

# ARGE Directive „Fire Detection in Rolling Stock“



**Procedure for the proof of function concerning  
the placement of fire detectors in rooms  
accessible to people, electric control cabinets  
and areas of combustion engines**

## Guideline / Inspection procedure

Rev. No.	Date	Responsible	Comment
1.0	30/03/2007	ARGE	Adoption



This Directive is the outcome of a joint project of the Detection Equipment Working Party (ARGE) with the following corporate members:



	<p><b>ARGE Directive</b>  <b>„Fire Prevention in Rolling Stock“</b></p> <p>Procedure for the proof of function concerning the placement of fire detectors in rooms accessible to people, electric control cabinets and areas of combustion engines</p> <p><b>Guideline / Inspection Procedure</b></p>	
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## 1. General

This Directive describes the functional testing of fire alarm systems for the determination of the response time of the fire detector at the installation location for variables such as, e.g., smoke / heat / radiation, assuming possible fire events in rolling stock.

The focus of the test is the location of the fire detectors in interior spaces of rolling stock and in technical areas.

### 1.1. Preface

The current state-of-the-art technology and the future European norm EN 45545-6 contain provisions for the installation of fire detection systems. They do not make requirements for proving the functionality.

To provide reliability of planning for the installation of fire detection systems in rolling stock, system specific requirements for the design, construction and provision of proof are needed.

This Directive identifies the required criteria for the practical proof.



### Objectives

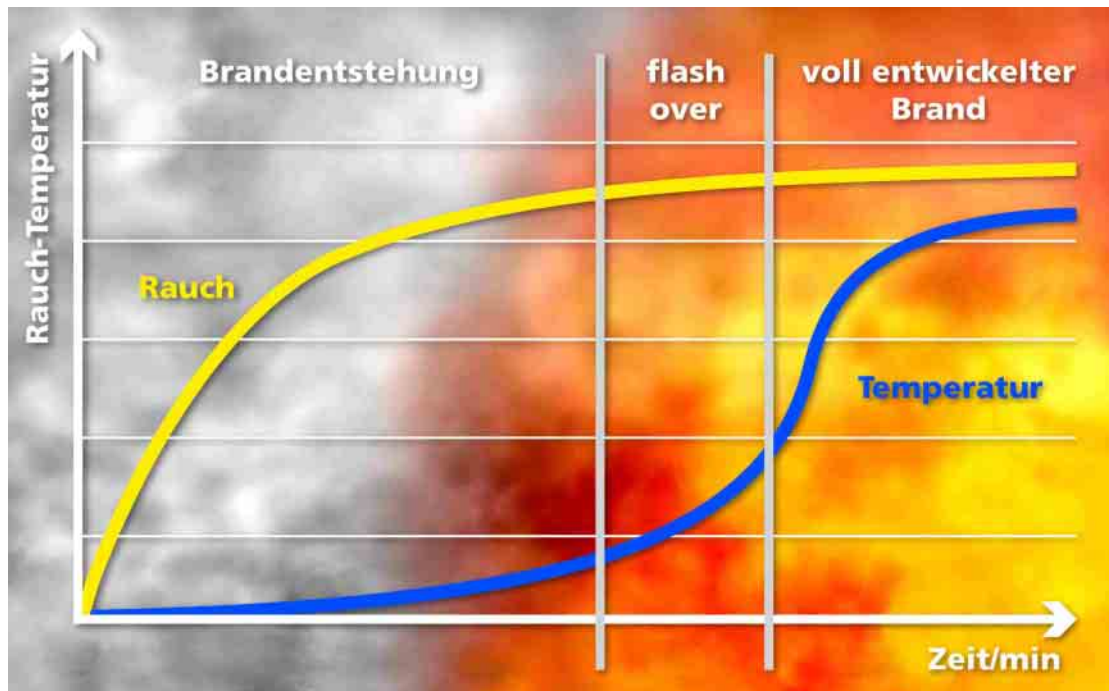
With respect to the protection objectives defined on the basis of laws, regulations and the state-of-the-art technology, a fire event should be detected at the formation phase (e.g., smouldering fire) or as quickly as possible after ignition (e.g., liquid fire).

The objective of the project is the development of an uniform, reproducible test procedure for fire detection equipment on board of trains which can be applied both to technical equipment and passenger areas. The prior procedure (use of a non-defined amount of test fog) cannot be reproduced and is therefore not particularly practicable. Besides, the thermal lift is not considered by this test procedure.

### Acceptance

The directive is accepted by the regulatory authorities in Germany (Eisenbahn-Bundesamt – EBA), Austria (Bundesministerium für Verkehr Innovation und Technologie – BMVIT) and Switzerland (Bundesamt für Verkehr – BAV).

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**Figure 1: Schematic of smoke and temperature development of a fire (development starting with a smouldering fire to the full flame fire)**

Rauch-Temperatur – Smoke-Temperature; Zeit/min – Time/min; Brandentstehung – Formation of fire; Rauch – Smoke; voll entwickelter Brand – fully developed fire; Temperatur – Temperature

## 1.2. Application

This Directive is used for verifying the correctness or expediency of the location of fire detectors, whereby smoke as well as hot gases or flames should be detected within the times assumed in the possible fire scenarios.

