ARGE Guideline - Part 1

“Fire detection in railway vehicles”

Functional assessment for positioning fire detectors in passenger and staff areas, electrical cabinets and in areas with combustion engines

Guideline/Testing instructions

Rev. No.	Date	Responsible	Comment
1.0	03-30-2007	ARGE	Adoption
2.0	06-14-2007	ARGE	1st Update
3.0	11-19-2009	ARGE	2nd Update
4.0	09-09-2012	ARGE	3rd Update
5.0	09-10-2018	ARGE	4th Update
5.1	15.11.2018	ARGE	Update

This Guideline is the result of a cooperation of the Detection Technology Consortium (ARGE)

ARGE Guideline - Part 1
“Fire detection in railway vehicles”

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1. General

The purpose of the Guideline is the functional assessment of fire detection systems related to the determination of their response time depending on their specific positioning. It respects criteria such as smoke, heat and radiation from possible fire incidents in railway vehicles.

The assessment focuses on positioning of fire detectors in passenger areas as well as inside technical equipment of railway vehicles.

The rules and standards in the present document are valid in their latest version.

1.1. Preface

The Technical Specifications for Interoperability (TSI), the current generally accepted technical rules and the European Standard EN 45545-6 include requirements for the installation of fire detection systems. Some requirements for the assessment procedure are included in Standard EN 50553. The purpose of Standard EN 50553 is to define requirements for railway vehicles in terms of running capability in case of fire, whereas the ARGE Guideline focuses on the aim “to protect passengers and staff”. Thus, the assessment procedures are more conservative than the requirements in Standard EN 50553.

To provide complete planning guarantee for the installation of fire detection systems in railway vehicles, system specific requirements for design, construction and assessment are needed.

This Guideline identifies the required criteria for the practical assessment.

1.2. Objectives

With respect to the protective aims defined in laws, regulations and generally accepted technical rules a fire incident must already be detected during the formation phase (e. g. smoldering fire) or after the inflammation (e. g. liquid fire). The requirement is to protect passengers and staff in railway vehicles. The objective is to ensure health conditions acceptable for a safe evacuation, which is also intended by TSI and the series of standards of EN 45545.

The objective is a consistent and repeatable assessment process for fire detection technology in railway vehicles applicable in passenger areas and for technical equipment. Other assessment processes or the use of invalid processes are currently not repeatable or specified by differing objectives (e. g. EN 50553). These are not suitable for the assessment process regarding the objective of this Guideline.

1.3. Acceptance

Since its release, the ARGE Guideline has been a generally accepted code of practice in the process of railway vehicle accreditation.

1.4. Scope

This Guideline is used for verifying the correct and functional position of fire detectors, whereas smoke, hot gases or flames must be detected within the defined time in the fire scenario.

- It is recommended to use the Guideline for the system design, i. e. determining the positioning of the detectors with respect to the potential fire starting points and the related fire development as well as to environmental conditions that may occur during operation. This can be done by the manufacturer/supplier of the fire detection system or by the vehicle manufacturer.
- The application of the Guideline for assessing the specified function serves the final verification of the detector position and detector selection in terms of confirming compliance with the time limit for fire detection. The assessment must be acknowledged by officially recognized experts in collaboration with the manufacturers/suppliers, so that an assessment is available for the approval body.

1.5. Validity

This Guideline applies to the use in railway vehicles and other track guided systems equipped with fire detection systems.

As necessary the Guideline can be applied to comparable technical systems (e. g. buses).

2. Test specification for the functional assessment of detector positioning and detector selection

This test specification focuses exclusively on positioning and selection of the fire detectors in relation to the potential fire starting points.

To meet the requirement of early fire detection, the following test criteria have been defined:

A) Testing detection of fire – smoke as parameter:

1. The simulation of smoke release in passenger areas (e. g. passenger compartments, lobbies, WCs) is based on the test fire "burning of a travel bag ignited by a 100 g paper cushion" /P-1/.

   Note:

   - The smoke release of a UIC paper cushion is not sufficient for a fire detection. It is only a repeatable ignition source which develops fire effluents in combination with the ignition object (travel bag or equivalent).
   - In EN 50553, the test fire for passenger and staff areas is defined as ignition model 5 from EN 45545, Appendix A. However, in this case, ignition model 5 does not represent the real/increasing fire development during the development phase.

2. The simulation of smoke release in electrical/technical cabinets is based on the test fire "cables with thermal overload"/P-1/.

   Note:

   In EN 50553, the test fire for electrical/technical areas is defined as a test with an "alternative burner", according to ISO/TR 9705-2, "Fire behavior of construction materials". This test is not fully based on real fire scenarios inside technical areas; in particularly for electrical devices in railway vehicles.

