SECURITON

HT (High Tension) Electrical Control Panels

SecuriHeat d-LIST

Case study | SecuriHeat d-LIST | HT (High Tension) Electrical Control Panels

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1 Introduction

Electrical related incidents are one of the biggest causes of fire in industrial and commercial built environments. High tension (HT) electrical control panels or cabinets, with a voltage of up to 33 kV or more, are therefore to be treated as a major fire hazard, as well as constituting an important infrastructure asset in need of protection. The tendency of electrical systems to overheat as a first warning sign of malfunction provides an opportunity to detect potential fire incidents before they start – meaning a well-designed heat detection system can also be used to inform preventative maintenance.

The root causes of fires in electrical cabinets with control panels vary, but a common denominator is the electrical hazard inherent in the flow of high current. Apart from the danger of arcing and defective equipment, environmental factors such as dust and humidity are also a significant risk. Overheating due to insufficient cooling of high density, high-current electrical hazards with lengthy energised cablings and connectors in between can also cause a fire. These fires must be detected at an incipient stage if significant damage is to be avoided.

HT cabinets are inherently dangerous, with restricted access. They are often located in areas which are themselves deemed as hazardous areas and are usually unmanned, such as underground utility corridors or electrical rooms located in isolated areas, e.g. in a complex metro rail tunnelling system. With a self-contained fuel load and service duct connections, any fire inside these cabinets has the potential to rapidly spread into open spaces or adjacent cabinets. An unnoticed incipient fire in these scenarios would delay essential responses such as shutting down HVAC or other power-down processes designed to prevent fire growth and spread.

What's more, a fire involving such high voltages is extremely hazardous and, should a fire take hold, at the very least the cabinet itself is likely to be destroyed. The combination of fire load and live electrical energy has caused ferocious fires and explosions.

The reliable operation of electrical cabinets is critical to general fire safety and hazard risk management in all commercial and industrial manufacturing facilities. The cabinets are also essential to the operations they support. Should an electrical cabinet be destroyed by fire operation then complex production systems, telecommunication hubs or rapid transit systems may grind to a halt. Certain industries such as power plants have banks of HT electrical control panels supplying hundreds of thousands of electrical and electronic components. HT electrical cabinets must therefore be kept in optimal operational condition 24/7 without interruption.

With a reliable supplementary fire detection system designed specifically to protect HT electrical control panels, fire incidents and even faulty components can be detected and managed to avoid or minimise operation interruption and damages. Widespread evacuation and power-shutdowns will also be avoided. Even as the fire situation progresses, fire suppression and extinguishing system can be actuated timely, and fire services notified automatically and arrive at the scene much earlier before fire incidents turn into fire disasters.

Securiton SecuriHeat d-LIST resettable line-type heat detector (RLTHD) offers a robust, reliable and quick-acting fire detection system well suited for all types of harsh industrial and exterior environments. SecuriHeat d-LIST uses a sealed cable system with embedded electronic sensors. It has been specially designed for EN 54-22 and offers precise localisation of a heat incident. Other key advantages include its relatively high sensitivity; its real-time system fault self-check and alarm; and the fact that it is free of routine maintenance, fully water resistant, discreet and easy to install.

The purpose of this Case Study is to provide fire safety and protection consultants, qualified fire system specifiers, design engineers or technicians, with recommendations for the application and use of SecuriHeat d-LIST to protect HT electrical control panels of varying size, content, fuel load, layout and design. A key design objective is to enhance fire detection methods to detect fire or overheating elements early and thus avoid business interruption and mitigate risks. The Case Study therefore takes the Performance-based Design (PBD) approach to fire detection, using object protection based on risk rather than simply following regulations and legal standards.

Where applicable, the Case Study also provides key requirements on Inspection, Testing and Maintenance (ITM) of SecuriHeat RLTHD; and world-class technical and application support offered by Securiton through its headquarters teams in Europe and its vast global network of local employees and distribution partners.

2 Aspects of fire safety and prevention

The reliable operation of electrical cabinets is critical to general fire safety and hazard risk management in most commercial and industrial manufacturing facilities, as well as infrastructure operations. Whether they support complex production systems, telecommunications hubs or rapid transit systems, electrical cabinets must always be kept in optimal operational condition 24/7 without interruption.

Statistically, electrical related incidents remain one of the major causes of fire in industrial and commercial built environments. The root causes of fires in electrical cabinets with control panels vary, but a common denominator is the electrical hazard inherent in the flow of high current. From a business continuity and asset protection perspective, the consequences of the fire hazards and risk of fires in and around electrical cabinets can be significant.

2.1 HT electrical control panels

In general, electrical cabinets with control panels are divided into low tension (LT) and high tension (HT) types. The main difference between these control panels is the voltage range they handle. LT electrical control panels distribute voltages up to 1,000 Volts (1 kV) and are typically used in residential and commercial buildings for powering small motors, lighting, and general electrical equipment. On the other hand, HT electrical control panels, which are the focus on this Case Study, operate at voltages greater than 1 kV. For example, in power utility and transmission grids, it is standard to have 11 kV, 22 kV, 33 kV or higher voltages with distribution cable networks connected from HT electrical control panels to transformers in switchyards or substations. These panels act as a central hub for controlling and distributing electrical power, ensuring efficient power management and protection against electrical faults. Figure 1 illustrates the components typically found in an HT control panel – note that the layout often varies.

