K21045
SCP02/01
2020-03-02

Specific Certification Program Fire Protection Systems - Components

Extinguishing of large fuel fires

Trust
Quality
Progress

Preface

This specific certification program has been accepted by the Kiwa Board of Experts Fire Safety, in which all relevant parties in the field of Fire Protection Systems are represented. The Board of Experts also supervises the certification activities and where necessary requires the evaluation guideline to be revised. All references to Board of Experts in this evaluation guideline pertain to the above mentioned Board of Experts.

This certification program will be used by Kiwa in conjunction with the Kiwa Regulations for Certification within the context of Certification Scheme K21045 “Fire Protection Systems”.

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Validation
This specific certification program within the context of certification scheme K21045 has been validated by the Director Fire Safety and Security of Kiwa on 2020-03-02

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Contents

1 Introduction

1.1 General

This specific certification program includes all relevant requirements which are employed by Kiwa when dealing with applications.

This specific certification program is a first version and shall be used in context with product certification scheme K21045 “Fire Protection Systems”.

In warehousing are flammable fluids present. In the case that these flammable fluids are escaping out of there containment during an incident can create a powerful pool fire.
Kiwa has drafted this initial type testing protocol to prove the effectives of fire protection systems in the scenario of a pool fire.

Based on research and experience has been established that most international standards for fire protection systems for land application have no specific requirements for large scale fires.
Kiwa has drafted this test protocol for fire protection systems for this specific scope based on the questions of parties like the Fire Brigade- and the Lost Prevention authorities.
The question is based on the use of Fire Protection Systems within chemical warehouses. The warehouses are storing several elements and combination of elements in emballage.

For these authorities is a large pool fire a serious risk. The situation with fuels stored in 1.000 litre polyethylene containers / barrels in racks is bases of this risk.
Leaking containers creating running fuel and a large pool with fuel.
Because of this is the performance to extinguish burning plastics in the protocol.

The dimensions of this pool are limited. If chosen bigger is it doubtful if the building will resist the pressure / heat of the starting fool fire.
Questionable if the regulations about storing flammable liquids in this quantity and stock arrangement is one that fits a proper risk scenario.

The stored elements have a classification according to ADR; (European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)). See;
https://www.unece.org/trans/danger/publi/adr/adr_e.html

The Fire Protection Systems have a classification based on EN2. See;
https://en.wikipedia.org/wiki/Talk:Fire_class

The goal is to draft a protocol that is having a realistic risk scenario and is also used in other applications. The protocols that are available within IMO (International Maritime Organization). See; http://www.imo.org/en/
The input from Solas 74 is used.

1.2 Field of application / scope

The performance requirement for large liquid fires of the fire extinguishing component is determined following.
The fire extinguishing system shall meet the assessments for Class B according to EN2 and additional circumstances as described in the test protocol.

Table 1 - Parameters of test fires

Fire	Type	Fuel	Fire size, MW	Remarks
Large	4 m^2 tray / 2 m2 tray	Diesel/fuel oil /	6	See Note 1 & 2.

		n-heptane		

Notes to table 1:
1. Diesel / Fuel oil means light diesel or commercial fuel oil.
2. Fire D is a 4 m2 tray or a 2 m2 tray n-heptane. Both are 6 Megawatt fires.

Table 2 - Test programme

The fire test programme should employ test fires singly or in combination, as outlined in table 2 below.

Test No.	Fire combinations (see table 1)
Large	D: 4 m^2 diesel tray under engine mock-up Total fire load: 6 MW

1.3 Acceptance of test reports provided by the supplier
See TIC scheme K21045.

1.4 Quality declaration
See TIC scheme K21045.

2 Terms and definitions

See TIC scheme K21045.

3 Procedure for granting a product certificate

See TIC scheme K21045.
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4 Setup of this specific certification program

4.1 General

This chapter contains the setup for the specification certification program.
For the performance of its certification work, Kiwa is bound to the requirements as included in EN-ISO/IEC 17065 “Conformity assessment - Requirements for bodies certifying products, processes and services” and certification scheme K21045.
This program describes a test plan large pool fires.
It describes the test requirements and/or laboratories to be used for the testing, identifies the tests to be performed and provides in minimal schedules for test activities.