- It is recommended to apply this Directive in system conceptualising, i.e., for defining the location of the fire detectors with consideration of the potential spreading of the fire and the related fire development as well as the conditions of the possible service environment. This can be done by the manufacturer/supplier of the fire detection system or rolling stock.
- The Directive provides proof of compliance with the specified function after technical implementation; e.g., in rolling stock prototype or sample rolling stock, pre-series rolling stock or 1<sup>st</sup>-series rolling stock, the Directive serves the final proof of functionality in terms of the confirmation of compliance with the time limit to detecting the fire. The proof must be made by officially accredited technical experts in cooperation with the manufacturers/supplier to ensure that a confirmed report is submitted to the regulatory authority.

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### 1.3. Additional rules and regulations (for information)

In connection with the actual practice of operating permit, this refers, *inter alia*, to the possibilities of cross acceptance on the basis of agreement among the European authorities issuing operating permit; the orientation is typically on the requirements applicable in the German-speaking area.



Following is a list of major rules, regulations, norms and directives with consideration of the possible criteria of fire detection systems.

Generally, the assurance of safety in the operation of rolling stock towards society is required by law.

- /R-1/:** **Allgemeines Eisenbahngesetz AEG** (Germany, 27/12/1993, with amendment by the second act amending railway law regulations of 21/06/2002)
- /R-2/:** **Bundesgesetz über das Eisenbahnwesen EisbG** (Austria, 13/02/1957, as of 07/2006 with amendment of 26/07/2006)
- /R-3/:** **Eisenbahngesetz EBG** (Switzerland, 28/01/2003)
- /R-4/:** **Eisenbahn-Bau und Betriebsordnung EBO** (Germany, 08/05/1967, with third order amending the EBO of 08/05/1991 and 12th edition 1998) as well as **Verwaltungsvorschrift für die Abnahme von Eisenbahnfahrzeugen VwV** pursuant to Article 32 clause 1 EBO within the jurisdiction of Eisenbahn-Bundesamt (Germany, 01/09/2004)
- /R-5/:** **Straßenbahn-Bau und Betriebsverordnung BOStrab** (Germany, 11/12/1987)
- /R-6/:** **Straßenbahnverordnung** (Austria, 03/03/2000)
- /R-7/:** **Magnetschwebbahn-Bau und Betriebsverordnung MbBO** (Germany, 23/07/1996)
- /R-8/:** **Verordnung über Bau und Betrieb von Eisenbahnen / Eisenbahnverordnung EBV** (Switzerland, 23/11/1983 as of 02/07/2006)
- /R-9/:** **Directive 96/48/EC** of the European Council on the interoperability of the trans-European high-speed rail system (Europe 23/07/1996) and the related **Technical specification for the interoperability relating to the rolling stock subsystem HS RST TSI** (Europe of 12/09/2002 or the last version of 21/07/2005)

Fire protection requirements are defined in national norms. In the German-speaking area, the German norm DIN 5510 with its parts 1, 2, 4, 5 and 6 is usually referenced.

- /R-10/:** **DIN 5510–6** (October 1988), Preventive fire protection in rolling stock „Accompanying measures ... Fire alarms ...“

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As transport is border-crossing, the railway administrations have agreed on common requirements for rolling stock within UIC (International Union of Railways). These are considered as generally accepted state-of-the-art standards because they also include the aspects of operation.



- /R-11/:** **UIC 564-2** (January 1991), Regulations relating to fire protection and fire fighting measures in passenger-carrying railway vehicles or assimilated vehicles used on international services – including 2<sup>nd</sup> amendment until 1994-07-01
- /R-12/:** **UIC 566** (January 1990), operational demands of coach bodies and their components
- /R-13/:** **UIC 642** (September 2001), Special provisions concerning fire precaution and fire fighting measures on motive power units and driving trailers used in international traffic
- /R-14/:** **UIC 660** (August 2002), Measures to ensure the technical compatibility of high-speed trains

Due to the new European norms for fire prevention in railway vehicles in the process of harmonization, the requirements made there at present are also considered.

- /R-15/:** **CEN TS 45545–4** (published by the Secretariat of DIN CEN/CENELEC/TC 256 as of November 2006) Railway applications – Fire protection of railway vehicles – Part 4: Fire safety requirements for rolling stock design“
- /R-16/:** **CEN TS 45545–6** (published by the Secretariat of DIN CEN/CENELEC/TC 256 as of November 2006) Railway applications – Fire protection of railway vehicles – Part 6: Fire control and management systems “

Other accepted engineering rules in connection with fire identification are listed below. They provide the basis for the focal areas of fire risk assessment and evaluation of fire development as well as fundamental requirements for fire alarm systems.

- /R-17/:** **VdS 2827** Design fires scenarios for fire simulations and fire protection concepts (Germany, Austria, Switzerland May 2000)
- /R-18/:** **Technical report TB 04/01** of vfdb – Guideline for engineering methods of fire protection, as of May 2006
- /R-19/:** **VdS 2489** Fire detection systems – automatic fire detection systems, requirements and testing methods (Germany, Austria, Switzerland, May 2000)
- /R-20/:** **DIN V 19250** Control technology – Fundamental safety aspects to be considered for measurement and control equipment (May 1994)
- /R-21/:** **DIN EN 60695-1-1** Fire hazard testing, Part 1-1: Guidance for assessing the fire hazard of electrotechnical products – General Guidelines(October 2000)
- /R-22/:** **DIN EN 50126** Rail applications – RAMS (March 2000)

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**/R-23/:** **EBA guideline** „Provisions for the evaluation of fire in rolling stock as part of acceptance pursuant to Article 32 EBO“ (June 2006)

#### **1.4. Editorial group of the directive**



The content of the directive and its revision is the editorial responsibility of TÜV SÜD Rail GmbH (TR-TW/MUC).