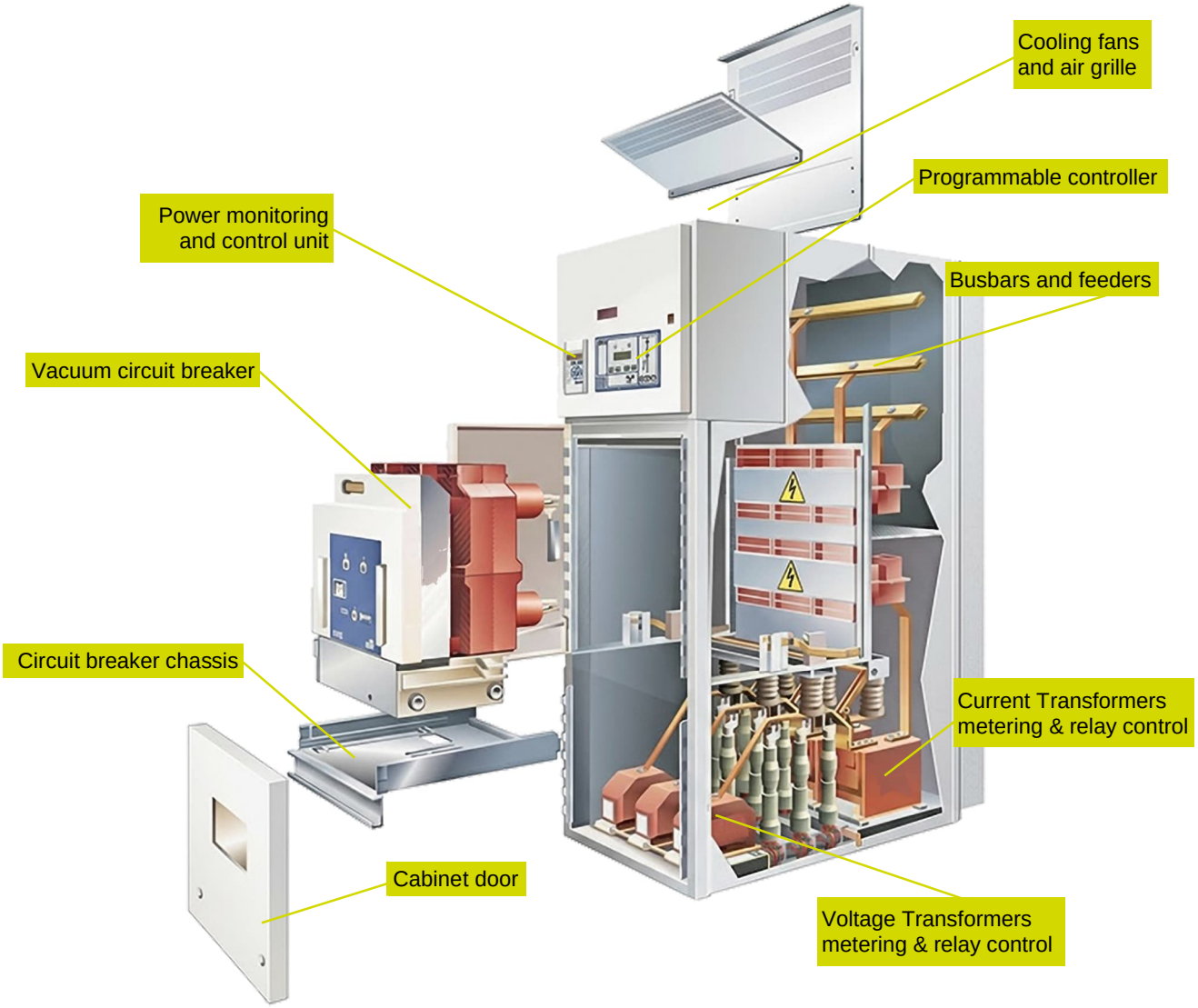


Figure 1: Components of a typical HT electrical control cabinet

Depending on the applications and specific requirements such as voltage levels, HT electrical control panels come in various configurations and are used in varied operational conditions. Many consist of key components such as vacuum circuit breakers, busbars, earthing switches, and current and voltage transformers (for metering and control). For the purpose of this Case Study, the following examples are used to illustrate typical HT electrical control panels (Figure 2):

(a) Indoor HT electrical control panels: Installed in indoor substations or control rooms, designed with protection against dust, moisture, and environmental factors.

(b) Outdoor HT control panels: Installed in outdoor environments (e.g. power distribution yards), designed to withstand harsh weather conditions for reliable power supply in challenging environments.

(c) Ring Main Units (RMUs): Integrated system with compact HT electrical control panels, these are pre-engineered and packaged with circuit breakers, isolators, and transformers into a single unit, particularly beneficial for compact urban installations.

