Fire Resilient Structured Cabling Systems Design

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This paper discusses contemporary Structured Cabling Systems (SCS) design, from a disaster-planning point of view. It presents the specific use case of fire-resistant, and fire-retardant infrastructure design not only supports faster mitigation of related threats but also minimal impact on both machines and human life.

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Introduction

The total number of data centers worldwide is estimated to be 7.2 million[1] by 2021. The Global Structured Cabling Market report[2] conservatively estimates the structured cabling field to grow up to USD 25 Billion by 2025. Asia-Pacific region currently ranks 3rd in this market, closely following North America and Europe, accounting for nearly 18% of the worldwide market share[3].

Data centers and IT working spaces are crucial components of a business landscape today, and these represent not represent an organization's investments but also carry its future ambitions.

Structured cabling has cleared many efficiency and effectiveness bottlenecks, and now seeks newer horizons for improvement and optimization. The foremost of which is human and infrastructure safety, in that order.

From a risk perspective, it is imperative that you evaluate not just all probable but also all possible threats. The most prominent of risks in such designs that have a lot of interoperating electronics and electricals is often fire. Least predictable but also having the ability to inflict lethal damage.

Understanding the leading practices that allow us to be sufficiently prepared for fire-related calamities is only the starting point of acknowledging the planning and pre-work needed towards making IT spaces safer for machines and ever safe for human life.

Common Fire Causes & Threats in IT Spaces

International Non-Profit organization, the National Fire Protection Association (NFPA) reports that 78% of non-home electronic equipment room fires originated with electronic equipment. 33% were related to ignition, 29% electrical distribution or lighting equipment, and 16% were spurred by issues with ventilation, heating, or AC equipment.

Some common causes of fire in IT spaces are as under:

- Electrical Failure of IT equipment - short-circuiting, overloading etc.
- Subfloor wiring issues
- Overhead electronic equipment
- Unrelated fires originating in other areas - through wall and ceiling penetrations and perforations

Potential Downsides

- Loss of human life
- Loss of SCS Capex investment
- Potential damage to non-IT assets, civil infrastructure, etc.

- Downtime, and hence loss of operational revenue
- Inability to fulfil professional obligations towards clients - loss of future revenue
- Loss of data
- Bad press; regulatory impact if applicable; legal implications if any, and more.

The recommended approach

A single product or stack will never be able to solve this multi-faceted problem. A combination of tools, technology and processes are required to ensure that your infrastructure is ready to handle any fire-related incidents with minimum downtime and maximum fightback.

Some of the prominent considerations are as under:

- Structured Cabling design planning
- Construction requirements - building, IT area, interior construction materials, raised floors, openings
- Permitted materials list in IT areas
- Fire detection, protection & suppressant equipment - automation, portability
- Utilities - HVAC (Heating Ventilating and Air Conditioning), Coolant systems for IT equipment, Electrical wirings & Supply circuits
- Processes to inspect, quantify and assess risks from time to time

Prevention is the best policy, but the risks are all too real to solely rely on our ability to arrest the incident before it erupts. Structured cabling design has to be viewed from two aspects:

- Structured cabling design for the Data center &
- Structured cabling design for the overall IT Workspaces

Fire Resilient Structured Cabling Design (overall)

Given the digital run of businesses, and the prolific growth of internet and data communications infrastructures, structured cabling holds a great responsibility in terms of helping to minimize both risk probability and impact.

Choosing the right types of cables and material can go a long way in adding value to fire control measures. Some prominent factors are:

Cable Sheath Installation

By far, the most common reason for data cables to catch fire is through contagion (i.e. fire kindled by nearby sources) and then the cable insulation sheath carrying the fire around. Below characteristics are evaluated and rated:

- Flammability
- Smoke production
- Acidity
- Flaming droplets

The fundamental considerations would undoubtedly be:

- Installing cables as far away from potential sources of fire as possible, &
- Using cables whose insulation is not easily flammable

Cabling Choices - PVC vs LSZH

PVC (Poly Vinyl Chloride) & Low Smoke Zero Halogen (LSZH) represent the materials used to build the insulating jackets.

Low smoke properties refer to the reduced smoke-producing characteristics of a compound when burned while zero halogens describe its ability to severely limit the release of harmful and toxic chemicals such as bromine, chlorine and fluorine when exposed to fire.

