PACIFIC CREST
TRANSFORMERS

February, 2015

Installation of "Less Flammable" Liquid Filled Transformers

Meeting construction codes when installing liquid filled transformers can be complicated and confusing, especially if the transformer is to be installed indoors or directly adjacent to or on a structure such as a roof-top. The confusion is exacerbated due to the existence of multiple local and/or national construction code references to transformer construction third party "approval" and/or "listing" requirements.

The goal for this paper is to provide a reference tool that demystifies the subject of less flammable liquid filled transformer installation requirements.

History- the Short Version

During the second half of the 19th century, Factory Mutual (FM), the National Fire Protection Association (NFPA, and Underwriters Laboratories (UL) came into being which collectively constitute the backbone of today's fire protection engineering industry resulting in a significant reduction in loss of life and property arising from destructive fires.

Factory Mutual (FM)

In 1835, Zachariah Allen, a prominent mill owner in Rhode Island, combined the concepts of mutual insurance and property protection to form Manufacturers Mutual Fire Insurance Company. This insurance company was based on the concept of insuring only factories that were good risks that would ultimately pay less for insurance because there would likely be fewer and smaller losses.

Using proven fire prevention methods and regular fire inspections, the concept proved successful and the Factory Mutual (FM) system was formed. In 1878, MIT engineer C.J.H. Woodbury was hired as an inspector for Boston Manufacturers Mutual, one of the FM insurance companies. As a graduate engineer, he became the first fire protection engineer in the industry. In 1886, John Freeman, also a MIT engineer, joined Factory Mutual. During the next few years, Factual Mutual grew a corps of engineers ultimately becoming the first to build a fire protection and prevention company focused on a truly scientific basis. FM grew in influence and size to become one of the major insurers of highly protected risks (HPRs) worldwide, continuing the concept of using fire protection engineering to achieve property

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loss prevention. FM also continued to expand its research activities to meet the needs of fire protection engineering, including continued expansion of its large-scale fire testing capability.

National Fire Protection Association (NFPA)

In 1896, in response to concerns about the reliability of fire sprinkler systems due to a lack of standardization, Factory Mutual and other developing insurance company representatives formed the National Fire Protection Association to provide the science and improve the methods of fire protection and to circulate information on the subject. NFPA organized technical committees of experts to establish consensus on the design of fire protection systems and fire protection safeguards for various hazardous occupancies.

Throughout the 20th century, many of the advances in fire protection were brought about as a reaction to disastrous fires, and NFPA and its technical committees were instrumental in shaping the foundation of fire protection engineering.

Its original membership was limited to insurance underwriting firms and there was no representation from the industries the NFPA sought to control. This changed in 1904 allowing other industries and individuals to participate in the development of the standards to be circulated and implemented by the NFPA. The first fire department to be represented in the NFPA was the New York City Fire Department in 1905. Today, the NFPA includes representatives from fire departments, many fire insurance companies, manufacturing associations, trade unions, and engineering associations.

The National Electrical Code (**NEC**) is a product and responsibility of the NFPA and has been for almost 100 years. It's "open, consensus-based process" ensures that each new code requirement or revision has a justifiable public safety concern and reflects current knowledge and technologies.

Underwriters Laboratories (UL)

In 1893 a young electrical engineer from Boston by the name of William Merrill was hired by a group of insurance companies to evaluate concerns about the fire risk of the electrical wiring of 100,000 Edison incandescent light bulbs in the Palace of Electricity at the 1893 World's Fair in Chicago. The success of this venture led Merrill, with the financial support of the National Board of Fire Underwriters (**NBFU**), to set up a laboratory to test the safety of electrical products which ultimately became Underwriters Laboratories.

Throughout the remainder of the 20th century, UL grew to become a major independent, not-for-profit electrical testing/certification organization in North America and a leader in advancing the science of fire protection engineering.

Transformer Manufacturing Standards

Today, all distribution and power transformers are designed and manufactured in accordance with applicable American National Standards Institute (**ANSI** – founded 1918) and National Electrical Manufacturers Association (**NEMA** – founded 1926) standards. These documents have evolved and exist today to insure that covered products are designed, constructed, and tested to meet or exceed all applicable requirements of these standards. Design modifications made to accommodate specific installation requirements are then evaluated, validated, and listed or approved as required by third party entities with FM and UL being, by far, the leaders..

So, who decides which codes are appropriate for a construction project in a specific location?

The Authority Having Jurisdiction (**AHJ**) is the governmental agency which regulates the construction process. Depending on the location and project, this may be the municipality in which the building is located or, the county or state agency. During the construction of a building, the AHJ inspects the building periodically to ensure that the construction adheres to the approved plans and the local building code. Any changes made to a building that affect safety, including its use, expansion, structural integrity, and fire protection items, require review and approval by the AHJ.

The AHJ specifies the electrical codes and listing requirements for the construction project. For transformer installations, transformers with a UL listing is generally used since it is usually the most efficient and cost effective means of assuring compliance with the relevant state and local electrical codes.

