Bauaufsichtlich anerkannte Prüf-, Überwachungs- und Zertifizierungsstelle
Prüfstelle für Feuerlöschmittel und -geräte
DIN EN ISO/IEC 17025: D-PL-17819-01-00
DIN EN ISO/IEC 17065: D-ZE-17819-01-00
DIN EN ISO/IEC 17020: D-IS-17819-01-00
ZLS-GS-0066
Notified Body no. 0767

MPA Dresden

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Freiberg, 2019-03-08
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Your order dated 2018-09-24, fire tests to evaluate the extinguishing capability of the S-AMFE and R- AMFE mini extinguishers

Test report no. 20181367

Fire tests to examine the extinguishing capability of AMFE small extinguishing units with 3M® NOVEC® filled gas cartridges and the option of thermal or electrical triggering by means of various thermo bulbs (mini extinguishers S-AMFE and R-AMFE) and E-bulbs

- Fire tests in a fire alarm control unit housing with defined fire load to examine the extinguishing capability of mini extinguisher AMFE with 3M™ NOVEC™ filled gas cartridges and control /triggering by means of S and R type thermo bulbs (S-AMFE = signal AMFE, R-AMFE = remote AMFE)
- Fire tests in an EC power supply housing with defined fire load to examine the extinguishing capability of glass extinguishing ampules (E-bulbs) with 3M™ NOVEC™

Customer:	JOB Thermo Bulbs GmbH An der Strusbek 5 22926 Ahrensburg
Subject of test:	Mini extinguishers AMFE in the execution S-AMFE (signal AMFE) and R-AMFE (remote AMFE), thermo bulb control and triggering of a screwed-on 3M™ NOVEC™ filled gas cartridge as extinguishing medium container E-bulbs (extinguishing bulbs) filled with 3M™ NOVEC™
Test method:	Fire tests with defined fire loads in a fire alarm control unit housing (S-AMFE, R-AMFE) as well as a power supply housing (E-bulb) in accordance with an agreed test plan without specification
Laboratory:	MPA Dresden GmbH Officially recognised test centre for fire extinguishing agents and equipment Fuchsmühlenweg 6F, 09599 Freiberg, Germany
Report:	This test report comprises 29 pages including 9 pages of appendices

1 Order and objective

JOB Thermo Bulbs GmbH instructed MPA Dresden GmbH to perform fire tests to examine the extinguishing capability of the miniature extinguisher AMFE consisting of a control and triggering unit with S or R type thermo bulb and a screwed-on gas cartridge with the extinguishing medium 3M™ NOVEC™ (designated mini extinguisher S-AMFE or R-AMFE in the following) – to verify the extinguishing capability of the miniature extinguisher for use in the area of electrical engineering/electronics. The examination of the S-AMFE and R-AMFE took place on a test setup with a production series fire alarm control unit (designated FACU in the following).

JOB Thermo Bulbs GmbH further instructed MPA Dresden GmbH to perform fire tests to examine the extinguishing capability of glass ampules filled with 3M™ NOVEC™ – so-called E-bulbs – to verify the extinguishing effect of these ampules especially for use in the area of electrical engineering /electronics in the example of a test setup with a conventional EC power supply housing prepared for these tests. These tests were performed with the objective of also verifying, aside from the extinguishing effect, the simultaneous interruption of a flow of current.

2 Basis of the test

Fire tests dated 2018-10-22 performed in the MPA Dresden GmbH test laboratory.

3 Subject of test

3.1 Signal or sensor AMFE (S-AMFE)

The tests were performed with an AMFE mini extinguisher which consisted of the following system components:

- Control and triggering unit AMFE, fitted with S type thermo bulb, thermal triggering temperature 68 °C, with the addition of applied conductive paths (linear arrangement, see Figs. 1 and 2).
- 3M™ NOVEC™ filled gas cartridge as extinguishing medium container (see Fig. 3)

The extinguishing medium supply for the size 0 gas cartridge used (see Fig. 3) was 24 ml of 3M® NOVEC. Nitrogen is used as the propellant (pressure when full: 60 bar).

The complete control and triggering unit S-AMFE can be screwed onto the extinguishing medium cartridge. Triggering takes place solely on a thermal basis. The inbuilt glass ampule of the S type thermo bulb (see Fig. 3) acts as control and trigger for the extinguishing process with the bursting of the ampule on reaching the triggering temperature effecting the activation of the extinguishing medium container by means of a pre-tensioned striking pin in the S-AMFE. By means of the conductive paths applied to the glass ampule, a permanent signal current of maximum 1 A can also be connected and routed via the S-AMFE. In the case of thermal triggering, this effects an interruption of the electrical circuit. This signal could, for example, be used as zero-state current switching for the system or as a signal to an internal or external alarm. The prerequisite for this would be the electronic monitoring of the current flow, the interruption of which initiates further steps. This, however, did not constitute part of the test. A visual signalling only was selected in the form of an LED indicator which ought to clearly illustrate this possibility.

The bursting of this S type thermo bulb occurs conventionally by heating up in the course of a combustion (analogous to the functioning of a sprinkler head in a sprinkler system).

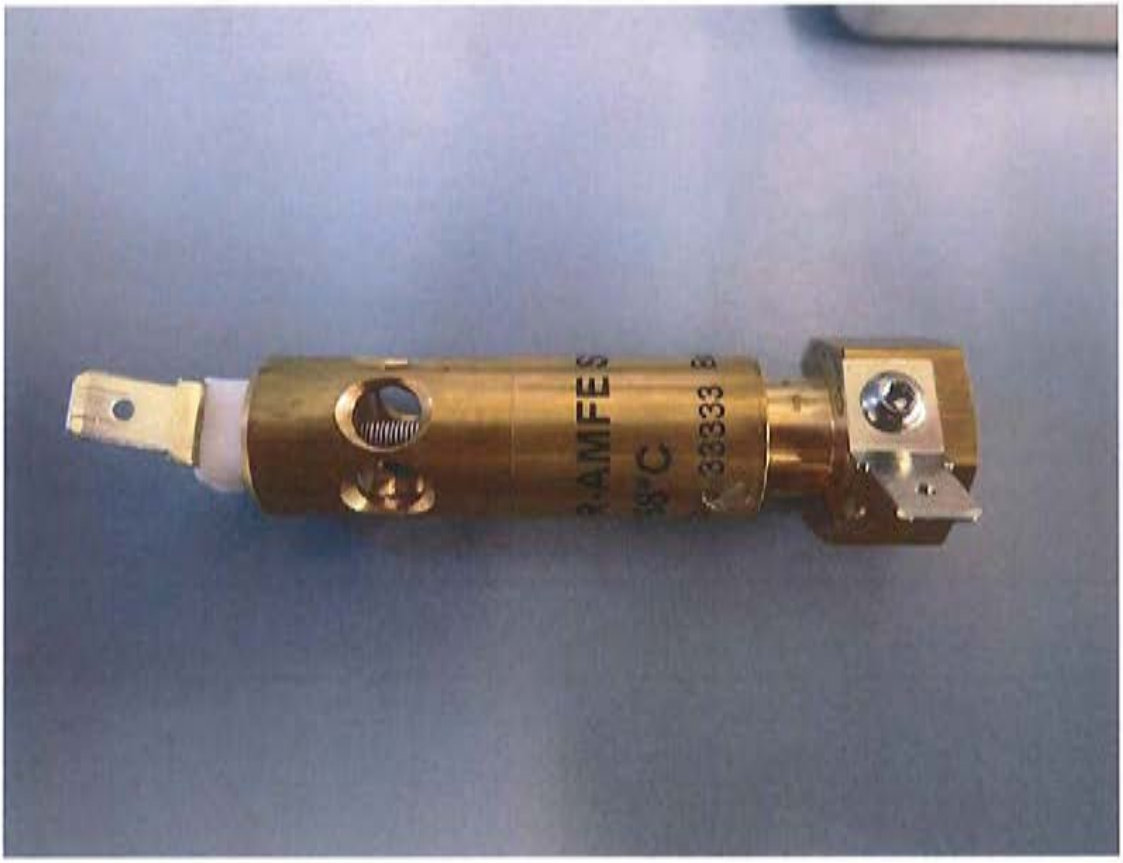

Fig. 1: AFME control and triggering unit, here fitted with R type thermo bulb

Fig. 2: S type thermo bulb, source: Job Thermo Bulbs

Fig. 3: Screw-on gas cartridge as extinguishing media container with 3M™ NOVEC™

3.2 Remote AMFE (R-AMFE)

The tests were performed with an AMFE mini extinguisher which consisted of the following system components:

- Control and triggering unit AMFE, fitted with R type thermo bulb, thermal triggering temperature 68 °C with the addition of applied conductive paths (meander arrangement, see Figs. 1 and 4).
- 3M™ NOVEC™ filled gas cartridge as extinguishing medium container (see Fig. 3)

The extinguishing medium supply for the size 0 gas cartridge used (see Fig. 3) was 24 ml of 3M™ NOVEC™. Nitrogen is used as the propellant (pressure when full: 60 bar).