3. For the simulation of smoke release, thermally driven cold smoke or fog generated from a fluid is used. Over the test period, the smoke release is increased in accordance with the defined test fire criteria.

   Note:

   - The geometric requirements regarding thermal power generation of the fog must be fulfilled. The generated fog must not decompose by the thermal lift. If the fog does decompose, another fog fluid (e. g. "Slow Fog", supplier LookSolution) can be used. This validation of changes regarding the requirement above must be proven.
   - For the proof of smoke detection EN 50553 refers to EN 61034-1 "Measurement of smoke density of cables burning under defined conditions". The requirements for measuring the smoke density described therein, in this case based upon cable burnings, might be insufficient for assessing the

position and selection of fire detectors e. g. in passenger areas. In addition, it would require a disproportionate amount of effort in the real vehicle.

- The fire detection system in **passenger and staff compartments** must respond within **60 seconds** after the beginning of smoke release under all operational conditions.

  The response time of 60 seconds may be exceeded by 100% at maximum if the following two conditions are fulfilled:

  - The operatating company accepts this variation in connection with the notified operational concept. In addition, there is a confirmed evacuation concept for the scope of application which takes into account escape and evacuation situations in the infrastructure.
  - The fire detection system is not being used for initiating a self-rescue from the train, for activating the closing mechanism or for deactivating hold-open devices for fire barrier doors, or for activating a fire suppression system.

Note:

In EN 50553 there is no response time specified for the protection of passengers and staff. To guarantee the function of railway vehicles regarding passenger and staff areas the response time is 2 minutes. To guarantee the aim "to protect passengers and staff" in combination with the considered reaction and evacuation time of passengers the ARGE experts evaluate this time as too long.

In **technical areas** the fire detection system must respond within **120 seconds** after the beginning of the cold smoke release under all possible operational conditions (note external ventilation influences during vehicle running).
In contrast, in **technical areas with combustion engines** the response time may not exceed **60 seconds** because of the high risk of extensive material damage.

Note:

In technical areas with combustion engines smoke should generally not be used as parameter for fire detection because of the risk of contamination resulting in low system availability.

The specified period of time includes the alarm transmission from detector to persons (passengers and/or staff).

B) Testing detection of fire – temperature as parameter:

1. For the assessment process the simulation of temperature development in places of technical equipment is not practicable, is too complex and partly hazardous.
2. The installation of heat detectors has been specified based on 1:1 fire tests in technical cabinets [see Appendix 7]. The correct geometrical arrangement of the detectors, taking into account the aerodynamic conditions, can be visually verified in the monitored area.

3. In large technical areas with forced ventilation (e. g. engine rooms) and in equipment installed outside of the vehicle body (e. g. underfloor areas), the correct spatial arrangement of the detectors must be demonstrated in connection with the aerodynamic conditions in the monitored space or area by numerical fire simulations or equivalent methods (e. g. fire test). The simulations are subject to determined inputs and/or simulation conditions [see Appendix 8].

   Note:

   EN 50553 also refers to CFD modelling for technical areas (electrical areas and engine rooms). However, for such simulations, no input criteria or conditions are defined. Concerning the ignition source, reference is made to the ignition model 5 from EN 45545, Appendix A.

4. For the installation of line detectors in underfloor risk areas, an assessment process is not necessary, if the risk areas determined by the fire hazard analysis are completely and directly monitored. Operational influences (e. g. aerodynamic conditions) have to be taken into account.

Note for the system concept:

In passenger areas, temperature should generally not be used as parameter for fire detection because the result is an advanced fire incident with significant consequences.

Detection using the parameter temperature in passenger and staff areas is allowed, when the ensured and verified response time does not exceed 60 seconds.

