IEEE, API, AND IEC STANDARDS UPDATE FOR TESTING AND INSTALLATION OF FIRE-RATED CIRCUIT INTEGRITY CABLES SUITABLE FOR HYDROCARBON AND GAS PIPELINE FIRES

Arturo J. **MALDONADO**, IEEE Senior Member, AM Technology Group LLC, Naples, Florida 34108 (USA)
art@amtechnologygroup.com

ABSTRACT – *Recent Refinery and Natural Gas Pipeline fires have increased the awareness regarding fire protection of vital ways of energy supply. This Paper will inform and update the electrical technical community about the development of new Standards for Testing and Installing Fire Protection (FP) Cables suitable for Hydrocarbon (HC) Fires.*

IEEE-P1717, "Draft Standard For Testing Circuit Integrity Cables Using A Hydrocarbon Pool Fire Test Protocol" is being developed based on the same fire conditions of UL-1709 Structural Steel Test. FP cables are designed for Remote Operated Shut Off Valves (ROSOV) which shuts *off fuel, limiting the severity and duration of an HC or natural gas fire.*

KEYWORDS

Hydrocarbon Pool Fire, Circuit Integrity Cable, Fire Rated, UL 1709, API 2218, API 14FZ, IEEE P1717, IEEE-P1810, IEC-60331, BS-6387, MOV, EIV, ROSOV, 1093˚C, 204 KW/m^2

INTRODUCTION

Refinery fires and gas pipeline explosions are very costly, both in terms of human lives and monetary damage. The existing Standards and Installation Guides do not adequately cover the testing and installation of such cables, especially the cables that need to withstand the most severe forms of hydrocarbon fires. A typical hydrocarbon pool or jet fire can reach up to 1150˚C (2100˚F) n a short period time, usually 5 minutes or less.

A jet fire is defined as "a fire type resulting from the discharge of liquid, vapor, or gas into free space from an orifice, the momentum of which induces the surrounding atmosphere to mix with the discharged material". [1]

Significant differences are: jet fires are pressure fed, are typically elevated above ground level, are randomly directional, can create immediate localized heat flux and can vary in length and duration. Jet fires are highly dependent on many factors, including release source (hole size and configuration), fuel inventory, pressure, temperature, wind, obstacles in the jet plume path, and phase of the fuel as it is released.

Earlier fire simulating tests such as UL-1709 [2], *Standard for Rapid Rise Fire Tests for Protection Materials for Structural Steel* established the fire temperature at 1093˚C (2000˚F) after 5 minutes with a heat flux of 204 kW/m^2 (65,000 BTU/hr-ft^2). A specimen is tested in an enclosed furnace with nominal dimensions of 1.8 m x 1.8 m X 1.8 m (6 ft × 6 ft × 6 ft). This temperature and heat flux has been widely accepted by the Petroleum Industry as representative of a hydrocarbon fire. UL-1709 was introduced in 1984 and was approved as an American National Standards Institute (ANSI) / Underwriters Laboratory (UL) standard on Feb 27, 1991.

However, fire simulating tests such as UL-1709, were not designed for testing electrical cables under hydrocarbon fire conditions. UL-1709 was intended for testing structural steel under hydrocarbon fire conditions.

HISTORY OF CABLE FIRE TESTING

Contrary to popular belief, flame resistance and fire resistance are not the same. The confusion between these two concepts has lead to the incorrect installation of cables, which have catastrophically failed in a Refinery fire.

Before the advent of advanced circuit integrity testing technology, flame resistance was considered a benchmark property for fire resistance. This was due, in part, to a lack in understanding of polymer chemistry as it applies to fire performance. A cable that would pass a flame resistance test was believed to perform in any fire situation. Some engineers perceived that a cable that passes a flame resistance test was suitable for a fire rated application.

Therefore, it was incorrectly assumed that passing a flame resistance test automatically qualifies the cable for all types of fire performance. Some cable designs with mica tape and glass braids have passed (virtually untouched) a flame resistance test such as IEEE-1202 [3], but failed catastrophically in a severe hydrocarbon pool fire test.

One of the original industrial cable tray flame propagation tests was developed by the Philadelphia Electric Company in the 1960's in the United States [4]. It consisted of a vertical galvanized steel cable tray loaded with cables. The flame source was a folded piece of burlap cloth soaked in transformer oil. Failure mode was the propagation of flame to the top of the tray. The test was not reliably reproducible because of the flame source variables. The Institute of Electrical and Electronics Engineers (IEEE) released Standard 383 [5] for Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations in 1974. This standard included the burlap/oil flame source but also introduced a 254 mm (10 inch) wide ribbon burner that used natural gas or propane. The flame source was very reliable and produced a uniform flame temperature of about 815˚C (1500˚F) and a heat flux of 220 kW/m^2-hr (70,000 Btu/ft^2-hr). This was quickly adopted as a standard.