5 Testing the performance of the system

5.1 Test protocol abstract

The tests should be performed in a room of minimal 100m2 and for the larger tests an room of circa 1000 m2, with no horizontal dimension less than 8 m, with a ceiling height of 5 m. The test room should be provided with a closable access door measuring approximately 4 m2 in area. In addition, closable ventilation hatches measuring at least 6 m2 in total area should be located in the ceiling.
A larger room may be employed if approvals are sought for larger volumes.

Integrity of test enclosure
The test enclosure should be nominally leak tight when doors and hatches are closed. The integrity of seals on doors, hatches and other penetrations (e.g., instrumentation access ports) should be verified before each test.

Engine mock-up
An engine mock-up of size (width x length x height) 1 m x 3 m x 3 m should be constructed of sheet steel with a nominal thickness of 5 mm. The mock-up should be fitted with two steel tubes diameter 0.3 m and 3 m length that simulate exhaust manifolds and a solid steel plate. At the top of the mock-up, a 3 m2 tray should be arranged (see figures 1, 2 and 3).

A floor plate system 4 m x 6 m x 0.75 m high should surround the mock-up.

Instrumentation
Instrumentation for the continuous measurement and recording of test conditions should be employed.
The following measurements should be made:
1. The temperature of the generator casing;
2. The temperature of the generator discharge stream measured at 0.5 m, 1.0 m and 2.0 m away from the discharge ports or specifications from the manufacturer based on earlier performed tests;
3. The temperature at three vertical positions (e.g., 1 m, 2.5 m and 4.5 m);
4. The enclosure pressure;
5. The gas sampling and analysis, at mid-room height, for oxygen, carbon dioxide, carbon monoxide and other relevant products;
6. The means of determining flame-out indicators;
7. The fuel nozzle pressure in the case of spray fires if applicable for other testing;
8. The fuel flow rate in the case of spray fires if applicable for other testing;
9. The discharge nozzle pressure if applicable for other testing; and
10. The means of determining generator discharge duration.

Generators/nozzles
For test purposes, generators/nozzles should be located as recommended by the manufacturer. If more than one generator/nozzle is used, they should be symmetrically located.

Enclosure temperature
The ambient temperature of the test enclosure at the start of the test should be noted and serve as the basis for calculating the concentration that the agent would be expected to achieve at that temperature and with that agent weight applied in the test volume.

5.1.1 System installation

The extinguishing system should be installed according to the manufacturer's design and installation instructions. The maximum vertical distance should be limited to 5 m.

Agent - Design application density

The agent design application density is the net mass of agent per unit volume (g/m3) required by the system designer for the fire protection application.

Test density
The test density of agent to be used in the fire-extinguishing tests should be the design application density specified by the manufacturer.

Quantity of aerosol agent
The quantity of aerosol agent to be used should be determined as follows:

$$W = V \times q\ (g) / f;$$

where:
W = agent mass (g);
V = volume of test enclosure (m3);
q = design application density (g/m3); and
f = efficiency coefficient of the manufacturer's generator (%)

5.1.2 Procedure

Fuel levels in trays
The trays used in the test should be filled with at least 30 mm fuel on a water base. Freeboard should be 150 ± 10 mm.

Fuel flow and pressure measurements
For spray fires, the fuel flow and pressure should be measured before and during each test.

Ventilation
Pre-burn period; During the pre-burn period the test enclosure should be well ventilated. The oxygen concentration, as measured at mid-room height, should not be less than 20% volume at the time of system discharge.

End of pre-burn period
Doors, ceiling hatches and other ventilation openings should be closed at the end of the pre-burn period.

Pre-burn time
Fires should be ignited such that 30 seconds of burning time occur before the start of agent discharge.

Discharge time
Agents should be discharged at a rate sufficient to achieve 100% of the minimum design density in 120 s or less.

Hold time
After the end of agent discharge the test enclosure should be kept closed for 15 min.

