SIEMENS

Cerberus™ PRO
Fire detectors

Application Guideline

Building Technologies

CPS Fire Safety

1 Introduction

Cerberus® PRO allows you to build highly technical, risk-adjusted fire detection installations that nevertheless protect against false alarms. This application guideline is intended to assist you in selecting the suitable fire detector and to select the proper settings.

The recommendations described in this document are based on more than a half century of global experience in building fire detection installations as well as a deep knowledge of Cerberus PRO fire detectors. It is important to pay attention to ambient conditions such as room sizes, deceptive phenomena or air exchange: You select the fire detectors, assign and configure them accordingly. For special projects, the selection and settings for the fire detectors are only possible after conducting tests. A general guideline for all possible applications is simply not possible.

The information contained in this document should be considered as recommendations only.
Only a person with the appropriate knowledge and understanding for the deployment conditions is in a position to make the final selection of the optimum detector.

We need your help to ensure that this guideline is kept up-to-date with the latest findings and experiences. We therefore request that you let us know about your experiences (both positive and negative) using Cerberus PRO fire detectors for system engineering.

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2 General

2.1 Fire detection systems

Cerberus PRO fire detectors allow you to engineer an installation that reliably detects a fire during the initial phase, while also providing one-of-a-kind immunity against interference.

The goal of fire detection installations is:
- To reliably alarm an incipient fire at a very early phase.
- To alarm only when a danger (a fire) exists.

Experience indicates that forces intervening seldom are alarmed too late to a real fire, but rather in many cases, the fire department is required to unnecessarily deploy in response to deception of the automated detectors, improper system operation, mischief, technical failures, etc. This fact must be considered carefully when selecting and setting the detector.

2.2 Consider national directives and regulations

Special requirements arising from laws, ordinances, directives and standards have priority over this engineering guideline and must be observed.

- National requirements:
  This must have priority under all circumstances. Authors include insurance companies, authorities, associations, customers, etc. Approval requirements must also be observed when selecting devices and systems.
- Product-specific requirements:
  This is an integral part of technical descriptions, service manuals, etc. You must comply with the technical data contained in this type of documentation.
- No requirements:
  If there are no special requirements to be considered, the project and execution is conducted in accordance with Siemens engineering guidelines – oriented on current performance state for Siemens products.

3 Cerberus PRO Fire detectors

3.1 Overview

Within the Cerberus PRO we are offering fire detectors for:

– Standard applications (offices, schools, shopping centers)
– Sophisticated applications (kitchens, event halls, underground garages)
– Special applications (IT-rooms, museums, factory buildings, hangars)

Properties	Standard Applications	Sophisticated Applications	Special Applications
Fire detector	OP720, OH720, HI720, HI722	OOH740, OOHC740	FDF241(221), FDL241, ASD
Signal processing	Detektion algorithms	**ASA***technology*	**ASA***technology*
No of parameter sets	two (HI722 one)	≥ seven switchable	≥ four
Operating mode	fix	selectable	fix

Tab. 1 Characteristics of the Cerberus PRO fire detectors

In addition to the different detection principles and the corresponding response behavior to fire phenomena, the Cerberus PRO fire detectors differ primarily in the areas of signal evaluation and parameter sets.

The Cerberus PRO fire detectors for standard applications work with detection algorithms. The detectors for sophisticated and special applications work with a signal processing function based on the **ASA***technology*.

For standard applications, fire detectors with two different parameter sets are sufficient. With these parameter sets the detector behavior can be adapted to the situation. Regarding sophisticated or special applications, fire detectors with a higher degree of flexibility concerning sensor technology and parameter sets are required.

In the fire detectors OOH740 and OOHC740, the operating mode can be selected, offering additional flexibility.

3.2 Fire detectors for standard applications

The fire detectors OP720, OH720, HI720 und HI722 are used for standard applications.

3.2.1 Smoke detector OP720

The smoke detector OP720 has an optical sensor built in a high-quality sampling chamber. It detects fires that cause smoke and has a limited immunity against deceptive phenomena such as cigarette smoke or steam.

3.2.2 Multi-sensor smoke detector OH720

The multi-sensor smoke detector OH720 is a multiple criteria fire detector with one optical and one thermal sensor built in a high-quality sampling chamber. The intelligent combination of the optical and thermal sensor signals optimizes the detection reliability. This detector enables early detection of all types of fire and medium immunity against false alarms which may be caused by deceptive phenomena.

3.2.3 Heat detectors HI720 and HI722

The heat detectors HI720 and HI722 have a straightforward design featuring a thermal sensor and detect open fires where a significant heat is created.

3.3 Fire detectors for sophisticated applications

The neural fire detectors OOH740 and OOHC740 are used in applications, where an early detection of all types of fire, an outstanding immunity against deceptive phenomena and a high flexibility regarding detection behavior are requested.

3.3.1 Neuronal fire detector OOH740

The neural fire detector has two heat sensors and unique optics. The optics consists of an innovative scattered light chamber with two light sources that illuminate aerosol particles from various directions. This creates homogenous response behavior to all types of smoke. The intelligent linking of the optic signals to signals from the heat sensors provides very solid detection behavior and very high immunity against deceptive phenomena (**ASA***technology*).

Operating modes:
The OOH740 can be easily adapted to changing conditions thanks for selectable modes.

- Mode 0 (OOH): Neural fire detector with homogenous response behavior to all types of fires
- Mode 1 (H): Heat detector to detect open fires
- Mode 2 (OO): Optical smoke detector with homogenous response behavior to light and dark aerosols

3.3.2 Neuronal fire- and CO-detector OOHC740

The neuronal fire- and CO detector OOHC740 is based on the neuronal fire detector OOH740. In addition, the OOHC740 is equipped with a high quality CO sensor.

In addition to the exceptional detection behavior on different types of fire and the extremely high immunity to deceptive phenomena, the OOHC740 is capable of generating a “Technical CO Alarm” as soon as a predefined CO concentration is exceeded.

Operating modes:
Same as the OOH740, the OOHC740 can be used as a neural fire detector, as a heat detector or as an optical smoke detector (Mode 0, 1 or 2).

3.4 Fire detectors for special applications

The flame detectors (FDF), the linear smoke detector (FDL) or the aspirating smoke detector systems (ASD) are used in areas with special environmental conditions, special room dimensions or special requirement regarding the alarming.

3.4.1 Flame detectors FDF241 and FDF221

Both flame detectors FDF221 and FDF241 measure radiation energy in the infrared range. They are suitable for detecting smokeless liquid and gas fires as well as smoke generating open fires of carbon materials as is the case for wood, plastics, gasses, oil products, etc. The infrared flame detectors do not detect fire of inorganic materials such as hydrogen, phosphorous, sodium, magnesium, sulfur, etc. Conversely, detection is guaranteed when these types or materials are burned together with organic materials.

In the addition to a sensor to measure infrared radiation in the CO_2 range, the FDF241 includes two additional sensors that measure the radiation from disturbances such as warm radiators and from light sources, such as the sun. The FDF241 flame detector has extremely high immunity to deceptive phenomena, such as heat radiation from disturbances or sunshine, thanks to its 3 sensors and associated signal processing. False alarms are practically impossible with the FDF241.

The FDF221 provides a cost-effective solution for trouble-free applications. FDF241 quickly and reliably detects open fires under difficult conditions.

3.4.2 Linear smoke detector FDL241

The linear smoke detector operates on the extinction principle (light attenuation / extinction = Absorption + scatter). An infrared light transmitter sends a ray to a reflector that returns the signal to the receiver. In the absence of smoke, a large portion of the rays reach the receiver – with smoke, the rays are absorbed and scattered with only some of the rays reaching the receiver. The difference between sent and received signals is analyzed and outputted as a danger level. FDL241 provides us a high-quality linear smoke detector. Built-in distance measuring is of special note for this detector. It allows for reliable recognition of foreign objects within the path of the ray, preventing potential false alarms.

The linear smoke detector is especially suited for large halls and detection of smoldering fires in high rooms thanks to its detection principle and large surveillance areas.

3.4.3 Aspiration smoke detector systems (ASD)

Aspiration smoke detector systems are fire detection systems to protect rooms and objects. A pipe system extracts air samples from the surveillance area and sends the samples to a smoke detector. An alarm is triggered if the smoke detector detects fire aerosols in the air sample. These types of systems are especially suited for areas where point measurement detectors cannot be used or only under certain conditions.

3.5 Signal processing

3.5.1 Detektion algorithms

The detection algorithms are advanced signal processing based on the experience gain from algorithm technologies developed by Siemens.