The complete control and triggering unit R-AMFE can be screwed onto the extinguishing medium cartridge. Triggering can occur in two ways, either thermally or electrically. As control and trigger for the extinguishing process the built-in glass ampule of the R type thermo bulb acts in both cases, the bursting of which triggers the activation of the extinguishing medium container by means of a pre-tensioned striking pin.

The bursting of this R type thermo bulb occurs, as always, thermally through heating up in the course of a combustion. Alternatively, the triggering can take place deliberately with this type by means of the applied conductive paths which, with sufficient current flow, heat up the R type thermo bulb to the point where the glass ampule bursts thus triggering the mini extinguisher.

A permanent maximum signal current of 40 mA can be conducted via the R-AMFE. In the case of thermal triggering the electrical circuit is then interrupted. The signal interruption can be used analogous to S-AMFE as zero-state current switching for the system or as a signal to an internal or external alarm. The prerequisite for this would be the electronic monitoring of the current flow, the interruption of which initiates further steps. This, however, did not constitute part of the test. A visual signalling only was used in the form of an LED indicator which ought to make this possibility clear.

Unlike the S-AMFE, the R-AMFE can, as already mentioned, be triggered deliberately by a flow of current. The triggering of such a flow of current could be, for example, the signal from a smoke alarm, a temperature monitoring device or similar. Utilising of the combination of the R-AMFE with a smoke alarm, a fire spread could thus be prevented very early on and be limited to a very low extent of damage. At present, the triggering current is approx. 0.5 A. For this test, the triggering current flow was started by manual switch (see chapter 4.2 of this test report).

Fig. 4: R type thermo bulb with 2-way activation, source: Job Thermo Bulbs

3.3 E-bulb

The so-called E-bulbs (extinguishing bulbs) are glass ampules filled with the fluid extinguishing medium 3M™ NOVEC™. In appearance, these E-bulbs are the equivalent of the generally familiar and common glass bulbs for conventional sprinkler systems. With the collapse of the ampules under thermal stressing, the extinguishing medium is released and vaporised thus developing its extinguishing effect.

The E-bulbs tested are furnished with a conductive coating which enables it in the normal state to route an electrical current and to effectively interrupt this latter in addition to initiating the extinguishing effect in the event that it is triggered (see Fig. 5).

Fig. 5: Extinguishing Bulbs (E-bulb) filled with 3M™ NOVEC™, source: Job Thermo Bulbs

4 Test method

The tests were not performed on the basis of any special test standard. The fire tests were performed without further specification in accordance with a jointly agreed test plan.

4.1 S-AMFE

The test setup for the extinguishing tests with the mini extinguisher S-AMFE covered the following components and auxiliaries:

- Fire alarm control unit housing with functioning display panel (FACU) as fire chamber in the dimensions 42.0 cm x 49.0 cm x 21.0 cm (W x H x D)
- Holding bracket for the mini extinguisher
- Mini extinguisher S-AMFE with 24 ml 3M™ NOVEC™ cartridge and screwed-on triggering device consisting of a thermally /electrically triggerable glass ampule S type thermo bulb (triggering temperature 68 °C) and striking pin
- Holding bracket for the fuel dish
- Approx. 8 grams combustion material (12 pieces of cable insulation)
- Isopropanol (as back-up fire for uniform combustion of the cable insulation)
- Igniter
- Fire dish
- Additional with the R-AMFE only: manual switch with current flow monitoring for electrical triggering of the extinguisher

The spatial volume of the test setup was 43 litres. The basic setup for the test of the extinguishing capability by means of thermal triggering of the S-AMFE and R-AMFE is illustrated in Fig. 6.

The series of tests for the thermal triggering comprised two tests with an S type bulb and an R type bulb each, with the same amount of combustible material.

The test procedure is described in more detail in the following.

The series of tests were performed exclusively with thermal triggering. Cable insulation of the type Draka UC900 SS23 Cat.7S/FTP 2x4P LSHF (Low Smoke Halogen Free) in 4 cm long pieces was used as combustion material.

The test plan provided for the combustible material to be stacked on the fire dish in previously determined and weighed quantities. Per test, 12 pieces of cable insulation with a total weight of around 8 grams were stacked in the fire dish. The combustible material was then provided with a few millilitres of isopropanol as ignition activator and ignited by means of a fire lighter (see Figs. 6 and 7). The isopropanol acts in this instance as back-up fire for the uniform combustion of the cable insulation.

At the point in time of ignition of the combustion material the extinguishing cartridge was ready for operation in the FACU housing (fitted with S type thermo bulb, striking pin tensioned), the contact points on the S-AMFE were connected and made the electrical connection for visual signalling of the operational state on the FACU display panel (see Fig. 6).

The visual signalling by means of LED indicator in the FACU operating panel trialled in the test setup supplemental to the test of the extinguishing effect of the new extinguishing medium constitutes the additionally provided new system possibility (hence the designation Signal or Sensor AMFE). The test report no. 2013-F-4872 by MPA Dresden GmbH on the mini extinguisher AMFE with CO_2 cartridge did not yet demonstrate this possibility.

After igniting the combustion material and the elapse of the pre-burn time, the fuel was inserted by hand below the mini fire extinguisher and the door of the FACU closed.

The existing housing openings in the FACU guaranteed a sufficient air supply and thus prevented the extinguishing of the combustion material due to a lack of atmospheric oxygen.

The pre-burn period in the case of all tests was consistently 15 seconds and started after the removal of the ignition source. After the elapse of the 15 second pre-burn time, the fuel was inserted by hand below the operationally-ready mini extinguisher (see Fig. 4) and the door of the FACU closed. The positioning of the combustion material below the mini extinguisher was selected so that the thermally triggering glass ampule on the mini extinguisher was situated centrally above the fire dish (see Figs. 6 and 7). The height of the extinguisher above the housing floor was 10 cm.

With the bursting of the thermally triggering glass ampule due to the rise in temperature (triggering temperature 68 °C), the built-in triggering mechanism was set off, the 3M™ NOVEC™ cartridge was pierced and the 3M™ NOVEC™ released as extinguishing medium. Fig. 6 shows the S-AMFE mini extinguisher.

After closing the FACU door, the triggering of the mini extinguisher and the extinguishing effect was recorded.

The complete exhausting of the extinguishing media from the mini extinguisher defined the end of the test. The FACU housing was then opened, cooled down in the ambient air and the next test setup prepared.

The test procedure was handwritten into a log in which fundamental subjective observations during the test were recorded. This included, among other things, changes in the flame development (size, colour, intensity), noise development or visual and/or audible changes in the test object during the duration of the fire.