5.1.3 Measurements and observations

Before test:
1 temperature of test enclosure, fuel and engine mock-up;
2 initial weights of agent containers;
3 verification of integrity agent distribution system and nozzles; and
4 initial weight of wood crib.

During test:
1 start of the ignition procedure;
2 start of the test (ignition);

3 time when ventilating openings are closed;
4 time when the extinguishing system is activated;
5 time from end of agent discharge;
6 time when the fuel flow for the spray fire is shut off;
7 time when all fires are extinguished;
8 time of re-ignition, if any, during hold time;
9 time at end of hold time;
10 at the start of test initiate continuous monitoring; and
11 for condensed aerosol generators: the temperature of the casing during the fire test and hold time period; and temperature profile of the generator discharge stream versus distance away from the discharge ports.

Tolerances
Unless otherwise stated, the following tolerances should apply:

1	length	± 2% of value;
2	volume	± 5% of value;
3	pressure	± 3% of value;
4	temperature	± 5% of value; and
5	concentration	± 5% of value.

These tolerances are in accordance with standard ISO 6182-1:2004.

5.2 Classification criteria

Class B fires should be extinguished within 30 s of the end of discharge. At the end of the hold period there should be no re-ignition upon opening the enclosure.
The ends of the test fuel trays should contain sufficient fuel to cover the bottom of the tray.
The design factor is the highest of the laboratory extinguishing factors for the three fuels multiplied by 1.3.

5.3 Test report

The test report should include the following information:
1 name and address of the test laboratory;
2 date and identification number of the test report;
3 name and address of client;
4 purpose of the test;
5 method of sampling system components;
6 name and address of manufacturer or supplier of the product;
7 name or other identification marks of the product;
8 description of the tested product with: drawings; descriptions; assembly instructions; specification of included materials; and detailed drawing of test set-up;
9 date of supply of the product;
10 date of test;
11 test method;
12 drawing of each test configuration;
13 identification of the test equipment and used instruments;
14 conclusions;
15 deviations from the test method, if any;
16 test results including measurements and observations during and after the test; and
17 date and signature.

5.4 Test executed with n-heptane

Central in the room is a steel fire pan positioned of 1.8 x 1 m and a height of 10 cm.
The fire pan shall contain a layer of 45 l heptane on 5 cm of water with a burning time of at least 5 minutes and a power of approx. 6 MW.
The pan shall be placed on the floor.

The fire extinguishing components shall be suspended in accordance with the supplier's specifications and distributed as specified by the supplier.
The fire cell shall be placed at the edge of the radius of the design extinguishing area.

The heptane shall be ignited for each test and have a free burning time of 30 seconds. After the end of the activation of the fire extinguishing agent the room shall remain closed for at least 15 minutes.
During this period the cell shall be monitored for signs of active fire and signs of spontaneous activation, based on the temperature measurements in the vicinity of the fire cell.

After this period the cell shall be inspected visually for signs of active fire and signs of active activation outside the test room without the presence of the fire extinguishing agent. Any signs of fire shall be described in the report. The temperature after extinguishing shall be decisive. Visible fire is considered as a sign of spontaneous activation, but solely smoke is not.

The result of the assessment and tests shall be declared in the attachment of the product certificate.

Note: it is possible to test other fuels. Fuel quantity shall be altered to achieve a power of approx. 6 MW.

5.5 Test protocol detail

The test is carried out in a sufficient air-tight room. Doors and windows shall be closed. However, a limited "open" area, for example small gaps/notches between wall and ceiling may be present. Any forced ventilation system or apparatus/system that will affect the density in the room, shall be shut down. The test shall be based on the exact arithmetical calculation of the number of grams per volume unit as this governs the value stated in the supplier specifications. There shall be no physical obstructions in the room.
The design formula shall allow for a quantity of remaining extinguishing agent in the extinguishing generator.
When testing Class B fires the operation of the extinguishing generator in relation to its dispersal shall be tested more extensively.

The test of the fire extinguishing effect shall be made under the following conditions.