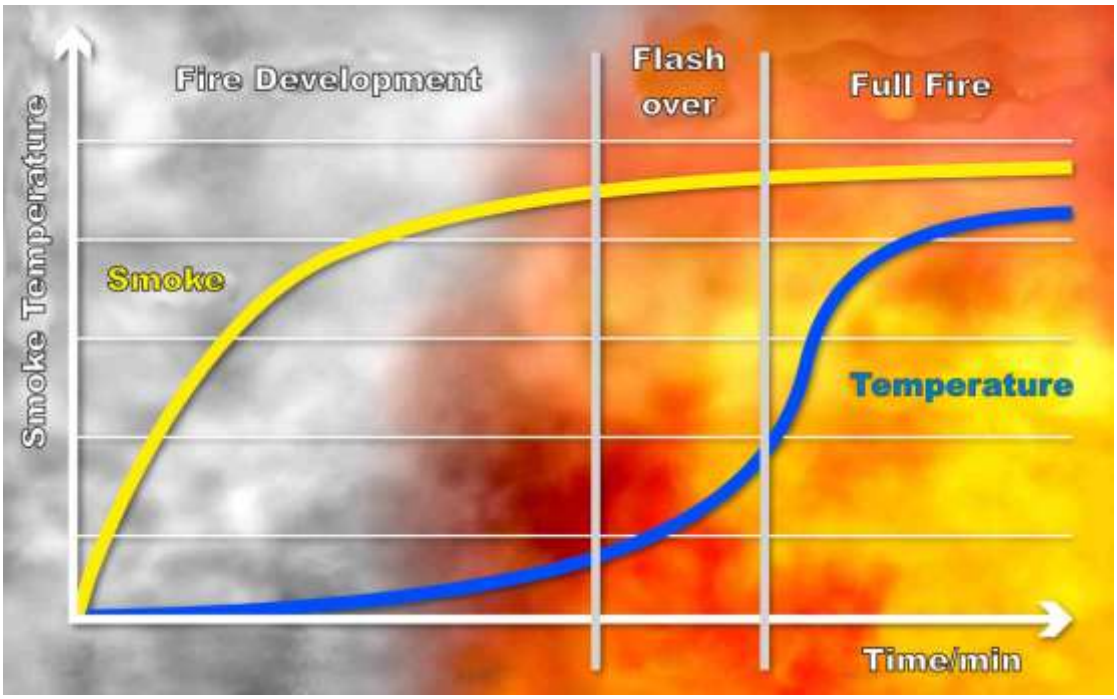

Figure 1: Schematic of smoke and temperature development of fire

The system functionality including fault simulations and the related reactions of the fire detection system and/or the signals released are not part of this test specification. These topics are considered in ARGE Guideline - Part 3.

The system functionality has to be specified by the vehicle operating railway company, as here, the focus lies on reliability and availability of the system. For the system design, this is an important design basis.

3. Assessment for detector positioning and selection

The assessment process verifies that the installed fire detection equipment can detect a fire incident in accordance with the specification.

The type testing (functional test of the interface between fire detection system and vehicle) should also be applied during the system design. This ensures a high probability of success for the type testing.

EN 50553 does not define any parameters related to assessment processes.

3.1. Independent evaluation

The evaluation complies with the appropriate approval process of the railway vehicle, for example:

- inspection body ISO/IEC 17020 Type A, accredited as specialist for fire safety in railway vehicles, with European evaluations of conformity according to the Technical Specifications for Interoperability (TSI),
- expert which is acknowledged by the appropriate body in the national approval process or
- other national acknowledged bodies.

This also applies to deviations from evaluation criteria mentioned in this Guideline.

Note: The test should be performed by a test center which is acknowledged according to ISO/IEC 17025, accredited according to this Guideline.

3.2. Requirements for system validation

To carry out the tests, at least the documentation that describes the system functions must be available.

A successfully type testing requires analysis of the general function with regard to railway standards, reliability and environmental conditions.

Assessments from accredited test centers or test laboratories will be accepted. Reference is also made to the requirements according to EN45. For the fire detection elements proof must be provided in accordance with the standards EN 54 and EN 60730 by submiting a test report or a certificate.

3.2.1. Vehicle parameters

For planning and performing the tests, the following information related to the test object (passenger area or staff area or technical area) are needed:

- Description of the individual railway vehicle or the semi-permanently coupled train set, in line with the operational use and the associated ambient conditions (e. g. tunnel operation)
- Control and regulation concept for the HVAC units (in terms of ventilation, heating, cooling, humidifying, dehumidifying, air freshening) and air flow system (assembly of air ducts and air entrance/outlet, dynamic or static exhaust air routes)
- Information on door and window openings and their possible handling (e. g. open in normal service or only if ventilation equipment fails)
- Information on ventilation concepts of technical cabinets and machine rooms (e. g. static or dynamic ventilation)
- Information on areas or components with a fire risk in technical areas; refers mainly to staff areas and technical cabinets as well as to machine rooms for which the detection concept is designed - reference to fire risk assessment (in accordance to EN 45545-1).

The vehicle operation mode at the time of testing has to be documented. Deviations to the possible operation modes have to be identified and evaluated in terms of their impact (note the situation in pre-series vehicles, prototypes or future conversion vehicles). In case of non-acceptable deviations, verification tests can be required.

