2.3 Tested fire suppression system

The Indirect Low Pressure Firetrace Systems with Integrated Isolate Valve (ILPINT 6kg), shown in Figure 3 from Firetrace Ltd was tested for its fire suppression performance. It is a dry chemical automatic suppression unit used with ABC FAVORIT X 90 Dry Chemical. A description of the fire suppression unit and the MSDS for the suppression agent are provided in Appendix 3.

The suppression agent containers containing 6 kg of ABC agent were pressurized using nitrogen. The working pressure of the systems was 12 bar (at +21 ° C). The suppression agent was distributed through three outlets using hoses with an inner diameter of ⅜″ and with a length of 3 meters for two hoses while the third was 4 meters long. Suppression agent was also delivered through a detection tube, which was used to activate the system. The length of the detection tube was seven meters. Three nozzles were installed and are shown in Figure 4. The distance to the most remote nozzle was 4 m. The systems were manually activated by introducing the detection tube above a pool fire slightly before time of activation[1] so that the system activated when the tube was ruptured by heat. The detection tube also functions as a discharge tube as it delivers the suppression agent through the ruptured tube. The pool fire which was used for activating the system was located inside obstruction 4 of the test apparatus.

Figure 3. ILPINT 6kg. The central photo shows the 7 m detection/discharge tube bundled before a test. The photo to the right shows the detection/discharge tube where it was introduced in obstruction 4 to activate the system during the tests.

[1] The time for activating the system is defined in the test procedure.

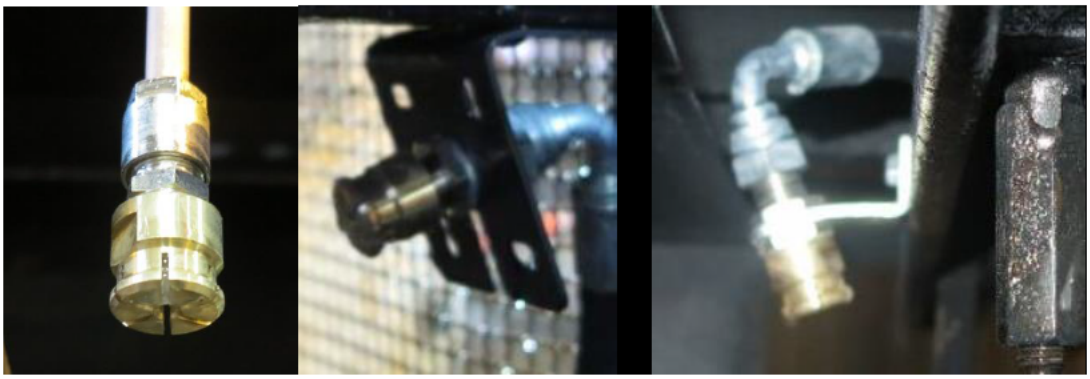


Figure 4. The installed nozzles in close view.

The suppression system configuration and the technical data of the tested systems are summarized in Table 1. Photos of the nozzle location in the test apparatus are shown in Appendix 2.

Table 1. Technical data for ILPINT 6kg Dry Chemical Automatic Fire Suppression Unit

Suppression agent	ABC (see datasheet in Appendix 3)
Suppression agent volume and mass	6 kg
Propellant gas	Nitrogen
Working pressure	12 bar
Number of discharge points	4
Type of discharge points	3 nozzles and 1 discharge tube
Number of nozzles	3
Type of nozzles	High-Throughput Diffuser 3/8" BSP (FT0284/HT)
Suppression agent delivery hose	⅜"
Total length of delivery hose system	10.3 m
Distance to the most remote nozzle	4 m
Nozzle mounting locations in the test apparatus (coordinates in accordance with UN regulation No. 107)	1 [27; 65; 75] 2 [80, 20, 75] 3 [225; 48; 79]
Length of detection / discharge tube	7 m
Dimension of discharge tube	8 mm
Discharge tube burst location in the test apparatus (coordinates in accordance with UN regulation No. 107)	[100; 135; 29] Approximately 6.9 meters tube length from suppression agent cylinder.

The equipment was delivered and installed by the client. The components of the tested suppression system have been selected by the client without RISEs assistance. It is not known to RISE if the components of the tested systems are representative of the mean production characteristics.