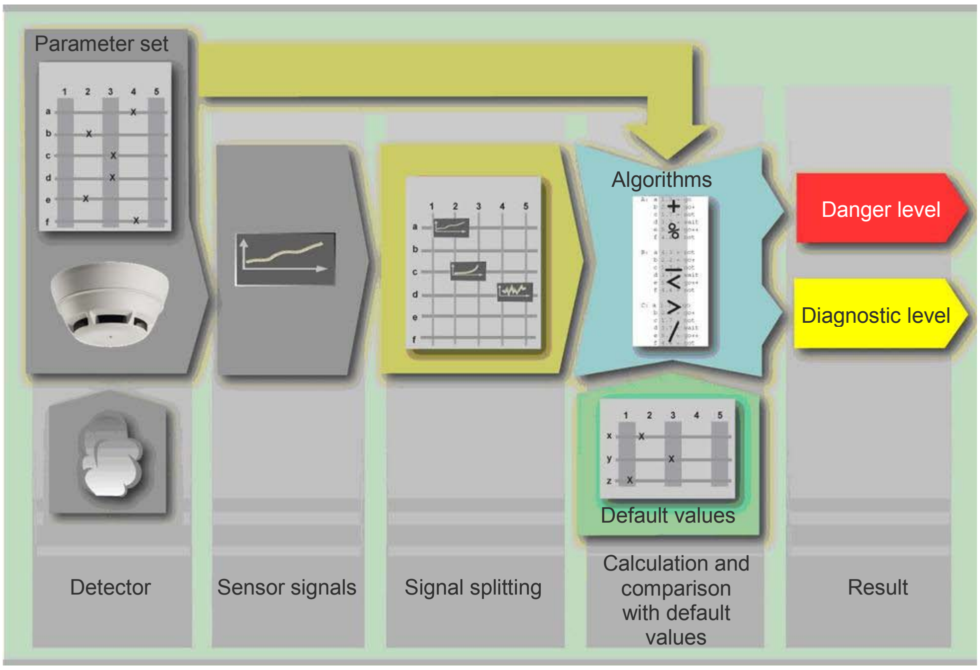

Fig. 1 OP720 signal processing with detection algorithms

The sensor acquires the fire phenomena, breaks it down into mathematic components and sends it to the programmed algorithms. The multi-sensor smoke detectors further analyze smoke and heat signals and undertake to weigh the information accordingly. You can influence the algorithms by selecting the parameter set and in this manner set the detectors to anticipated fire phenomena and environmental influences.

3.5.2 **ASA***technology*

ASA*technology*™ (ASA = Advanced Signal Analysis) represents the continued development of algorithm technology developed by Siemens.

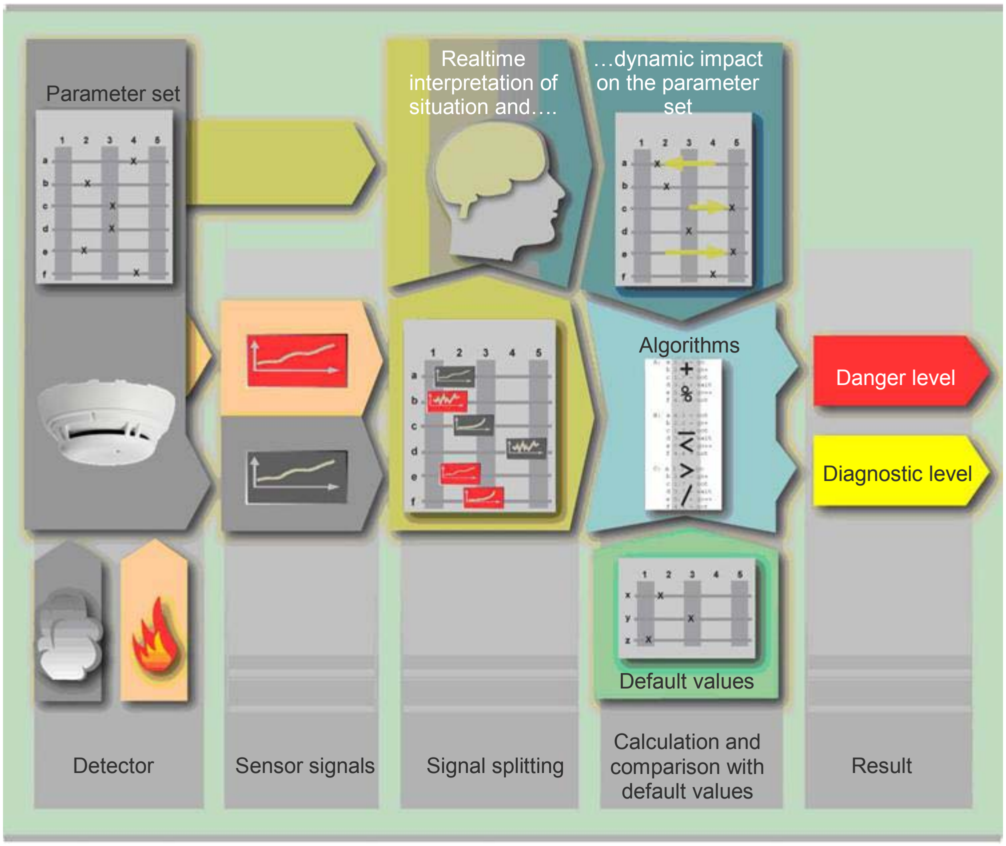

Fig. 2 OOH740 signal processing with **ASA***technology*

The sensor acquires the fire phenomena, breaks it down into mathematic components and sends it to the programmed algorithms. Neural fire detectors further analyze smoke and heat signals and undertake to weigh the information accordingly. You can influence the algorithms by selecting the ASA parameter set and in this manner set the detectors to anticipated fire phenomena and environmental influences. In contrast to the detection algorithms, selected parameters are not fixed using **ASA***technology.* Real-time interpretation of the situation has a dynamic impact on the selected ASA parameter set. This results in an adjustment to the optimum effective range of the detector allowing it to be more sensitive to fires, yet more robust against deception. We achieve in this manner a unique degree of detection reliability while maintaining a very high immunity to deception.

3.6 Parameter sets

3.6.1 Parameter sets standard fire detectors

HI720/722 — **Heat detector**

Nr.	Name				Thermal			Property / priority
					Min [°C]	Max [°C]	Diff Δ[K]	
1	A2S				-	60	-	Alarming if T > 60°C
2	A2R 1)				10	60	25	Alarming at significant heat rise or T > 60°C

1) Parameter set available only for HI720

OP720 — **Smoke detector**

Nr.	Name	Optical						Property / priority
		Response time [s]	S-fire [%/m]	O-fire [%/m]				
1	Standard	10	2.5	2.5				Very early alarming to fires with good visible aerosols
2	Sensitive	10	1.8	1.8				Very early alarming to fires with visible aerosols

OH720 — **Multi-sensor smoke detector**

Nr.	Name	Optical			Thermal			Property / priority
		Response time [s]	S-fire [%/m]	O-fire [%/m]	Min [°C]	Max [°C]	Diff Δ[K]	
1	Robust	35	3.5	3.5	10	60	25	Immunity against low deceptive phenomena – early alarming to open fires
2	Sensitive	10	2.5	2.5	10	60	25	Very early alarming – especially to open fires with visible aerosol

OOH740 & OOHC740 — **Neuronal fire detector (ASA*technology*)**

Nr.	Name	Optical			Thermal			Property / priority
		Response time [s]	S-fire [%/m]	O-fire [%/m]	Min [°C]	Max [°C]	Diff Δ[K]	
8	High Suppression 2)	60 - 80 - 360	8.0	2.3	30	80	25	No alarm without temperature rise
5	Suppression	90 - 160 - 760	11.4	3.2	30	80	29	Very robust against deceptive phenomena
12	Suppression CO 1)	75 - 150 - 760	8.6…11.4 3)	3.2	30	80	29	Very robust against deceptive phenomena. Sensitivity influenced by the CO concentration.
7	High Compensation	80	11.4	3.2	30	80	29	High long-term stability even in dirty environment
2	Robust	80	11.4	3.2	30	80	29	Robust behavior in a „normal“ environment
4	Balanced	40 - 64 - 300	8.0	2.3	30	80	25	Early alarming and robust against deceptive phenomena
10	Balanced CO 1)	25 - 50 - 300	5.0…8.0 3)	2.3	30	80	25	Early alarming and robust against deceptive phenomena. Sensitivity influenced by the CO concentration.
6	Fast Response	20 – 30	5.7	1.6	3	80	22	Early alarming to open fires and low levels of smoke concentration.
9	High Sensitive Fast	20 – 30	2.8	0.8	3	60	16	Early alarming to open fires and minimum levels of smoke concentration

1) Parameter set available only for OOHC740
2) Alarming only possible at a temperature increase of ca. 8K (not comply with standards EN 54-7)
3) The CO signal helps to speed up alarm activation in the event of smoldering fires but cannot trigger fire alarms on its own.

As noted, the OOH740 as well as the OOHC740 can be set to an operating mode where the response behavior corresponds to a heat or pure optical smoke detector. In these operating modes, the following parameter sets are available.

OOH740 & OOHC740 Sensor mode 1 **Heat detector**

Nr.	Name	Optical			Thermal			Property / priority
					Min [°C]	Max [°C]	Diff Δ[K]	
1	A1R				3	60	25	Alarming at significant heat rise or T > 60°C
2	BR				30	80	29	Alarming at significant heat rise or T > 80°C
3	A1S				30	60	-	Alarming if T > 60°C
4	BS				30	80	-	Alarming if T > 80°C

All parameter sets meet the criteria of standard EN 54-5

OOH740 & OOHC740 Sensor mode 2 **Smoke detector**

Nr.	Name	Optical			Thermal			Property / priority
		Response time [s]	S-fire [%/m]	O-fire [%/m]				
2	Robust	80	8.0	2.3				Robust against deceptive phenomena
1	Universal	50	8.0	2.3				Balanced behavior regarding alarming and robustness
3	Sensitive	30	5.6	1.6				Early alarming – especially to open fires

- Response time: Minimum time required by the detector to alarm, even when the smoke concentration is well beyond the value required for alarming. For the neuronal fire detectors, this time can vary strongly up or down depending on dynamic influence. This time will be reduced for the multi-criteria and the neuronal fire detectors, depending on the temperature rise at the detector position.
- S-fire: Minimum smoke concentration (combination of forward and reverse scatter) is required to trigger an alarm of a smoldering fire. This value will be lower for the multi-criteria and the neuronal fire detectors, depending on the temperature rise at the detector position.
- O-fire: Minimum smoke concentration (combination of forward and reverse scatter) is required to trigger an alarm on an open fire. This value will be lower for the multi-criteria and the neuronal fire detectors, depending on the temperature rise at the detector position.
- Min: Alarm only possible after reaching this temperature.
- Max: An alarm is triggered when this temperature is breached, no matter how strong the temperature rise.
- Diff: An alarm is triggered when this temperature increase and the Min are breached. In case of low temperature increase between 1 K/min and 10 K/min, this value increases by a few degrees (detector compensates 1K/min.)