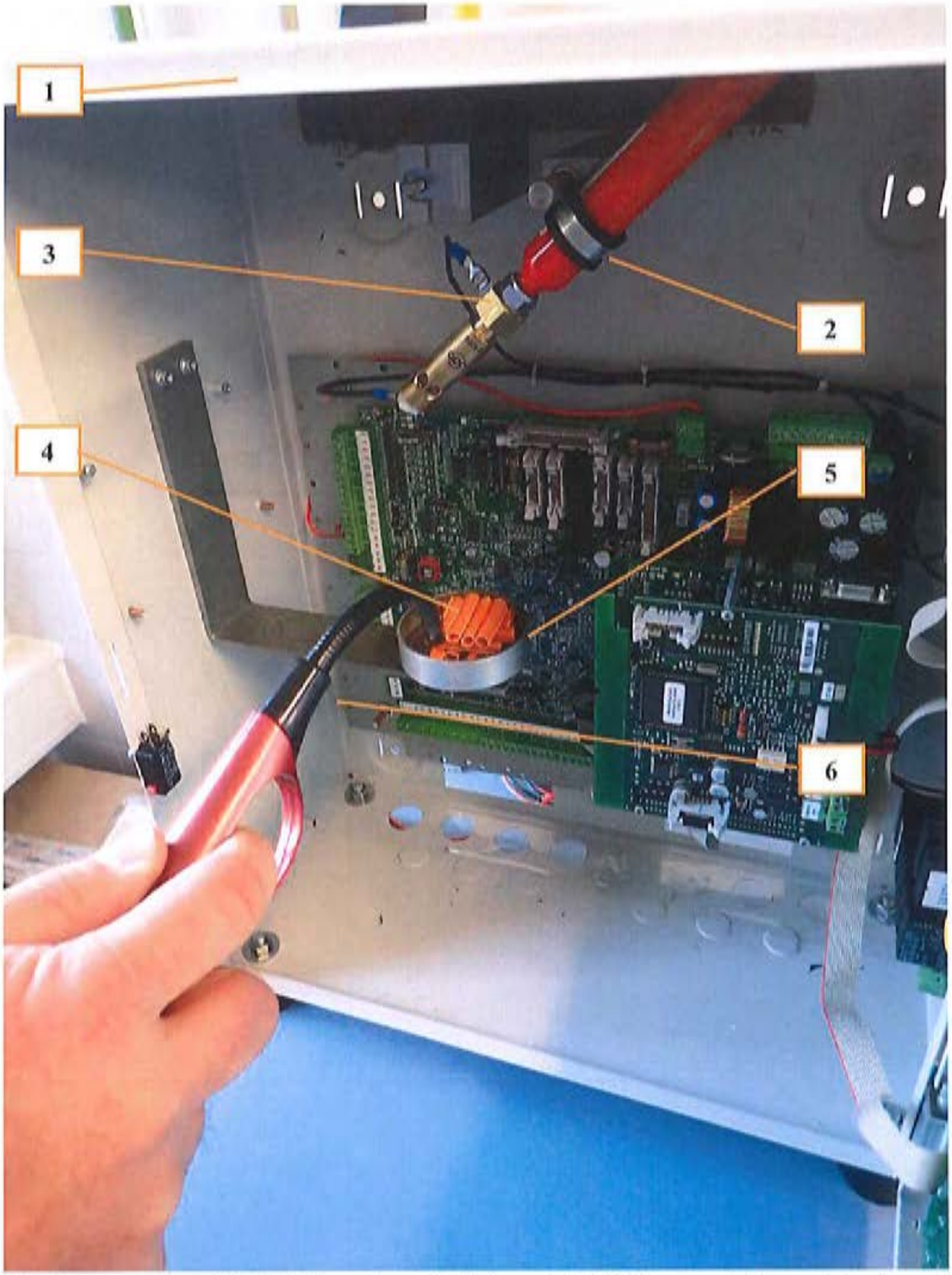

Fig. 6: Test setup: **(1)** FACU housing with fixtures **(2)** Holding bracket for mini extinguisher **(3)** AMFE mini extinguisher **(4)** Combustion material: cable insulation **(5)** Fire dish **(6)** Igniter

Fig. 7: Interior of the FACU housing with functionally ready S-R-AMFE mini extinguisher and combustion material (cable insulation) for the thermal triggering test (fire dish below the extinguisher)

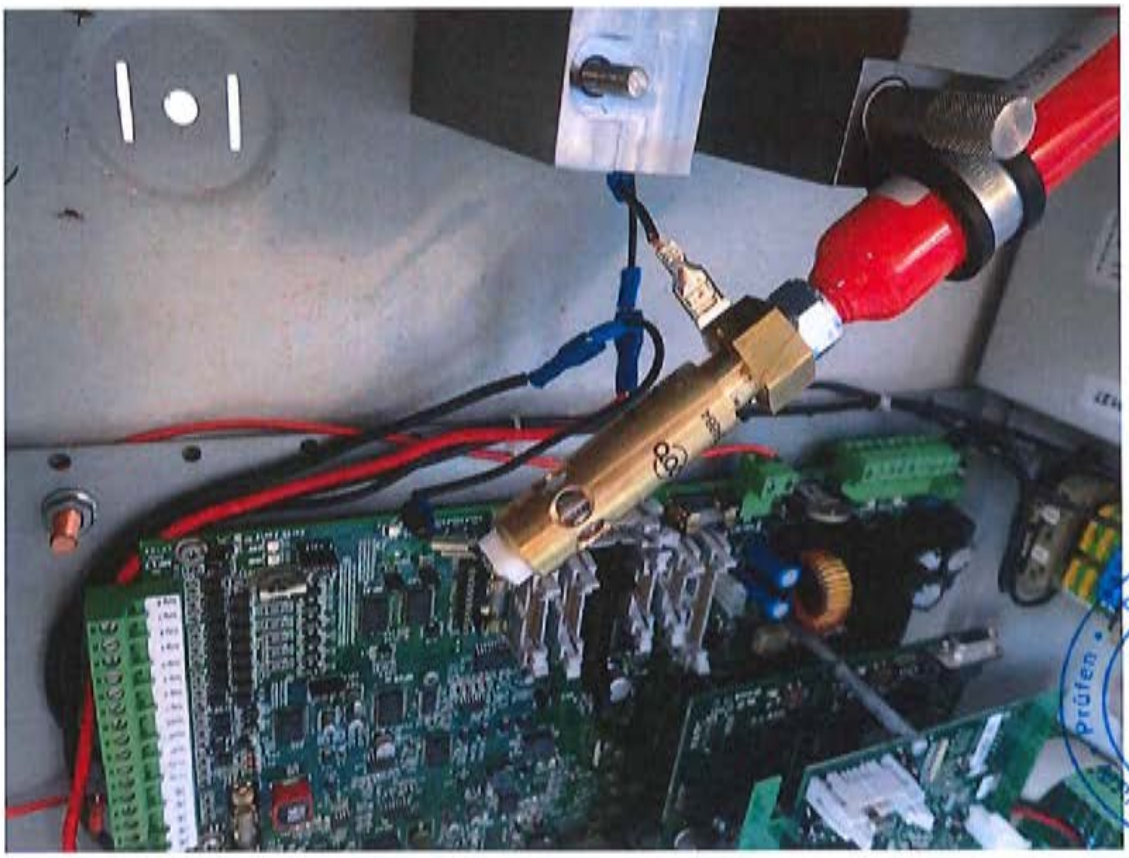

Fig. 8: S-R-AMFE in the functional state, electrical contact for signalling connected

4.2 R-AMFE

The test setup for the extinguishing tests with the mini extinguisher R-AMFE covered the following components and auxiliaries:

- Fire alarm control unit housing with functioning display panel (FACU) as fire chamber in the dimensions 42.0 cm x 49.0 cm x 21.0 cm (W x H x D)
- Holding bracket for the mini extinguisher
- Mini extinguisher R-AMFE with 24 ml 3M™ NOVEC™ cartridge and screwed-on triggering device consisting of a thermally /electrically triggerable glass ampule R type Thermo Bulb (triggering temperature 68 °C) and striking pin
- Holding bracket for the fuel dish
- Approx. 8 grams combustion material (12 pieces of cable insulation)
- Isopropanol (as back-up fire for uniform combustion of the cable insulation)
- Igniter
- Fire dish
- Manual switch with monitoring of the current flow for electrical triggering of the extinguisher

The spatial volume of the test setup was 43 litres. The basic test setup is illustrated in Figs. 6 and 7 (thermal triggering) and Fig. 9 (setup as in Figs. 6 and 7, augmented only by the equipment for the electrical triggering).

The examination comprised two series of tests (thermal triggering and electrical triggering) with one and the same test object.

The test procedure is described in more detail in the following.

The test series were differentiated by the manner of triggering the mini extinguisher. The first test series was performed with thermal triggering, the second test series with electrical triggering. Cable insulation of the type Draka UC900 SS23 Cat.7S/FTP 2x4P LSHF (Low Smoke Halogen Free) in 4 cm long pieces was used as combustion material in all tests.

The test plan for thermally triggering the system equates exactly to the test procedures for testing the extinguishing capability of the S-AMFE mini extinguisher described under 4.1.

For the test on the electrical triggering of the extinguisher, the fuel was placed to the side of the mini extinguisher so that no direct heating up of the R type thermo bulbs could take place. The electrical triggering was started by operating a manual switch after igniting the fire dish and the elapse of the pre-burn time and the closing of the FACU door (see Fig. 9). The actual triggering = the bursting of the R type thermo bulbs took place in these tests through the electrical heating up of the glass ampule by means of the printed conductive coating which, with the applied current flow of 0.5 A in this instance, fulfils the function of electrical trace heating.

After closing the FACU door, the triggering of the mini extinguisher and the extinguishing effect was recorded.

The complete exhausting of the extinguishing media from the mini extinguisher defined the end of the test. The FACU housing was then opened, cooled down in the ambient air and the next test setup prepared.

The test procedure was noted down in a log in which fundamental subjective observations during the test were recorded. This included, among other things, changes in the flame development (size, colour, intensity), noise development or visual and/or audible changes in the test object during the duration of the fire.