3. Tests

The testing was performed March 6-7, 2017. For a description of the tests see Appendix 1. The fire suppression system was installed and operated by the customer.

4. Results

A summary of the results can be found in Table 2. Photos from the tests are presented in Appendix 1.

Table 2. Results

Test	**Air flow**	**ILPINT 6 kg**
High-load fire	0 m^3/s	Pass *
Low-load fire	1.5 m^3/s	Pass
High-load fire with fan	1.5 m^3/s	Pass
Re-ignition	0 m^3/s	Pass

* Test was performed with the suppression system container conditioned in -20 °C.

5. Assessment

The tested fire suppression system, ILPINT 6kg, from Firetrace Ltd showed the ability to extinguish large fires, small fires and fires with and without forced ventilation as specified in the document ECE Regulation No. 107, Revision 6, Amendment 5, Annex 13. No re-ignition occurred within the required 45 s during the hot surface re-ignition test. The high-load fire test was performed with the pressurised suppression unit conditioned in -20 °C.

[redacted]

Appendices
Appendix 1 – Fire tests scenarios and fire suppression performance
Appendix 2 – Photos of the system setup and discharge point location in test apparatus
Appendix 3 – Technical documents on suppression system and suppression agent

Appendix 1

Appendix 1 – Fire tests scenarios and fire suppression performance

The fire tests scenarios are briefly described below. For more detailed information, the reader is referred to the ECE Regulation No. 107, revision 6, Amendment 5, Annex 13.

ILPINT 6kg Dry Chemical Automatic Fire Suppression Unit

1 High-load fire

High-load fire is a test with diesel pool fires, diesel soaked fibreboard fires and a diesel spray fire. The test was performed without forced air flow and with the suppression system container cooled to -20 °C in a climate chamber. The test was performed with the following sequence:

- 00:00 Starting measuring the time
- 01:20 Ignition of the pool fires
- 01:50 Starting diesel spray
- 02:00 Manual activation of the suppression system

The fire sources and their locations are shown in Figure 1- 1 and Table 1- 1.

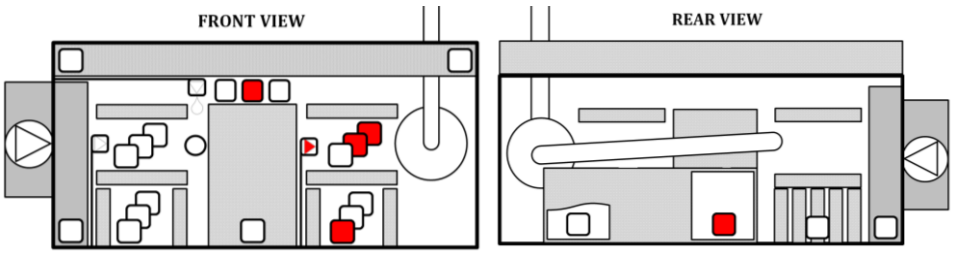


Figure 1- 1. Fire source locations in test *High-load fire*.

Table 1- 1. Details on fire sources and their location.

Description	Coordinate (x, y, z)
Spray fire **(4.5 bar, 0.19 kg/min)**	(1.47, 0.73, 0.46)
Pool fire **0.2 m × 0.3 m**	(0.97, 0.85, 0.70)
Pool fire **Ø 0.15 m**	(0.97, 1.28, 0.00)
Pool fire **0.2 m × 0.3 m**	(1.54, 0.57, 0.36)
Pool fire **0.3 m × 0.3 m and 2 Fibreboards**	(1.54, 0.77, 0.36)
Pool fire **0.2 m × 0.3 m**	(1.54, 0.13, 0.00)

All fires were completely extinguished within 3 seconds after activation of suppression system. Figure 1- 2 and Figure 1- 3 shows photos from the test.

Appendix 1

Figure 1- 2. *High -load fire*: 5 seconds before activation of the suppression system (time 1:57). The system activated at 2:03

Figure 1- 3. *High-load fire*: fully extinguished 3 seconds after activation of the suppression system (time 02:06).

Appendix 1

2 Low-load fire with fan

Low-load fire with fan is a test with focus on small peripherally located diesel pool fires.