Changeover the parameter sets

In addition to freely selecting the ASA parameter set, the neural fire detectors (OOH740 and OOHC740) also allow time and process controlled switching of the ASA parameter sets. This function provides an optimum detection behavior in rooms where massive deceptive phenomena may occur over several minutes or hours.

For example, an OOH740 can be operated in a disco during operation with parameter set 8 (high suppression) making it resistance to deceptive phenomena caused by disco fog. For the remaining period, when no fog is generated, the OOH740 can work at parameter set 4 (balanced) and is then able to alarm lower concentrations of smoke at an early stage.

3.6.2 Parameter sets for special detectors

FDL241 **Linear smoke detector**

Nr.	Name	Response threshold	Property / priority
1	Standard with open line	65%	Robust behavior in a „normal“ environment
2	Standard with BS alarm	65%	
3	Sensitive with open line	50%	Early alarming and robust against low deceptive phenomena
4	Sensitive with BS alarm	50%	
5	Highly sensitive with open line	30%	Early alarming already at very low aerosol concentration
6	Highly sensitive with BS alarm	30%	

- response threshold: Reduction of the signal (gla) compared to compensation value (NFW) to trigger an alarm. Without smoke, signal (gla) and compensation (NFW) are about the same size (signal gla ≈ 100% compensation NFW).

Comment:
Sensitivity for linear smoke detectors is highly dependent on the distance from detector to reflector as the light obscuration is established over these lengths.
At an equal smoke distribution in a room, an FDL241 alarms at a detection distance of 20m and a parameter set "Highly sensitive with open line" as soon as the smoke density reaches 0,75%/m (30%/(2x20m)). At a detection distance of 50m, the linear smoke detector with the same parameter set alarms as soon as the smoke density of 0,3%/m (30%/(2x50m)) is reached.

FDF221 **Flame detector**

Nr.	Name	Sensitivity	Response time [sec]	Deception resistance	Property / priority
1	Robust	normal	7 – 13	low	Robust against short deceptions
3	Universal fast	normal	2 – 3	low	Alarming for medium sized fire
4	Sensitive	sensitive	4 – 7	low	Alarming for a small fire
5	Sensitive fast	sensitive	2 – 3	low	Fast alarming for small fire

FDF241 **Flame detector**

Nr.	Name	Sensitive	Response time [sec]	Deception resistance	Property / priority
1	Robust	normal	7 – 13	high	Very robust against deceptions
2	Universal	normal	4 – 7	high	Alarming for medium sized fire
3	Universal fast	normal	2 – 3	high	Fast alarming for medium sized fire
4	Sensitive	sensitive	4 – 7	high	Alarming for small firer
5	Sensitive fast	sensitive	2 – 3	high	Fast alarming for small fire
6	Rapid	sensitive	1	low	Extremely fast alarming for small fire
7	Motor test bed	sensitive	7 – 13	hot bodies	Extremely robust against radiation from hot bodies

- Sensitivity: At a normal sensitivity, the FDF, for example, detects a 0.5m^2 large ethyl alcohol fire up to a distance of 19 meters. This type of fire can be detected at a distance of up to 38 meters with a more sensitive setting.
- Response time: Time that the detector "analyzes" the fire before triggering an alarm.
- Deception resistance: Resistance to deceptions such as hot bodies, sunlight or electric arcs.

Comment:
When comparing the parameter sets for the FDF221 with the sets for the FDF241, you will notice that the FDF221 has 4 parameter sets that are virtually the same as the FDF241. Both flame detectors operate identically with the corresponding parameter sets when operating the FDF221 in an environment without deceptions. In addition to the additional parameter sets, the FDF241 differs primarily from the FDF221 through its higher immunity against deceptive phenomena such as hot bodies or sunlight.

FDA221

Set no.	Sensitivity [%/m]			
	-	Pre-alarm	Fire 1	Fire 2
6	-	0.14	0.20	6
7	-	0.28	0.40	8
8	-	0.50	0.70	10
9	-	0.70	1.00	15
10	-	1.40	2.00	20

FDA241

Set no.	Sensitivity [%/m]			
	Inspect	Pre-alarm	Fire 1	Fire 2
1	0.03	0.04	0.05	2
2	0.03	0.045	0.06	2.5
3	0.04	0.055	0.07	3
4	0.05	0.075	0.10	4
5	0.07	0.10	0.15	5
6	0.08	0.14	0.20	6
7	0.18	0.28	0.40	8
8	0.30	0.50	0.70	10
9	0.40	0.70	1.00	15
10	0.80	1.40	2.00	20

4 Select the proper fire detector

4.1 General

Observe the following points when selecting fire detectors:
- Fire phenomena
- Room dimensions
- Environmental influences

In addition to these criteria, you should also consider existing risk, desired flexibility and costs.

4.2 Fire phenomena

Various assessable fire phenomena may occur depending on the type of fire. Not all of them can be acquired using the same detection principle. A smoke detector should be used if you anticipate a smoldering fire (strong smoke development, low fire thermals) during the initial phase, as is the case with cable fires. If you anticipate strong heat generation, flame radiation and/or smoke development during the initial stage of the fire, you should use smoke, heat or flame detectors. You may have to combine the various types of fire detectors to reliable recognize all anticipated causes of fires.

The table below illustrates the type of detectors and the fire phenomena they react to. The table further lists typical fires for which these detectors are particularly suited.

OH, OOH, OOHC (multi-sensor smoke detectors)	**OP** (smoke detector)	**HI** (heat detectors)
- Flaming fires with or without smoke (wood, oil, plastic, gas, solvents, etc.). - Smoldering fires (wood, paper, plastic, etc.)	- Smoke generating fire (plastic, oil, etc). - Smoldering fires (wood, paper, plastic, etc.).	- Flaming fires with or without smoke (wood, oil, plastic, gas, solvents, etc.).
Smoke and heat increase	**Smoke**	**Heat increase**

FDL (Linear smoke detector)	**ASD** (Aspirating smoke detector)	**FDF** (Infrared flame detector)
- Smoke generating fire (plastic, oil, etc). - Smoldering fires (Be careful about mounting height).	- Early stage of a smoke forming fire.	- Flaming fire of carbon / organic materials (e.g. word, alcohol, petrol by-products, etc.).
Smoke		**Thermal radiation**

Tab. 2 Detector type and fire phenomena

4.3 Room dimension

Fire alarms can only be triggered when the fire detector detects the fire. In order to detect, the fire phenomena (smoke, heat, radiation) must reach the detector.

4.3.1 Room height

The room height limits the range of application for individual detectors, since most detectors are mounted on the ceiling. Application limits are established in the requirements for the various types of fire detectors (these values may vary depending on the country).

Detector type	Max. room height	Comment
- Point type smoke detectors (DIN EN45-7)	12m	
- Linear smoke detectors (DIN EN54-12)	16m	Lowermost detection level
- Aspirating smoke detectors (DIN EN54-20)	16m 12m	For class A and B For all classes
- Point type heat detectors (DIN EN54-5)	7.5m 6.0m	For class A1 For all classes
- Flame detectors (DIN EN54-10)	26m 20m	For class 1 / 45° angle For class 2 / 45° angle

Tab. 3 Suitability of fire detectors dependence on the room height according DIN VDE 0833-2

For rooms higher than 12m, point type smoke detectors are not anymore allowed. For height room application a combination of linear smoke detectors (on a level below 16m) and point type smoke detectors (below the ceiling) is a proper solution. The use of flame detectors for height room applications is suitable to detect an open fire if the detectors can be installed within sight of the entire monitoring area.

4.3.2 Floor space

Please consider the following when selecting the optimum fire detector in rooms with lots of floor space:

- When smoke from a fire propagates over a large distance, the sensitivity and thus, the response time for a linear smoke detector or an ASD system is superior to a point detector.
- Large halls are often equipped with linear smoke detectors or ASD systems for business reasons. The disadvantage is that the system can only tentatively determine the location of the fire.

4.4 Environmental influences

4.4.1 General

Most applications are not subject to special environmental influences that would otherwise be considered when selecting a fire detector. In the few cases, where special environmental influences occur, they must be considered; otherwise you could seriously impact the reliability of fire detection.

Of special note are:
- High air circulation
- Unusual ambient temperature
- Dirt
- Humidity
- Deception phenomena

4.4.2 Air circulation

High air circulation, as is the case, for example, in computer rooms, significantly dilutes the concentration of smoke. Point smoke detectors detect the fire at a late stage in this type of environment. This is why ASD systems are often used for this type of application, where the piping is installed in front of the extract air duct.

4.4.3 Ambient temperature

You need to consider the operating temperature when installing fire detectors in rooms with extreme ambient temperatures.

You must further note when using heat detectors, that the minimum static response temperature is set to a few degrees above the maximum ambient temperature. If this is not considered, so will likely result in false alarms.

4.4.4 Dirt

Dirt such as flying strands or dust particles within textile production or the smallest particles at a coal-fired power plant impact the reliability of fire detectors. At best this results in shortened maintenance intervals; at worst, your fire detection installation may no longer operate reliably. You must always take a dirty environment into consideration when selecting the fire detector.