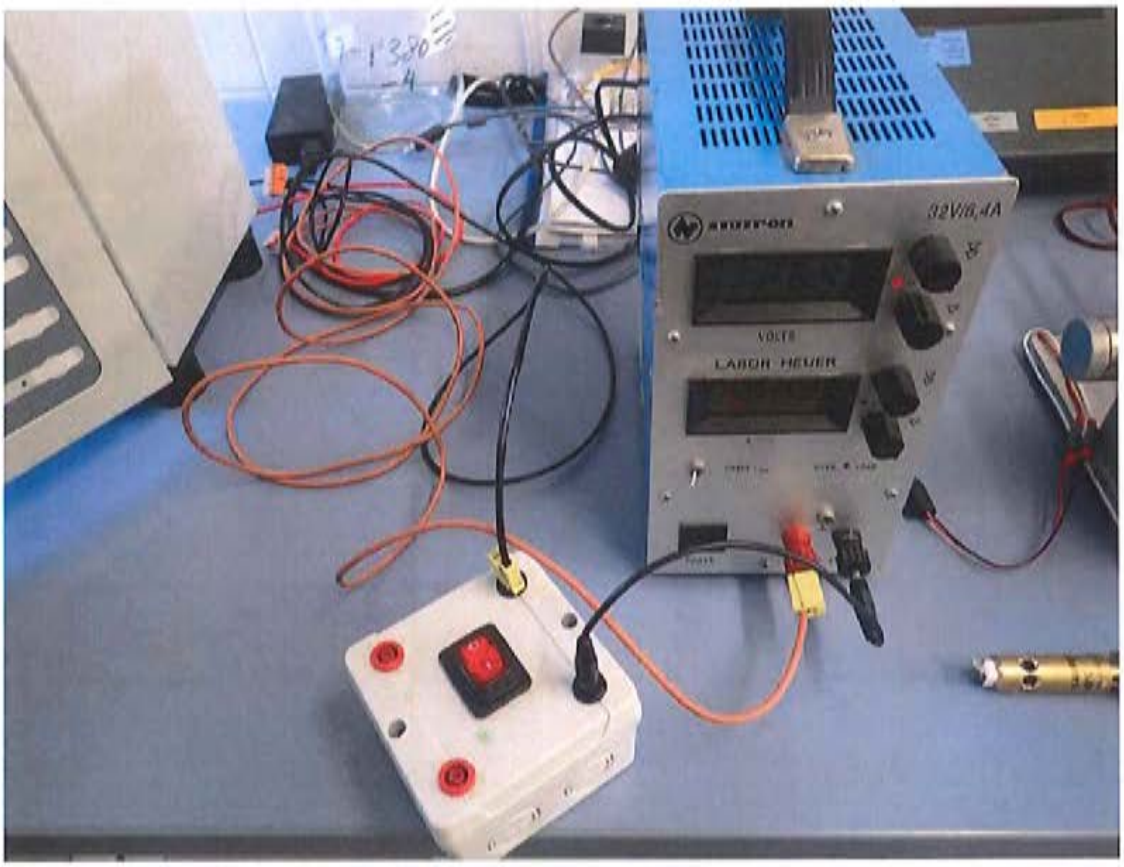

Fig. 9: Test of electrical triggering, interconnected electrical triggering device

Fig. 10: Test of electrical triggering, fire dish pushed to one side

4.3 E-bulb

The test setup for the extinguishing tests covered the following components and aids:

- Metal test base plate with mounted ampule holder.
- EC power supply housing as test housing (14.2 cm x 15.2 cm x 8.7 cm (W x H x D)) with standard existing mains connection and fan guard
- Fire dish
- E-bulb 6 mm x 40 mm
- Combustion material
- Igniter

The spatial volume of the test setup was 1.88 litres. The test setup is illustrated in Fig. 11.

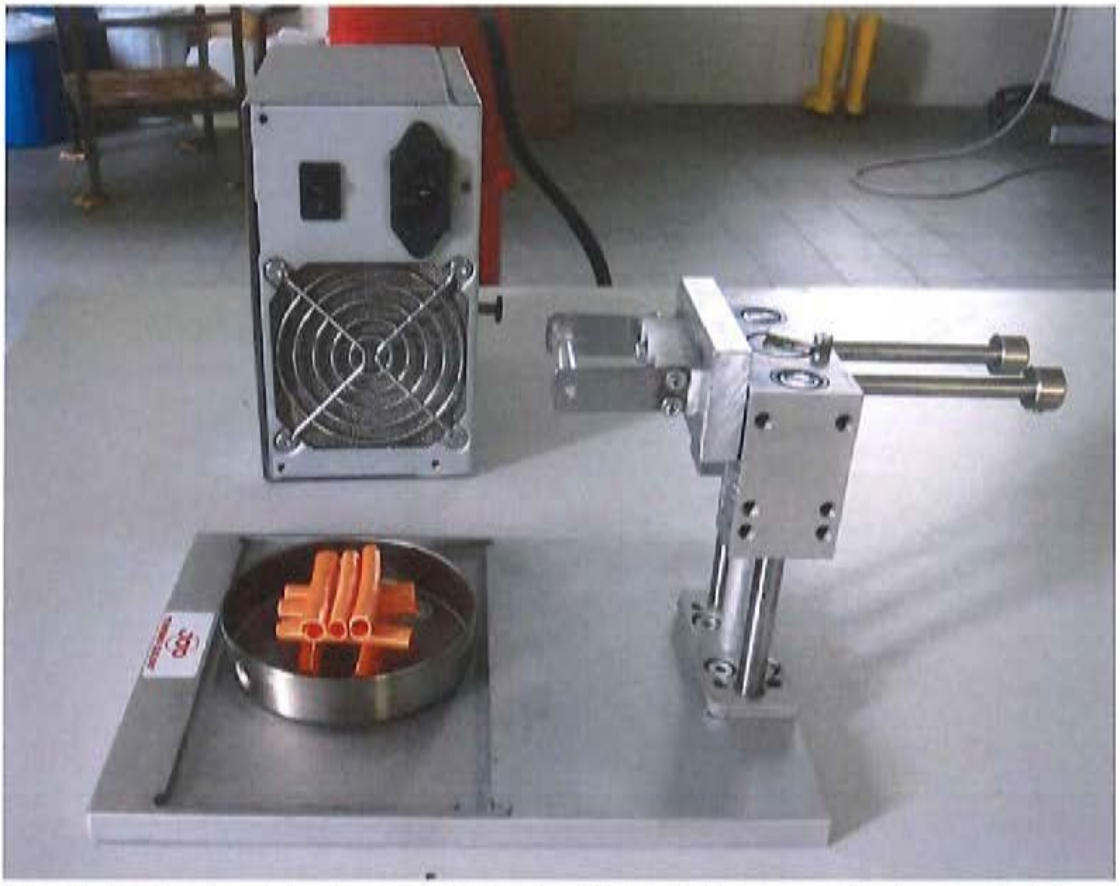

Fig. 11: Test setup side view with stacked cable insulation as combustion material, ampule holder with E-bulb in initial position outside of the fire dish; here: virtually identical test setup from the year 2013

The examination comprised one series of tests with one and the same test setup. Each test series included a maximum of three fire tests with the same quantities of combustible material, of which two tests had to be concluded positively. In the case of two consecutively positive test results, the third test was no longer performed. The test procedure is described in more detail in the following.

The combustible material used for the tests was:

- Cable insulation Draka UC900 SS23 Cat.7S/FTP 2x4P LSHF (Low Smoke Halogen Free) in 4cm long pieces

The test plan provided for combustible material to be stacked on the fire dish in previously determined and weighed quantities. The holder was then furnished with an extinguishing ampule and the combustion material completely ignited using the igniter (see Figs. 12 and 13). A lamp in front of the housing gave a visual signal of the functioning flow of current through the conductive paths of the E-bulb. The voltage supply was provided by a standard 9 volt battery.

At the time at which the combustible materials were ignited the extinguishing ampule was located at the rearmost stop point of the horizontally movable ampule holder at a height of 10 cm above the test setup base plate. After igniting the combustible material and placing the power supply housing over it, the ampule holder was pushed by hand into the functional position in the area of the fire dish. The existing housing openings on the EC power supply guaranteed a sufficient air supply and thus prevented the extinguishing of the combustible material due to a lack of oxygen. A functioning ventilating fan was not built into the housing. The influence of an engineered ventilation and/or extraction on the extinguishing effect of the ampules in the power supply housing cannot be evaluated with this test setup and was not an inherent part of the examination.

The pre-burn period in the case of all tests was consistently 15 seconds and started after the removal of the ignition source. After the elapse of the 15 second pre-burn time, the power supply housing was put in place as the spatial enclosure (see Fig. 14). The positioning of the extinguishing ampule was constructively selected so that the extinguishing ampule in its functional position was not situated exactly central above the fire dish but slightly offset to the rear (see Fig. 12 and 13).

The collapse of the extinguishing ampule defined the end of the test. The power supply housing was then cooled in the ambient air and the next test setup prepared.

The test procedure was noted down in a log in which fundamental subjective observations during the test were recorded. This included, among other things, changes in the flame development (size, colour, intensity), noise development or visual and/or audible changes in the test object during the period of the fire.