The quality assurance process is defined in the „Quality Manual of TÜV Rail „Rail Technology“ (QSH) which is based, *inter alia*, on

**/R-24/:** **EN ISO/IEC 17025** General requirements for the competence of testing and calibration laboratories (August 2005).

#### **1.5. Scope**

The directive applies to rolling stock and guided vehicles which are equipped with fire detection equipment.

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## 2. Test specification for determining functionality

This test specification focuses exclusively on the location of the fire detectors in relation to the potential starting points of fires.



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

### **A) Detection of fire by smoke as guiding variable:**

1. The simulation of smoke release in areas for passengers (viz. passenger compartments, entrance vestibules, WCs, etc.) follows the example of the test fire „combustion of a travelling bag with an UIC paper cushion as fire source “ [/P-1/](#).
2. The simulation of smoke release in equipment cabinets follows the example of the test fire for „Cables with thermal overload “ [/P-1/](#).
3. The release of smoke is simulated with heat-driven cold smoke or smoke generated with a fluid. As required by the defined test fire criteria, the smoke release is increased during the test period.
  - ***The detection system in passenger and staff areas must respond within a period of 1 minute after the beginning of smoke release under all possible conditions of service.***
  - ***The detection system in equipment areas must respond within a period of 2 minutes after the beginning of smoke release under all possible conditions of service (Consider external factors of influence during the trip).***
  - ***The specified time period includes the communication of the alarm from the detector to people (passengers and / or train staff).***

### **B) Detection of fire by temperature as guiding variable:**



1. The simulation of temperature development in installation areas using technical testing instruments is impracticable, too expensive and involves risk.
2. The installation of heat detectors was specified on the basis of 1:1 fire tests in control cabinets. [see [Annex 7 – Specification of the detector location in small installation spaces / control cabinets \(temperature identification\)](#)] Thus, compliance with the geometrical layout of the detectors, also with consideration of the aerodynamic conditions in the monitored space, can be tested visually.  
**Note:** In this case, the „temperature“ variable is the criterion for activating fire fighting measures because it fails to meet the requirements for early detection of the fire.

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3. In large equipment compartments with forced ventilation (e.g., engine compartments) and machine systems installed outside the rolling stock (e.g., underfloor installation), the correct spatial arrangement of the detectors should be shown in connection with the aerodynamic conditions in the monitored compartment or area by computational fire simulations or equivalent methods (e.g., fire test). The simulations must follow defined inputs and fringe conditions of the simulation. [see [Annex 1 – Specification to prove the correct detector location \(temperature identification\) in large installation spaces \(e.g., machine spaces\) and machine systems installed outside installation spaces \(e.g., underfloor areas\) by computational fire simulation](#)]

The system functionality tested, including on the basis of fault simulations, and the related reactions of the fire detection system and signals issued, resp., are not part of this test specification.

The system functionality must be defined by the rolling stock operator or the railway operating company, resp., because the focus here is on reliability and availability of the equipment. However, this is a major basis for system design.

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### 3. Performance of the type test

The type tests supplies proof that the installed fire detection equipment can detect a possible fire event as required by the specification.

The type testing principle should also be applied at the system conceptualising. This ensures a high probability of success of the type test.

#### 3.1. Preconditions of the system test

The performance of the test requires the availability at least of those parts of the documentation in which the system function is described.

Precondition for the successful type test is proof in relation to the general function with consideration of the rail worthiness and reliability, and the environmental factors to be considered in this connection.



Proof submitted by certified test bodies or test laboratories are accepted. Reference is also made to the requirements in [/R-19/](#) and [/R-27/](#). Proof shall be by submission of a test certificate according to EN 54.

##### 3.1.1. Rolling stock parameters

For planning and performing the tests, the following information relating to the test unit (passenger or staff area, equipment area) must be available:

- Description of the individual rail vehicle or train set not separable for operation, as regards service and the related environment (e.g., operation in tunnels)
- Control and regulation concept concerning the air treatment units (for ventilation, heating, cooling) in the rail vehicle or the train set and the air routing concept (layout of air ducts and air inlet and air outlet situations, dynamic or static exhaust air routes)
- Information on door and window openings and the ways of handling them (e.g., open in normal service or only if ventilation equipment fails)
- Information on ventilation concepts of control cabinets and engine compartments (e.g., static or dynamic ventilation)
- Information on areas or assemblies with a fire risk in technical areas, refers mainly to staff areas and control cabinets as well as engine compartments to which the alarm concept is organised – reference to the examination of the fire risk, e.g., on the basis of [/R-21/](#) and [/R-22/](#)

The state of the rolling stock at the time of the test should be documented. Deviations from the possible service states should be described and assessed in terms of their

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effects (consider the situation of pre-series rolling stock, prototypes or rolling stock converted in future). Re-testing may be required if deviations are unacceptable.

This situation should also be considered in the light of the preconditions for system specification tests, e.g., at older type rolling stock.