With regard to	Requirement/ Function	Unit	Tolerance
Fire class Assessment method to EN2 and applicable standard	According Fire Class B	N/A	N/A
Thermal energy/power	See fire extinguishing test or objective	N/A	N/A
Burning time due to catalyst	See fire extinguishing test or objective	Minutes	± 15 sec
Catalyst	Heptane	N/A	N/A
Relative humidity in the room, before the fire, measured with a hygrometer	60	%	± 20%
Ambient temperature before	According test protocol	°C	According test protocol

With regard to	Requirement/ Function	Unit	Tolerance
Temperature in the test room	20 or ambient Note: According test procedure. Otherwise determined using at least 2 thermocouples on the ceiling with ΔT 10 sec recording using a data logger	°C	5, N/A for ambient
Thermocouples	The use of K type thermocouples (Ni-CrNi), diameter 1 mm, is recommended.	N/A	N/A
Dimensions of the test room	According test protocol	m and m^3	- 0 / + XX
Ventilation during the pre-burning time and free burning time, using constant measurement	Adequate ventilation	N/A	N/A
"Open" area or leakage area and position during extinguishing	0.1% max. of the volume of the room, distributed evenly across the room *	% in m^2	-0.1 / +0
Air flow through the room	Non-forced (Natural), <1	m/s	-1 / +0
Oxygen level in the room	According test protocol	% O2	According test protocol
Closing of the test room after igniting the fire	According test protocol	s	N/A
Required amount of fire extinguishing agent	Supplier's design formula	g/m^3	Supplier's design formula
Extinguishing time	According test procedure and generator type	s	According test protocol
Monitoring time	According test procedure	s	According test protocol
Agent discharge	According test protocol	s	According test protocol
Weight of agent to determine percentage of agent discharged	Before and after extinguishing, any generator type	gr	± 5
Activation	Supplier's system	N/A	N/A
Electrical activator	Measurement of resistant according generator type.	Ω	± 1
Instrumentation			
Weighing scale	Measurement (Incremental) from approx. 0 till approx. 75	Kg	± 0.005
Oxygen meter	Measurement from approx. 0 till approx. 25	% O2	± 0.1
Multi meter	Measurement of resistance from approx. 0 till approx. 30	Ω	± 0.1

* "Open" area or leakage area during extinguishing = 0.1% (e.g.: 1000 m^3 = 1 m^2 and 100 m^3 = 0.1 m^2).

"Open" areas are generally allowed as, for example, small gaps/notches between wall and ceiling but not as, for example, open ventilation piping or a hole/opening in a wall or ceiling.

- Open ventilation piping or a hole/opening in a wall or ceiling are to be considered as a an defect regarding the architectural and/or technical design of the room.
- Small gaps/notches between wall and ceiling are to be considered as a an defect regarding the architectural finishing of the room.

5.6 Mandatory registrations during the test

Mandatory registrations during the test in seconds are:

- Time of activation of the heptane.
- Pre burning time (catalyst)
- Free burning time
- Time of initial activation of the fire extinguishing generator.
- End of the discharge of the generator.
- Time at which the flames are extinguished (if possible)
- Soak time

There shall be adequate ventilation during the pre-burning and free burning time and the oxygen concentration in the test room shall be maintained. If this cannot be guaranteed then during the activation the oxygen percentage at the level of the source of fuel shall not deviate more than 0.5 vol% from the normal percentage under ambient conditions and the oxygen percentage shall be measured with a calibrated oxygen gauge using a sensor at the same level as the source of fuel.