The test is performed with 1.5 m^3/s forced air flow from the fan and in accordance with the following test sequence:

- 00:00 Starting measuring the time
- 01:00 Ignition of the pool fires
- 01:30 Fan activation
- 02:00 Manual activation of the suppression system

The fire sources and their locations are shown in Figure 1- 4 and Table 1- 2.

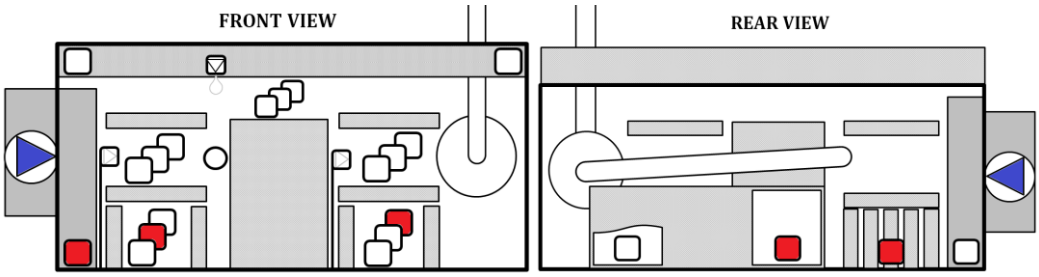


Figure 1- 4. Fire source locations in test *Low-load fire with fan.*

Table 1- 2. Details on fire sources and their location

Description	Coordinate (x, y, z)
Pool fire **Ø 0.15 m**	(0.02, 0.08, 0.00)
Pool fire **0.3 m x 0.2 m**	(0.37, 0.57, 0.00)
Pool fire **Ø 0.15 m**	(0.45, 1.20, 0.00)
Pool fire **Ø 0.15 m**	(0.97, 1.28, 0.00)
Pool fire **Ø 0.15 m**	(1.54, 0.57, 0.00)

All fires were completely extinguished within 3 seconds after activation of the suppression system. Figure 1- 5 and Figure 1- 6 shows photos from the test.

Appendix 1

Figure 1- 5. *Low-load fire*: 5 seconds before activation of the suppression system (time 02:17). The system activated at 2:22

Figure 1- 6. *Low-load fire*: fully extinguished 3 seconds after activation of the suppression system (time 02:25).

Appendix 1

3 High-load fire with fan

High-load fire with fan is a test with diesel pool fires, diesel soaked fibreboard fires and a diesel spray fire.

The test is performed with 1.5 m^3/s forced air flow from the fan and in accordance with the following test sequence:

- 00:00 Starting measuring the time
- 01:00 Ignition of the pool fires
- 01:30 Fan activation
- 01:50 Diesel spray activation
- 02:00 Manual activation of the suppression system

The fire sources and their locations are shown in Figure 1- 7 and Table 1- 3.

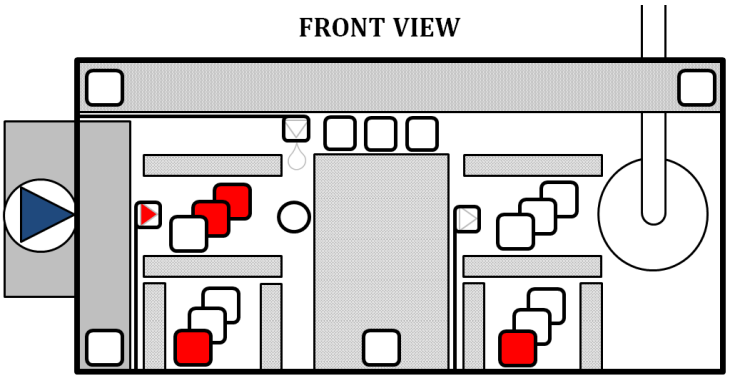


Figure 1- 7. Fire source locations in test *High-load fire with fan.*

Table 1- 3. Details on fire sources and their location

Description	Coordinate (x, y, z)
Spray fire **(4.5 bar, 0.75 kg/min)**	(0.37, 0.70, 0.46)
Pool fire **0.3 m × 0.3 m and 2 Fibreboards**	(0.37, 0.77, 0.36)
Pool fire **0.3 m × 0.3 m**	(0.37, 0.47, 0.36)
Pool fire **0.3 m × 0.3 m**	(0.37, 0.13, 0.00)
Pool fire **0.3 m × 0.3 m**	(1.54, 0.13, 0.00)

All fires were completely extinguished within 2 seconds after activation of the suppression system. Photos taken during the test is shown in Figure 1- 8 to Figure 1- 9.