While the addition of these halogens provides flame retardant properties to cables, these are also potentially harmful to human ingestion through airways.

Fig.1 PVC vs LSZH Cable types

PVC Cables	LSZH Cables
Soft & Smooth texture	Rough texture (owing to flame retardant compound)
Acceptable looks	Aesthetically pleasing finishing
Cheaper	Relatively expensive
Lends itself to flexible installations	Best suited for static lays
Reacts to fire - More smoke & Toxic chemicals (halogens) emitted	Inert to fire - Low smoke, Zero emissions
Unsafe around densely populated office spaces	Minimal risk to human life

Fig.2 Common LSZH Abbreviations[5] (L) and Typical Halogen Content in Common wire types[5] (R[5]

Abbreviation	Meaning
LSZH	Low smoke, zero halogen
LSF	Low smoke, fume
LSOH	Low smoke, zero halogen
LSHF	Low smoke, halogen free
LSNH	Low smoke, nonhalogen
NHFR	Nonhalogen, flame retardant
HFFR	Halogen free, flame retardant
FRNC	Fire retardant, noncorrosive
LS	Low, limited smoke
ST	Smoke test (limited smoke)
FRLS	Fire resistant, low smoke
RE	Reduced emissions
LC	Low corrosivity
LH	Low halogen

Polymer	Halogen Content (% by weight)
XLP (cross-linked polyethylene) with halogen-free flame retardants with halogenated flame retardants	<0.02 <0.02 7–17
EPR (ethylene propylene rubber) with halogenated flame retardants	<0.02 9–14
PU (polyurethane)	<0.02
PE (polyethylene) with halogen-free flame retardants	<0.02 <0.02
CSPE (chlorosulfonated polyethylene)	13–26
CPE (chlorinated polyethylene)	14–28
PVC (polyvinyl chloride)	22–29
FEP (fluorinated ethylene propylene)	62–78
<0.02 generally considered zero halogen	

Smoke & Halogen Content Testing

Developed economies such as the US have established standards for measurements of smoke and halogen content - smoke generation is covered by UL 44 and UL 1685, while ICEA T-33-655 and MIL- DTL-24643 address halogen content measurements.

Following tests are run to ascertain LSZH categories of products:

1. Electrical performance - Long term insulation resistance (LTIR) test, Capacitance and relative permittivity tests
2. Flame propagation - IEEE 1202, UL 1685 and UL VW-1 flame tests
3. Smoke measurement - UL 1685, ICEA T-33-655, NES 711 tests
4. Halogen content measurement - MIL-C-24643 guidelines

Fig.3 Standard industry smoke tests[5]

Name	Description
ASTM D5424	Smoke obscuration of insulating materials in a vertical tray configuration
ASTM E662	Specific optical density of smoke generated by solid materials
BS EN 61034	Measurement of smoke density of cables burning under defined conditions
C22.2 No. 0.3	Test methods for electrical wires and cables
Def Stan 02-711 (formerly NES 711)	Smoke index of the products of combustion from small specimens
IEC 61034	Measurement of smoke density of cables burning under defined conditions
NFPA 262 (formerly UL 910)	Flame travel and smoke of wires and cables for use in air-handling spaces
UL 1685	Vertical-tray fire-propagation and smoke-release test
UL 2556	Wire and cable test methods

Table 2: Industry Smoke Tests

Cabling Materials - Thermoplastic vs Thermoset

Thermoplastics and thermosetting plastics are separate types of polymers that respond differently to heat. While the former melts on exposure to high heat conditions, a thermoset material exhibits massively better flame-propagation resistance characteristics and fights softening and degradation.

Flame Resistant vs Flame Retardant Cables

An important distinction exists between fire-resistant cables and flame-retardant cables - flame retardant cables are designed to resist the spread of fire into a new area. Fire-resistant or fire rated cables are designed to maintain circuit integrity and continue to work for a specified period under defined conditions.