This situation shall also be considered in terms of preconditions for system specification tests, e. g. at an older type of railway vehicle.

3.2.2. System parameters

For planning and performing the tests, the following information related to the fire detectors connected within the system is needed:

- Description of the fire detection system concerning the fire detectors function within the system (e. g. single function, collective function, redundant function)
- Description of the fire detector types and their positions (including possible variations) in the vehicle or the monitored area
- Proof of compliance with requirements for use in railway vehicles, possible requirements deviating from standards must be taken into account (e. g. corresponding conditions concerning operation and storage temperature).

If assessments based on other standards are submitted, equivalent assessments shall also be submitted.

3.2.3. Test equipment parameters

The requirements for the simulation of the "fire parameter smoke" and for the thermal lift characteristics are defined in Appendix 5 and 6.

This concerns the requirements of the fog generator e. g. fog intensity and controllability (e. g. “Viper NT from Look Solutions”), on the fog fluid in terms of stability and dwell time of the fog (e. g. “Regular-Fog” from Look Solutions) and the requirements for the thermal lift (hot gas generation).

As different fog generators might be used, they must meet certain minimum requirements [see Appendix 6].

The equipment for generating thermal lift (fire pan) has to be designed and operated according to the requirements [see Appendix 5]. The specification of the thermal lift determines the maximum allowed size of the fire pan. Smaller dimensions are to be considered as conservative. This is shown by the test report [P-5].

Appropriate assessments have to be made and to be confirmed in the template according to Appendix 2 (focused on the characteristics and assessment of the test equipment) with a reference to the calibration document.

Following a successful assessment according to /P-1/ alternative simulations concerning the “fire parameter smoke” are permitted.

3.3. Preparing and performing the tests

The potential fire risks determine the testing.

3.3.1. Passenger and staff areas

In passenger areas fire risks are defined by possible vandalism. For this reason the positioning of a 100 g paper cushion (with reference to UIC 564-2) at any point of the vehicle interior according to the following generally accepted technical rules requirements (with reference to EN 45545-1) is mentioned as example.

Therefore, the positioning of the test equipment and the realization of the test smoke's thermal lift should be focused in areas which

a) are most unfavorable for quick fire detection,

b) permit hidden ignition,

c) can be used for storage of larger items of travel luggage.

The tests have to be performed with all possible air ventilation situations in service (e. g. ventilation ON, OFF, heating, cooling). Thereby individual tests can be omitted if the related situations are covered by other similar air ventilation situations.

3.3.2. Technical areas

Tests in technical areas such as technical cabinets require information on potential fire risks. This concerns, among other things, switching components for higher electrical power or components with hot surfaces in cases of failure.

The blow-out point of the test smoke should be located where

a) the risk-bearing component is most unfavorable for quick fire detection,

b) the air volume flow for heat removal at the risk-bearing component is the lowest,

c) permanently hot surfaces can occur by liquid fire loads in cases of failure (e. g. diesel engine rooms and hydraulic systems).

The tests have to be performed using all possible air ventilation situations in service (e. g. ventilation ON, OFF). Thereby individual tests are not necessary if the related situations are covered by other similar air ventilation situations.

The thermal lift of the test smoke is not necessary for situation assessments in areas with high air ventilation.

If the assessment cannot be provided within the test (e. g. at non- ventilated equipment enclosures or containers of low construction height), the deviation has to be assessed by an authorized expert.

3.3.3. Test report

The test report on the assessment of the functionality of fire detectors shall be written based on the corresponding templates [see Appendix 2 and Appendix 3].

Picture documentaries illustrating the test results have to be included. This concerns, among other things, the test layout (hot gas thermal lift and fog generator) and the position of the fire detectors.

4. Revisions of the Guideline

ARGE is exclusively responsible for changes and updates of the Guideline as a result of technical discussions and exchange of experience. Current findings in connection with the application of the Guideline are taken into account.

The leading editorial work is supervised by TÜV SÜD.

TÜV NORD ensures the "4-eyes principle".

Editorial work:	**TÜV SÜD Rail GmbH** **Schützenstraße 15-17** **10117 Berlin** **Germany**	**TÜV NORD Systems GmbH & Co.KG** **Große Bahnstraße 31** **22525 Hamburg** **Germany**
	TÜV Rheinland AG **Am Grauen Stein** **51105 Cologne** **Germany**	

5. Literature references

If necessary, the non-published documentation listed below can be viewed at TÜV NORD or TÜV SÜD Rail, due to internal analysis of the ARGE consortium.

/P-1/ Report about determining the simulation basic conditions for cold smoke tests for fire detection by smoke detectors.