Appendix 1

Figure 1- 8. *High-load fire with fan*: 5 seconds before activation of the suppression system (time 01:59). The system activated at 2:04

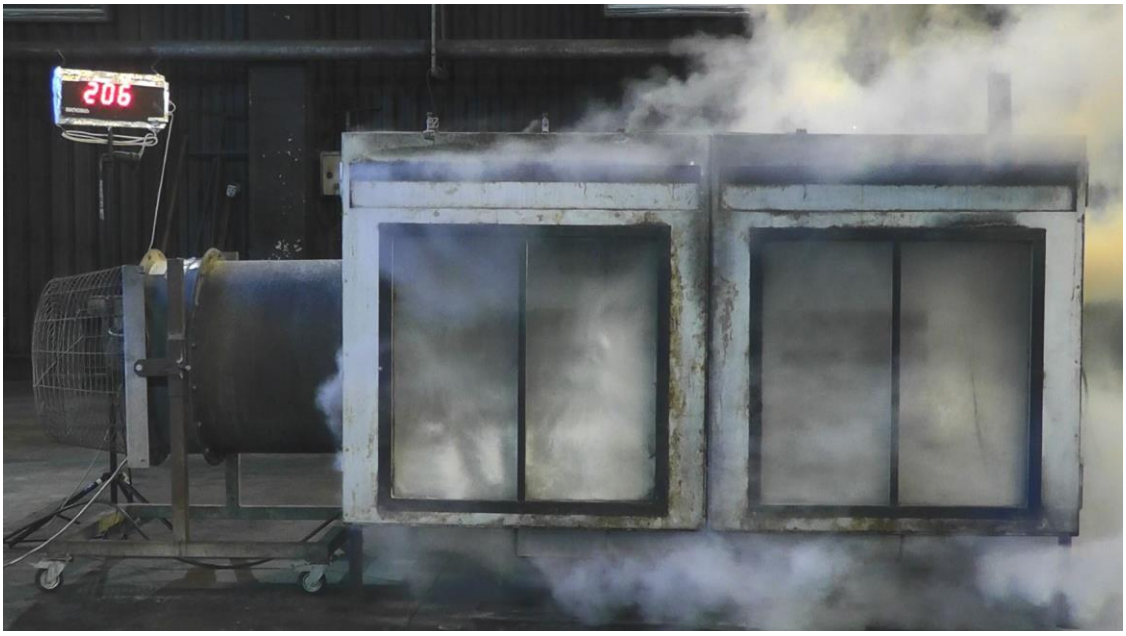


Figure 1- 9. *High-load fire with fan*: fully extinguished 2 seconds after activation of the suppression system (time 02:06).

Appendix 1

4 Re-ignition

Re-ignition a test of the suppression system potential to prevent re-ignition of dripping oil getting in contact with a hot surface.

The test is performed with no air flow from the fan and in accordance with the following test sequence:

- $t(T = 600\ °C) - ca\ 15\ min$ Starting pre-heating of the re-ignition tube
- $t(T = 600\ °C) = 00:00$ End of tube pre-heating
- 00:30 Start of oil dripping on the tube
- 00:45 Manual activation of the suppression system*
- $t(extinguishment) + 45\ s$ Test passed if no re-ignition at this time

*sustained flame on the tube is required before activation

The fire sources and its location are shown in Figure 1- 10 and Table 1- 4.

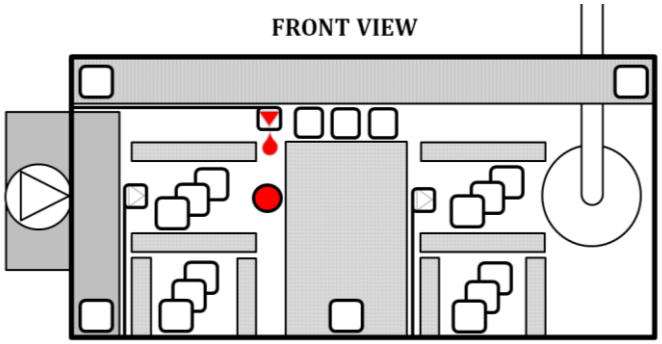


Figure 1- 10. Fire source location in test *Re-ignition*.