Often, operators forgo point type smoke detectors in such environments in favor of closed detectors (flame detectors or linear smoke detectors) only. ASD systems with automated flushing are also suitable for some of these applications.

4.4.5 Humidity

Fire detectors selected for use in humid or even wet environments must have the necessary IP protective class (IP = International Protection). If the planned point detector does not have the protective class required for this room, you may have to check whether an appropriate supplemental base can achieve the results you need.

4.4.6 Deceptive phenomena

The fire detector has the task of detecting fire from fire aerosols, heat and radiation at an early stage and to trigger an alarm. Aerosols, heat and radiation, however, are also generated by production processes, from plants in a room, such as motors, or by environmental factors such as sunlight. If these deceptive phenomena are sufficiently intense and exist over a certain period, they may impact fire detectors enough to trigger an alarm (false alarm).

False alarms can often be prevented by optimum positioning of the fire detector. If this is not possible, you should select a fire detector with sufficiently high immunity against deceptive phenomena. Under certain circumstances, you may have to combine the detector with another that applies a more suitable detection principle for the application.

4.5 Business perspective

Business considerations are playing an increasingly central role in selecting a fire detector.

In other words:

- Where ever possible fire detectors for standard applications (OP720, OH720, HI720 or HI722) are used.
  - The first priority is mostly given to the smoke detector OP720
  - Do we expect an open initial fire or do we have to deal with low deceptive phenomena, most often the multi-sensor smoke detector OP720 is used.
  - Heat detectors are only used in areas where smoke detectors cannot be employed due to immunity to deception.
- The two neural fire detectors OOH740 and OOHC740 are mainly used for high risk applications and in areas with significant deceptive phenomena.
  - Due to the high flexibility of the OOH740 (different parameter sets and different operating modes) the detector behavior can easily adapted to the existing environmental conditions and the requested alarming in case of a fire.
  - The OOHC740 is used in areas where in addition to reliable fire detection process-related or due to faulty installation non acceptable CO concentrations must be detected.
- The special detectors (FDF241, FDF221, FDL241, ASD Systems) are mainly used in areas where a specific detection behavior is requested.
  - In general, the flame detector is used wherever an open fire must be detected as quickly as possible.
  - Thanks to its large coverage area, the linear smoke detector is often used in large halls. In addition, it is often used in very high halls, where the detection of fires occurring at a significant distance from the ceiling is required.
  - ASD systems are used wherever extremely early fire detection is required and where this cannot be guaranteed with point-shaped detectors due to the high air exchange rates.

5 Fire detection with point detectors

5.1 General

This chapter describes the fire detection with the Cerberus PRO point detectors for both standard and sophisticated applications. As the behavior of the OOHC740 is almost identical to that of the OOH740, the statements and recommendations given apply to both detector types. The additional functionality of the OOHC740 concerning CO detection is described in detail in Chapter 7.

The fields of application and settings of the special detectors are described in Chapter 6.

5.2 Detector selection

The choice of point detectors is oriented on the anticipated fire to be detected.

Type of fire / Detector type	OP720	OH720	OOH740	HI72x
- Smoldering fire	●	○	●	-
- Open fire without or little smoke development (examples include methanol, ethanol, ethyl alcohol, dry wood)	-	○	●	○
- Open fire with smoke development	○	●	●	○

● well suited ○ suited - not suited

Tab. 4 Choice of point detector based on anticipated type of fire

The smoke detector OP720 is especially suited to detect smoldering fires; however, it is also capable of detecting open fires with clearly visible aerosols.

According to the table, both the OH720 and the OOH740 are suited for all types of fire. Taking a closer look at the detector features, however, it becomes obvious that in practice the neural fire detector OOH740 is nearly always superior to the multi-sensor smoke detector OP720.

- Thanks to the two optical sensors the OOH740 ensures a more constant response behavior to fires generating visible aerosols.
- The more intelligent signal processing with the **ASA***technology* in the OOH740 accelerates alarming in the event of a fire, at the same time increasing the detector’s immunity to deceptive phenomena.
- The higher number of different parameter sets in the OOH740 in comparison to the OH720 makes it possible to ideally adjust the detector to the prevailing risks and ambient conditions.

In new fire detection systems the heat detectors HI720 and HI722 are only used when exclusively open fires have to be expected, or when other fire detector types cannot be used for reasons of immunity to deceptive phenomena.

5.3 Standard applications

5.3.1 Definition

A standard application is considered rooms with low risk to life and limb, low risk to property, a low risk of fire and no large deceptive phenomena.

Whereas:

- **Low risk to life and limb**
  No large collection of people; sufficient possibility of escape exists and people can save themselves.
- **Low risk to property**
  Rooms with little to medium concentration of assets. Reconstruction after a claim can occur at reasonably costs for procurement and interruptions to production.
- **Low risk of fire**
  There are no sources of ignition such as flames, welding, electric heating elements and no increased fire load such as large amounts of highly flammable liquids.
- **No large deception phenomena**
  Clean rooms without any large amounts of aerosol or heat development. No welding work or process-related vapor or heat development.

5.3.2 Selection and setting

Rooms where the standard application approach is used, include:

- Offices and conference rooms
- Break and exhibition rooms
- Retail areas
- Clean production and storage rooms
- Corridors and stairwells

These types of areas do not have an increased risk. No large deceptive phenomena occur and ambient conditions are non-critical and relatively constant. Furthermore, if there is no pending change in use in the rooms, the performance of the OP720 and the OH720 are sufficient for such rooms up to a ceiling height of 7m.

To be considered in the selection of the detector type:

The risk of false alarms is higher in lower rooms where deceptive phenomena such as cigarette smoke or process-related aerosols occur in rather high concentrations due to the lower volume. This is why in such applications the OH720 with robust settings is recommended.

Due to the low thermal, aerosols caused by a smoldering fire are transported to a height of only 5 to 7 meters. This means that aerosols found in heights > 7m are usually generated by open fires. Thanks to the backward scattered sensor in the OOH740, this detector detects open fires much earlier than an OP720 or OH720, which is why it should be exclusively used in such applications.

The table below shows the detector selection and the applicable parameter set in more than 90% of standard applications. When an open fire can be expected already in an early stage (e.g. rooms with highly flammable materials), the OOH740 should always be used, with its corresponding parameter set depending on the room height.

Detectors and parameter set for standard applications	**Detector**	**OP720**		**OH720**		**OOH740**
	Parameter sets	**1 / Standard**	**2 / Sensitive**	**1 / Robust**	**2 / Sensitive**	**9 / High Sensitive Fast**
Ambient conditions	**Room height**					
No deceptive phenomena exists - Clean environment - No smoking - No vapor development	≤ 2.5m	●				
	> 2.5m		●			
	> 5.0m		●			
	> 7.5m		○		○	●
Minimum deceptive phenomena exists - Smoking allowed - Low vapor development possible - Low process-related dust development	≤ 2.5m			●		
	> 2.5m	●				
	> 5.0m		●			
	> 7.5m		○		○	●

● well suited ○ suited

Tab. 5 Detectors and settings for standard applications

5.4 Increased risk

5.4.1 Definition

You need to specially consider rooms with an increased risk to life and limb, dominated by increased fire risk or that contain high asset values. The same applies to areas where an interruption to operations caused by fires could result in high costs. For these types of conditions, the priority is clearly on early and reliable alarming.

Whereas:

- **Increased risk to life and limb**
  Rooms containing people that cannot or, only under certain conditions, are able to save themselves. Rooms with a large concentration of people causing problems for fast evacuations.
- **Increased fire risk**
  Rooms containing sources of ignition such as open flames, welding, electric heating elements and increased fire loads such as rooms where larger quantities of highly flammable liquids are stored, suggests an increased fire risk.
- **High asset values**
  Rooms that contain assets that may only be replaced at considerable expense or are irreplaceable (examples include works of art or stored data).
- **High costs caused by interruption to operations**
  Production facilities and areas where a fire-related interruption to operations would be costly (examples include production lines for electronic components or pharmaceutical products).

5.4.2 Selection and setting

Rooms, where the "increased risk" approach is often applied, include:

- Hospital and care rooms
- Hotel rooms
- Prison cells
- Event rooms such as large conference rooms
- Exhibition rooms with expensive or hard to replace objects, e.g. museums
- Production areas where a small fire could result in high follow-on costs, e.g. a room for chip production
- Energy distribution plants and power plants

In these types of areas there is an increased, or to some extent, even high risk to life and limb or assets. Fast alarming of incipient fires while simultaneously avoiding false alarms is required.

To note when selecting the detector type:

- Most fires develop from a smoldering fire that eventually turns into an open fire. As a result, OP720 fire detectors are primarily used in rooms with a room height of maximum 7 meters
- Aerosols at a height of > 7 meters generally originate from an open fire. Thanks to the backward scatter in the OOH740, this detector detects open fires much earlier than an OP720 or an OH720. OOH740 fire detectors are primarily used in rooms with a room height in excess of 7 meters.
- You should always select an OOH740 if you anticipate an open fire in the beginning phases (for example, a room with highly flammable materials).

Even the OOH740 detector with the **ASA***technology* has limits when it comes to alarming the smallest possible amounts of aerosols or slight temperature increases while maintaining a high degree of security against deceptive phenomena. You should therefore note the following when selecting a suitable parameter set:

- The risk of false alarms is greater with sensitive parameter sets than with indifferent sets. High-sensitive parameter sets are only used in rooms that are free of deceptive phenomena.
- Aerosol concentration or temperature raises that impact the ceiling-mounted fire detector decrease as the room height increases. In other words, sensitive parameter sets may also be selected in high rooms with medium deceptive phenomena.

