FULL REDUNDANT RING BUS FIRE DETECTION SYSTEMS FOR RAILWAY APPLICATIONS:
EN 54-2, EN 54-13 (VdS)
Reducing False Alarms

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See also... Presentation [D] ...in APPENDIX.
1. **History / System requirements**

As an introduction, it can be stated that with modern ring bus detection technology through which analogue measurement values are transmitted bidirectionally via a digitized protocol to an EN 54-2 certified, microprocessor-controlled fire alarm control panel within an EN 54-13 certified system, the currently highest level of security against false and erroneous alarms can be provided through intelligent algorithms by using a digital protocol (drift compensation, event delay, filtering of recurrent detection patterns).

Since the early 1990s, this detection technology has proven itself in commercial and also heavy industrial environments. Since about 2004, a few manufacturers have tested this technology according to the stringent requirements of the specific standards for environmental and ambient conditions in railway construction and have already used it successfully for several years. Recently, the strict requirements of the EN 45545 series were also applied to all products used in respect to flammability and toxicity.

Nevertheless, EN 45545-6 [1] does not stipulate detailed rules for products and systems concerning requirements on EN 54 standards series.

In addition, the “ARGE Guidelines” [2], which are best known within the rail industry, do not suggest a mandatory EN 54 approved and certified system. Only Chapter 3.4 in part 3 contains a recommendation, but nothing compulsory.

*Excerpt from Chapter 3.4 - ARGE-Guideline, Part 3:*

The monitoring requirement has to be realized in accordance with DIN EN 54-2 (affects fire alarm central control panels) and DIN EN 12094-1 (affects gas extinguishing systems), as far as required for rail vehicles.

2. **EN 54-2 FCAP, EN 54-13 certified systems**

2.1 **Cabling structure / short circuit isolators**

Compared to outmoded stub-like wiring structures, the highest degree of reliability is achieved on the line system with ring bus detection technology and input- and output-side short circuit isolators in accordance with EN 54-17 for each element (detectors, signal generators, I/O interfaces). An interruption of the ring leads to the activation of the isolators and 2 branch lines result, whereby 100% functionality is still guaranteed in this case. A simultaneous double line fault can be excluded on the basis of high-quality cabling in rail vehicles (FE 180).

Due to the exclusive use of components certified in accordance with harmonized product standards of the EN 54 [3] series (FACP: EN 54-2, detector: EN 54-5, EN 54-7, signal generators: EN 54-3, short circuit isolators: EN 54-17, I/O devices: EN 54-18), a high degree of interference resistance and interoperability is ensured in the system.

The highest level of reliability and availability can be achieved in the area of the fire alarm control panel, as the FACP features redundant processors both on the central control unit and on the loop card.
2.2 Reducing False Alarms

False alarms are alarms caused by external influences on an automatic fire detector (smoke detectors or multi-sensor smoke / thermal detectors) not caused by a fire (e.g., cigarette smoke, dust, fire work activities, water vapor, wantonness, rapid heat increase, etc.).

Through the use of modern, analog-addressable ring bus detection technology with drift compensation, multiple adjustable alarm limits or additional programmable event delay (e.g. 10 seconds) and use of multi-criteria detectors (smoke / thermal) in specialized areas (e.g. switching cabinets, suspended ceilings, cooking areas, possibly even restrooms), false alarms can be minimized to a large degree by use of modern detection technology.

If a false alarm variable is present over a longer period of time, a false alarm cannot ultimately be prevented 100% of the time, even with state-of-the-art technology, since with respect to analysis algorithms and adjustable event delay requirements of binding product standards for smoke and heat detectors, EN 54-7 and EN 54-5 must be observed and the compromise between the desired maximum immunity to false alarms and the fastest possible detection behavior is thus a limiting factor.

If it turns out that this false alarm behavior in such areas occurs again and again, a different type of detection type (e.g. thermo-maximum or flame detector) must be selected.

In some cases, programming a 2-detector dependency (2 detectors must respond before the main alarm criterion is reached at the FACP) can provide selective assistance.

When using outmoded, conventional limit value detection technology or "smoke switches" without different configurable alarm thresholds, false alarms during operation are inevitable with this technology. In particular, the following causes are responsible for false alarms:

1) Shortly occurring, small amounts of smoke or smoke-like particles (e.g. dust, mist) can very likely lead to a false alarm.

2) Since, as a rule, drift compensation is not applied and the detectors cannot be configured with respect to the alarm threshold, a false alarm arises specifically in the event of an advanced degree of pollution in the presence of small amounts of smoke or smoke-like particles. The transmission of the alarm signal (without measurement value) is usually purely digital (relay) to a central location with binary input, thus no assessment of the alarm signal is possible there.