Table 1- 4. Details on the fire source and its location

Description	Coordinate (x, y, z)
Dripping oil fire **(2 bar, 0.01 kg/min)**	(0.78, 0.40, 0.73)

After activation of the suppression system no re-ignition occurred within the required of 45 seconds. Photos from the tests can be seen in Figure 1- 11 to Figure 1- 13.

Appendix 1

Figure 1- 11. Re-ignition scenario before activation of the suppression system (00:40).

Figure 1- 12. Re-ignition scenario: 1 second after activation of the suppression system (00:46).

Figure 1- 13. Re-ignition scenario: 45 seconds after extinguishment (01:31).

Appendix 2 – Photos of the system setup and discharge point locations in test apparatus

Figure 2- 1 to Figure 2- 4 show photos of the nozzle locations during the tests.

Figure 2- 5 to Figure 2- 7 show photos of the detection / discharge tube installation. Figure 2- 8 shows the discharge location during the tests.

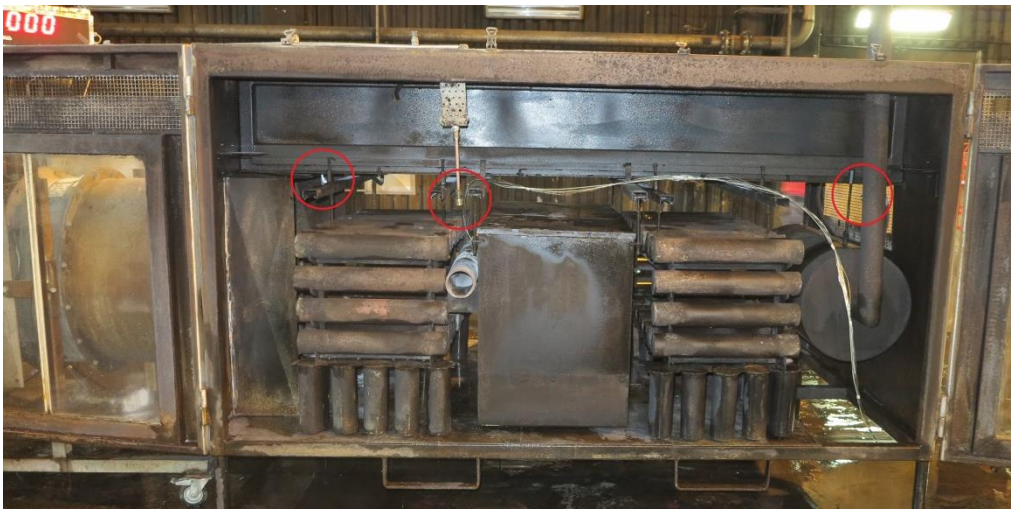


Figure 2- 1. Location of nozzles – front view

Figure 2- 2. The nozzle above the heated pipe for the re-ignition test.

Appendix 2

Figure 2- 3. Location of nozzle on the right side of the engine mock-up - front view.

Figure 2- 4. Location of nozzle on the left side of the engine mock-up - front view.

Figure 2- 5. Installation of the 7 m detection / discharge tube – front view.

Appendix 2

Figure 2- 6. Installation of the 7 m detection / discharge tube – rear view.