### 3.1.2. System parameters

For planning and performing the tests, the following information relating to the fire detector(s) linked in the system must be available:

- Description of the fire detection system, i.e., the function of the fire detectors in the system (e.g., individual function, group function, redundancy function)
- Description of the fire detector types and their locations (including variations, if any) in the rolling stock or the monitored area
- Proof that the requirements for installation in rolling stock are met [see [Annex](#) ], which should also consider possible requirements that deviate from norms (e.g., service conditions concerning operating and bearing temperatures)

If certificates based on other norms are submitted, proof of equivalence shall also be submitted.

### 3.1.3. Testing instrument parameter



The requirements on fog generation and the thermal lift characteristics are defined on the basis of the test report confirmed by ARGE.

This relates to the requirements on the fog generator, such as fog intensity and control (e.g., Viper NT from Look Solutions), the fog fluid in terms of fog stability and life of the fog (e.g. “Regular-Fog“ from Look Solutions) and the requirements on thermal lift (hot gas generation).

As different fog generators may be used, these must meet certain minimum requirements [see [Annex](#) ].

The means (fire pan) producing the thermal lift shall be designed and operated according to the prescription [see [Annex](#) ]. The specification of the thermal lift is the maximum permitted pan size. Smaller sizes should be valued conservatively. This is revealed by the test report [P-5].

Corresponding proof is to be submitted for this and confirmed in the form in Annex 5 (designed for the characteristic + proof of the testing instrument) with a reference to the calibration document.

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## 3.2. Test preparation and test performance

Decisive for the performance of the tests are the potential fire risks.

### 3.2.1. Passenger and staff areas

Fire risks in areas for passengers are defined by possible vandalism. For this reason, an UIC paper cushion should be placed at any location of the interior space of the vehicle in accordance with the following typical accepted state-of-the-art rules.

**/R-25/:** **DIN 5510–1** (October 1988), Preventive fire protection in railway vehicles; Levels of protection, fire prevention measures and certification“ (see explanations)

**/R-26/:** **UIC 564-2** (January 1991), Provisions relating to the prevention and fighting of fire for rolling stock used in which passenger are carried in international traffic or which can be assigned to the passenger coach type (see Annex 14 of UIC)

To this effect, the test equipment and the thermal lift of the test smoke should be concentrated at points which

- a) are most unfavourable for the quick detection of the fire,
- b) permit hidden ignition,
- c) can be used for storage of larger items of travel luggage.

These tests shall be made for all air circulation situations possible when the stock is rolling (e.g., ventilation ON, OFF, heating, cooling). Individual tests need not to be made if the situations are included in other air circulations of the same type.

### 3.2.2. Equipment areas



Tests in rolling stock equipment, e.g., control cabinets, require information on potential fire risks. These include, e.g., switching-type electrical assemblies of higher output rating or assemblies which involve hot surfaces if a defect occurs.

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

- a) the risk-prone assembly is most unfavourable for a quick detection of the fire,
- b) the air volume flow for heat removal is lowest at the risk-prone assembly,
- c) permanently hot surfaces can result due to liquid fire loads in case of defect (relates, e.g., to diesel engine compartments).

These tests shall be made for all air circulation situations possible when the stock is rolling (e.g., ventilation ON, OFF). Individual tests need not to be made if the situations are included in other air circulations of the same type.

The thermal lift of the test smoke is not required for tests to assess the situation in areas with high air change rate.

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### 3.3. Test report



The report on the test of the functionality of the fire detector shall be prepared on the basis of the forms [see [Annex 2 – Form F-1 „Documentation of detection test results“](#) and [Annex 3 – Form F-2 „Documentation of the detection test“](#)].

Pictorial documentation shall be included for better illustration of the test results. This includes, *inter alia*, the test layout (hot gas lift and fog generator) and the location of the fire detectors.

### 4. Revisions of the directive

This Directive is administered by ARGE and editorially under the responsibility of TÜV SÜD Rail. Current findings in connection with the Directive are also considered. It is intended that the ARGE meets annually to discuss revisions of the Directive.

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## 5. References

The reports listed below can be inspected at TÜV NORD or TÜV SÜD Rail, if necessary.

- /P-1/:** Bericht zur Ermittlung der Simulationsrandbedingungen für Kaltrauchtests zur Branderkennung durch Rauchmelder.
- /P-2/:** Bericht über durchgeführte Brandtests für die Abschätzung der Temperaturentwicklung in Einbauräumen zur Branderkennung durch Thermomelder, Beispiel Schaltschrank
- /P-3/:** Versuchsbericht - Brandversuche ARGE zur Validierung der Brandsimulationsprogramme FDS und Kobra 3D zum Nachweis der richtigen Melderpositionierung (Temperaturerkennung) in großen Einbauräumen (z.B. Maschinenräumen) und außerhalb von Einbauräumen installierten Maschinenanlagen (z.B. Unterflurbereichen)
- /P-4/:** Prüfnachweis zur Ermittlung der Charakteristik der Nebelerzeugung – Kalibrierung der Nebelgeneratoren (TÜV Rail Prüfmittel)
- /P-5/:** Prüfnachweis zur Brandwannengeometrie hinsichtlich des thermischen Auftriebs

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## Annex 1 – Abbreviations / definitions and terms



### A Abbreviations

ARGE	Working party
UIC	UNION INTERNATIONALE DES CHEMINS DE FER – International Union of Railways

### B Definitions and terms

Reference is made to **DIN ISO 13943** Fire Safety – Vocabulary (October 2000) and norm series **DIN EN 54**.