False alarms can also be caused by a technical failure of the fire alarm system components (also cabling) without apparent external influences.
When using outmoded, conventional limit value detection technology or "smoke switches" with digital transmission (no transmission of analog values with bidirectional communication with a microprocessor-controlled fire alarm control panel in ring bus topology), technical false alarms may appear very likely and normally there is no way to analyse the reason for this failure. In such situations, components usually get changed much earlier than expected in relevant analysis.

2.3 Analogue / Digital protocol

The term “analogue” is used to describe a signal which goes up and down stagelessly. See Fig 1. Signals that record phenomena such as the increase in smoke or heat are by nature analogue at their source and this is why modern fire detectors are called analogue.

For example, a heat detector will record stageless increases in temperature from a typical starting point of 20–21°C (comfortable room temperature) to an alarm level of 55°C, however fast the increase.

Each point on the analogue signal indicates a particular value. However, the problem with analogue signals is that if, during transmission, electrical corruption affects the signal, a 2 might appear as a 3, for example.

![Analogue signals](image)
The term “digital” describes a signal that consists of a series of 0s and 1s, or “offs” and “ons”, which make up a message in binary arithmetic. The advantage of this system is that there is a much lower risk of the signal being transmitted poorly and hence giving the wrong information.

Fig 2 shows the simple levels of 21, 22 and 23 (illustrated by the curve in Fig 1) as digital signals.

As we learned in the last section, each degree in the example of a heat detector can be expressed in digital form (i.e., binary arithmetic). 30 degrees Celsius would then be “11110” and this is what would be transmitted to the FACP.

A digital protocol is much less susceptible to corruption than the analogue protocol and is preferable in a life-critical system.

Only digital protocols fulfill the high demands of EN 54-13.

3. **Advantages of “open protocol”**

In the fire detection industry, intelligent systems use control panels and detectors (and, of course, devices such as sounders and interfaces), which communicate with each other by means of a protocol. Some manufacturers offer both panels and detectors. These companies do not need to disclose the nature of their protocol to anyone, since they offer all the elements needed to provide an intelligent system.

No equipment supplied by other manufacturers is expected to be compatible with such systems, so the protocol used is said to be “closed”.

![Fig 2 Digital signals](image-url)
3.1 **Closed protocol – Dependency of system and supplier on the system operator**

Manufacturers of equipment using closed protocols claim that all elements of their equipment (detectors, panels, call points, interfaces, special detectors such as beam detectors) work harmoniously with each other, since they are all designed and made by the same company.

The implication is that a system consisting of detectors and interfaces from one manufacturer and panels from another cannot work as well.

3.2 **Open protocol - Independence for the system operator**

A number of manufacturers of detectors which use open protocol do not produce control panels; they have created partnerships with independent panel manufacturers and, in some cases, companies who offer special equipment such as aspirating detection systems.

The detector manufacturer determines the protocol used by the detectors and publishes the information and technical data required by panel makers to design panels that will drive the detectors. Since all details of the protocol must be disclosed, it is referred to as an “open protocol”.

The manufacturers of the components of a system with an open protocol would assert that products from different manufacturers of fire products work just as well as closed protocol products, and there might even be an advantage in different specialist manufacturers concentrating on their own skill areas.

4. **Distinction between pre-alarm / main alarm**

In order to avoid panicked reactions by both the car personnel and the passengers in the event of false alarms, an area-wide acoustic, unlimited alarm should not be triggered right away when an alarm occurs at the FACP.

Experience in recent years by railroad operators have shown that these alarms are no longer interpreted conscientiously both by car personnel and passengers in the event of repeated occurrence and therefore, regarding the emergency plan, which is also largely dependent on organizational and operational responses and measures, significant delays and hazardous situations are to be expected in an actual real fire event.

This situation could be dangerous in that proven weak points would exist for the responsible staff of the operator in case of damage.

It is therefore strongly recommended that a distinction be made between a "pre-alarm" and "main alarm" for the alarming concept and the emergency measures to be introduced.
5. **Main characteristic of the railway-tested fire alarm system NSC Solution F1 – Rail combined with Apollo Discovery ring bus components**