The points above illustrate how the selection of a fire detector and optimum settings can vary greatly depending on the object and ambient conditions – which is why there are no generally applicable rules. The following table shows the suitable detector types and suitable parameter sets for commonly occurring applications.

Detectors and parameter set for applications with increased risk	**Detector**	**OP720**		**OOH740**			
	Parameter sets	**1 / Standard**	**2 / Sensitive**	**2 / Robust**	**4 / Balanced**	**6 / Fast Response**	**9 / High Sensitive Fast**
Use / Application	**Room height**						
Hospital rooms / high risk to life and limb - Not or only partially able to save selves - No deceptive phenomena	-						●
Hotel rooms / increased risk to life and limb - Able to save selves - Low deceptive phenomena	≤ 2,5m	○			●		
	2.5 – 5m		○			●	
Event room / increased risk to life and limb - Able to save selves - Deceptive phenomena	≤ 2.5m			●			
	> 2.5m			●			
	> 5.0m	○			●		
	> 7.5m						●
Museum / high asset risk - Able to save selves - No deceptive phenomena	≤ 2.5m		●		○		
	> 2.5m		●			○	
	> 5.0m						●
Computer room / high damage from loss of data – high "asset risk" - Able to save selves - No deceptive phenomena	≤ 2.5m		●				○
	> 2.5m		●				○
	> 5.0m						●
Storage of highly flammable materials / increased fire risk - Able to save selves without problem - Low deceptive phenomena	≤ 2.5m				●		
	> 2.5m					●	
	> 5.0m						●
	> 7.5m						●
Production hall for electronic components / high costs from interruption to operations - Able to save selves without problem - No deceptive phenomena	≤ 2.5m		○			●	
	> 2.5m		○			●	
	> 5.0m						●
	> 7.5m						●

● well suited ○ suited

Tab. 6 Detectors and setting for applications with increased risk

5.5 Deceptive phenomena

5.5.1 Definition

Deceptive phenomena such a cigarette smoke or heat radiators influence the detection behavior of fire detectors and may result in false alarms. You must estimate the intensity of the deception at the detector's location to assess the risk of deception. Rule of thumb: The greater the distance from the detector to deception, the less the intensity of the deception and its impact on the detector and the lower the risk of a false alarm. Rooms with low-to-medium deceptive phenomena may be considered standard applications. The priority is clear for rooms with large to extremely large deceptive phenomena, to prevent false alarms while maintaining a reasonable response time.

In other words:

- **Large deceptive phenomena**
  Rooms where clearly visible or perceptible deceptive phenomena are anticipated at the detector's location. This typically includes aerosols or heat development caused by smokers, heat radiators, welding or process-related vapor or heat development.
- **Extreme deceptive phenomena**
  Rooms where intentionally generated or process-related deceptive phenomena occur at a very high intensity. This would include, for example, large kitchens or laundry rooms, where massive vapor development occurs, discos that use fog machines or production halls for paper production with large heat development.

5.5.2 Selection and setting

Rooms, where the "immunity to deceptive phenomena" approach is often applied, include:

- Hotel rooms with anticipated large vapor development around the detector. Smaller rooms, where the detector must be mounted close to the bathroom door.
- Prison cells with built-in showers
- Production areas with large smoke development (examples, foundries, or areas where a lot of welding takes place).
- Rooms where large amounts of process-related vapors are generated (examples include large kitchens or chemical plants and areas where machines are regularly steam cleaned).
- Event rooms where fog machines are used
- Recycling plants that produced lots of dust

There is little room to maneuver when selecting suitable point detectors for areas with large and extreme deceptive phenomena. If the intent is to prevent the risk of false alarms, you must use the detector with the highest immunity against deceptions – the OOH740 with **ASA***technology*™ and the specially developed parameter sets. And if the OOH740 may result in false alarms, select the HI720. The maximum occurring temperature is decisive for selecting the parameter set.

The OOH740 fire detector allow for time or process-controlled changeover of parameter sets. The parameter sets recommended in the table below refer to settings where deceptions occur. At other times, the detectors may be operated at a more sensitive parameter set.

Detector and parameter set for applications with large deceptive phenomena	**Detector**	**HI720**		**OOH740**			
	Parameter sets	**1 / A2S**	**2 / A2R**	**8 [1] / Hing Suppression**	**5 / Suppression**	**2 / Robust**	**4 / Balanced**
Use / Application	**Room height**						
Hotel rooms with "vapor in sleeping area" - Able to save selves - Large deceptive phenomena	-	○			●		
Production areas with smoke development - Able to save selves without problem - Large deceptive phenomena	≤ 2.5m		○	●			
	> 2.5m				●		
	> 5.0m					●	
	> 7.5m						●
Large kitchens with massive vapor development - Able to save selves - Large deceptive phenomena	≤ 2.5m	○			●		
	> 2.5m				●		
	> 5.0m					●	
Event rooms with fog machine - Able to save selves - Large to extreme deceptive phenomena	≤ 2.5m		○	●			
	> 2.5m				●		
	> 5.0m				●		
	> 7.5m					●	
Recycling plants with lots of dust emissions - Able to save selves without problem - Large deceptive phenomena	≤ 2.5m				●		
	> 2.5m				●		
	> 5.0m					●	
	> 7.5m						●

[1] Parameter set 8 does not meet EN54!

● well suited ○ suited

Tab. 7 Detectors and settings for applications with large deceptive phenomena

Comment:

Under very special circumstances, additional measures may be required such as protecting against deceptive phenomena using diaphragms or establishing multi-detector zones.

In most cases, it may be better to consider using special detectors for difficult applications, detectors that have higher immunity to deceptions or whether a combination of point and special detectors provides the best possible solution.

5.6 Extreme ambient conditions

Employing point detectors in areas with very high dirt from dust or smoke particles often results in an unacceptable (for the customer) exchange interval for the detectors. A specially developed parameter set for the OOH740 (and OOHC740) takes this into account. The OOH740 with the parameter set 7 / High Compensation react from detection behavior the same as parameter set 2 / Robust, but has twice the drift compensation compared to all other parameters. This detector with the parameter set High Compensation is especially well suited for applications requiring longer exchange intervals.

Occasionally, you are forced to operate the detectors beyond the limits described in the data sheets regarding ambient conditions. Furthermore, detectors will also be used in areas with ambient conditions for which we can make no or no reliable claims. You must review the use of Cerberus PRO detectors on a case-by-case basis for such applications.

Troublesome is:

– Employment in switching plants or tunnels with cables that have very high magnetic or inductive fields.
– Employment in areas with increased concentrations of corrosive gases or vapors.
– Employment in areas with increased radioactive emissions.

6 Fire detection with special detectors

You must take note of the probable type of fire or anticipated fire phenomena when selecting the optimum fire detector. Room dimensions and environmental influences are also important.

Point detectors are by far the most used fire detectors. In practice, however, applications arise where point detectors or not suitable or only to a limited extent. You can use as alternative linear smoke detectors, flame detectors, air sampling smoke detection systems or other fire detection systems such as linear heat detection systems.

6.1 Linear smoke detector

6.1.1 Use

The linear smoke detector FDL241 is especially suited for large halls and detection of smoldering fires in high rooms thanks to its detection principle and large surveillance areas. Some typical range of applications for linear smoke detectors includes:

- Large halls (lower investment and maintenance costs compared to point detectors).
- Atriums and high halls (detection of smoldering fires in high rooms as well by assigning them at various heights).
- Churches and buildings with valuable, art historically significant ceilings (no impact on the ceiling from installation and point detectors).
- Long corridors, cable and energy channel conduits (lower investment and maintenance costs compared to point detectors).

6.1.2 Project engineering

You should note the following to prevent undesired faults and alarm triggers:

- Detection distance between detector and reflector 7 meter – 100 meters.
- An unbroken view must exist between the detector and the reflector.
- The mounting location for the detector must be very stable. In most cases, cement and brick walls will fulfill this property. Wood and steel construction is often not suited as they can be influenced by temperature changes or strong winds.

6.1.3 Selection and setting

The FDL241 is the linear smoke detector used in a Cerberus PRO installation. A number of variations are possible for selecting the reflector.

- The reflector foil is normally suited for applications with a maximum detection distance of ca. 60 meters.
- The prism can be used for a detection distance of up to a maximum 100 meters. If the prism is used at a detection distance of > 50 meters, the mounting location for the detector must be absolutely stable; otherwise the risk of faults or even false alarms may occur.

You must take note of existing risk and current ambient conditions such as room dimensions, deceptive phenomena and potential interference when selecting the suitable parameter set.

Parameter sets with the following sensitivity are available:

– 1 and 2 / Standard with a response threshold of 65%
– 3 and 4 / Sensitive with a response threshold of 50%
– 5 and 6 / Highly sensitive with a response threshold of 30%

(The detector alarms as soon as less than 70 % of the transmitted light is measured at the receiver).

Comment:
In the event that a linear smoke detector requires response behavior comparable to a smoke detector with a response sensitivity of 1.6%/m, select, on the FDL241 under the conditions:

– that the smoke is distributed evenly within the room under the ceiling and
– the distance between the detector and reflector is 20 meters

the parameter set 1 or 2 (1.6 x 2 x 20 = 64). Parameter set 5 or 6 achieve sensitivity comparable to point detectors of 0.75%/m.

The example illustrates how linear smoke detectors react with greater sensitivity than most point detectors even at a medium distance. However, this also means that linear smoke detectors are generally more susceptible to deceptions such as smoke, vapors or dust. You must consider this when selecting and setting the fire detector.