Fire identification system	Total of all devices and components matched for functional interaction.
Fog generator	Device producing an aerosol from a fluid for test purposes.
Rolling stock	In this Directive, it includes all rail-guided rolling stock such as, e.g., railways, trams, cable railways, funicular railways, mine railways and magnetic railways.
Installation space	Space or housing for the installation of technical equipment such as, e.g., electric control cabinet, equipment container, roof internal space.
Machine system	Technical or drive system installed in, under or on rolling stock.
Cross acceptance	Reciprocal acceptance of different evidence documents or certificates of the same claim.
Flow conditions	Operation-related air flow situation in a separated area (e.g., static or dynamic ventilation) or an outdoor area
Rail worthiness	Characteristic of a technical system for which proof of application in rolling stock is provided.
Thermal lift	Convection flow generated by a heat source.
Certificate / statement	Document based on tests of the functionality of the components under defined fringe conditions.

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**Annex 2 – Form F-1 „Documentation of detection test results“**



<b>Job No.:</b>	<b>Document No.:</b>	<b>Number of appendices:</b> (depends on the number of tests carried out)
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Parameter		Details	
Rolling stock type / design		e.g., electric locomotive	
Rolling stock type of construction		e.g., RE 484	
Rolling stock number			
Type of fire detection system		e.g., smoke detector	
Designation of the fire detection system			
<b>Object of protection</b>	Direct protection of persons <input type="checkbox"/>	Indirect protection of persons <input checked="" type="checkbox"/>	Asset protection <input checked="" type="checkbox"/>
Confirmation of the testing instrument type (e.g., calibration report), see <a href="#">Annex 6 – Generation of test fog for performing the function test of fire detector (smoke identification)</a>			

<b>Defects found</b>

	Yes	In part	No
Requirement met	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Further inspection required	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<b>Test date:</b>	<b>Name / signature:</b>	
	Rolling stock equipment appraiser:	
	Person responsible for fire detection equipment system:	
	Technical expert / Evaluator:	

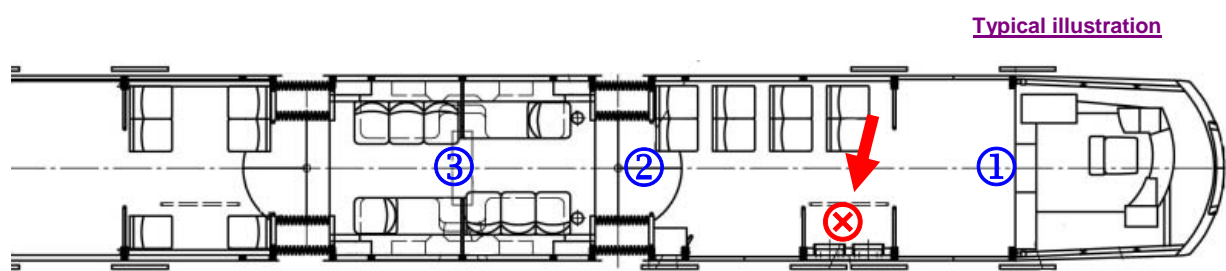
	<b>ARGE Directive</b> <b>„Fire Prevention in Rolling Stock“</b> Procedure for the proof of function concerning the placement of fire detectors in rooms accessible to people, electric control cabinets and areas of combustion engines <b>Guideline / Inspection Procedure</b>	 Rail
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### Annex 3 – Form F-2 „Documentation of the detection test“

<b>Job No.:</b>	<b>Document No.:</b>
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<b>Test No.</b>	xy	
<b>Test time</b>	0:00	
<b>Test object:</b>	Pre-series rolling stock for system specification	
<b>Test fringe conditions</b>	Stationary rolling stock <input checked="" type="checkbox"/>	Running rolling stock <input type="checkbox"/>

#### Positions marking in the rolling stock ground plan





<b>Test target</b>	<b>Smoke detection:</b> <input checked="" type="checkbox"/> - <b>Detector type:</b> <b>Hot gas detection:</b> <input type="checkbox"/> - <b>Detector type:</b>
<b>Location of the detector(s)</b>	Location marked in the sketch (number) and - occasionally - elevation, <b>Discussion: Detectors (1, 2, 3) in luminaire band, mounted during the test</b>
<b>Location of the fog generators</b>	Location marked in the sketch <b>Discussion: Fog lift in the stowage areas of large luggage and folding seats</b>
<b>Thermal lift of fog</b>	Thermal lift (stack)            on <input type="checkbox"/> off <input checked="" type="checkbox"/> Thermal lift (pan)             on <input type="checkbox"/> off <input checked="" type="checkbox"/> Reheater                            on <input checked="" type="checkbox"/> off <input type="checkbox"/>
<b>Air circulation inside the rolling stock or operating state of the air treatment equipment</b>	Monitoring area ventilation    on <input checked="" type="checkbox"/> off <input type="checkbox"/> Even area ventilation            on <input checked="" type="checkbox"/> off <input type="checkbox"/> Other effects: <b>Windows</b> open <input type="checkbox"/> closed <input checked="" type="checkbox"/>