5.7 Test setup

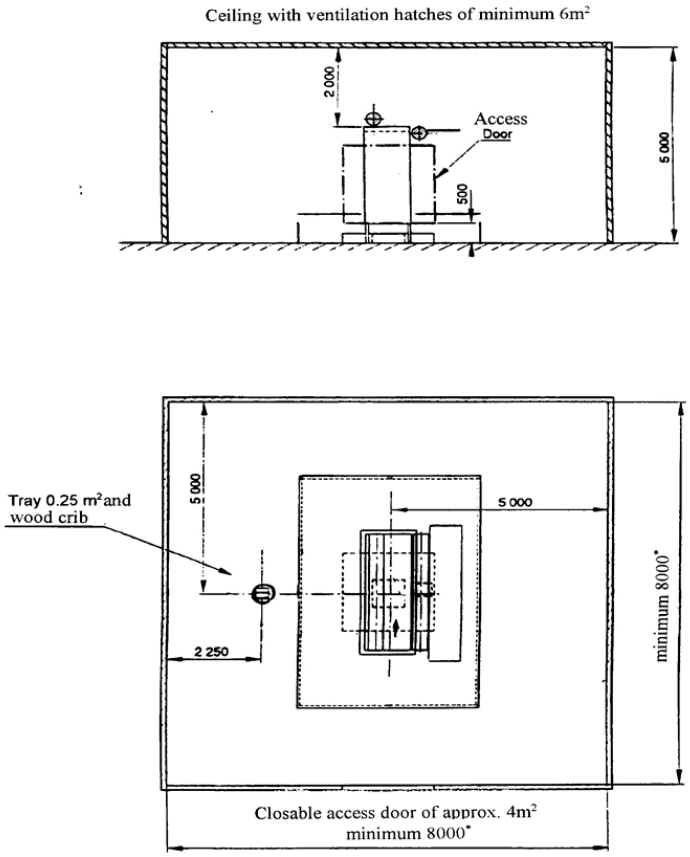

Figure 1

*The area should be 100m²

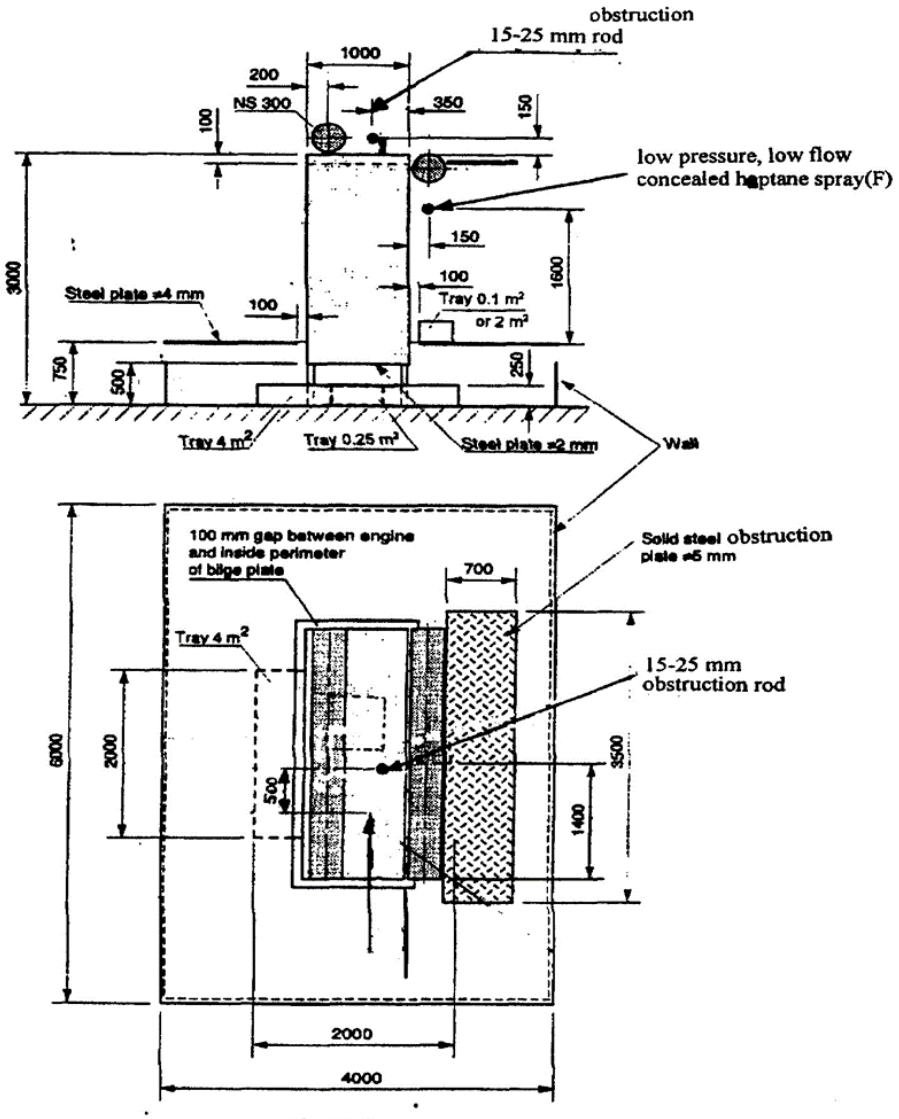
obstruction
15-25 mm rod
1000
200
NS 300
350
150
100
low pressure, low flow
concealed heptane spray(F)
150
100
1600
3000
Steel plate ≠4 mm
100
Tray 0.1 m²
or 2 m²
750
500
250
Tray 4 m²
Tray 0.25 m²
Steel plate ≠2 mm
Wall
100 mm gap between engine
and inside perimeter
of bilge plate
700
Solid steel obstruction
plate ≠5 mm
Tray 4 m²
15-25 mm
obstruction rod
6000
2000
500
3500
1400
2000
4000