The UL listing service is defined as:

A service whereby UL determines that a manufacturer has demonstrated the ability to produce a product that complies with UL requirements with respect to reasonably foreseeable risks associated with the product. As part of the service, UL authorizes the manufacturer to use the UL Listing Mark on products that comply with UL requirements and establishes Follow-Up Service conducted by UL as a check of the means the manufacturer exercises to determine compliance with UL requirements. ∗

∗ http://ul.com/corporate/faq/general/terminology/

For transformers, this translates to having the product audited by UL to insure that it is designed, manufactured, and tested per the applicable ANSI & NEMA standards. On approval, the transformer nameplate and/or labeling can include the UL listing logo.

The confusion arises when the AHJ sites a requirement for the transformers to have FM Approval status. FM Approval includes requirements as outlined in NEC 450-23 which sets the requirements for “less flammable” transformers that are to be installed indoors, next to, or on top of buildings. Transformers with FM Approval must be filled with less-flammable fluid having a fire point not less than 300° C and have a high voltage rating of ≤ 35,000 volts.

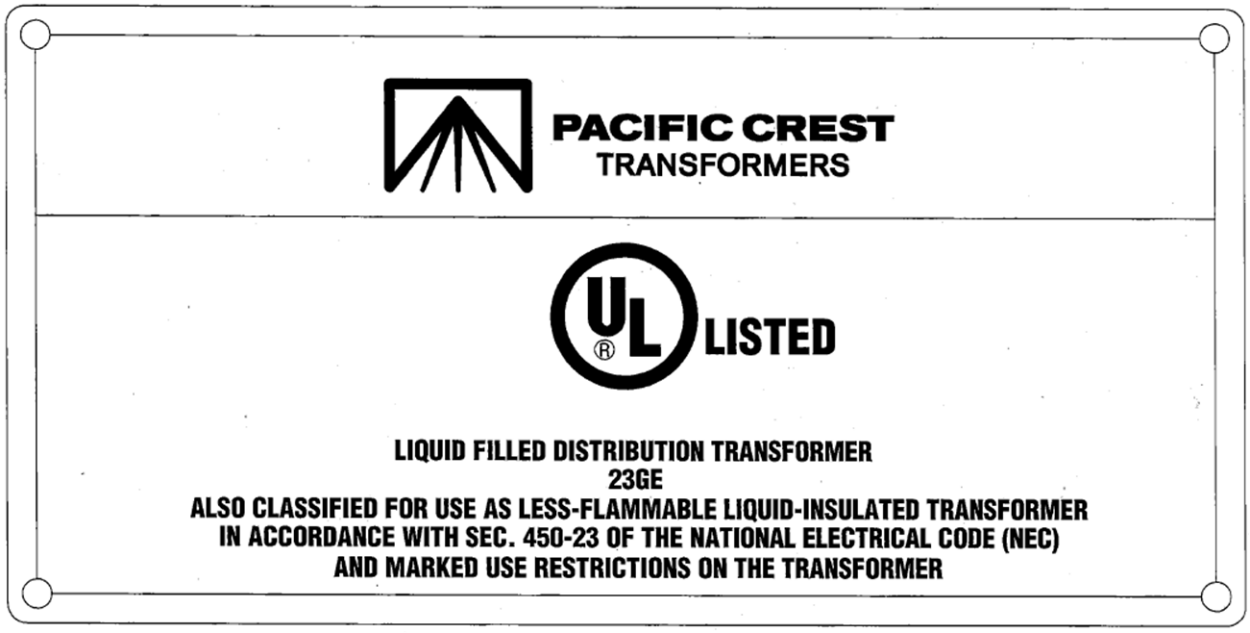
A UL listed transformer is not subject to these requirements. To achieve the same, one must specify a transformer that is both UL Listed **and** Classified, otherwise known as a UL Combination Classification/Listing.

The UL classification service is defined as:

CLASSIFICATION SERVICE – A service whereby UL determines that a manufacturer has demonstrated the ability to produce a product that complies with UL requirements for the purpose of classification or evaluation with respect to one or more of the following: (1) specific risks only, e.g., casualty, fire or shock, (2) performance under specified conditions, (3) regulatory codes, (4) other standards, including international standards, or (5) such other conditions as UL may consider desirable. UL authorizes the manufacturer to use the Classification Mark on products that comply with UL requirements and establishes follow-up service as a check of the means the manufacturer exercises to maintain compliance with UL requirements. ∗

∗ http://ul.com/corporate/faq/general/terminology/

The classification process enables the transformer manufacturer to provide a transformer that is in compliance with NEC 450-23 thereby matching requirements met by a transformer that has been labeled as FM Approved. To confirm compliance however, a ”UL Combination Classification/Listing” nameplate must be applied to the transformer (see below).



Although the means in which UL and FM approach compliance with NEC 450-23 differ, both are considered equal in their application. The FM approach uses a dedicated standard for compliance whereas UL combines a listed transformer with a classified fluid while adding the specific requirements of NEC 450-23 to achieve compliance. The net result is that both approaches provide third party compliance with NEC for indoor and outdoor transformer installations and are verifiable by the AHJ.

Note that the above transformer although outdoors, is installed directly against the building wall. The transformer HV is 25 kV class, is filled with fluid classified as “less-flammable” and is “curbed” for fluid containment as required for both the FM Approval and UL Combination Classification/Listing.

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