Test time (sec)	Comment / test result

	<p><b>ARGE Directive</b>  <b>„Fire Prevention in Rolling Stock“</b></p> <p><b>Procedure for the proof of function concerning the placement of fire detectors in rooms accessible to people, electric control cabinets and areas of combustion engines</b></p> <p><b>Guideline / Inspection Procedure</b></p>	
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## Annex 4 – Minimum requirements or preconditions for the performance of function test of fire detectors

1. Concept characterization with reference to the safety and function requirements to be met (detection equipment and information transfer / communication and linked control equipment or control function of the fire fighting system), *inter alia*, on the basis of order requirements (e.g., supply specification)
2. Hardware description, circuit diagrams, system layout and information on the components and materials used within the meaning of a project description
3. Certificates of other accredited testing and certification bodies (conformity statements, conformity certificates, if necessary), in which case one document or statement based on test documents must be available for each indicated norm; refers to:
  - /R-27/: **DIN EN 54 Part 1:1996** (Introduction), **Part 5: 2000** (Heat sensitive detectors— point detectors), **Part 7:2000** (Smoke detectors — Point detectors using scattered light, transmitted light or ionization), **Part 10: 2002** (Flame detectors), **Part 12: 2003** (Line detectors using transmitted light), **Part 15: pr2006** (Multi-sensor point detectors for the combined detection of different fire phenomena), **Part 20: 2006** (Intake smoke detector), **Part 22: pr2007** (Line heat detectors) and also **Part 27** (Combined CO – heat detectors; as soon as available)
4. Proof of rail worthiness according to:
  - /R-28/: **DIN EN 50121 Part 3-2** Railway applications – Electromagnetic compatibility (May 2001)
  - /R-29/: **DIN EN 50153** Railway applications – Rolling stock, protective provisions relating to electrical hazards (December 1996)
  - /R-30/: **DIN EN 50155** Railway applications – Electronic equipment used on rail rolling stock (January 2004)
  - /R-31/: **DIN EN 61373** Railway applications – Rolling stock equipment, shock and vibration tests (November 1999)
  - /R-32/: **DIN EN 60068 part 1** (March 1995), **2-1** (March 1995), **2-2** (August 1994), **2-27** (March 1995), **2-30** (February 2000), **2-47** (August 2000), **2-64** (August 1995), Environmental testing – Test methods
5. Safety related operating instructions or use instructions
6. Installation requirements for the professional installation of equipment and the performance of acceptance and quality tests (procedures) of series rolling stock

	<p><b>ARGE Directive</b>  <b>„Fire Prevention in Rolling Stock“</b></p> <p>Procedure for the proof of function concerning the placement of fire detectors in rooms accessible to people, electric control cabinets and areas of combustion engines</p> <p><b>Guideline / Inspection Procedure</b></p>	
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## Annex 5 – Specification of testing instruments for function tests of fire detectors

### Thermal lift – Test in installation compartments

To test a smoke detector in an equipment area, thermal lift of the fog in form of a fog heater in the outlet hose is required.

The fog heater consists, e.g., of a copper sheet of approximately 10 x 10 cm size, which is turned to form a tube. Glued on it is a heating foil 10 x 10 cm 12 W, 10 V. The foil has a power supply unit and reaches a temperature of 80-90 °C, a preheating time of about 5 min should be considered. The fog flow through the hose heats and ascends when it leaves the hose.

Schaltschrank – Control cabinet; Rauchmelder – Smoke detector; Nebelheizung – Fog heater; Schlauch – Hose; Nebelmaschine – Fog generator

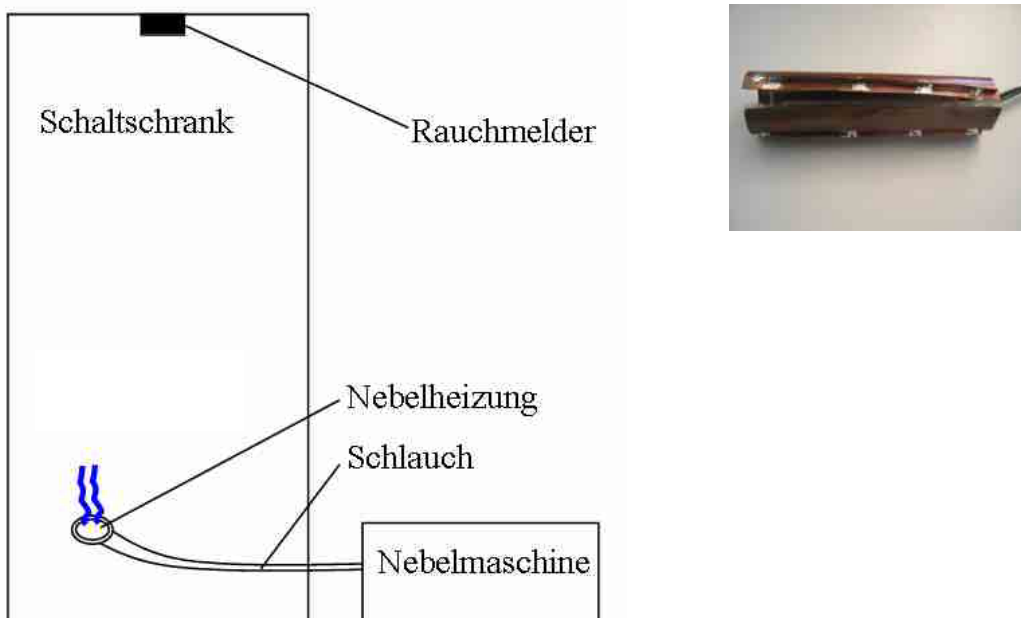


Figure 2: Test layout for equipment compartment test / fog heater for hose

### Thermal lift – Test in spaces accessible for people

Nebelmaschine – Fog generator; Thermik – Thermal lift; Methanolbehälter – Methanol container