/P-2/ Report about performed fire tests for estimating the temperature development in places of installation for fire detection by heat detectors (e. g. technical cabinet).

/P-3/ Test report - Fire tests of ARGE consortium for validating the fire simulation programs FDS and Kobra 3D for proving the correct detector positioning (sense of temperature) in large places of installation (e. g. in engine room) and in mechanical equipment installed outside of the vehicle (e. g. in underfloor area).

/P-4/ Assessment for identifying fog generation characteristics – calibration of fog generators.

/P-5/ Assessment for fire pan layout concerning thermal lift.

/P-6/ Test report about the assessment of gas burner (Fa. Fogtec 10-2014)

List of appendixes

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Appendix 1 Abbreviations, definitions and terms

A) Abbreviations

ARGE	Arbeitsgemeinschaft-Brandbekämpfungstechnik – Consortium – Fire detection technology
TSI	Technical Specification for Interoperability
UIC	UNION INTERNATIONALE DES CHEMINS DE FER - International Union of Railways

B) Definitions and terms

Refer to **EN ISO 13943** Fire safety – Vocabulary and the **EN 54** standards.

Areas with technical equipment	Places of installation separated from passenger and staff areas for electrical installations or machinery, which are not intended to be accessible to passengers. These areas or containers housing electrical or electronic components or equipment requiring monitoring such as batteries, fire load carrying systems or engines.
Certificate	Document based on functional tests of the components regarding defined basic conditions.
Cross Acceptance	Mutual agreement of assessments or certificates with the same intention.
Fire detection system	Total of all devices and components matched for functional interaction.
Flow condition	Operation-related air flow situation in a separated area (e. g. static or dynamic ventilation), or an outside area.
Fog generator	Device producing an aerosol from a fluid for test purposes.
Mechanical equipment	Technical or drive system installed inside, under or on top of railway vehicles.
Place of installation	Room or enclosure to house technical equipment such as technical cabinets, equipment containers, roof interior.
Railway standards	Verified characteristic of a technical system, which is applicable in railway vehicles.
Railway vehicles	These include all track-guided vehicles, such as railways, tramways, cable railways, mine railways and magnetic levitation railways.
Thermal lift	Convection flow generated by a heat source.

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Appendix 2 Template F-1 “Result documentation of detection test”

Order No.:	Document No.:	Number of Appendixes: (depends on number of performed tests)

Parameters		Specifications	
Vehicle type		e. g. electric locomotive	
Vehicle design type		e. g. RE 484	
Vehicle no.			
Type of fire detection system		e. g. smoke detector	
Designation of fire detection system			
Objection	direct safety of passengers and staff	indirect safety of passengers and staff	object safety
	☐	☒	☒
Confirmation of test equipment characteristics (e. g. calibration protocol) Generation of test fog for performing the functional test on fire detectors (smoke detection)			

Established deficits

	yes	in parts	no
Requirement fulfilled	☐	☐	☐
Additional tests are required	☐		☐

Test date:		Name/signature:
	expert for railway vehicle equipment:	
	responsible system engineer for fire detection technology:	
	expert/assessor:	

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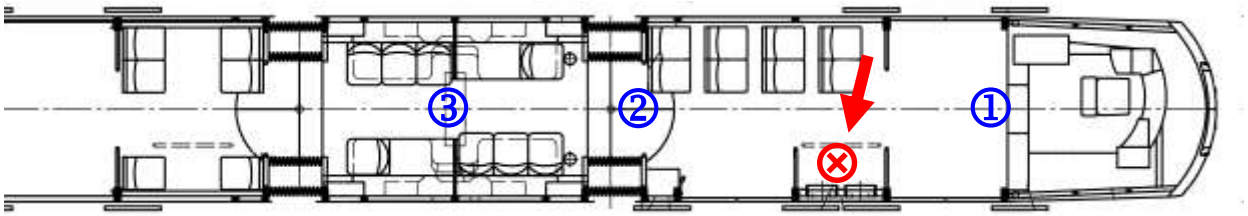
Appendix 3 Template F-2 "Documentation of the detection test"

Order No.:	**Document No.:**

Test no.	xy			
Testing time	0:00			
Test object	pre-series vehicle for system specification			
Basic test conditions	static conditions	☒	dynamic conditions	☐
Position marked in vehicle layout drawing				
Legend:	①: detector		⊗: fire location	
Example: 				
Test objective	smoke detection:	☒	detector type:	
	hot gas detection:	☐	detector type:	
Position of the detector(s)	position (number) marked in layout drawing and height information, if necessary **Explanation:** detector (1, 2, 3) in light strip, mounted during the tests			
Position of the fog generator	position marked in layout drawing **Explanation:** thermal lift of the fog in areas for luggage and folded seats			

