, gear boxes, drive shafts, lubrication skids, diesel engine driven generators, and other similar machinery using fuel and/or lubrication fluids with volatilities less than or equal to light diesel.

Special Machinery Spaces:
• Rooms with machinery such as internal combustion engines or other equipment using fuel and/or lubrication fluids with volatilities less than or equal to heptane, and incidental use or storage of limited quantities of flammable liquids of not more than two 55 gal (208 l) drums.

Turbine Enclosure:
• Combustion turbines with or without thermal insulation.

FM 5560 Approval Standard for Water Mist Systems
Fire Test Protocols
BS8489 – 1 – Fire Test Protocols

The water mist system is to be:

- Tested in accordance with a recognized test protocol;
- Published in a printed or online record by the testing laboratory.
- Use only components and equipment recognized by a testing laboratory
- Installed by trained personnel in accordance with the manufacturer’s water mist system design and installation manual.

A match needs to be established between test conditions on which the testing is based and the conditions of the actual installation

Where a water mist system application is not covered by a recognized standard fire test, additional testing might be required to meet the requirements of the authority having jurisdiction (AHJ).
Bs8489 – 1 – Fire Test Protocols

• Fire Test Protocols
  • Robust, reliable, repeatable
  • Specific fire load
  • Specific risk geometry

• Matching the risk to the fire test protocol
  a) Is the fuel similar to the test protocol (liquid or solid fuel, flash point, combustibility, quantity, arrangement)?
  b) Is the compartment volume equal to or less than the volume of the test room?
  c) Is the compartment height equal to or less than the test protocol?
  d) Is the compartment ventilation conditions similar (presence of fans, forced ventilation, etc., area of openings, position of openings)?
  e) Are there more obstructions to the distribution of mist than the test protocol?
  f) Is the duration of protection provided
### BS8489 – 1 – Fire Test Protocols

**Deluge / Extinguishment Protocols:**

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Fire test protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery spaces ≤80 m³</td>
<td>BS 8489-5 or FM 5560:2012, Appendix A</td>
</tr>
<tr>
<td>Machinery spaces ≤260 m³</td>
<td>FM 5560:2012, Appendix C</td>
</tr>
<tr>
<td>Machinery spaces &gt;260 m³</td>
<td>FM 5560:2012, Appendix E</td>
</tr>
<tr>
<td>Combustion turbines ≤80 m³</td>
<td>BS 8489-5 or FM 5560:2012, Appendix B</td>
</tr>
<tr>
<td>Combustion turbines ≤260 m³</td>
<td>FM 5560:2012, Appendix D</td>
</tr>
<tr>
<td>Combustion turbines &gt;260 m³</td>
<td>FM 5560:2012, Appendix F</td>
</tr>
<tr>
<td>Industrial oil cookers</td>
<td>BS 8489-6 or FM 5560:2012, Appendix J</td>
</tr>
<tr>
<td>Pool and spray fires – local application</td>
<td>BS 8489-4 or FM 5560:2012, Appendix I</td>
</tr>
</tbody>
</table>
FM 5560 – Fire Test Protocol

- Restricted Approval – 260m³ : 7.3m x 7.3m x 4.9m
- 5m ceiling height
- Personnel Access door without locking mechanism
- Twelve test configurations
- Approval Criteria
  - Extinguishment

![Elevation View](image1)

![Side View](image2)

![Plan View](image3)
FM 5560 – Fire Test Protocol

// Test 1 : Unshielded 1MW Heptane Spray Fire
// Test 2 : Shielded 1MW Heptane Spray Fire
// Test 3 : Shielded Heptane Pool Fire
// Test 4 : Shielded 2MW Heptane Spray Fire - Ventilated
// Test 5 : Shielded 2MW Heptane Spray Fire – Small Enclosure
// Test 6 : Unshielded 1MW Diesel Spray Fire
// Test 7 : Shielded 1MW Diesel Spray Fire
// Test 8 : Shielded Diesel Pool Fire
// Test 9 : Shielded 2MW Diesel Spray Fire – Ventilated
// Test 10 : Shielded 2MW Diesel Spray Fire – Small Enclosure
// Test 11 : Saturated Mat and Spray Fire
// Test 12 : Large Mat Pool Fire
FM 5560 – Fire Test Protocol

// Approval Criteria
- Extinguish all fire tests with no manual intervention
- Quickest 1.06 minutes
- Slowest 4.49 minutes