(a) Illustration of HT electrical control panels (indoor)

(b) Illustration of HT electrical control panels (outdoor)

(c) Ring Main Units (RMUs)

Figure 2 HT electrical control panels

2.2 Fire risk, consequence and safety

Fire in electrical cabinets is of major concern, particularly in certain industries such as power plants which feature banks of HT control panels supplying thousands of electrical and electronic components. The combination of fire load and live electrical energy has caused fires and explosions [1].

Due to the extreme high fuel load and danger of rapid fire growth and spread, substantial research and tests have been conducted and reported by leading organisations such as Sandia National Laboratories, Technical Research Centre of Finland (VTT) and National Fire Research Laboratory of NIST [2]. This research was, in part, to establish fire risk, ignition and fire spread characteristics using circuit breakers and motor controls as a common source of fire or leading to high energy arc fault (HEAF) events in industrial settings, and the heat release rate (HRR) and damage caused by these fires to provide quantitative data in fire risk assessments and measures for best fire prevention, detection and protection.

The root causes of fires in HT electrical cabinets vary, but a common denominator is the electrical hazard inherent in the flow of high current. Apart from the danger of arcing and defective equipment, environmental factors such as dust, humidity and corrosion are also a significant risk. Overheating due to insufficient cooling of high density wiring and components, coupled with combustible materials inside the enclosures, and high-current electrical hazards with lengthy energised cablings and connectors in between can also cause a fire.

Given that many of these causes involve a heat build-up before the fire starts, heat detection is an ideal early indicator of problems that can inform proactive maintenance of the HT panels as well as alarm in the case of an actual fire. Such a supplementary fire detection will help avoid or minimise operation interruption and damages. Even if a fire situation progresses, fire suppression and extinguishing system can be actuated timely, and fire services notified automatically and arrive at the scene much earlier before the fire spreads.

Coupled with usually unmanned occupancy in remote or isolated locations, or in critical infrastructure like power plants and substations where potential fire spread due to extreme high fuel load is a major concern, a well-designed heat detection system provides risk mitigation to potentially prevent a fire from happening or developing out of control.

3 Challenges to reliable fire detection

The key objective of HT electrical control panels protection is to detect a fire at an incipient stage so that significant damage is to be avoided. However, high-current electrical hazards in compact and concealed cabinets, often located in unmanned or remote locations, present significant challenges to early detection.

Whereas overheating components are can be the first signal that something is wrong in an electrical system, an electrical fire sometimes starts with smouldering smoke and limited heat during its incipient stage. Inside the cabinets, there can be compartmentations as well. As such, it is important to choose a reliable fire detection system that is capable of detecting such types of fire incidents with pinpoint location addressability at a high detection sensitivity. Additionally, the system should take into account factors which commonly hamper fire detection, such as:

- Dust build-up over time, including oily dust in industrial premises.
- Changes in ambient conditions such as temperature, humidity, air pollutants or others in a naturally ventilated, outdoor or semi-enclosed environment.
  For outdoor installed HT electrical panels, extreme temperatures: Depending on location, winter temperatures could fall to -30°C (-22°F) or lower; in summer, temperatures could be well over 40°C (104°F).
- The source of an incipient fire inside a cabinet is almost impossible to pinpoint unless it is detected and alarmed automatically.
- The actuation of other building or fire protection systems, such as smoke management or fire suppression systems, depends on a timely and reliable detection to be effective.
- Opening cabinets regularly for service and maintenance is undesired.
- Need to avoid false alarms which lead to disruptive shutdowns.

A fire detection system for HT electrical control panels must therefore be robust enough to offer a good working lifespan in tough ambient conditions, with low service and maintenance requirements. It is particularly desirable to avoid maintenance and servicing that requires access to and within the cabinets.

SecuriHeat d-LIST is an ideal solution to address the key challenges of ensuring a reliable fire detection inside HT electrical control panels (see Table 1). SecuriHeat d-LIST is an electronic sensor cable system that has been specially designed for EN 54-22. Consisting of individual sensors embedded in a robust cable, it offers precise localisation of an incident. Other key advantages include its relatively high sensitivity; its real-time system fault self-check

and alarm; and the fact that it is free of routine maintenance, fully weather resistant, discreet and easy to install. SecuriHeat d-LIST control units are installed outside the cabinets, with sensor cables running into the cabinets for detection. This remote detection technology allows for non-intrusive access for any maintenance that is required.

Challenge	Securiton advantages
Smoke dispersion and dilution in outdoor or ventilated environments	Use of SecuriHeat d-LIST for heat detection, integrated with gaseous suppression actuation where applicable.
Wide ambient temperature range	SecuriHeat d-LIST operating temperature range: ▪ Control unit -25°C to +70°C (-13°F to +158°F), ▪ sensing cable -40°C to +85°C (-40°F to +185°F).
Need to place sensors near fire risk objects within cabinets	Small cable diameter with minimum bending radius. Variety of sensor spacings available.
Obstructed or difficult access	Control unit can be installed outside the cabinets, and even outside of the high voltage danger area.
False alarms	SecuriHeat d-LIST adopts unique highly sensitive rate-of-rise detection combined with fixed threshold alarm for maximum reliability.
Low TCO with minimal ongoing services and maintenance	Routine service and testing are done from the main control unit. Reinforced cable with strain relief and aluminium foil shielding: easy to clean, immune to dust, grease and fumes. The whole detection system, including the sensor cables, require no or minimal routine maintenance. No drift = no re-calibration; performs self-test = no maintenance tests; no limits to cuts & repairs, with no loss of performance.