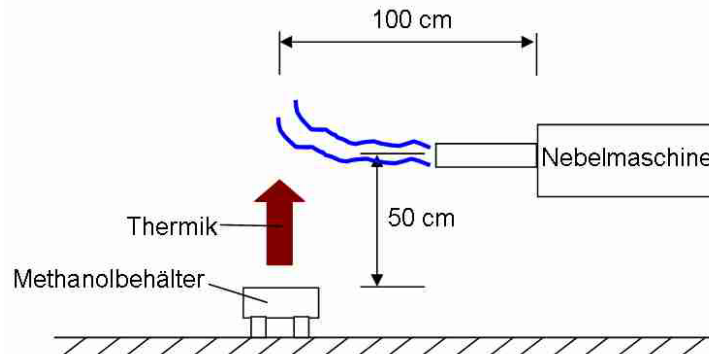


Figure 3: Test layout with methanol container

Technical specification of the methanol tank for the passenger compartment fire test::

- Square metal container of maximum 500 cm<sup>2</sup> base area
- Container height should be up to 10 cm to ensure that the flames do not extend beyond the edge
- Feet 2-5 cm high (to take care of heat transition to the floor), other arrangements are also possible (e.g. heat insulated pad), observe stability especially if tests are made while the train is running
- Methanol in the container should be filled between 0.5 and 1 cm (this corresponds to a minimum fire duration of 1 minute)
- The container should be closed with a non-flammable plate at the end of the test or when the test is interrupted → to extinguish the flame due to lack of oxygen

Nebelmaschine – Fog generator; Kamin – Stack; Methanolbehälter – Methanol container

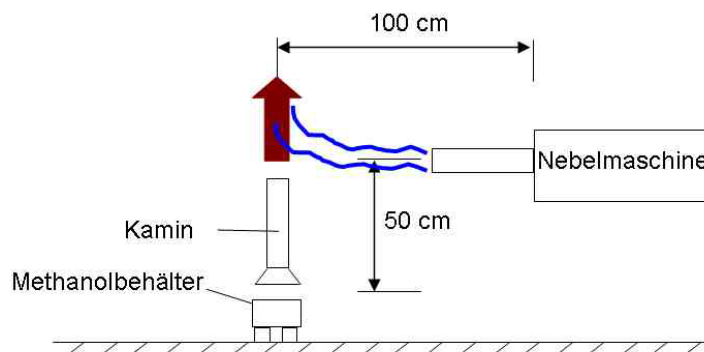




Figure 4: Test layout with methanol container and stack

	<p><b>ARGE Directive</b>  <b>„Fire Prevention in Rolling Stock“</b>  <b>Procedure for the proof of function concerning the placement of fire detectors in rooms accessible to people, electric control cabinets and areas of combustion engines</b>  <b>Guideline / Inspection Procedure</b></p>	
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## Annex 6 – Generation of test fog for performing the function test of fire detector (smoke identification)

A quantity of test fog specified below is generated by a fog generator. The fluid consumption of the fog generator must be known so that the required fog volume can be generated. This is done in the form of recorded measuring instrument calibration (consumption measurement).

If different intensity levels cannot be set, the required fog volume is produced by blow-out and pause times.

It is recommended to use a fog fluid of medium half-life (e.g., Regular-Fog – supplier: Look-Solution).

Example of fog volume generation with fog generators Viper NT and Viper 2.6 from OTTEC Technology GmbH:

- Fog volumes can be set in 1 % increments up to 100 %.
- Switching steps / per cent of maximum possible conversion:
  - St 1 or 1% with approx. 7.5 ml / min (Viper NT) and 10.0 ml / min (Viper 2.6)
  - St 5 or 5% with approx. 8.5 ml / min (Viper NT) and 15.0 ml / min (Viper 2.6)
- Small fog volumes should be valued conservatively, the prescribed maximum response times must be observed here as well.

### **Fog volume/fog duration**

#### **Passenger and staff areas (response time max. 1 minute):**



Fog duration: 60 seconds with totally 10 ml

Example: 30 seconds with totally 4 ml +/- 0.5 ml  
 30 seconds with totally 6 ml +/- 0.5 ml

#### **Installation area (response time max. 2 minutes):**

A fog heater (see Annex 5) is required in non-ventilated installation areas or installation areas with passive ventilation (e.g., control cabinets or equipment spaces).

Test duration: 120 seconds with totally 15 ml +/- 1 ml

	<p><b>ARGE Directive</b>  <b>„Fire Prevention in Rolling Stock“</b></p> <p><b>Procedure for the proof of function concerning the placement of fire detectors in rooms accessible to people, electric control cabinets and areas of combustion engines</b></p> <p><b>Guideline / Inspection Procedure</b></p>	
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**Measuring instrument calibration (fog generator) – measuring methods of fluid consumption:**

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

1. Fluid intake from a graduated beaker for a period of at least 2 min
2. Operation of the machine at a fluid volume of 20 ml with time recording

The fluid consumption in ml/min is calculated from the time and the fluid volume.

