ELECTRICAL SERVICES IN BUILDING FIRES

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Introduction
With increasing attention to risk management and environmental sustainability, there has been a growing interest in materials used in modern construction practice. This paper discusses aspects of electrical services in the built environment: particularly, fire safety and environmental impact of electrical cabling and cable support systems.

Cable Support Systems
In Australasia, support systems for cabling in electrical installations are addressed in AS/NZS 3000 and AS/NZS 2080** Whilst the latter mandates many characteristics of non-metallic conduits, it is silent on significant aspects of performance of materials and conduit products under fire conditions.

Fire Performance
The principal requirements specified for cable support systems is that they will not, of themselves, burn or propagate flame. Common polymers used for thermoplastic conduit products will support generally combustion. In order to comply with standards, various compounds are added in order to reduce flammability and flame propagation. Unfortunately, many of these compounds create toxic by-products in conditions encountered in building fires.

Critical Applications
Whilst electrical cabling, conduit and cable support systems are ubiquitous in modern buildings, there are two significant circumstances where current practices can create significant risk with unintended consequences for the health of building occupants.
First is the sheer volume of cabling often encountered in riser and ceiling spaces. This has become an increasing problem with the use of PVC sheathed data cables, often amassed in thick bundles and often accumulating as new services are laid whilst redundant cables are not removed.
The second area of risk is the incorrect use of cable and conduit for applications where intrinsic fire safety is required, such as in fire isolated stairways and in support of essential emergency services such as emergency lighting and EWES systems. An example is the incorrect selection of conduit for installations in fire escape passages in the mistaken belief that the conduit will protect the enclosed services or will not create a hazard under fire conditions.

Plenum Cable considerations
In the USA, plastics used in the cable systems in Plenum spaces in building construction are regulated under the National Fire Protection Association standard NFPA 90A: Plenum Cable regulations were first introduced in the 1970's to limit risk of spread of fire and threat to life from toxic smoke in fire incident. Regulation to address this risk has not been widely adopted outside of the USA. One exception is growing constraint on plastic cable materials in isolated fire escape and underground corridors, pedestrian and rail tunnels.

Underground Railways
Concern at the materials used in underground railways also arose in the 1970's as a result of two incidents: fires on the transbay tube in SanFrancisco and the London Underground. A rapid spread in awareness of the risks posed by use of traditional materials, such as PVC, lead to demands for new materials with improved safety performance in fire conditions. Early options included development of PTFE ("Teflon") cable sheath and polyethylene and XLPE functional insulation.

Cable Systems
An approach widely adopted to Plenum requirements, tunnels and other inhabited spaces at risk, was the use of sealed light steel cable enclosures, such as screwed conduit. Whilst relatively effective in limiting smoke evolution in a fire, steel conduit is difficult and costly to install and inadequate to meet the need

for flexibility in applications such as commercial office ceilings. Indeed, changes to office fitout often left abandoned cables and unsealed sections of conduit, contributing to both fuel load and risk in a fire.

Availability and cost of specialist fire-safe cables and the limited success of steel conduit, lead to demand for alternate, fire-safe cable enclosure systems.

Halogen Free Plastics

The principal problem in fire was considered to be the evolution of large volumes of smoke and toxic products of combustion from cable and PVC conduit. The halogen component was identified as principal risk. A drive to develop "Halogen Free" plastics saw a range of cable enclosure systems developed that eliminated or modified halogen content or fire performance.

Various attempts to promote "Halogen Free Conduit" have been made in different countries. However, HFC is not a regulated term and not all products claiming the title of "HFC" are equal, or are even safe in fire. Some manufacturers and vendors have sought to distort the acronym "HFC" by applying to products on the basis that they are "High temperature, Flame retardant, Conduits" or other spurious interpretations.

Physical Considerations

A cable enclosure system must offer appropriate levels of physical protection to the circuits it carries. Protection is required to maintain safety of the public from exposure to live parts. Protection should also be afforded to the circuits from damage likely to be encountered in the environment.

Physical strength of the system must be sufficient to support and protect the cables over the spans encountered and over time. Too often, conduit installations sag between fastenings leading to failure, especially where the material becomes embrittled due to ultraviolet exposure. Material characteristics and wall thickness limit the maximum unsupported span of a conduit for a given cable load. Need for additional support can become a significant cost in large installations.

Impact resistance is an important consideration in most installations as conduits can be exposed to inadvertent blows from other trades during normal building maintenance. Some so-called "fire safe" conduits are quite brittle and others have very low impact resistance.

Insulation qualities should be considered as electrical and thermal insulation. Good electrical insulation is an important safety issue in unearthed cable support systems. Thermal insulation must be considered in derating power circuits and in special applications discussed below. Dielectric characteristics can become important in certain communication and high voltage applications.

Fire Performance

Performance of the cable system in fire conditions (or even under unusually high temperature) must be considered. Many installations can be found in locations where personnel could safely evacuate a building on fire, even if the escape route was uncomfortably hot due to build up of combustion products at ceiling level.

Some conduit systems sold as "low smoke" or "HFC" will quickly collapse in heat. Worse, others will melt, burn or even drip burning material. Where these materials have been used to enclose life safety circuits, such as emergency lighting or alarm, emergency communication or control cabling, the early failure of the cable enclosure system can add substantially to the risk faced by occupants or emergency services.

Installation in Normally Hot Locations

The built environment poses applications where cabling has to be installed in areas normally subject to elevated temperatures. Boiler rooms and glazed atria are typical examples. Whilst steel conduit performs well structurally, it offers virtually no protection to the cables within from heat. The performance of various thermoplastic conduits differ considerably at elevated temperatures and all will require additional physical support. The thermal insulating quality of the conduit should be considered as some conduit systems can provide improved performance and protection of cables, especially to heat surges. techniques are available to extend thermal performance in critical applications where it is not possible to re-route the service.

End of Life

Worldwide, there is a growing concern for environmental sustainability including recognition of the impact of products and the built environment on the natural environment. Increasingly, government infrastructure projects and major private developments are looking at "whole-of-life costs", which includes an assessment of the cost of removal, remediation and disposal of materials at the end of their economic service life. The feasibility of recycling or means of safe disposal differ widely between products, hence estimates of end of life costs can show considerable variation. Whilst most PVC products are recyclable, the addition of compounds aimed at modifying fire performance currently render the product unsuitable for most recycling purposes. Disposal to landfill of PVC and halogenated materials is problematic, although currently unregulated in most Australian jurisdictions. Safe incineration of halogenated materials is uneconomic. It is likely that disposal of halogenated materials will come under tighter regulation around the world, with authorities taking the lead of the European Parliament
which has proposed directives on reduction of hazardous materials, including halogenated plastics and PVC.

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