Table 1 Fire detection challenges to and solutions for HT electrical control panel protection

4 Optimised design & Use case

This Case Study provides design criteria and scenarios for the use of the SecuriHeat d-LIST line-type heat detector for close object protection of high tension (HT) electrical control panels. These are protected using a Performance-based Design (PBD) approach after assessing the fire hazards and risks around these critical assets. The aim is not only to detect fire incidents at a very early stage, but also to enable and inform preventative maintenance operations by detecting and locating heat build-ups which are indicative of faulty or worn our components.

HT electrical control panels can be found in many industrial, manufacturing and critical infrastructure facilities, with various building occupancy and use classifications per international and national codes and standards and mandated by the local Authority Having Jurisdiction (AHJs). For general building protection and detection system design, Table 2 shows relevant Securiton Design Guides and Case Studies.

Related built environment	Securiton Design Guide/Case Study
Processing	Industrial Manufacturing [3]
Hazardous	Intrinsically safe and hazardous areas [4]
Challenging environments	Harsh environments (dusty and corrosive) [5] EWFD to Replace Point Type Smoke Detectors [6]
Equipment & Object Protection	EWFD for Electrical and IT Cabinet Protection [7]
Infrastructure	Power Transmission and Distribution [8] EWFD for Power Plants [9] Fast heat detection for transformers [10] EWFD for Cable Pathway Spaces [11]

Table 2 List of Securiton application design literature

4.1 Design codes of practice

The industrial and infrastructure facilities where HT electrical control panels are usually found must comply with life and building safety provisions (e.g., NFPA 1 [12], NFPA 101 [13] and NFPA 5000 [14]) as prescribed per international and local codes in accordance with relevant building occupancy classification or property uses. These building and life safety codes stipulate the need for fire detection in addition to other fire safety measures in a building or around the whole facility. However, these requirements also allow for enhancements or refinements on the basis of a proper risk management assessment around the operational characteristics of the building use.

All electrical and electronic devices installed in industrial control cabinets are required to meet stringent standards in terms of mechanical and electrical safety (e.g., IEC[1] 60204-1 [15]); immunity, radio emissions and a wide range of environmental testing from hazard-based product-safety standards such as IEC 60060-1 [16], UL 508 for Industrial Control Panels and Power Conversion Equipment [17] or AS/NZS 3100 [18]. Others like UL 1604 specifically address uses of Electrical Equipment in Classified Hazardous Locations [19]. Additionally, there are corresponding requirements for each installation type in accordance with test standards like IEC 60890 [20].

While the above equipment standards are intended to address specific electrical safety around the production and use of all types of electrical cabinets, hazard profile of such electrical cabinets installed in a built environment (e.g. adoption of NFPA 101 Life Safety Code [21]) is not fully addressed in prescriptive building or life safety codes.

A risk-based fire safety design approach is commonly applied to adequately identify and mitigate risks from electrical cabinets and ensure asset protection and business continuity. This approach requires fire engineering professionals to work within the prescriptive constraints of the applicable building codes while applying the best engineering practices to address industry and building occupancy specific needs[2]. In practice this often means addressing general building fire protection to satisfy regulations, with a performance-based design of fire detection separately addressing the risks of a fire or overheating incident inside HT electrical control panels. This object protection approach safeguards the requirements for uninterrupted business operation. In this regard, Performance-based Design (PBD) together with a risk-based approach (e.g., NFPA 551 [22], ISO 16732-1 [23]) to the optimisation of fire detection, fire protection and human interaction to supplement prescriptive baseline design, is the key to meeting the requirements, as well as applicable local AHJ's directives for building and life safety.

Early detection of an incipient or overheating fire inside HT electrical cabinets can prevent avoidable business interruption by ensuring an early onsite intervention, including a power-down of the cabinet, as well as facilitate orderly and safe evacuation if the fire evolves. When a suitable fire detection system can be designed and installed at a low TCO, the system can achieve protection of business asset objectives as well as enhancing life safety beyond the required minimum.

Table 3 illustrates how LTHD fire detection systems are required to perform, as well as other design parameters such as environmental conditions and typical applications are defined. Note that design of SecuriHeat d-LIST in this Case Study is in the context of PBD and is likely accompanied by a more general fire detection system for open areas. Response classes, environment groups, temperature classes and range of embedded sensor spacing per codes and standards are therefore applied as design references.