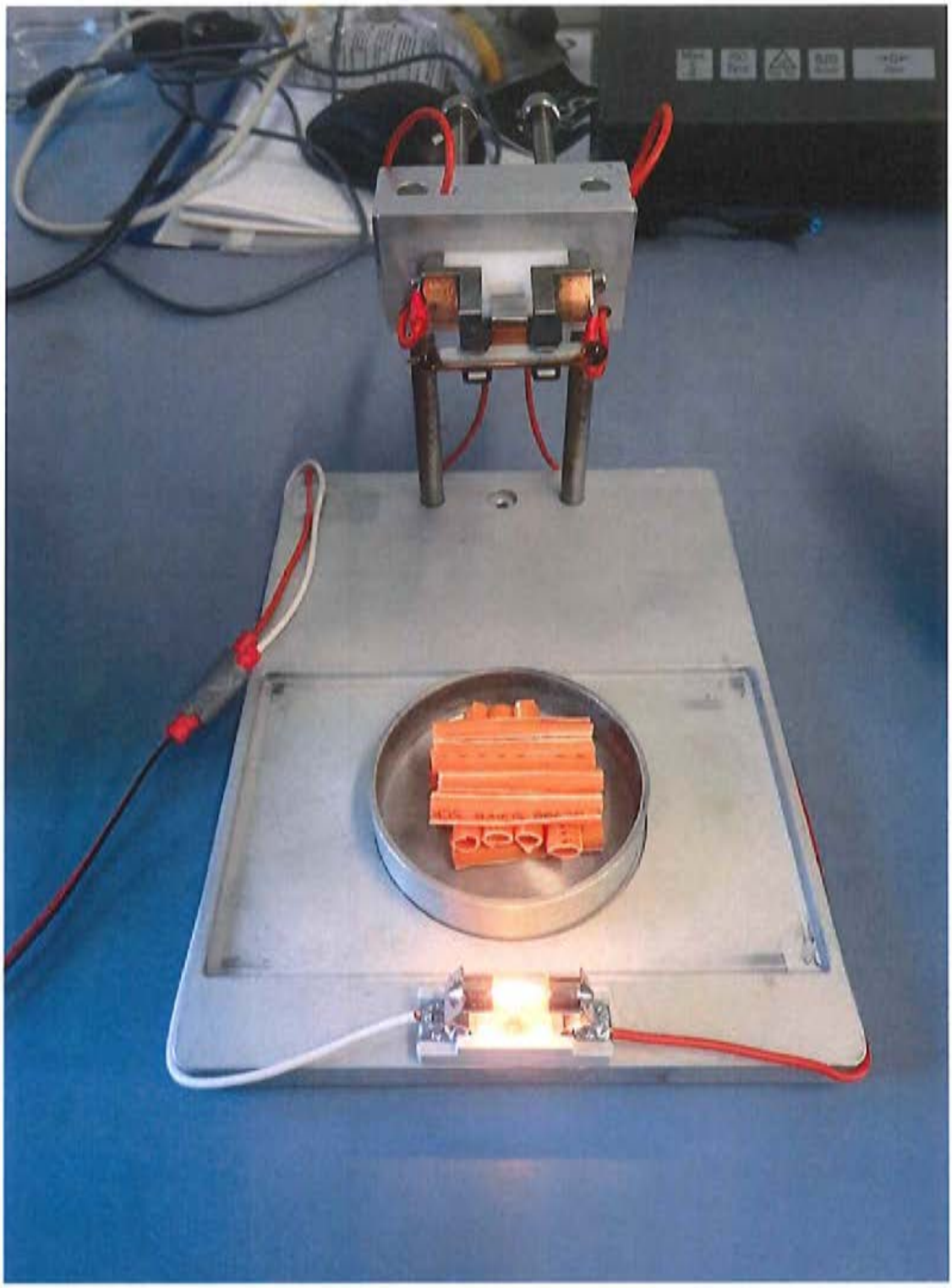

Fig. 12 Test setup without housing cover

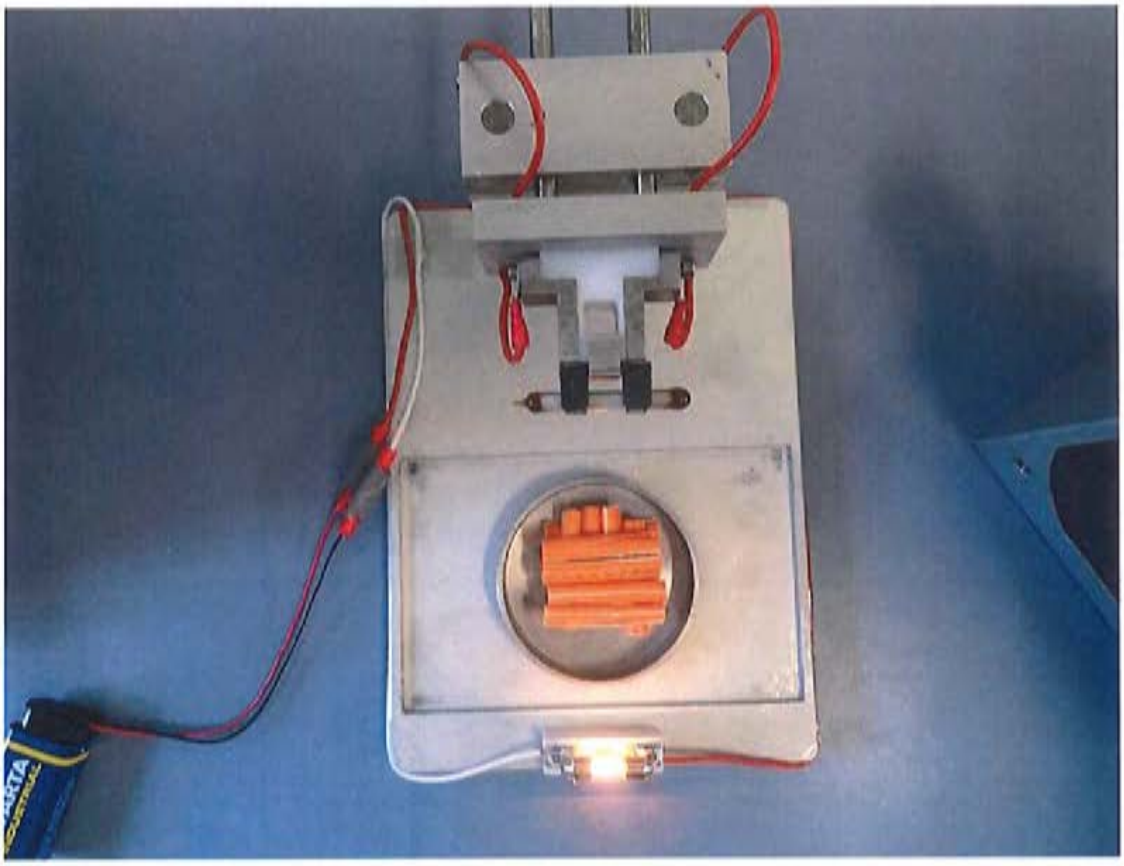

Fig. 13: E-bulb test setup, plan view with connected 9 volt battery

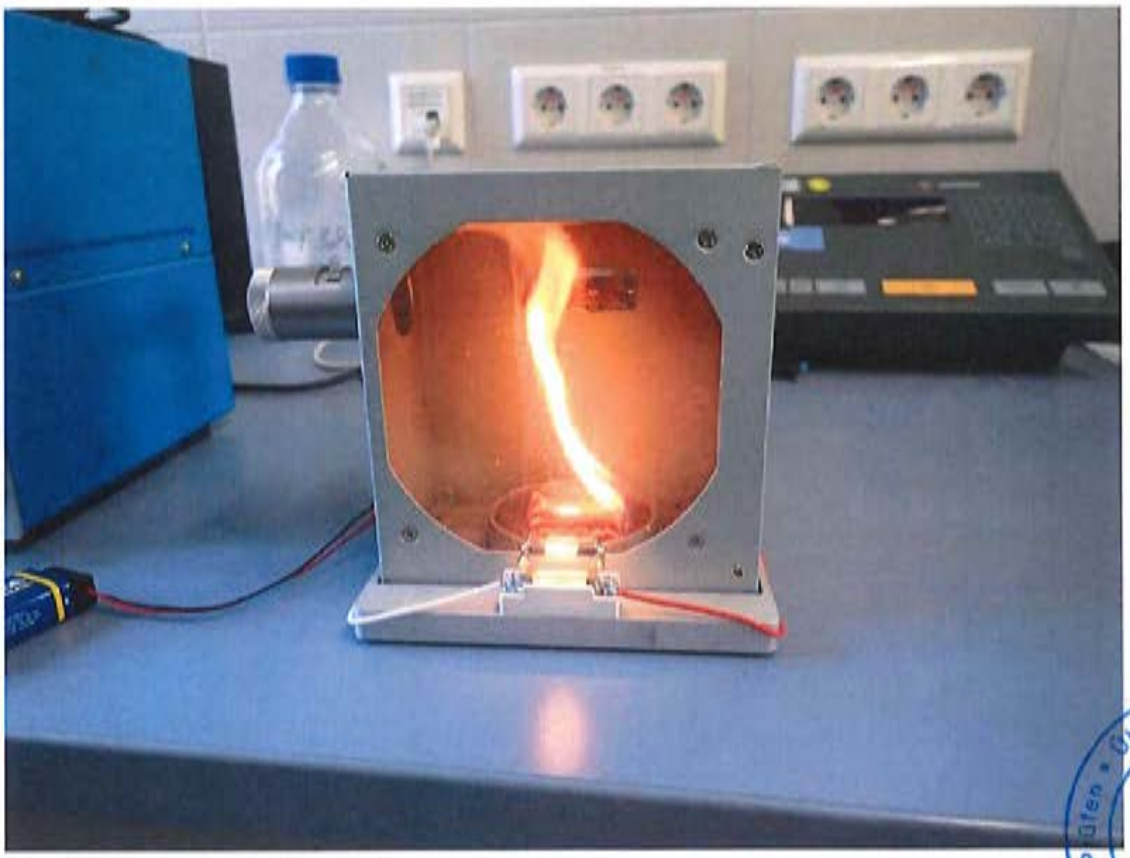

Fig. 14: Test setup with housing cover in place

5 Test results

5.1 S-AMFE and R-AMFE

All S-AMFE and R-AMFE extinguishers used in the course of the thermal triggering functioned as per their intended use and extinguished the burning material. The extinguishing process – triggered solely by the thermally provoked bursting of the S and R type thermo bulbs – was accompanied by a clearly audible and visible outflowing of the extinguishing medium.

The extinguishing in the test of the thermal triggering started a few seconds after the firing of the mini extinguisher with the bursting of the triggering glass ampule and escape of the extinguishing media with no measurable time delay. A timed record of the duration of the extinguishing process from the bursting of the triggering glass ampule to the extinguishing of the fire could not be implemented with justifiable time and effort and was not a constituent part of the tests (see Table 1).

The extinguishing in the test of the electrical triggering started a few seconds after operating the mini extinguisher triggering switch with the bursting of the triggering glass ampule and with no measurable time delay. A timed record of the duration of the extinguishing process from the bursting of the triggering glass ampule to the extinguishing of the fire could not be implemented with justifiable time and effort and was not a constituent part of the tests (see Table 2).

An extinguishing of the test fire due to lack of mass or lack of atmospheric oxygen was not detected in any of the tests. In each test there was still sufficient combustible material in the fire dish after the test fire was extinguished. The oxygen content of the surroundings was 21 % by volume. The structural design of the FACU housing (openings in the rear wall of the housing) moreover guaranteed an adequate air supply.

Table 1: Test series 1 – thermal triggering by means of firing

Test no.	Weight of combustion material in grams	Pre-burn time in seconds	Comments
1 S-AMFE	approx. 8	15	Status indicator LED green = "Ready" switched to LED red = "Released" (triggered) and LED yellow = "Calling Fire & Resc"
2 R-AMFE	approx. 8	15	Status indicator LED green = "Ready" switched to LED red = "Released" (triggered) and LED yellow = "Calling Fire & Resc"
3	--	--	Not necessary, 2 tests positive

Table 2: Test series 2 – electrical triggering by means of triggering switch

Test no.	Weight of combustion material in grams	Pre-burn time in seconds	Comments
1 R-AMFE	approx. 8	15	Triggering time 10 seconds until bursting of glass ampule Status indicator LED green = "Ready" switches to LED red = "Released" (triggered) and LED yellow = "Calling Fire & Resc"
2 R-AMFE	approx. 8	15	Triggering time 10 seconds until bursting of the glass ampule Status indicator LED green = "Ready" switches to LED red = "Released" (triggered) and LED yellow = "Calling Fire & Resc"
3	--	--	Not necessary, 2 tests positive

No re-ignition of the combustion material took place in any of the tests after opening the test setup. The combustion material had been completely extinguished, no glowing hot spots were determined.

5.2 E-bulbs

All E-bulbs used in the fire tests triggered in the course of the firing. The burning material was successfully extinguished in all tests. The extinguishing process – triggered by the collapse of the extinguishing ampule – took place along with a clearly audible bursting of the glass ampule (short pop). The current flow was interrupted, the visual signalling went out with the triggering of the E-bulb.

The extinguishing effect set in immediately with the collapse of the extinguishing ampule and without delay. A timed record of the duration of the extinguishing process from the collapse of the ampule to the extinguishing of the fire could not be implemented with justifiable time and effort (see Table 3).

An extinguishing of the test fire due to lack of mass or lack of atmospheric oxygen was not detected in any of the tests. In each test there was still sufficient combustible material in the fire dish after the test fire was extinguished. The oxygen content of the surroundings was 21 % by volume. The constructive design of the EC power supply guaranteed an adequate air supply.

