CURRENT RATINGS AND INSTALLATION CONSIDERATIONS FOR FIRE RESISTANT WIRING SYSTEMS

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ABSTRACT

Fire Resistant cables are designed to maintain electrical continuity during fire emergencies to keep essential life safety and fire-fighting equipment operational for as long as possible to:

- *facilitate evacuation;*
- *protect first responders;*
- *safeguard buildings and equipment; and*
- *aid in fire-fighting interventions.*

Fire temperatures have adverse effects on electric cables and their supports which are an integral part of the installed wiring system. These adverse effects include decreasing insulation resistance of dielectrics, material degradation of polymer based insulation and sheath materials (reducing the ability of cable fixings to support cables in vertical installations), weakening of fixings and supports due to heat and fundamental changes to the cables' copper conductors including:

- *increasing conductor resistance;*
- *lowering of tensile strength; and*
- *oxidation.*

This paper examines the effects of fire temperatures on the ability of Fire Resistant wiring systems to carry the sufficient load current necessary and maintain integrity to ensure the functional operation of connected equipment for the required time.

KEYWORDS

Electrical Integrity; Current Ratings; Cable Installation; Fire Resistant; Life Safety.

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INTRODUCTION

BS 7671:2018, (*18th edition IET Wiring Regulations)*, **IEC60364-5-52:2009** (*Selection and erection of electrical equipment – Wiring systems)*, and **AS/NZS3008.1.1/2:2017** (*Electrical installations - Selection of cables*), hereinafter collectively referred to as "The Current Rating Standards", give current ratings and derating information for standard electric cables in common installation configurations and locations as used in the building and construction industry. These current ratings are derived by calculation of the thermal equilibrium reached, when a given current is passed through a given conductor with given insulation and sheath materials and thicknesses in a given installation configuration.

Whilst seemingly complex the explanation is relatively simple: passing current through a conductor will result in heat due to the inherent resistance of the conductor. Copper has a relatively low resistance, minimising ohmic (I^2R) losses and thus minimising heat. Inherently, Aluminium has a higher resistance so for the same current and conductor area and conditions, aluminium conductors will achieve a higher final temperature (higher ohmic losses).

Heat is primarily lost from a body in air through thermal convection. The higher the thermal difference between a body and its surrounding air, the faster the heat loss. As most common building cables have an insulation (dielectric) and a sheath (protective), the heat generated in the conductor(s) needs to pass through the insulation and sheath in order to dissipate to the surrounding medium. Different insulations and sheath materials have different thermal conductivity. Some allow heat to transfer more easily than others. This needs to be factored in our calculation of current ratings namely IEC 60287 (*Electric cables – Calculation of the current rating*). As with heatsinks, the larger the surface area of the cable the faster the heat loss.

Different insulation materials (such as PVC, XLPE, EPR, LSOH materials, etc.) have different thermal conductivities and have different allowable continuous operating temperature ratings. Generally PVC is 70°C and XLPE or EPR is 90°C. In turn, this means a 70°C rated cable will commonly have a lower maximum current rating than a 90°C rated cable. The Current Rating Standards give the maximum current ratings for these common cables in different installation configurations, however caution should be used when actually using the maximum current ratings because of the higher volt drop consequence and importantly, the higher I^2R (Watt) losses which can translate into significant costs over the cables life span due to the additional kW/hrs consumed at these maximum temperatures. Most designers don't realise that this consumed energy (I^2R losses as heat) can cost the project owner/operator in power consumption, 5 times or more of the purchase price of the cable itself over the circuits expected life span. Therefore, in the long run it is often much cheaper to choose cable conductor sizes somewhat larger than the minimum sizes required for the demand current as indicated by the tables in The Current Rating Standards.

The reason why an insulation or sheath material has a 'so called' operating temperature of 70°C or 90°C (higher for Silicone rubber and FEP Teflon®) generally is to do with the deterioration of the insulation materials' useful life-span over a given time based on a reduction of the materials elongation at break. In general, a 90°C insulation is said to have a continuous, useful lifespan of 20,000 hours or 2.3 years at a continuous 90°C for a reduction in elongation at break to 50% absolute (IEC