Design Parameters	BS/EN 54-22 [24]		NFPA 72 [25]	
Detection Class vs. Detection Range	**Response Class**	**Detection Range °C (°F)**	**Temperature Class**	**Response Temperature °C (°F)**
	A1	54-65 (129-149)	Low	38 – 57 (100 - 135)
	A2	54-70 (147-158)	Ordinary	58 – 79 (136 - 174)
	B	69-85 (156-185)	Intermediate	80 – 121 (176 - 250)
	C	84-100 (183-212)	High	122 – 162 (252 - 324)
	D	99-115 (210-239)		
	E	114-130 (237-266)		
	F	129-145 (264-293)		
	G	144-160 (291-320)		

[1] IEC: International Electrotechnical Commission

[2] Each country or state/province may have its own (or adopted) building and fire code or directives. Examples are the Muster-Verwaltungsvorschrift Technische Baubestimmungen (MVV TB) in Germany, The Regulatory Reform (Fire Safety) Order 2005 in the UK and National Building Code of India 2016.

Design Parameters	BS/EN 54-22 [24]		NFPA 72 [25]
Environment Group	**Environment Group**	**Temperature Range °C (°F)**	n.a.
	(E)1	-25 to +70 (-13 to +158)	
	(E)2	-5 to +40 (+23 to +104)	
	(E)3	-10 to +55 (+14 to +131)	
Typical Applications and Boundary Conditions	E1: Indoor; stable and clean conditions; commercial and industrial E2: Indoor; varying and polluted environment; commercial and industrial E3: Outdoor; harsh conditions		

Table 3 Design and performance parameters for LTHD per codes and standards

4.2 Design criteria: SecuriHeat d-List

This chapter describes design criteria using SecuriHeat d-LIST products to protect HT electrical control panels. SecuriHeat d-LIST detects temperature changes to alert and alarm almost instantly to any potential fire incident or developing fire event. The d-LIST sensing cables represent sealed systems that are immune to dust and moisture. A summary of SecuriHeat d-LIST key performance parameters is shown in Table 4 below.

Although fire detection for object protection is a PBD approach and separate general area protection likely satisfies the requirements of local fire safety codes, relevant codes and standards remain a useful reference for the basis of the design. When protecting equipment outdoors or in semi-enclosed areas, the SecuriHeat d-LIST control units themself can be located inside a building or in a convenient adjacent area for easy access.

Model	Key performance parameters
SecuriHeat SCU 835 (d-LIST) classes, sensors and cable length	
Classes	Integrating: A1I, A2I, BI, CI Non-integrating: A1N, A2N, BN, CN
Cable length	SEC-15 cable 2 x 350 m (1’148 ft)
Addressable sensors # (# of zones)	2 x 100 sensors (1-32 zones) Sensors embedded in the cable at intervals of 1, 2, 3, 4, 5 or 10 m (3.3, 6.6, 9.9, 13.0, 16.5 and 33.0 ft.), or to bespoke design
Rating and operational data	
Rating	SCU 835 Sensor Control Unit (evaluation unit): IP65 SEC-15 cable: weather-proof fully sealed system
Operating temperature	SCU 835 Sensor Control Unit: -25°C to +70°C (-13°F to +158°F) SEC-15 cable: -40°C to +85°C (-40°F to +185°F)
Measuring temperature range	SEC-15 cable: -40°C to +120°C (-40°F to +248°F) Temperature resolution of 0.1°C (0.18°F)
Sensor cable attributes	Cable diameter: 15 mm (0.59 in); Minimum bending radius: 250 mm (9.8 in)
Detection and actuation	Maximum temperature and temperature changes (differential or integration algorithm)
# of Relays	4 Built-in; Expanded to 16 with REL 835 Module
Product Type Approval Standards and compliance level	
EN 54-22:2015+A12020	Integrating and non-integrating line-type heat detector; Response classes: A1N, A2N, BN, CN as well as A1I, A2I, BI, CI
UL 521; NFPA compliant	Response Classes: LOW, ORDINARY, INTERMEDIATE

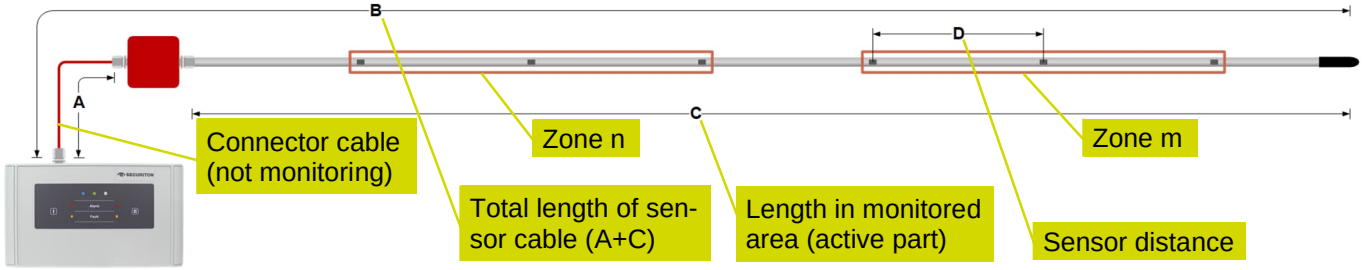
Table 4 Key performance parameters of SecuriHeat d-LIST SCU 835 controller and SEC-15 cable