Fire Resilient Data center design

A resilient data center design arises from a strong standards-based approach to design. Security and resiliency do not work as additives, rather these are best built at the time of design. Two of the more popular approaches include:

- ANSI/TIA-942 Telecommunications Infrastructure Standard design for data centers
- ANSI/NECA/BICSI-002 Data Center Design and Implementation Best Practices

The TIA-942 is worthy of a special mention. It helps add following value stack to the design process:

1. Provides detailed specifications for data center telecommunication pathways and spaces
2. Supports recommendations on media and distance for applications over structured cabling
3. Stewards data center standards & evaluation metrics

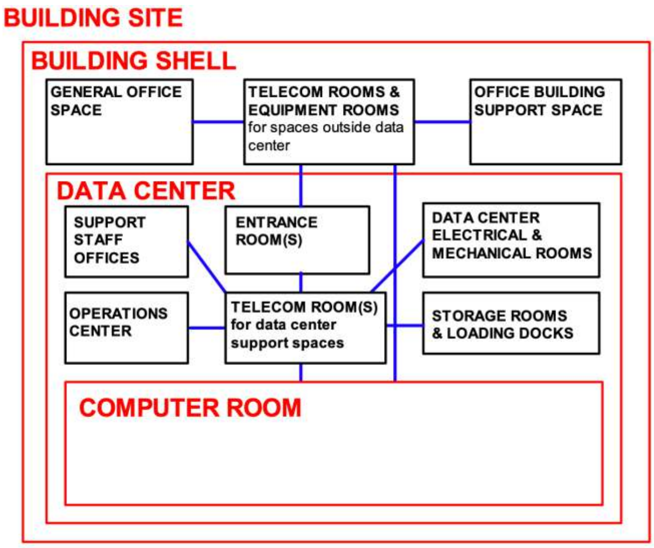
Fig.4 Unstructured (L) vs Structured Cabling Setups (R)[6]

The TIA-942 acts as the perfect tool to communicate design requirements for planning of data centers, computer rooms, and IT workspaces. It stipulates standards-based leading practice for below crucial parameters:

- Cabling design: Copper and fiber cabling and connectors, distribution hardware, Horizontal and backbone cabling distances and space management.
- Facility design: Data center sizing, Power distribution methodologies, Pathways and spaces, HVAC, Security, Operations, Infrastructure administration - Labelling mechanisms & identifiers, Space management - Raised Floors, Overhead Cable trays
- Network design: provision to support legacy as well as emerging, bleeding-edge technologies.

Cabling and facility design have the broadest impact of a fire-retardant design model for IT workspaces and data center setups that use structured cabling.

Fig.5 TIA-942 specified facility design - Relationship of Spaces[6]



TIA-942 defined spaces

- Entrance Room (ER)
- Main Distribution Area (MDA)
- Horizontal Distribution Area (HDA)
- Zone Distribution Area (ZDA)
- Equipment Distribution Area (EDA)

Other Critical Safety Factors

- Physically Cleared Escape Route & diagrammed Evacuation Plan
- Cabling Support Mechanisms that respond well to thermal stresses
- Periodic audits
- Periodic action drills

Self-evaluation considerations

- Are you aware of the possible risk spectrum surrounding your IT investments; especially structured cabling and data center assets?
- How critical is it for your data center and IT workspaces to be resilient to downtimes from natural and accidental disasters?
- Is your organization answerable to regulatory bodies for audits and incidents? Either way, are you documenting all possible proactive actions & preparatory stance proving due diligence?
- Do you have a plan in place for periodic audits of Structured Cabling Systems? Do you have a dedicated and expert team to do this?
- Do you have a risk audit process that quantifies the potential loss per incident in case of a calamity, considering risk probabilities and risk impact?
- Are you seeking to take your business ahead of the curve and become a thought leader by ensuring leading practices and best recommendations worldwide?

Summary

Structured cabling has permeated businesses of all sizes world-wide. This massive dependence on IT is great since it allows businesses to raise the collective bar competitively, but at the same time, all possible risks to and from these elements need to be understood, prepared against and documented. Structured cabling and data center investments require thoughtful nurturing and doing the same can have a hugely beneficial impact on your organization's ability to bounce back from natural and accidental calamities relating to fire.

References

1. Data Centers - Statista
2. Global Structured Cabling Market Report 1
3. Global Structured Cabling Market Report 2
4. NFPA 75 and Fire Protection and Suppression in Data Centers
5. https://www.anixter.com/content/dam/Anixter/White%20Papers/12F0003X00-Anixter-LSZH-WP-W%26C-EN-US.pdf
6. http://www.ieee802.org/3/hssg/public/nov06/diminico_01_1106.pdf