Figure 2

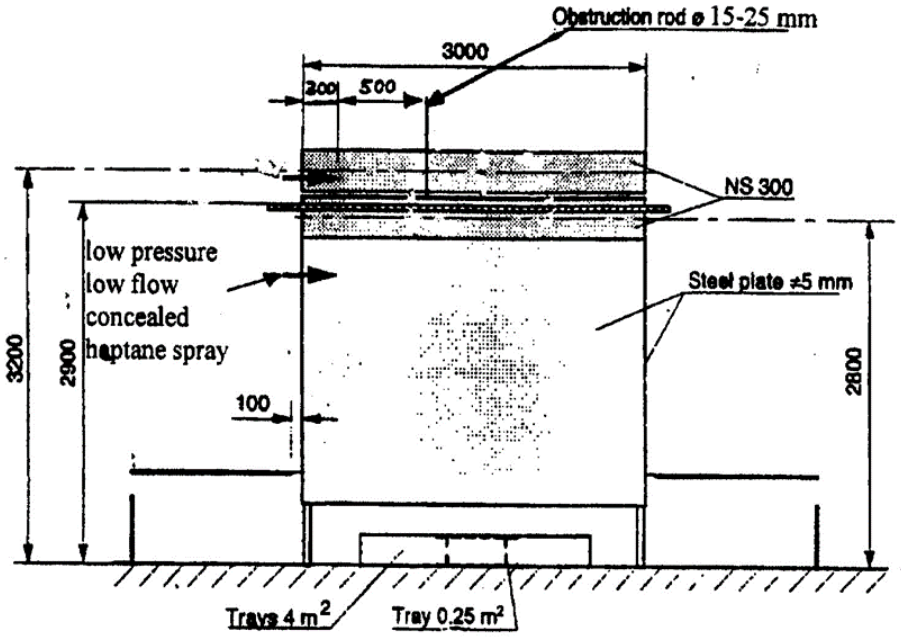
Obstruction rod ø 15-25 mm
3000
200
500
NS 300
low pressure
low flow
concealed
heptane spray
Steel plate ≠5 mm
3200
2900
2800
100
Trays 4 m²
Tray 0.25 m²

Figure 3

6 Factory Production Control Fire Protection Components by Kiwa

See TIC- scheme K21045.

7 Inspection of Fire Protection Systems by Kiwa

See TIC- scheme K21045.

8 Marking

8.1 General

See TIC scheme K21045.

8.2 Certification mark

See TIC scheme K21045.

9 Requirements in respect of the quality system

See TIC scheme K21045.

10 Summary of tests and inspections

See TIC scheme K21045.

11 Agreements on the implementation of certification

See TIC scheme K21045.

12 Titles of standards

12.1 Public law rules

See TIC scheme K21045.

12.2 Standards / normative documents

See TIC scheme K21045.

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