6.2 Flame detectors

6.2.1 Use

Both flame detectors FDF221 and FDF241 are suitable for detecting smoke-free liquid and gas fires, as well as smoke causing open fires of carbon-based materials. To this end, the FDF221 provides a cost-effective solution for trouble-free applications. FDF241 even quickly and reliably detects open fires under difficult conditions. The FDF241 flame detector has extremely high immunity to deceptive phenomena, such as heat radiation from disturbances or sunshine, thanks to its 3 sensors and **ASA***technology*. False alarms are practically impossible with the FDF241.

FDF221 can be employed in:
– Storage rooms without sources of interference
– Large halls without sources of interference

FDF241 can be employed in:
– Large industrial facilities
– Airplane hangars
– Power plants
– Transformer stations
– Engine testing facilities
– Atriums (malls)
– Outside applications such as wood storage
– Underground tunnels

Chemical production facilities, oil refineries, gas storage facilities, pumping stations or battery rooms are also typical applications for the use of flame detectors. However, for such applications, only one flame detector in one design is employed in areas at risk of explosions.

6.2.2 Project engineering

You must note the following points to guarantee reliable detection of open fires:

- The flame radiation of potential fire locations must reach the detector. This can take place through direct radiation in the line-of-sight or indirect radiation on walls, facilities, etc.
- Direct radiation is stronger by an order of magnitude than indirect. Consequently, the detector should always have a direct line-of-sight to all potential fire locations within the coverage area.
- There is no general area of coverage for flame detectors. The area of coverage is essentially determined by the size of the fire to be detected.
- Detector sensibility and arrangement must be considered with determining the area of coverage.

6.2.3 Selection and setting

You must consider existing risk and ambient conditions such as room dimensions and deceptive phenomena when selecting the flame detector and its setting.

Type of flame detector
The FDF221 can be used in interior applications where no deceptive phenomena such as sunlight, strong halogen lights or hot radiators exist. Select the FDF241 for exterior applications and rooms with existing deceptive phenomena.

Selecting the parameter set
You must strike a balance between existing risk and the risk of false alarms when selecting a suitable parameter set. This raises the following issues:

- How quickly should a fire be detected?
- What additional damage results when the fire is not detected in 3, but rather in 7 or 13 seconds?
- How fast is the reaction to an alarm?
- What effort and costs occur in the event of a false alarm?
- At what size must the fire be detected?
- Is detection of a fire at a flame height of 60cm sufficient, or must a fire already be detected at a height of 30cm?

Response time often plays a subordinate role when selecting the parameter set. It is not unusual for the intervention to an alarm to take a minute or more; what does a response time by the detector of 3, 7 or 13 seconds mean? In high-risk areas, however, an alarm from a flame detector quite often triggers an automatic extinguishing system. Of course, in this case it is important whether the detector alarms 10 seconds earlier or later.

The following recommendations apply:

- Select a parameter set with a response time of 4-7 seconds for standard applications in rooms without deceptive phenomena.
- Select a parameter set with a response time of 7-13 seconds for standard applications in rooms with existing deceptive phenomena.
- Parameter sets with a response time of less than 4 seconds should only be selected for high-risk plants, where the flame detector triggers an automatic extinguishing system.

You must consider the size of fire to be detected, the maximum distance from detector to fire, anticipated fire development and the risk of false alarms when selecting the parameter set with the corresponding sensitivity. The table below illustrates the influence of sensitivity and distance from the detector to fire and the detection behavior with two different sensitivities "normal" and "sensitive".

Gas fire with area of [m^2]	**0.01**	**0.025**	**0.05**	**0.1**	**0.25**
Flame height [m]	0.3	0.6	0.9	1.3	2.2
Power [kW]	4	18	46	120	430
Max. detection distance at „normal“ sensitivity [m]	7	11	15	22	35
Max. detection distance at „sensitive„sensitivity [m]	14	22	30	44	70

Tab. 8 Detektion distance depending on the size of the fire

If room dimensions require a detection distance of the flame detector of 20 meters, it can detect a fire at a flame height of 1.3 meters with a parameter set at sensitivity "normal" and a flame height of 0.6 meters with a parameter set at sensitivity "sensitive".

The following rules apply:

- Select a parameter set at sensitivity "sensitive" for rooms without deceptive phenomena.
- Select a parameter set at sensitivity "normal" if deceptive phenomena are possible.
- You can often achieve increased sensitivity by reducing the detection distance in rooms with increased risk and existing deceptive phenomena (but you will need more detectors).

You must also consider the anticipated fire growth when selecting the sensitivity. As a rule, a liquid fire develops must faster than wood or paper fires. As such, sensitivity plays a smaller role for liquid fires compared to wood fires, as the period between a flame height of 0.6 meters and 1.3 meters will only be a few seconds.

6.3 Aspirating smoke detectors

6.3.1 Use

Aspirating smoke detector (ASD) systems are primarily employed in areas where point detectors cannot be employed or only to a limited extent.

This is particularly true of areas,
- Where very high sensitivity is required.
- Those have strong HVAC (air exchange).
- That are hard to access and where point detectors are difficult to mount or maintain.
- Where point detectors are undesirable for aesthetic reasons.

Typical areas of application in room protection include:
- IT rooms
- Raise floors, dropped ceilings
- Tunnels, conduits and difficult to access hollow areas
- Storage, stacker storage, elevator shafts
- Museums, cultural institutions
- Deep freeze storage

Typical areas to protect physical assets include:
- Unventilated and forced ventilated devices/panels
- Distribution panels, switching cabinets
- Telecommunications facilities
- Measuring and control facilities

6.3.2 Project engineering

The piping system is engineered to ensure safe detection at any anticipated fire location within the coverage area. The design of the piping system and the number of extraction openings depends on the size and geometry of the coverage area and the required system response behavior.

Only specially trained personnel should conduct project engineering; you must comply with local regulations and manufacturer's project engineering guidelines.

6.3.3 Selection and setting

Siemens offers a wide range of various air sampling smoke detection systems. Observe the following points when selecting the type:

- What is the required sensitivity?
- How pure is the air in the coverage area?

ASD systems are generally divided into the following sensitivity classes:

- Normal sensitivity with smoke sensitivity from 1.0 to 0.1%/meter
- High/highest sensitivity with smoke sensitivity of 0.1 to 0.005%/meter

Note the following when determining required sensitivity:

- When a fire occurs in a room, the smoke rising from the thermals are acquired by the extract air openings and led to the smoke detector via the piping system.
- The ASD system provides an alarm as soon as the average smoke concentration from the extract air opening exceeds the alarm threshold in the employed detector.
- It does not matter whether this value is achieved by very high smoke concentration at one extract air opening or by lower smoke concentration at multiple extract air openings.

If the fire is to be detected as early as possible, the ASD system must trigger the alarm as soon as the smoke is located at one extract air point. Such systems normally require a very high ASD sensitivity.

For room monitoring one often accepts alarming, when the smoke spread is already so large that the smoke is extracted from more than one extract air point. If the smoke reaches two or three extract air points, the ASD will detect double or even triple the amount of smoke. This effect is called the collection effect or smoke accumulation. You can select an ASD with lower sensitivity when alarming at a greater smoke spread is acceptable.

The required ASD sensitivity is calculated based on the following formula:

$$S_{ARM} = \frac{S_{DP}}{N_{DP}} \times N_{DPS}$$

S_{ARM} = Required sensitivity of the ASD sensor

S_{DP} = Sensitivity an the extract air point as required by the fire protection concept

N_{DP} = Selected number of extract air points in piping system

N_{DPS} = Accepted smoke spread (number of extract air points in the smoke)

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7 CO detection with the OOHC740

7.1 General

In addition to its fire detection functionality, the point detector OOHC740 has the ability to detect CO.

If the detector detects an excess CO concentration, it reports a 'Technical CO Alarm' to the control panel. This 'Technical CO Alarm' is independent from the CO signal processing of the fire detection functionality and is thus treated differently and separately by the control unit.

7.2 Parameter sets

Nr.	Name	CO Threshold [ppm]	Response time [min]	Standard
1	Balanced EU2	33 ±3 55 ±5 110 ±10 330 ±30	≥120 60 … 90 10 … 40 ≤3	EN 50291
4	Static 40	40	0	–
5	Static 50	50	0	–
6	Static 60	60	0	–
7	Balanced US1	70 ±5 150 ±5 400 ±10	60 … 240 10 … 50 4 … 15	UL 2034

Tab. 9 Parameter sets 'Technical CO Alarm' for OOHC740

Comment:

If the parameter set 1 or 7 is selected, the 'Technical CO Alarm' is triggered, provided that the required CO concentration is exceeded over a predefined period of time.

With the parameter set 1, the 'Technical CO Alarm' is triggered, if:
- the CO concentration exceeds 33ppm for more than 120 min.;
- the CO concentration exceeds 55ppm for more than 90 min
- etc.

With the parameter sets 4, 5, and 6, a 'Technical CO Alarm' is triggered as soon as the respective CO concentration is exceeded.

7.3 Positioning

The density of carbon monoxide is comparable to that of air (1.25 kg/m^3 vs. 1.29 kg/m^3). For this reason, carbon monoxide is equally distributed in the room at constant ambient temperature.

If the OOHC740 shall be primarily used to detect the CO concentration in the event of a fire, the detector must be positioned like a smoke detector, as the CO rises to the ceiling together with the fire aerosols when sufficient heat is generated.