**Typical log**



Parameter	Date
Fog generator	
Model No.	
Step setting option	
Fluid designation	
Measuring method	

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

Date:

Tester:



Signature:

	<p><b>ARGE Directive</b>  <b>„Fire Prevention in Rolling Stock“</b></p> <p><b>Procedure for the proof of function concerning the placement of fire detectors in rooms accessible to people, electric control cabinets and areas of combustion engines</b></p> <p><b>Guideline / Inspection Procedure</b></p>	
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## Annex 7 – Specification of the detector location in small installation spaces / control cabinets (temperature identification)



1. Combustion will be limited in enclosed and non-ventilated installation compartments.  
**Installation requirement** above potential sources of ignition up to approx. 0.5 m.
  
2. Combustion with normal thermal lift exists in installation compartments with static ventilation.  
**Installation requirement** above potential sources of ignition up to approx. 2 m or in the roof area of the compartment.
  
3. Combustion with deflected thermal lift exists in strongly ventilated installation compartments.  
**Installation requirement** at the bottom flow-off edge of the installation area.
  
4. If the installation compartments contain nearly full-area obstacles or partitions, the detectors should be located below the areas in which a fire risk exists. A separate location may not be necessary where forced ventilation is available.

In addition, the installation requirement is a function of the up keeping of the required functionalities of the assemblies installed in the installation compartment.

	<p><b>ARGE Directive</b>  <b>„Fire Prevention in Rolling Stock“</b></p> <p><b>Procedure for the proof of function concerning the placement of fire detectors in rooms accessible to people, electric control cabinets and areas of combustion engines</b></p> <p><b>Guideline / Inspection Procedure</b></p>	
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**Annex 8 – Specification to prove the correct detector location (temperature identification) in large installation spaces (e.g., engine compartments) and machine systems installed outside installation spaces (e.g., under floor areas) by computational fire simulation**

1. Computational fire simulations are made with a field model (e.g., Kobra 3D or FDS). Full fire models or zone models are not suitable for the proof.  
For model definition, reference is made to „Technical report TB 04/01 of vfdb, as of May 2006 - Guideline engineering methods of protection against fire“. /R17/
2. The programs FDS and Kobra 3D have been validated for the proof on the basis of real fire tests /P-3/.  
Other programs require validation.
3. For fire simulation, the fringe conditions for the relevant case of application must be defined and described exactly.  
In particular, the heat release rate (thermal power), heat transition to components enclosing the fire space and to internals as well as the ventilation conditions of the compartment / area must be considered.
4. At least two fire scenarios must be calculated for installation compartments of combustion engines:
  1. Sputter fire caused by break of an injection line with a heat release rate which corresponds to the released amount of fuel per unit of time of the respective engine.  
Example: Under floor engine – leak in an injection line: 0.0033 l/s
  2. Puddle fire with an area of 0.25 m<sup>2</sup> underneath the engine (heat release rate of 347 kW for diesel fuel).  
The fire scenarios for other installation compartments should be determined together with the evaluator.
5. The interpretation of the results of the simulation the following should be considered for the spatial arrangement of the detectors:
  - Decisive for the assessment is the temperature distribution 2 min after the beginning of the simulation.
  - The release temperature of the sensor should be 80% of the calculated temperature at the location of the detector.

	<p><b>ARGE Directive</b>  <b>„Fire Prevention in Rolling Stock“</b>  <b>Procedure for the proof of function concerning the placement of fire detectors in rooms accessible to people, electric control cabinets and areas of combustion engines</b>  <b>Guideline / Inspection Procedure</b></p>	
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## Annex 9 – Members of the Working Party (ARGE)

Firm	Expert	Function
AOA Apparatebau Gauting GmbH	Herr Kreutle	Development
DETECTOMAT GmbH	Herr Müller	Managing director
FOGTEC Brandschutz GmbH & Co. KG	Herr Dirksmeier	Product manager
HEKATRON Vertriebs GmbH	Herr Walter	Rail manager
IME Elektrotechnik GmbH	Herr Ley	Managing director
KIDDE-DEUGRA Brandschutzsysteme GmbH	Herr Kniesa	Project sale
RWS Railway Service GmbH	Herr Radam	Managing director
SECURITON AG	Herr Brügger	Product manager
Wagner Alarm- und Sicherungssysteme GmbH	Herr Kainz	Managing director
TÜV NORD Systems GmbH & Co. KG	Herr Thiel	Evaluator
TÜV SÜD Rail GmbH	Herr Dr. Heyn	Evaluator
TÜV SÜD Rail GmbH	Herr Ehrenberg	Technical expert

Meetings	Date	Place
1st meeting – Kick-off	16/07/2004	Munich
2nd meeting – Project orientation	23.09/2004	Berlin
3rd meeting – Project orientation	31.03/2005	Munich
4th meeting – Result presentation (smoke)	26&27/01/2006	Munich
5th meeting – Directive detail discussion (smoke)	22&23/05/2006	Hamburg
6th meeting – 1:1 fire test planning (heat)	22/09/2006	Berlin
7th meeting – Fire simulations (heat)	02&03/11/2006	Rostock
8th meeting – Discussion of results (heat)	22/11/2006	Hamburg
9th meeting – Adoption of the Directive	02/02/2007	Berlin