4.3 Risk-based detection design

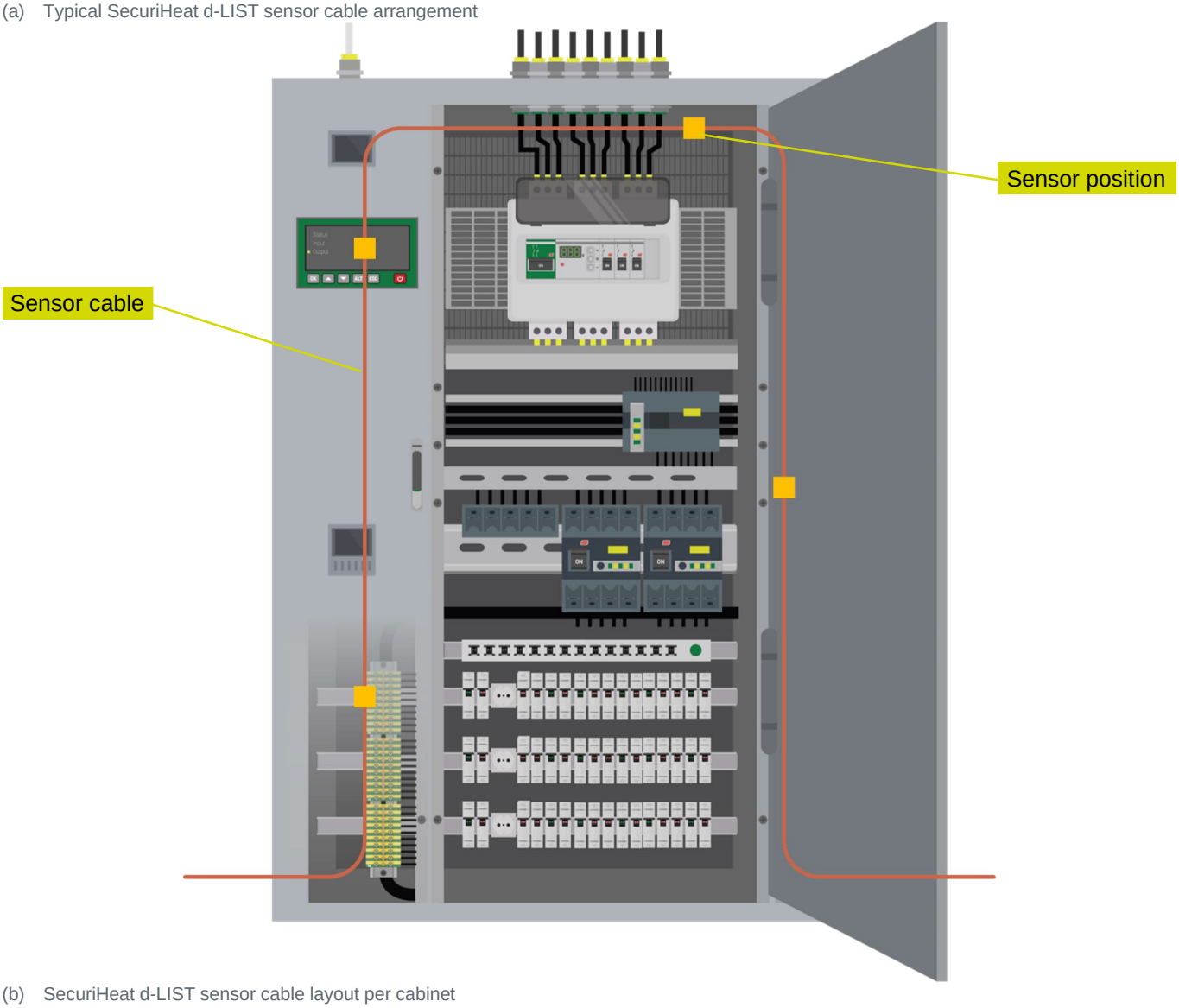
A single SecuriHeat d-LIST system consists of an SCU 835 sensor control unit and up to 2 x 350 m (1,148 ft) lengths of SEC 15 cable, each can accommodate up to 100 individual sensors. Bespoke sensor spacing is available but most systems can easily be designed around the available spacings available as standard (see Table 4). The cable is robust yet flexible. The CBO 15 connection box allows individual sensor extensions and also helps position d-LIST main controller away from the operational area or from outdoor to indoor using a further legth of connector cable (without sensors). Individual system designs should be based on an assessment of the fire risks and potential overheating points of and around the control panels to be protected.

Figure 3 below illustrates:

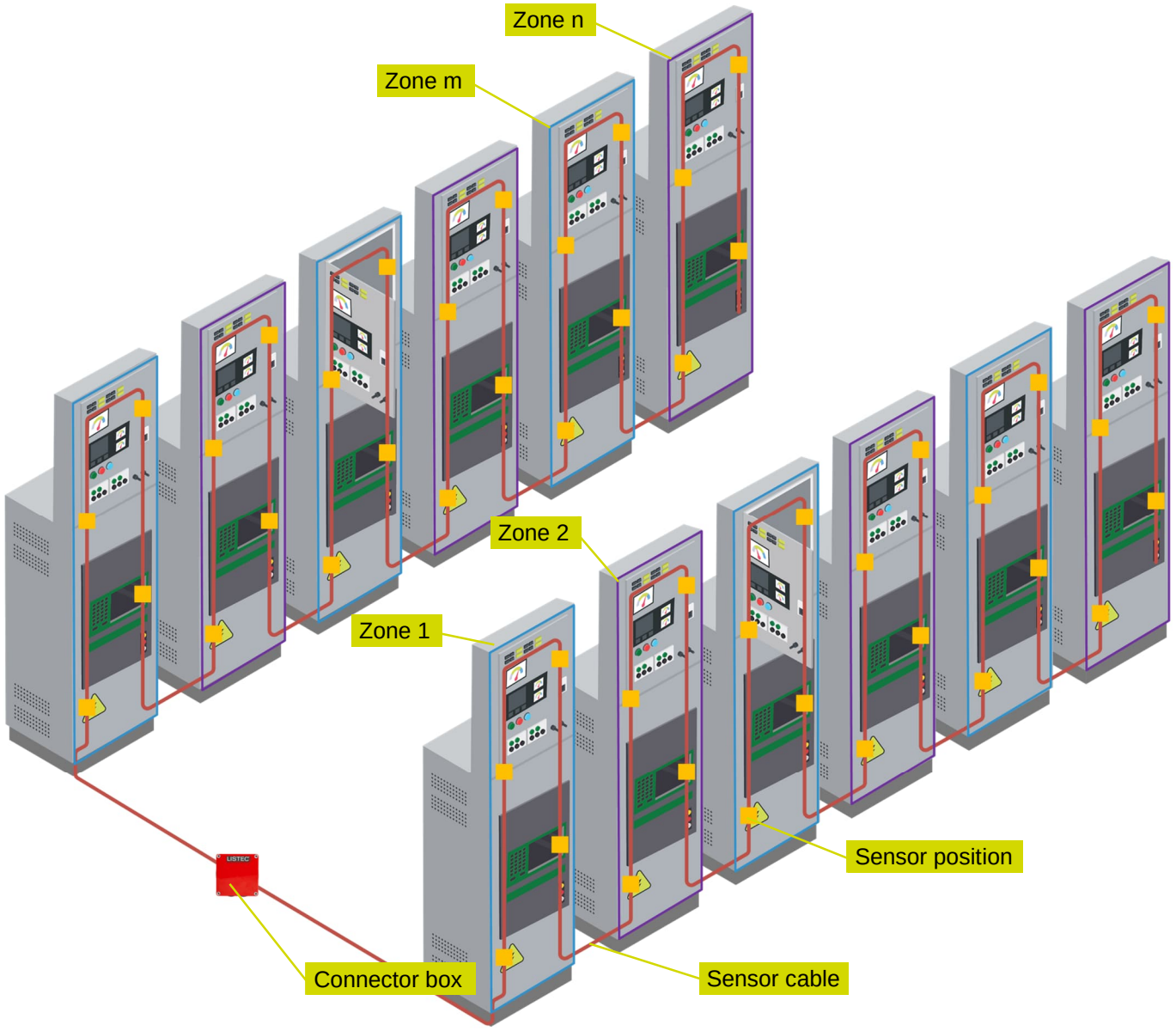
(a) SecuriHeat d-LIST flexible system design with stable, precise zoning function. This does not require extra cable, maximising efficiency.
(b) SecuriHeat d-LIST sensor cable layout per cabinet.
(c) SecuriHeat d-LIST sensor cable layout with connection box CBO 15 for branched sensor cable layout design.
(d) SecuriHeat d-LIST sensor cable and connection box in a cabinet



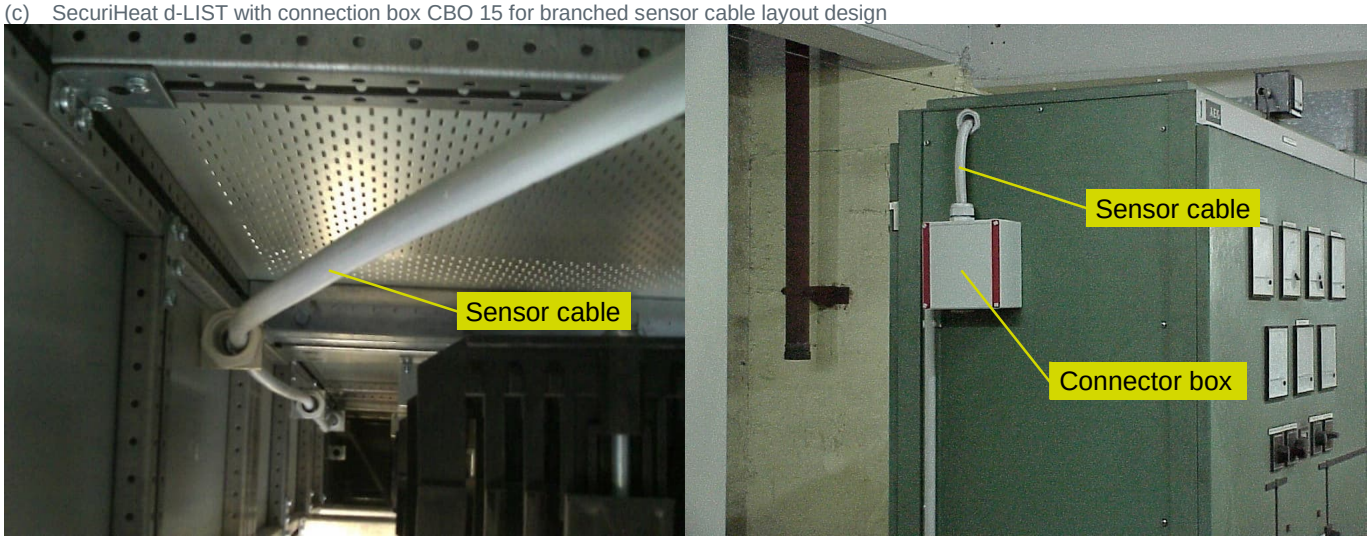
(a) Typical SecuriHeat d-LIST sensor cable arrangement



(b) SecuriHeat d-LIST sensor cable layout per cabinet



(c) SecuriHeat d-LIST with connection box CBO 15 for branched sensor cable layout design



(d) SecuriHeat d-LIST sensor cable and connection box in a cabinet

Figure 3 Fire detection placement SecuriHeat d-LIST (risk-based protection)

Additionally, it should be noted that:

- Manufacturers guidelines for planning and installation must be followed [26].
- Avoid drilling additional holes, wherever possible, points of entry and exit of sensing cables should always utilise the existing cable conduit entry and exit points of the electrical cabinets.
- Sensor cables are flexible enough to be bended to go around obstacles and other fittings.
- In a risk-based design (Figure 3 (b) and (c)) additional external sensors can be added to areas with a high risk of overheating.
- When running sensor cables through or close to each protected HT electrical control panel, sensors can be grouped into desirable alarm zones. The detection and alarm thresholds can be configured for a maximum of 32 different zones.
- When use SecuriHeat d-LIST as part of fire detection for code compliance, the area of coverage includes the entire zone is aligned with relevant fire code requirements, such as compartmentation, fire alarm notification or need for FFFS system integration.
- SecuriHeat d-LIST allows installers to add branches and connect controllers easily with connector boxes (CBO 15).
- SecuriHeat d-LIST control unit can be placed well away from the busy operational and HT danger area.
- Choice of Max Alarm, Difference respectively; Integration Alarm to enable Pre-signals in order to investigate and manage fire incidents earlier.

4.4 System integration considerations

Depending on the number of HT electrical control panels deployed on a site, SecuriHeat d-LIST control units can be connected to a laptop for easy monitoring and troubleshooting. It can also be connected to a building FAS.

If gaseous suppression is used, SecuriHeat d-LIST detector can also be configured to actuate the release of the clean agent systems.

SecuriHeat d-LIST control units can be connected via a redundant loop to a SecuriFire FAS. The networked detectors from multiple locations of one site or multiple sites can be centrally monitored and managed from a remote location, such as an on-site control room or any authorised off-site location or certified remote monitoring centre.

SecuriHeat d-LIST detectors can be managed and monitored using Securiton d-LISTconfig software or through an enterprise BMS software when integrated.

4.5 Features and benefits

Securiton AG as a whole is certified in accordance with ISO standards 9001, 14001 and 45001 and thus meets globally applicable standards with regard to quality management, environmental management, and occupational health and safety management systems.

SecuriHeat d-LIST offers unobtrusive, easy to install heat detection that is immune to harsh environments and can easily be cleaned and maintained. Key features and benefits of SecuriHeat d-LIST are summarised below.

Feature	Benefits
Individually assessable sensors	Rapid pinpointing of incipient fires.
Sealed cable with choice of sensor spacings	Easy installation, no maintenance required.
Extremely durable cables	Operate in extreme environments.
Non-intrusive System Access for ITM	Such maintenance as is required can be carried out from the accessible location where the control unit is installed without need to access the protected cabinets.

4.6 Integrated verify, control and respond

SecuriHeat d-LIST features two levels of alarm: the alert (‘Pre-signal’) and alarm signal (‘Alarm’). Typically, an alert from one sensor escalating to an alert from adjacent sensor or alarms from the originally alerting sensor provide timely alert to an overheating or incipient fire situation, while the Alarm signal is used for fire alarm as well as pre-action sprinkler or gaseous suppression system actuation.

Table 5 summarises the use of multilevel alarms from SecuriHeat d-LIST.

Level	Signal	Typical use
1	Pre-signal	Verify and control (manually initiate the suppression)
2	2nd sensor pre-signal	Automatic stop/cut off power supply to affected location; call emergency team
3	Alarm	Initiate fire alarm; call fire brigade; initiate suppression or extinguishing system

Table 5 Alert and alarm levels for SecuriHeat d-LIST LTHD

4.7 Support with peace of mind

SecuriHeat d-LIST is supported by Securiton's d-LISTconfig software. This enables easy design, installation and service as well as monitoring and managing devices.

Application support includes mainly:
- Partner accreditation program
- Application and field engineering support
- Worldwide reach through a network of partners as well as subsidiaries and investment companies, with branch offices or local employees on all continents.

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