// System supply shall be twice the worst case fire test result or 10 minutes, whichever is the largest
- Machinery rundown time must be considered

// Pass
FM 5560 – Fire Test Protocol

• Mandatory Interlocks
  • Automatic Door Closures
  • Electrical Shutdown
  • Fuel Shutdown
  • Lubrication shutdown
  • Ventilation shutdown
  • Containment of flammable liquid releases

• Mandatory Monitoring
  • Nitrogen / Air pressure to a manned location

• Mandatory Temperature
  • +4°C
  • +54.4°C
FM 5560 – Fire Test Protocol

![Graph showing temperature and pressure over time after ignition. The graph includes various lines indicating different measurements such as temperature (°C), pressure (bar), and time (s).]
# Certificate of Compliance

## WATER MIST SYSTEMS

This certificate is issued for the following:

<table>
<thead>
<tr>
<th>General:</th>
<th>AQUAPPOG Water Mist Design for Fire Protection of Machinery Spaces, Special Machinery Spaces and Turbine Enclosures not exceeding 260 m² (2805 ft²) and maximum ceiling height of 16.0 ft (5 m).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Mist System Type:</td>
<td>Pre-Engineered system single fluid system</td>
</tr>
<tr>
<td>Discharge Type:</td>
<td>Continuous discharge, dead volume</td>
</tr>
<tr>
<td>Min. Water Flow Rate (per nozzle):</td>
<td>Ceiling Nozzle: 1.16 gpm (4.4 L/min) / Door Nozzle: 0.29 gpm (1.1 L/min)</td>
</tr>
<tr>
<td>Min. Water Pressure (at nozzle):</td>
<td>Ceiling Nozzle: 725 psi (50 bar) / Door Nozzle: 725 psi (50 bar)</td>
</tr>
<tr>
<td>Temp. Installation Range:</td>
<td>40 to 122°F (4 to 50°C)</td>
</tr>
<tr>
<td>Provision:</td>
<td>-Use of FM Approved fire detection equipment is required.  -Required: Automatic fire detection, ventilation closure devices, fire shut off devices</td>
</tr>
</tbody>
</table>

Prepared for: LPG Técnicas en Extinción de Incendios, S.L., C/ Mestre Joan Corrales, 107-109, 08950, Empuries de Lloret de Mar, Barcelona, Spain

FM Approvals confirms that the products above have been found to comply with the following standards:

FM Approvals Class 5560 – Approval Standard for Water Mist Systems, March 2009

Approval Identification: 3013088 Approval Granted: June 24, 2010

Said Approval is subject to satisfactory field performance, continuing follow-up Facilities and Procedures Audits, and strict conformity to the constructions as shown in the Approval Guide, an online resource of FM Approvals.

For more than 150 years FM Approvals has partnered with business and industry to reduce property losses.

**Signature**

Date: 6/24/10

Richard B. Dunn
Group Manager - Hydraulics
FM Approvals
1121 Boston Providence Turnpike
Norwood, MA 02062
Detection and Actuation
BS 8489-1 - Detection, Actuation and Control

• Detection
  • BS5839-1
  • Match characteristics of risk

Actuation & Control
  • Indicate operation of system (BS5839-1)
  • Indicate failure of supervised device
  • Electrical actuation
    ▪ BS7273-3 (Pre-action)
    ▪ BS7273-5 (Except pre-action)
  • Non-Electrical actuation
    ▪ Subject to approval
BS 8489-1
System Design
BS 8489-1 - System Design

- Manufacturers Design and Installation Manual
  - Fire test protocol
  - Minimum and maximum heights
  - Minimum and maximum distance between nozzles
  - Minimum and maximum distance to walls
  - Positioning relative to ceiling
  - K factor
  - Minimum and maximum pressure
BS 8489-1 - System Design

- **Duration**
  - Deluge Systems
  - Twice time to extinguish fire and prevent re-ignition as established in the test
  - Minimum:

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Operating volume</th>
<th>Minimum discharge duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery spaces</td>
<td>&lt;80 m³</td>
<td>10</td>
</tr>
<tr>
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<td>&lt;260 m³</td>
<td>10</td>
</tr>
<tr>
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<td>&gt;260 m³</td>
<td>60&lt;sup&gt;A)&lt;/sup&gt;</td>
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<td>&lt;80 m³</td>
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<td>Industrial oil cookers</td>
<td>As per test protocol</td>
<td>10</td>
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<td>Pool and spray fires – local application</td>
<td>As per test protocol</td>
<td>10</td>
</tr>
</tbody>
</table>