Thermal lift of the fog	thermal lift (chimney)	on	☐	off	☒
	thermal lift (pan)	on	☐	off	☒
	reheater	on	☒	off	☐
Ventilation in the object or in operation in the appropriate HVAC unit	ventilation monitoring area	on	☒	off	☐
	ventilation incident area	on	☒	off	☐
	other influences: windows	open	☐	closed	☒

Testing time (s)	**comment/test result**

Appendix 4 Specification for test equipment for functional tests on fire detectors

Thermal lift – Test in passenger and staff areas

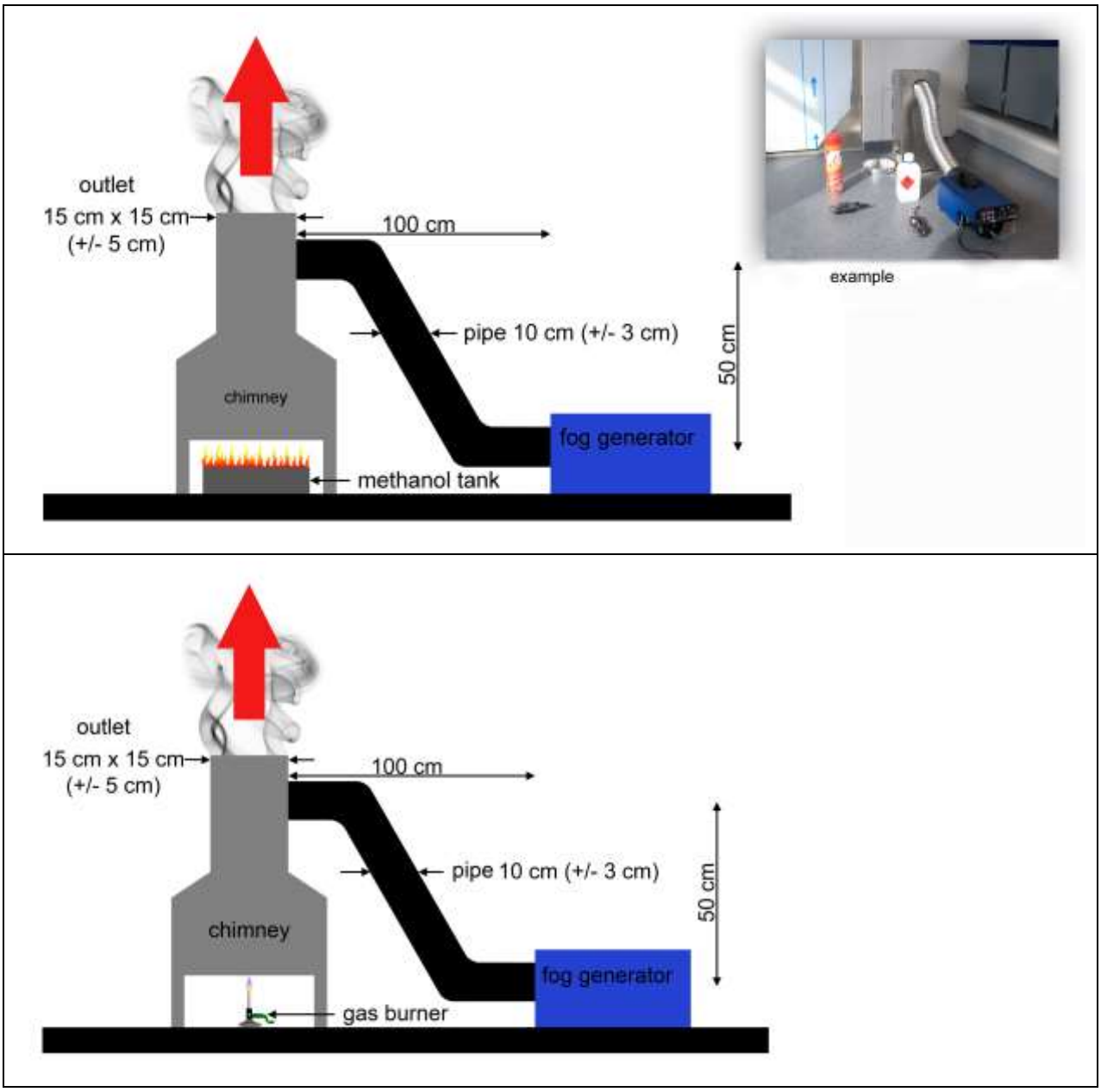


Figure 2: Test equipment with methanol tank (above) or gas burner (below) /P6/

Technical specification of the methanol tank for fire test in passenger area:

- square shaped metal tank with a surface area not greater than 500 cm² (Attention: it is recommended to use a smaller surface area under conservative aspects) chimney outlet not greater than 400 cm².
- to avoid heat transmission to the supporting surface, 2 to 5 cm high legs or other measures are necessary (e. g. heat insulated base), precise observance of the stability especially for tests during vehicle running.
- the tank should be filled between 0.5 and 1 cm (this corresponds to a minimum fire duration of one minute).
- when the test is finished or interrupted the tank should be closed with a non-flammable plate → fire fighting with deoxygenation
- Note: attention on potential risk for running vehicles.

Technical specification of the gas burner for fire test in passenger area:

- the gas burner must provide a power of 2.9 kW independent from the used gas.

  Note: if the gas content decreases the power of 2.9 kW will not be reached. In case of a marginal detection time (e. g. 65 s) the test must be repeated with a full gas cartridge.

Figure 3: Picture test equipment gas burner /P6/

Appendix 5 Generation of test fog for performing the functional test on fire detectors (smoke detection)

With a fog generator, the volume of test fog described below is generated. This requires the fluid consumption of the fog generator to produce the required volumes of fog. This is done by a recorded calibration of measurement equipment (consumption measuring). The calibration must be performed in the location of the smoke tests (an identical power supply system is important). In terms of smoke tests the calibration of the fog generator must be performed every test day and test location.

If different intensity levels cannot be set, the required fog volume is to be produced by setting intervals for blow-out and stops.

Fog volume/fog duration	
Passenger and staff areas (release time at most 1 minute):	
Fog duration:	60 seconds with a total of 10 ml (+/- 1 ml)
Including	30 seconds with a total of 4 ml +/- 0.5 ml
	30 seconds with a total of 6 ml +/- 0.5 ml
Place of installation (release time at most 2 minutes):	
In non-ventilated or passive ventilated areas (e. g. technical cabinets or machine rooms) a fog heater is necessary [see Appendix 5].	
Test duration:	120 seconds with a total of 15 ml +/- 1 ml

Smaller amounts of fog must be evaluated as conservative, whereas the defined release times must not be exceeded.

In case of exceeding the release time (> 60 sec) consider, if there are active software configurations (e. g. special evaluation data in combination with comparison of fire models) with respect to avoiding spurious alarm and which can be switched off by "revision circuit". (The artificial fog produced by the smoke generator could be prevented as illusion).

Note the following aspects:

Smoke tests with an active revision circuit may only be performed under the following conditions:

- no change of alarm delay
- no change of sensitivity adjustment.

Calibration of measurement equipment (fog generator) – measuring methods of fluid consumption:

One of the following measuring methods must be applied for the relevant level settings (if available) of the fog generator.

Example template:

Parameters	Specifications
Fog generator	
Model No.	
Level setting option	
Fluid	
Measuring method	

Method a)

1. Fluid aspiration from a measuring cup during a selected time, e. g. 2 minutes
2. Operation of the machine with a fluid volume e. g. of *20 ml* with time measurement

Based on time and fluid volume, the fluid consumption in ml/min is calculated. This results in the necessary level setting for the simulation during 1 minute in passenger areas or more than 2 minutes in technical areas. **(In contrast, in technical areas with combustion engines the response time may not exceed a duration of 60 seconds because of the risk of a high extent of damage.)**

Note: A different quality of the public power supply influences the function of the generator. That requires a new calibration in case of location change, change of mains operation or generator operation i. e. change of power supply.

Example template

Level setting	Measuring time [s]	Fluid volume [ml]	Consumption [ml/min]

Date:

Test performer:

Signature:

Method b)

The table of densities below displays the values for the fluid (e. g. Regular-Fog by Look Solutions) in milliliters and grams. The values in the table are determined by practical tests and therefore they can be verified. The measurements have determined how many grams of the fluid equal to which amount in milliliters. Different fluids require a new measurement.

Table of densities					
Weight [g]	1	5	10	50	100
Fluid volume [ml]	0.94	4.70	9.40	47.00	94.00
Fluid volume [ml]	1	5	10	50	100
Weight [g]	1.08	5.41	10.82	54.10	108.20

Procedure of this method:

A measuring cup is placed on a balance and then the scale is set to "zero". Then 200 g (equals 188 ml) of fluid is weighed and filled into the cup. Subsequently the fog generator is set to an arbitrary level (e. g. level 15 at "Viper NT"). To reduce measuring errors the fog generator shall generate fog for 120 seconds.