If the OOHC740 shall be primarily used to monitor CO concentrations (e.g. leaka-ges in gas cylinders or an excess gas concentration in heating facilities), wall mounting (at head level) is preferably recommended.

8 Appendix

8.1 Basics

8.1.1 General

The rule that fire phenomena (smoke, heat, radiation, gas) must reach the detectors applies as well to the Cerberus PRO system. Fire phenomena generated by a fire propagate in different ways. You must consider this when engineering and building fire detection installation. Accordingly, the arrangement and number of required detectors (or the coverage area per detector) is largely determined by the propagation characteristics of the corresponding fire phenomena.

⚠ **COMPLY WITH DIRECTIVES!** **The number and placement of fire detectors is often proscribed by domestic directives. They must have priority under all circumstances.**

8.1.2 Propagation of the fire phenomena

The higher the room, the larger normally the distance between the seat of fire and the detectors on the ceiling. As the room height increases, the intensity of the fire phenomena acquired by the detector decreases, i.e. smoke density, temperature rise and radiation intensity, decrease as the ceiling gets higher. Conversely, however, the incipient fire can be larger as a rule, as the room height increases, since the risk of the fire spreading quickly or flashovers is reduced by the larger volume.

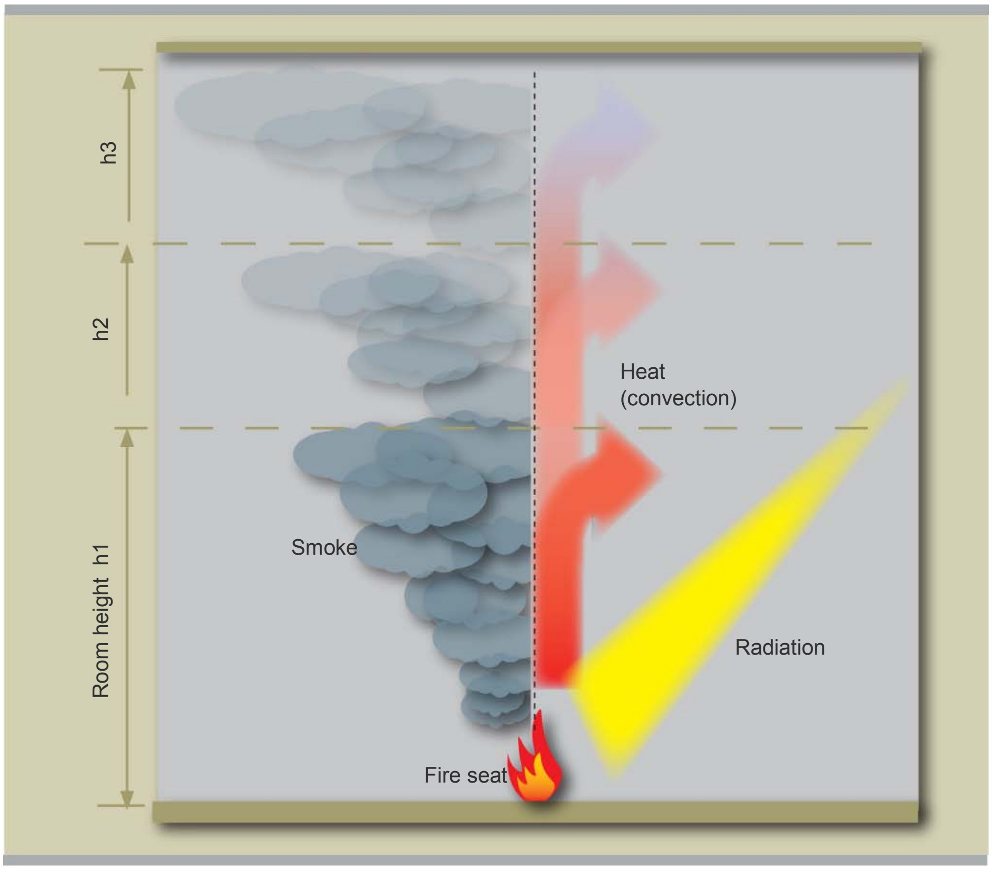

Fig. 3 Propagation characteristics of fire phenomena

Smoke
Fire thermals from open fires transport smoke particles, which are diluted in the larger air volume, to the high ceilings as well. This smoke dilution can be countered through the use of smoke detectors with sensitive response behavior.

Smoldering fires largely lack the fire thermals needed to transport the smoke. Consequently, these types of fires are only detected by detectors mounted on high ceilings when they develop into open fires.

Heat
The rising hot air flow from an open fire quickly cools off as the distance increases. As a result, the use of heat detectors are subject to tight limits as the height of a room increases.

Radiation
Although radiation energy reduces quadratically to the distance from the location of the fire to the detector, flame detectors can still be used in very high rooms thanks to their high response sensitivity.

Generally applicable circumstances
You must ensure that the fire phenomenon reaches the fire detectors when arranging them. This is the only way that detectors can detect a fire.

Each room to be monitored must have at least one automatic fire detector.

As a rule, the fire detectors should be distributed equally and symmetrically.

Placement of the detectors must take the dominate room conditions into account, e.g. type of ceiling (ceilings with joists, special roof and ceiling forms) or room subdivisions (corners, furnishings, installations, etc.).

Other consideration in placing fire detectors include:

- The optimum arrangement of fire detectors is of central importance when monitoring rooms that have very strong deceptive phenomena. Slight changes to the detection position can result in massive improvements against deceptions without impacting detection reliability.
- In some countries, a flame detector may be used in a room height of up to 26 meters (45° mounting angle). You must however clarify the size of fire that would still be detected with such an arrangement and whether this would fulfill the defined and desired protection.
- In very special cases, experience is not enough. On-site testing may be needed to find the optimum setting and placement of the detectors.

8.2 Arrangement of point smoke detectors

8.2.1 Placement

Point smoke detectors are installed on the ceiling or wherever the spread and collection of fire phenomena smoke is anticipated. Point fire detectors that simultaneously detect smoke and heat are placed in the same manner as point smoke detectors.

At increasing room heights, the cooling down smoke may not be able to breach the heat cushion on ceilings of higher rooms. Accordingly, smoke detectors should be placed at a distanced from the ceilings based on room height.

	Roof slope (angle α)	
Room height [m]	**< 30°**	**> 30°**
< 6	3 - 30cm	20 - 50cm
6.0 - 7.5	7 - 40cm	25 - 60cm
7.5 - 9.0	10 - 50cm	30 - 70cm
9.0 - 12	20 - 80cm	50 - 100cm

Tab. 10 Distance of the smoke detectors to the ceiling based on room height

8.2.2 Coverage area

Smoke density at the ceiling decreases with increasing room height as the existing smoke is distributed among greater air volume. As a result, you can increase the coverage area per smoke detector with increasing room height by also increasing the response sensitivity.

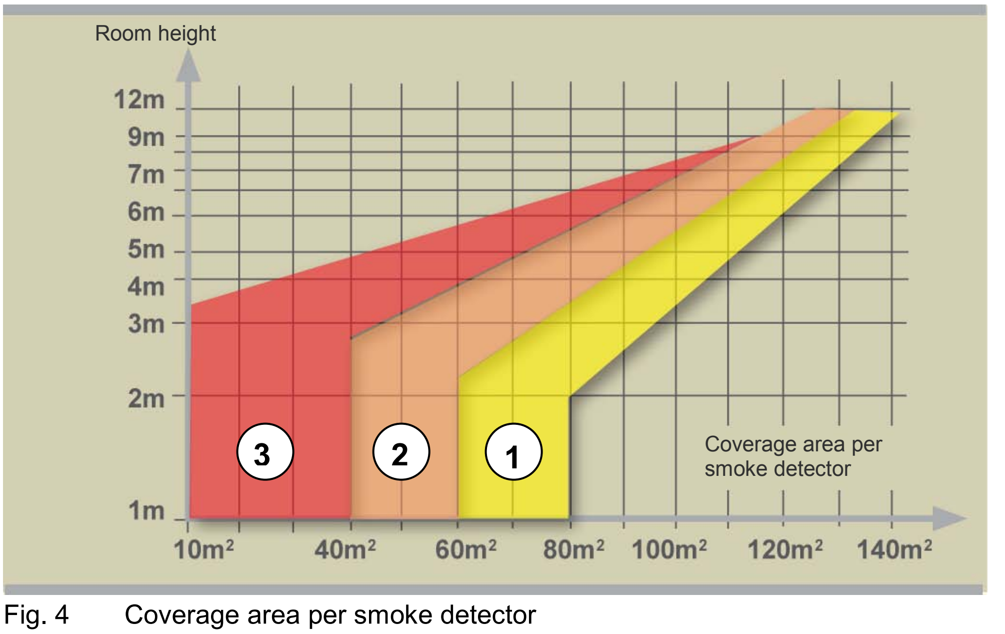

Fig. 4 Coverage area per smoke detector

Area 1 with minor hazard potential should only be selected when the following conditions are fulfilled:

– any danger to human life can be ruled out
– neither valuable property nor irreplaceable goods are stored in the area
– the fire risk is very low
– other fire protecting measures prevent possible fire propagation
– no hazard can be caused in adjacent areas, for example by corrosive decomposition products

Area 2 with medium hazard potential can be selected for most applications.

Area 3 with high hazard potential is recommended in the following cases:
– Increased danger to life
– valuable property or irreplaceable goods are stored in the area
– The loss of goods or installations endanger the economic existence of the owner
– The fire risk is classified as "high"

8.3 Arrangement of point heat detectors

8.3.1 Placement

Heat detectors are – in contrast to smoke detectors – always mounted at the highest point in the ceiling. The temperature rise on the ceiling directly above the fire location decreases quadratically as the room height increases. Consequently, the response sensitivity must be higher as the height of the room increases or a larger fire is required to trigger an alarm.

8.3.2 Coverage area

The coverage area depends on the size of the room to be monitored and the slope of the ceiling. For sloped ceilings, heat rises along the slope to the highest point. Resulting in a concentration of heat at the ridge. For this reason, the basic monitoring area and the detector spacing can be increased for slope ceilings.

Basic surface of the room to be monitored	Maximum coverage area (A_M) and maximum Distance between detectors (s) based on roof slope					
	$<$ 10°		10° - 20°		$>$ 20°	
	A_M	s	A_M	s	A_M	s
≤ 30m²	30m²	7.8m	30m²	9.2m	30m²	10.6m
$>$ 30m²	20m²	6.6m	30m²	9.2m	40m²	12.0m

Tab. 11 Coverage areas and distances between heat detectors

8.4 Arrangement of Linear smoke detectors

8.4.1 Placement

Heat cushions below ceilings may prevent rising smoke from reaching the ceiling. The linear smoke detector must therefore be mounted below any anticipated heat cushion. At a room height of 12 meters, the distance to the ceiling should be between 60 and 120cm.

To ensure that smoldering or smaller fires with lower fire thermals can be detected in high rooms as well, you may have to install a second or even third detector at the suspected height of the smoke spread from the smoldering fire. This level difference is important in rooms that are higher than 6 meters.

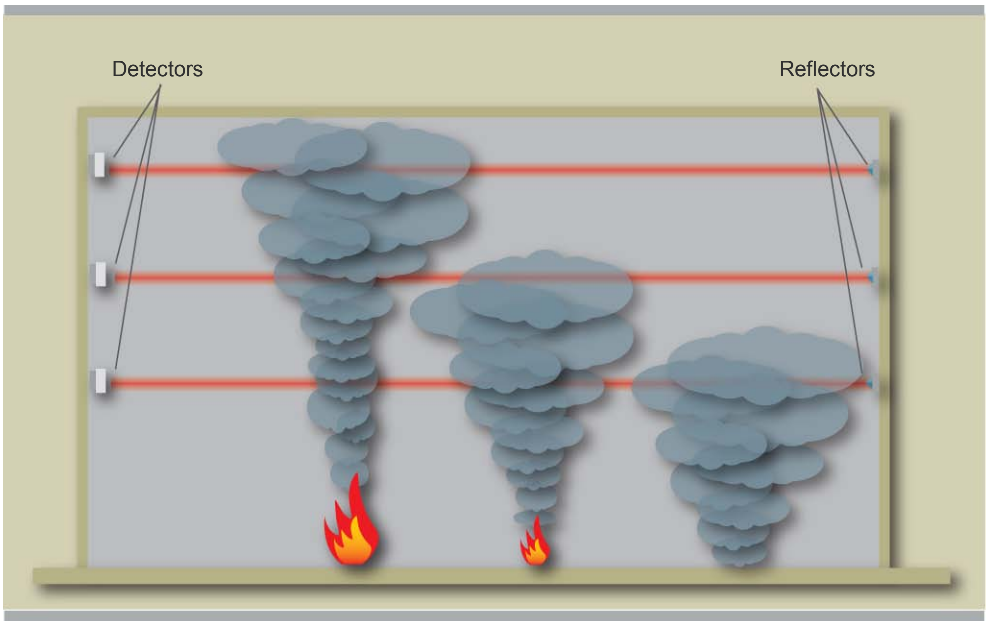

Fig. 5 Detection of smoldering fires in high rooms

8.4.2 Coverage area

The coverage area is determined by the distance between the detector and reflector and by the horizontal distance between the detectors.

A distance between transmitter / receiver and reflector of up to a maximum of 100 meters is permissible.

The monitoring width may be enlarged due to the smoke propagation with increasing room height. For example, a mounting height of 3 meters permits a maximum monitoring width of 8 meters, at 6 meters it extends to 11 meters, or at 12 meters mounting height to 13 meters.

8.5 Arrangement of flame detectors

8.5.1 Placement

The radiation from possible fires must reach the flame detector. As a consequence, flame detectors should always have a clear line-of-sight to the entire monitoring area and are best mounted in a high room corner.

8.5.2 Monitoring area

The monitoring area is based on the maximum permissible detection distance. The maximum detection distance (d) is determined by the maximum size of the detected fire and response sensitivity of the detector. Please note that response behavior decreases quadratically at increasing detection distances.

Flame detectors with a 90° angle of visibility are normally installed at a slope of 45° corresponding to the maximum detection distance (d) of the room diagonal of a cube.

Resulting in a monitoring area of $\mathbf{a^2 = \frac{1}{3}d^2}$.

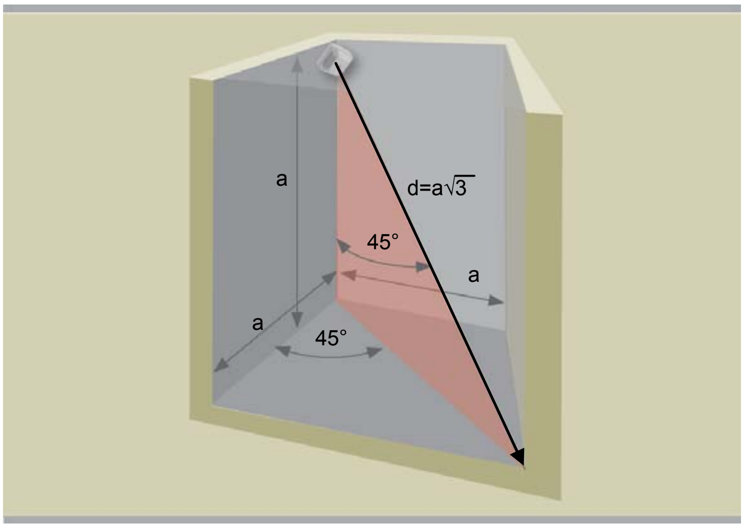

Fig. 6 Monitored cube of a flame detector

It may make sense to select an angle that is less than 45° depending on the ratio of floor space to room height. If, however, an angle > 45° is chosen, the area directly underneath the detector with a visibility angle of 90° is no longer within the visible range and thus not monitored.

8.6 European standard EN54

8.6.1 General

The European standard series EN54 establishes, among others, requirements, testing procedures and performance characteristics used to demonstrate the effectiveness and reliability of the various fire detectors.

8.6.2 Test fires per EN54

Test fires per EN54 serve to document that EN54 approved fire detectors possess sufficient sensitivity against a broad range of smoke types, as required for a general application in fire detection installations. Test fires are designed to generate a different, typical aerosol spectrum. Ensuring that fire detectors can reliably recognize the various types of fires at an early stage.

EN test fires	TF1	TF2	TF3	TF4	TF5	TF6
Type of fire	Open cellulose fire (wood)	Pyrolysis smoldering fire (wood)	Smoldering fire (cotton)	Open plastic fire (Polyurethane)	Liquid fire (n-Heptanes)	Liquid fire (ethyl alcohol)
Heat development	strong	negligible	negligible	strong	strong	strong
Upward flow	strong	weak	very weak	strong	strong	strong
Smoke development	yes	yes	yes	yes	yes	no
Aerosol spectrum	mainly invisible	mainly visible	mainly invisible	partially invisible	mainly invisible	none
Visible range	dark	light, strong scatter	light, strong scatter	very dark	very dark	none

Tab. 12 Characteristics of test fires per EN54-9

The response behavior for point-type smoke detectors required by EN54-7 is tested in the test fires 2 to 5.

The response behavior for point-type heat detectors required by EN54-5 must be tested in a heat channel.

8.6.3 EN54-7 and Cerberus PRO smoke detectors

EN54-7 establishes requirements, tests and performance characteristics for point, resetting smoke detectors using scattered light, transmitted light or ionization.

Point smoke detectors must detect test fires TF2 through TF5 prior to test completion as defined in the standard. Test fires TF1 and TF6 are not required for approval of the point smoke detector (optional).

8.6.4 EN54-5 and Cerberus PRO heat detectors

EN54-5 establishes requirements, testing procedures and performance characteristics for point heat detectors used in fire detection installations.

For approvals per EN54-5, the point heat detector must match one or multiple classes A1, A2, B, C, D, E, F or G. In other words:

Class	Minimum static response temperature [°C]	Maximum static response temperature [°C]
A1	54	65
A2	54	70
B	69	85
C	84	100
D	99	115
E	114	130
F	129	145
G	144	160

Tab. 13 Classification of heat detectors

A class index S or R can be added to the classes. In other words:

- S: Reacts only to a static response temperature.
- R: Reacts to a fast temperature rise and to a static response temperature.

Heat detectors from class index R alarm in a fire situation often based on a fast temperature rise – before the static response temperature is reached. Therefore, where ever possible, heat detectors with class index R are used.

Detectors from class index S are particularly used in applications with high rate of temperature rise over longer periods of time, e.g. in boiler rooms or kitchens.

When heat detectors are used, it must be born in mind that the maximum ambient temperature in the detector's coverage area must be at least 5°C below the minimum statistic response temperature as otherwise false alarms must be expected.

Cerberus PRO heat detectors fulfill standard EN54-5 for the following classes based on the selected parameter set:

HI720	**HI722**	**OOH740 & OOHC740[1)]**
A2S	A2S	A1R
A2R		BR
		A1S
		BS

[1)] OOH740 & OOHC740 operated as heat detector (Mode 1)

Tab. 14 Approvals per EN54-5

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