Table 3: Test series 3 – thermal triggering of E-bulb through firing

Test no.	Weight of combustion material in grams	Pre-burn time in seconds	Comments
1	approx. 8	15	Fire extinguished due to the bursting E-bulb and release of the extinguishing agent, signal lamp off.
2	approx. 8	15	Fire extinguished due to the bursting E-bulb and release of the extinguishing agent, signal lamp off.
3	--	--	Not necessary, 2 tests positive

No re-ignition of the combustion material took place in any of the tests after opening the test setup. The combustion material had been completely extinguished, no glowing hot spots were determined.

6 Summary and conclusions

The agreed test procedure provided for stressing the mini extinguishers S-AMFE and R-AMFE within a defined spatial volume with fire loads. To this end, a fire alarm control unit housing was used for the mini extinguishers and a special test setup constructed; for the E-bulb test a conventional power supply housing was used.

The fire load was simulated by cable insulation which was ignited by hand with the aid of isopropanol. The pre-burn time of the combustible material was consistently 15 seconds. The test series comprised a maximum of three tests with uniformly consistent combustion material. After two consecutive positive test results the test series was ended and a third test dispensed with.

For the thermal triggering of the mini extinguisher AMFE, an S type and an R type thermo bulb were tested respectively. After the elapse of the pre-burn time, the fire load was inserted into the fire area below the mini extinguisher and exposed to the effect of the fire until the bursting of the thermally triggering glass ampule (triggering temperature 68°C). The extinguishing medium cartridges, filled with 3M™ Novec™ triggered in every test and extinguished the test fire. No re-ignition took place.

For the electrical triggering of the mini extinguisher AMFE, R type thermo bulbs only were tested. After the elapse of the pre-burn time, the mini extinguisher was started electrically and the bursting of the electrically heated up glass ampule (triggering temperature 68°C) was recorded. The extinguishing medium cartridges used, filled with 3M™ Novec™ triggered in every test and extinguished the test fire. No re-ignition took place.

The thermal triggering of the E-bulb was tested by the combustion of a defined fire load until the bursting of the thermally triggering glass ampule (triggering temperature 68 °C). The E-bulbs used, filled with 3M™ Novec™, triggered in every test and extinguished the test fire. The striven for visual signalling had functioned. With the bursting of the E-bulb, the signal lamp went out in every test as a visual indicator of the interruption of the flow of current. No re-ignition took place.

Under the given conditions of the test arrangement the S-AMFE and R-AMFE mini extinguishers tested are able to recognise and extinguish spontaneous, small developing fires. In so doing, by means of the new functionality of the tested S and R type thermo bulbs, a signalling of the fire recognition through to the raising of an alarm is possible. Besides this, the R type thermo bulbs can be triggered electrically due to the application of a suitable triggering current flow.

Under the given conditions of the test arrangement the E-bulbs tested are able to extinguish small developing fires. An interruption of the flow of current was verified.

The influence of an engineered ventilation and/or extraction on the extinguishing effect could not be evaluated with the test setups selected and did not constitute part of the tests.

According to information from the manufacturer, the quantity of the available extinguishing medium can be adapted to requirements. As to the variation of the triggering temperature (from 57 °C to 320 °C) as well as the triggering speed (e. g. ESFR glass ampules, i.e. early suppression - fast response glass ampules), there are numerous tried and tested glass ampules available on the market. These, however, did not constitute part of the test.

7 General notes

Only those facilities and materials as stated in this report have been used for the tests.

The test results relate solely to the specimens tested.

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Each page of this report has been endorsed with the official stamp of the company MPA Dresden GmbH.

2019-03-08

Dipl.-Forsting. Holger Romberg
Test laboratory manager

Prüfen • Überwachen • Zertifizieren • MPA Dresden GmbH

Appendix: Photographic documentation

Fig. 15: Control and triggering unit of the mini extinguisher S-AMFE with S type thermo bulb (linear conductive paths) and without extinguishing cartridge

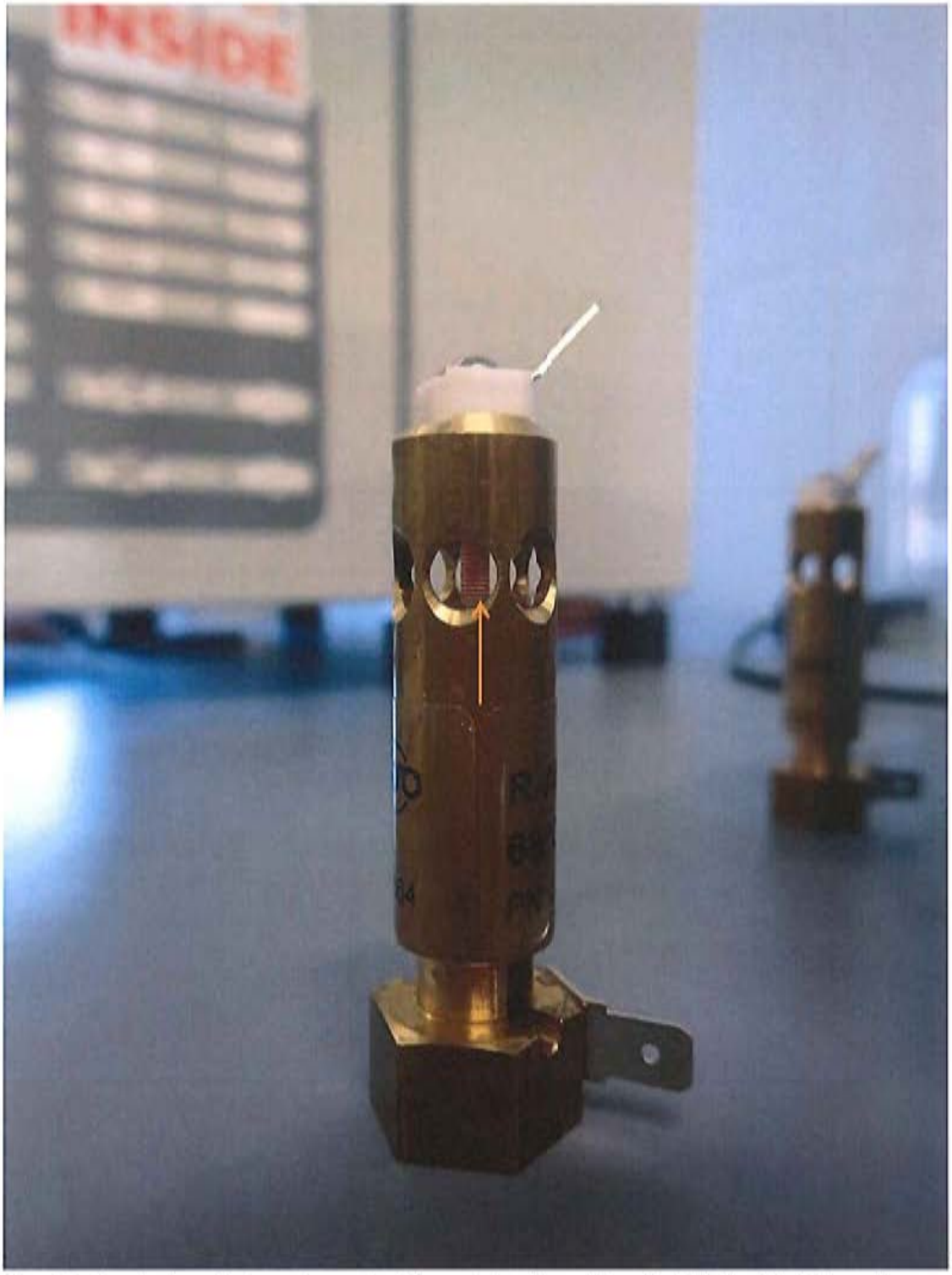

Fig. 16: Control and triggering unit of the mini extinguisher R-AMFE with R type thermo bulb, the meandering conductive paths are clearly visible on the R type thermo bulb (see arrow)

Fig. 17: Arrangement of the AMFE mini extinguisher in the FACU (standard for all tests)

Fig. 18: Test setup for thermal triggering directly before igniting the combustion material

Fig. 19: Introduced fire load = 12 pieces of cable insulation of the type Draka UC900 SS23 Cat.7S/FTP 2x4P LSHF (Low Smoke Halogen Free) at 4 cm in length

Fig. 20: During the test, test series for thermal triggering

Fig. 21: System has triggered and extinguished, traces of extinguishing medium fluid clearly recognisable on the FACU viewing window

Fig. 22: FACU with status indicator "Ready" at commencement of test

Fig. 23: Mini extinguisher S-R-AMFE has triggered, status indicator switched from "Ready" to "Triggered"

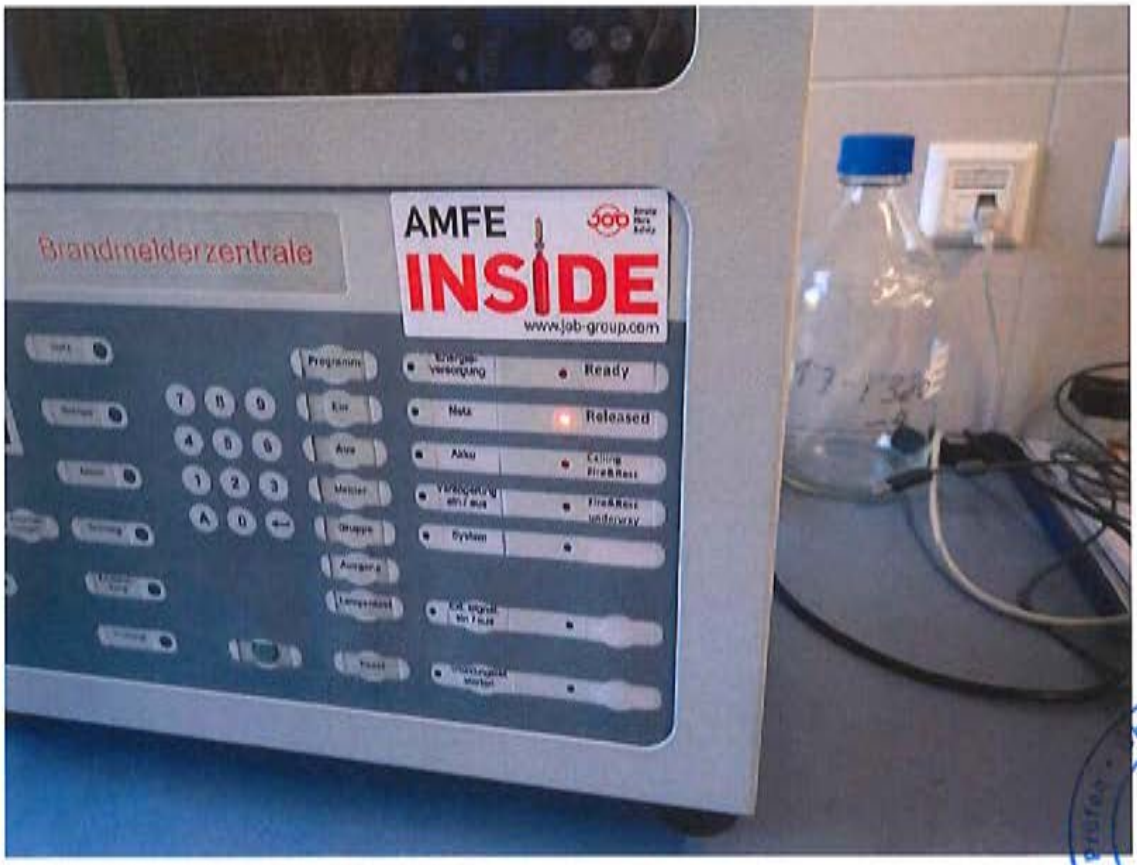

Fig. 24: Status message "Triggered"

Fig. 25: S-R-AMFE control and triggering unit after triggering, thermo bulb has burst