With the table of densities as shown above the correct "consumption" of the fog fluid can be calculated in milliliters. This value has to be compared with those given in this appendix. If a predetermined value is not reached, a different level has to be selected at the fog generator and then the procedure has to be repeated until the defined values in appendix 5 are reached.

Appendix 6 Specification for fire detection positioning in small places of installation/technical cabinets (temperature sensing)

1. In enclosed and non-ventilated places of installation there will be only a limited burning.
   Installation requirement: above potential ignition sources up to approx. 0.5 m.
2. In static ventilated places of installation, a burning occurs with normal thermal lift conditions.
   Installation requirement: above potential ignition sources up to approx. 2 m or in the ceiling area of the room.
3. In intensely ventilated places of installation, a burning occurs with deflected thermal lift conditions.
   Installation requirement: at the lower outlet edge of the air outlet.
4. If places of installation include extensive obstructions or separating elements, the fire detectors have to be placed in fire risk areas underneath these places of installation. In forced ventilated areas a separate positioning of detectors is not necessary.

In Addition, installation requirement depends on maintaining the required function of the components installed.

Appendix 7 Specification for assessing detector positioning (temperature sensing) in large places of installation (e. g. engine rooms) and external technical equipment (e. g. underfloor areas) by numerical fire simulation

1. The numerical fire simulations have to be performed with a field model (Kobra 3D or FDS). For the assessment, fully physical fire models or zone models are not suitable. For defining models see "Technical report TB 04/01 of vfdb – engineering guide for fire prevention methods". In numerical fire simulations, the flow conditions have to be considered for the positioning of fire detectors.
2. For the assessment, the models FDS and Kobra 3D have been validated by real fire tests /P-3/. The application of other models requires the validation by an independent assessment body specialized for fire safety in railway vehicles.
3. For the fire simulation, the basic conditions have to be exactly defined and described for the respective application. Especially the heat release rate (thermal power), the heat transmission on surrounding components of the fire area and installed equipment as well as the ventilation conditions in the area have to be taken into account.
4. At least two fire scenarios have to be calculated for places of installation of combustion engines:
    1. Spray fire by rupture of an injection line with a heat release rate which corresponds to the released fuel volume per time of the respective engine. Example: underfloor motor – leak in an injection line: 0.0033 l/s
    2. Pool fire with an area of 0.25 m² below the motor (heat release rate 347 kW for diesel fuel). For other places of installation, the fire scenarios must be discussed and agreed by an assessor.
5. When interpreting the results of the simulation, note the following aspects for the spatial arrangement of the detectors:
    - For the assessment, the temperature distribution of 2 min after the beginning of the simulation is important.
      Deviating from this, in technical areas with combustion engines the response time may not exceed a duration of 60 seconds because of the risk of a high extent of damage.
    - The release temperature of the sensor should be 80 % of the calculated temperature at the detector position.

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Appendix 8 Members (ARGE)

AQUASYS Technik GmbH

Diehl Aviation Gilching GmbH

Fritz Rensmann GmbH & Co. KG

FOGTEC Brandschutz GmbH & Co. KG

IFAB GmbH

IME Elektrotechnik GmbH

KIDDE-DEUGRA Brandschutzsysteme GmbH

TÜV NORD Systems GmbH & Co. KG

TÜV Rheinland AG

TÜV SÜD Rail GmbH

WAGNER Rail GmbH / Schweiz AG

Consortium meetings	Date	Location
1st consultation – Kick Off	07-16-2004	Munich
2nd consultation – Project alignment	09-23-2004	Berlin
3rd consulation – Project alignment	03-31-2005	Munich
4th consultation – Result presentation (smoke)	January 26 and-27, 2006	Munich
5th consulation – Detailed discussion of Guideline (smoke)	May 22 and 23, 2006	Hamburg
6th consultation – Planning 1:1 fire tests (thermal)	09-22-2006	Berlin
7th consultation – Fire simulations (thermal)	November 02 and 03, 2006	Rostock
8th consultation – Discussion of results (thermal)	11-22-2006	Hamburg
9th consultation – Adoption of the Guideline	02-02-2007	Berlin
10th consultation – Exchange of experiences	09-24-2008	Berlin
11th consultation – Revision 03	11-19-2009	Ahrensburg
12th consultation – Revision 04	06-19-2012	Berlin
13th consultation – Revision 05	2013	Cologne
14th consultation – Revision 06	2018	Munich -Haar and Dortmund