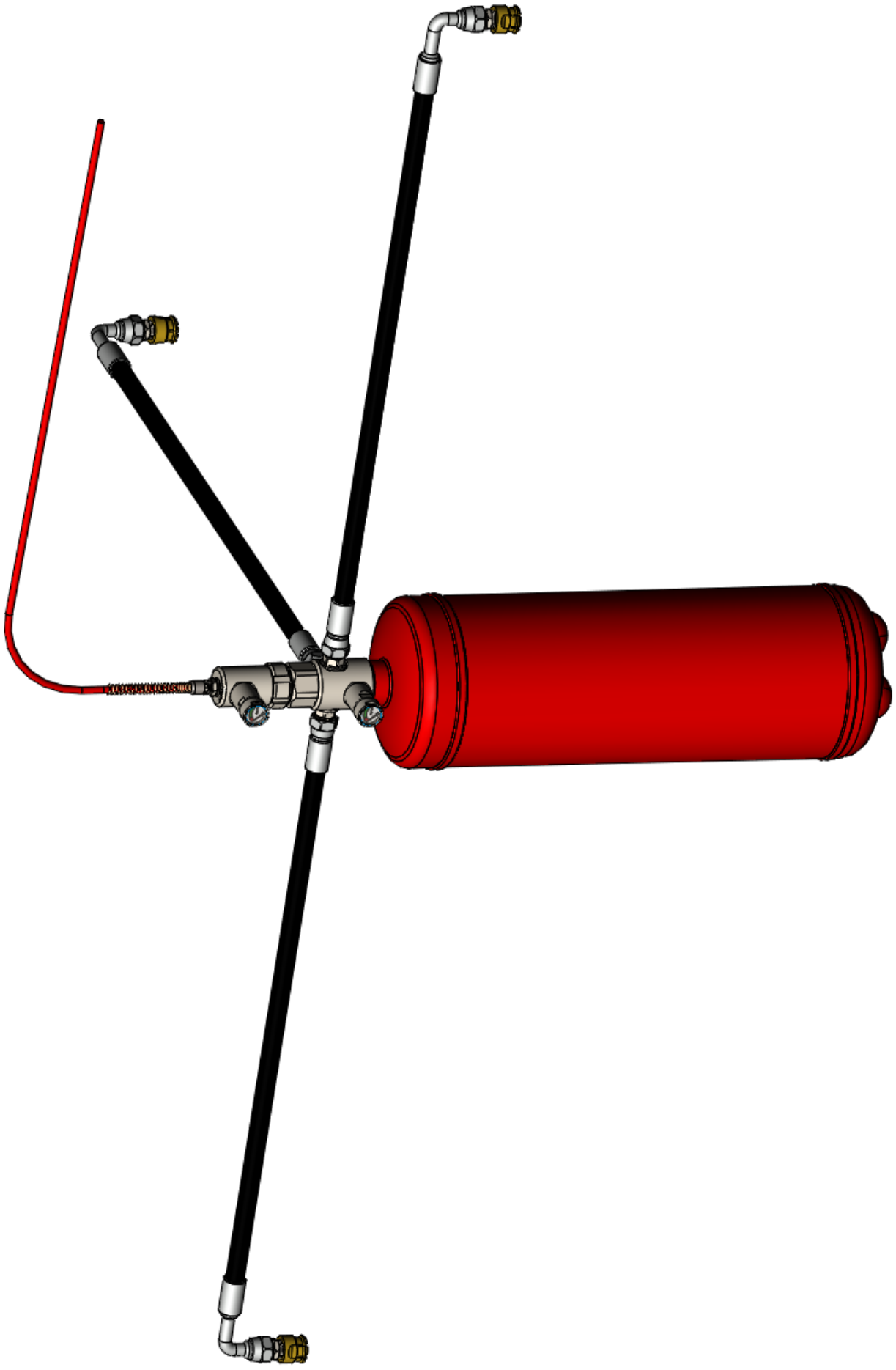
Figure 2- 7. Installation of the 7 m detection / discharge tube. The end of the tube installed inside obstruction 4. Discharge location encircled.

Appendix 2

Figure 2- 8. Discharge tube setup for the tests. The tube was inserted above a Ø 15 cm pool fire in order to activate the suppression system.

Appendix 3 - Technical documents on suppression system and agent

This appendix includes technical drawings and descriptions of the suppression agent containers, the nozzles, the detection/discharge tube and the suppression agent.



System Component List

ITEM NO.	PART NO.	DESCRIPTION
1	FTILPINTHBIV	Indirect Low Pressure High-Throughput Integrated Bi-Directional Valve
2	FT0438/6-HT	Diptube High-Throughput 426mm White
3	FT0133-P	Steel Cylinder 6kg/Litre with ABC Powder
4	FT0150	6kg Bracket with Stainless Steel Strap
5	FTILPINTHTBI/8	ILP High-Throughput Bi-Directional M18x1 Plug
6	FT1511-8/6-1/8-S	1/8" BSP Fitting for 8mm
7	FT0322/8	Plastic Black Cap for 8mm
8	FTSIMI	Optional Status Indicator Module