Fig. 26: S-R-AMFE control and triggering unit prior to and after triggering

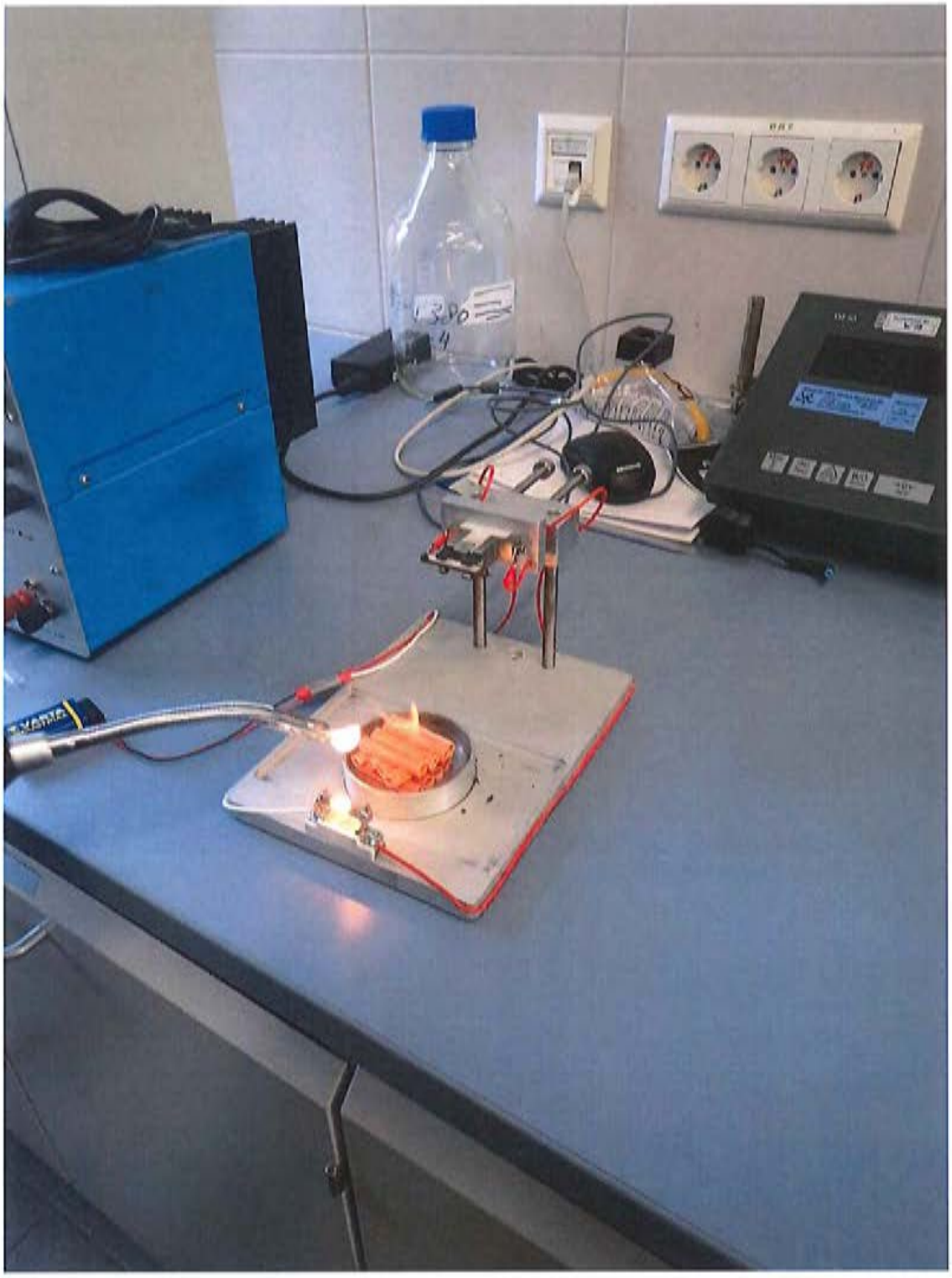

Fig. 27: Ignition of fire load for E-bulb test, signal lamp clearly visible for visual illustration of the flow of current

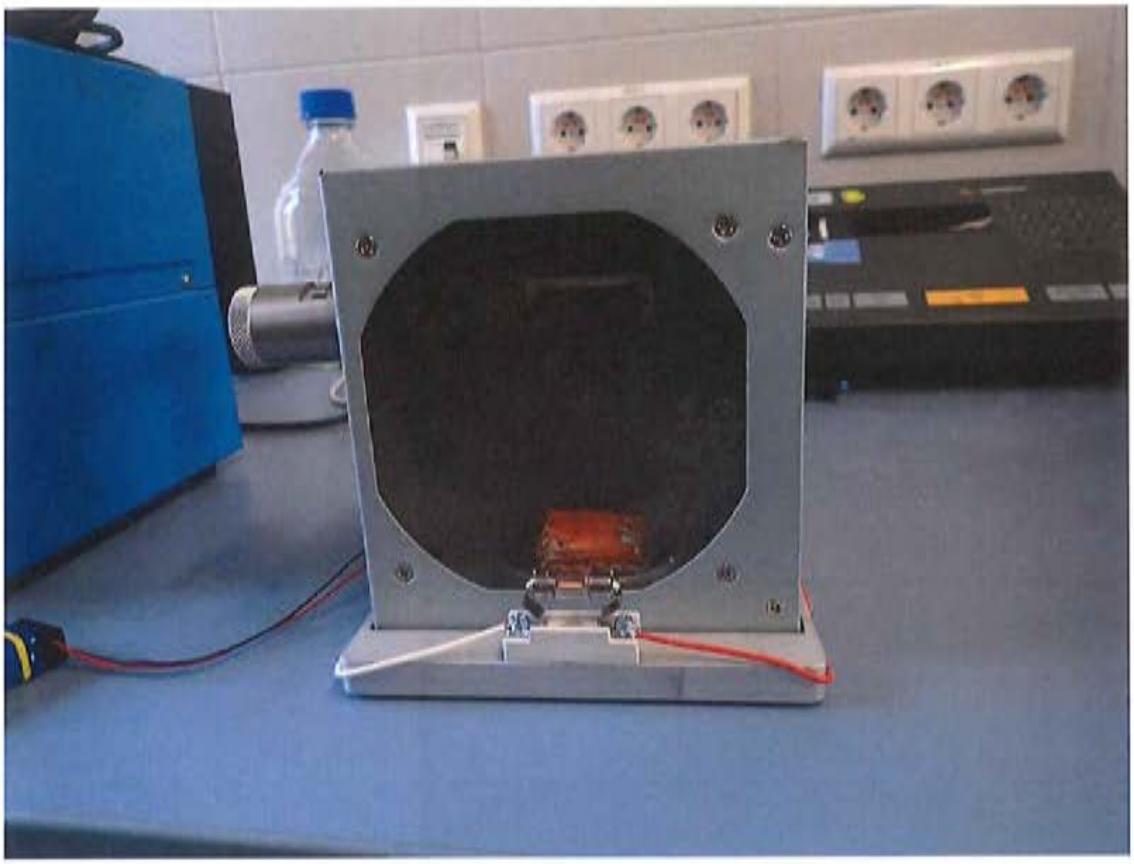

Fig. 28: E-bulb has triggered, signal lamp off

Certificate

No. BS3.20180828.131352 V1.0

TÜV NORD Systems GmbH & Co. KG hereby certifies to

JOB GmbH

Kurt-Fischer-Straße 30
22926 Ahrensburg
Germany

that the automatic mini fire-extinguishing system

S-AMFE

meet the requirements listed in the below mentioned standards

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ARGE-Guideline Part 2 i.c.w.
ARGE- Guideline Part 1 and
DIN EN 45545-2:2016-02, Section 4.2h

- Variants of the S-AMFE and limitations see Annex to this Certificate

The extinguishing effectiveness of the S-AMFE has been demonstrated basically by test flooding tests with the measurement of concentration in sample technic cabinets. In the concrete case of application of the AMFE the extinguishing effectiveness must be proven according to section 3.2 ARGE-Guideline Part 2.

Certification Programm Brandschutz (SEB-ZE-SEECERT-VA-320-40, Rev. 3/9.15)

Base of certification is the report No. BS3.201702313.084846 V1.0 form 08.06.2018 and the annex to this certificate.

Valid until: 14.09.2023
File reference: 8116187199

Hamburg, 14.09.2018

Tobias Nelke
(Head of certification body)

Certification Body SEECERT
TÜV NORD Systems GmbH & Co. KG
Große Bahnstraße 31, 22525 Hamburg, Germany

Annex to Certificate

BS3.20180828.131352 V1.0

1) Variants

Variants S-AMFE	Size Diameter x Length [mm]	Capacity [L]	Description Mounting clamps	Quantity extinguishing agent (NOVEC) [ml]
#0	22 x 133	0,026	RGSS 22	24
#1	35 x 149	0,080	RGSS 35	72
#2	40 x 179	0,133	RGSS 40	120
#3	50,8 x 226	0,267	RGSS 51	241
#4	50,8 x 311	0,400	RGSS 51	360
#5	60,3 x 357	0,670	RGSS 60	603

2) Quantity of the mounting clamps

The required number of mounting clamps for the different variants of the S-AMFE can be found on page 12 of the document "Handling and Safety Instructions - AMFE series (with 3MTM NOVECTM), Version 2.1_EN (April 2018)", produced by JOB GmbH.

3) Tripping temperature of the glass ampoules

For the mentioned variants of the S-AMFE under point 1, the validation of the nominal tripping temperatures for the glass ampoules used for 68°C, 79°C, 93°C and 141°C are provided by VdS test reports.

4) Railway suitability

The railway suitability for the temperature class T1 (-25°C to +55 °C) acc. to EN 50155

and

the moist heat (+25°C, +55°C, 80% to 96% rel. humidity) acc. to DIN EN 60068-2-30 are proved.

The spray nozzle of the S-AMFE has two electrical contacts for triggering the signal of the release.