<sup>A</sup) Unless verified as lower according to certification against fire protocol.
BS 8489-1 - System Design

• **Approval**
  • FM5560
  • LPS 1283
  • Alternative equivalent

• **Nozzles**
  • Corrosion resistant material
  • Marked
    ▪ Manufacturer
    ▪ Model
    ▪ Year of Manufacturer/
    ▪ k-factor
BS 8489-1 - System Design

• Pipe
  • Approved to maximum design pressure
  • Identified BS 1710
  • Stainless Steel 316 (or equivalent)
  • Copper BS EN 1057
  • Galvanised Steel BS EN 10255
  • A strainer, and downstream test valve, should be fitted at the termination of the galvanized piping upstream of the piping feeding the nozzles.
  • CPVC
BS 8489-1 - System Design

- **Pipe supports**
  - ISO 6182-11

- **Pipework**
  - Minimise exposure to damage
  - Air vents
  - System drains
  - Suitably earthed

### Maximum spacing of fixings for copper and stainless steel pipework

<table>
<thead>
<tr>
<th>Nominal diameter (mm)</th>
<th>Horizontal run (m)</th>
<th>Vertical run (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1.2</td>
<td>1.8</td>
</tr>
<tr>
<td>16</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>22</td>
<td>1.8</td>
<td>2.4</td>
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<tr>
<td>28</td>
<td>1.8</td>
<td>2.4</td>
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<tr>
<td>35</td>
<td>2.4</td>
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<tr>
<td>42</td>
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<td>3.0</td>
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<tr>
<td>54</td>
<td>2.7</td>
<td>3.0</td>
</tr>
</tbody>
</table>

### Maximum spacing of fixings for steel pipework

<table>
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<th>Nominal diameter (mm)</th>
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<td>25</td>
<td>2.4</td>
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<tr>
<td>32</td>
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<td>3.0</td>
<td>3.6</td>
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<tr>
<td>50</td>
<td>3.0</td>
<td>3.6</td>
</tr>
<tr>
<td>80</td>
<td>3.6</td>
<td>4.5</td>
</tr>
</tbody>
</table>

### Maximum spacing of fixings for CPVC pipework

<table>
<thead>
<tr>
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<th>Horizontal run (m)</th>
<th>Vertical run (m)</th>
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</thead>
<tbody>
<tr>
<td>12</td>
<td>0.6</td>
<td>1.2</td>
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<tr>
<td>15</td>
<td>0.8</td>
<td>1.5</td>
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<tr>
<td>22</td>
<td>0.8</td>
<td>1.5</td>
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<tr>
<td>28</td>
<td>0.9</td>
<td>1.8</td>
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<tr>
<td>32</td>
<td>1.0</td>
<td>2.0</td>
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<tr>
<td>40</td>
<td>1.05</td>
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<tr>
<td>50</td>
<td>1.2</td>
<td>2.4</td>
</tr>
<tr>
<td>65</td>
<td>1.35</td>
<td>2.7</td>
</tr>
<tr>
<td>80</td>
<td>1.5</td>
<td>3.0</td>
</tr>
</tbody>
</table>
BS 8489-1 - System Design

Key
1 Propellant low pressure switch
2 Propellant regulator
3 System low pressure switch
4 System flow switch
5 Propellant vent valve
6 Propellant safety vent
7 System drain valve

Nozzle
Isolation valve
Stop valve
System drain valve
Pressure gauge
Water cylinder
Inert gas cylinder
BS 8489-1 - Commissioning

General
• Pipe is clean and free of debris
• End of line test valve discharge
• Checked against design documentation
• Visual inspection

Pipework
• 1.5 x maximum working pressure for 2 hours with no loss
• Dry pipe
  ▪ 2.5 bar air test for 24 hours with no loss greater than 0.15 bar
  ▪ 60 second water delivery
BS 8489-1 - Commissioning

Detection and Actuation

- BS 8489-1
- BS 7273-3
- BS 7273-5
- Function check all valves

Documentation

- Completion certificate
- Pressure test certificate
- Conformation of pipe cleaning
- O&M
- As installed drawings
Thank you