- System tested according to the latest rail standards (EN 50155, EN 50121-3, EN 60068, EN 61373, EN 45545-2)
- EN 54-2 tested FACP, EN 54-13 tested system (VdS)
- Multi-protocol panel, open protocol detectors and ring bus components
- Modern 2-wire ring bus detection technology, analog value transmission and evaluation via digitized protocol
- SIL 2 certified ring bus protocol
- Highest level of immunity to false alarms (drift compensation, event delay, filtering of recurrent detection patterns)
- Ring-bus-compatible components with analog value transmission: smoke detectors, multi-sensor detectors (smoke / thermal), UV / IR flame detectors, smoke suction system, line type heat detectors, manual fire detectors, I / O modules
- Detector housing have been meeting the highest standards with regard to flammability (V0 according to UL94) for many years
- Long-term certifications of detector components according to all international standards (VdS, LPCB, and many more)
- Many years of outstanding references regarding industrial capability far beyond standard requirements - independent of the rail sector (e.g.: -40 to + 70° C)
- Different detection modes and sensitivities can be adjusted via the FACP
- 2 LEDs integrated in the detector for 360° alarm verification
- Contamination level indicator of the detector can also be queried in the FACP display, no PC necessary
- Short circuit isolators (EN 54-17) in each element ➔ In case of malfunction, 2 branch lines without functional limitations are created from the ring
- 2 loops with 126 elements each can be connected, approximately 1000 m loop length possible for operation with ring bus-supplied signal generators
- Up to 128 panels can be networked via "ARCNET" fieldbus technology proven in industry, multi-master network, redundancy also possible
- Multi-protocol fire alarm control panel (2 "open protocol" detector manufacturers can be connected)
• Backward compatibility of ring bus protocols used mainly until 1986 ➔ Assured of a good future
• The detector is addressed in the base with a binary coded address card ➔ Detectors can be exchanged easily by the operator without software addressing
• Mechanical removal protection of the detector integrated with locking screw
• EN 54-3 tested ring bus signal generator (tone type, volume and duration can be configured via FACP configuration software), e.g. 63 detectors with 63 signal generators per ring with 80 dB sound level can be operated simultaneously, different volume values, sound types and duration programmable
• 100% redundant (processor redundancy in main CPU and loop card)
• Sheet steel housing, wear-free touch control panel ➔ Maximum EMC resistance
• 8 freely programmable macro keys (e.g. language switching, 18 languages integrated)
• 16 Digital outputs, 8 digital inputs, 4 potential-free relay 60 V DC, 0.5 A load, inputs and outputs expandable via ring bus-supplied I/O modules
• Extinguishing agent control monitored for short circuit / wire break
• Freely programmable according to Boolean algebra with Windows software (no paid software licenses)
• Redundant RS-232 and RS-485 interface on board
• Up to 64 LCD display and control panels can be connected to the FACP (optimum functionality for train conductors)
• Multi-protocol gateway can be connected for bidirectional connections to rail systems (MVB, WTB, CAN, ETH) - all data and events can be passed to a superior system. Even remote commands to the FACP can be realized (e.g. reset, signal generators off, detector shutdown and much more)
• Integrated modem interface (analog / ISDN / Ethernet) for remote access
• Optional Web server for remote access
• Non-volatile event memory for up to 10,000 messages (optionally expandable via SD memory card slot)
• Optional: single and multi-region extinguishing according to EN 12094-1 (gas extinguishing systems)
6. Conclusion

All technical measures described above were successfully implemented by Rail Services International Austria GmbH, together with the Detection System manufacturer NSC Sicherheitstechnik GmbH, in agreement with the operator during the equipping of prototypes of the standard IC and ICN passenger car fleet of the Swiss Federal Railways. The aim was to drive through the Gotthard Base Tunnel with as few false alarms as possible with a state-of-the-art system certified in compliance with standards.

Summary

With the use of modern ring bus detection technology through which analogue measurement values are transmitted bidirectionally via a digitized protocol to an EN 54-2 certified, microprocessor-controlled fire alarm control panel within an EN 54-13 certified system, the currently highest level of security against false alarms can be provided through intelligent algorithms (drift compensation, event delay, filtering of recurrent detection patterns).

Zusammenfassung in DEUTSCH


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SOURCES (standards and guidelines):


ARGE Guideline - Part 2: "Fire fighting in rolling stock"
ARGE Guideline - Part 3: "System functionality fire detection and fire fighting systems in rolling stock"

[3] EN 54-2: Fire detection and fire alarm systems - Part 2: Control and indicating equipment
EN 54-3: Fire detection and fire alarm systems - Part 3: Fire alarm devices - Sounders
EN 54-5: Fire detection and fire alarm systems - Part 5: Heat detectors - Point detectors
EN 54-7: Fire detection and fire alarm systems - Part 7: Smoke detectors - Point detectors using scattered light, transmitted light or ionization
EN 54-17: Fire detection and fire alarm systems - Part 17: Short-circuit isolators
EN 54-18: Fire detection and fire alarm systems - Part 18: Input/output devices

INTERNET REFERENCES: