Electrical Systems for Tank Installations

Except from Technology of Underground Liquid Storage Systems, Independent Study Course with additional help from John T. Quigley, Ph.D. and Joe Wainemuende.

Independent Study Course
This is the first of a two-part feature on installing electrical equipment in tank systems. It provides an overview on sections of the National Electrical Code (NEC) that are especially applicable to the petroleum equipment industry. In the February issue of PE&T, we will outline burial depth requirements as well as other installation require-ments for electrical work at service stations; we will also explain distinctions between electric current used in cathodic protection applications, communications, lighting, pump power and other equipment systems.
Highlights

This article highlights sections of the National Elec-tric Code (NEC) of special concern to installers and owners of equipment at facilities designed to store flammable and combustible liquids. In this article, you'll learn more about:
• Significance of the NEC for our industry
• Identification of hazardous locations
• Decoding the Code
• Flammable and combustible liquids criteria

This article is drawn from the Technology of Under-ground Liquid Storage Systems, Independent Study Course (ISC), a 20-lesson course. The course material has been developed for the University of Wisconsin- Madison's live training courses, and is based on nationally recognized codes and standards.

Gasoline vapors ignite easily. If the wrong kind of electrical equipment is used to connect a dispensing pump to a power source, the equipment could emit a spark and ignite vapors. Even the right kind of electrical equipment, improperly installed, can cause an explosion or fire.

The National Electrical Code (NEC) [1996], published by the National Fire Protection Association (NFPA), is the authority on proper wiring at service stations, petroleum bulk plants, marinas, and other locations where flammable and combustible liquids are stored and dispensed. This continuing education article will explain how the code identifies and classifies hazardous locations and what basis is used to specify the type of electrical equipment that must be installed in such locations. Typically, a jurisdiction adopts the NEC by refer-ence and then it takes on the authority of law.

It is essential to understand the basics of the NEC classification scheme to determine exactly what electrical equipment is required at a particular location.

The Need to Understand NEC

A modern facility for the storage and handling of flammable and combustible liquids, such as motor fuel, requires a complex network of electrical wiring for a variety of power needs, such as lighting, controls, communication and data transmission.

Electricity powers everything from the island dispensers and submersible pumps to leak monitoring systems. Electricity is required for the lights that illuminate the driveway, for the point of sale equipment that connects cash registers to pump meters and for remote computers and pumpmounted card acceptors. There is also electricity hungry accessory equipment, ranging from air compressors to automatic car wash tunnels. Proper design and installation are as important for this electrical equipment as they are for the storage tanks, piping, valves and fittings.

Typically, UST installation contractors will subcontract the electrical work to licensed electrical contractors, who have special expertise in explosionproof environments. The installation contractor installs the tanks, piping and dispensers. The electrical contractor installs the conduit, wiring, switches and controls.

Most contracts stipulate, however, that the tank installation contractor is ultimately responsible for the overall job. This suggests that the electrical subcontractor should be chosen and hired by the installation contractor, and that compensation arrangements in the master contract should take into account this additional responsibility.

If a tank owner chooses to enter in a separate direct contract with the electrical contractor, presumably the tank installation contractor would be relieved of responsibility for the electrical portion of the work. Such agreements are not recommended because they result in fragmentation of responsibility, which can lead to misunderstandings and disputes. This is because performance of the work is so closely intertwined that it is difficult to pinpoint responsibility if something should go wrong.

Regardless of the contractual relationship, tank instal-lation contractors should have a basic understanding of the code that governs how the electrical components should be specified and installed.

The tank system installation contractor should maintain responsibility for the electrical portion of the work.

Finding the Right Code

In the NEC, the National Fire Protection Association aims to cover every circumstance in which a spark from an electrical installation might ignite flammable or combustible substances. The code lists and classifies the ignitable characteristics of numerous chemicals, ranging from methyl isobutyl ketone to zirconium hydride. It also lists and classifies ignitable agricultural dusts, begin-ning with alfalfa meal and ending with powdered sugar—not to mention resins, dyes and pesticides.

For a petroleum system contractor or tank owner, the vast majority of the substances covered in the NEC will not be pertinent. Tank contractors and owners only really need to know about NEC regulations on the wiring at service stations, fleet fueling facilities, bulk plants and other locations relevant to their work. Nevertheless, it can be difficult to figure out exactly what the NEC requires for a wiring installation at a particular location.

Since the codes cover so many substances in so many different industrial fields, those who wrote the code decided to base NEC requirements on a system of clas-sifications. Products are first classified by how likely it is that they will produce vapors in concentrations that could become an ignitable mixture, or by their f l a s h point. NEC defines flash point as the minimum tem-perature at which a liquid gives off a vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

Decoding the Code

To figure out electrical requirements at a service station or bulk plant, you must:

• First, determine the NEC classification of the products that will be stored and handled at the facility.
• Second, identify the precise location at which the equipment will be used to obtain what is called the location classification.
• Third, establish the likelihood of exposure of the product at that location. That is, you need to determine whether vapors from the product will be present at the particular location on a normal, frequent basis, or whether the vapors will occur only occasionally, under abnormal conditions.

It is essential to understand the basics of the NEC classification scheme to determine exactly what electrical equipment is required at a particular location, such as where the electrical wiring connects with the motor of a submersible pump. Therefore, we will go through the classification procedure, step-by-step, using the example of gasoline, to illustrate how the NEC classification scheme works.

Classifying the Product

NEC breaks substances down into three broad classes. They are as follows:

• Class I: Flammable gases or vapors in the air in ignitable quantities
• Class II: Combustible dust
• Class III: Ignitable fibers or flyings

NEC Class III, ignitable fibers or flyings, is the class least likely to present a hazard. The term ignitable fibers or flyings encompasses bits and particles that might be found in the air at a textile plant, a woodworking mill or a rope manufacturing plant. This class includes sawdust, cotton lint, hemp particles and so on.

Concentration of these materials in the air, under just the right conditions, can produce a mixture that will ignite when exposed to a spark or flame. However, a room where the air is laden with cotton particles is con-siderably less likely to explode than a room where the air is saturated with alcohol vapors.

NEC Class II, combustible dust, encompasses materials like the dust that can accumulate in a wheat storage elevator or an enclosed coalhandling storage room. Under certain concentrations, dust that accumulates in the air in a grain storage facility or coalhandling facility can ignite and explode. Since coal dust is more likely to ignite than hemp flyings in a ropemaking factory, combustible dusts are given a higher NEC classification.

NEC Class I encompasses gases or vapors present in the air in ignitable quantities. To qualify for Class I, a product must have a low flash point and other characteristics that make its vapors likely to ignite. This classification applies to flammable gases and to the vapors released by flammable liquids, i ncluding gasoline, ethanol, methanol and many industrial solvents. It also includes home heating oil, diesel fuel and jet fuel, under circumstances when these liquids are heated to temperatures above their flash points.

First Classes, then Groups

Because not all of the vapors, liquids and gases noted in NEC Class I ignite under the same conditions or at the same temperatures, NEC divided Class I materials into four groups. These groups are designated by the letters A, B, C and D.

Class IA has only one product: acetylene. Fewer than six products fall into group B: ethylene oxide and hydrogen are examples. The same is true of group C, which includes diethyl ether and ethylene. The last group, Class ID, contains the most products. They include gasoline, acetone, alcohol, methanol, ethanol, benzene and propane.

Thus far, gasoline vapors have been identified by NEC as belonging in Class I, Group D (also expressed as C l a s s I D). This means gasoline vapors are highly susceptible to ignition. They are more likely to ignite than hemp particles or wheat dust, but less likely to ignite than acetylene or ethylene oxide vapors.

Determining the Location

It is an important first step to classify product vapors. But this is not enough to determine the type of electrical equipment that will be needed in a service station, bulk plant, fleet fueling facility or similar site. The specific physical location at which the equipment will be used must also be established.

NEC uses an additional category to identify the locations at which classified vapors, such as gasoline vapors, might be present. This category is referred to as a division. NEC has established two divisions for the purpose of classifying locations: Division 1 and Division 2.

Whether a particular location, such as a service station, will be classified as Division 1 or Division 2 i s based on how often certain conditions can be expected to occur at the location.

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Division 1

NEC's Division 1 refers to locations where normal operating conditions may cause ignitable concentrations of gases or vapors to be present on a daily basis. Two other circumstances may also cause a Division 1 classification. One is the probability that ignitable concentrations of vapors will occur frequently because of repair or maintenance operations on the equipment or because leaks are likely to occur at that location. The second circumstance arises when a breakdown or faulty operation of equipment might release ignitable concentrations of flammable vapors and might also cause a simultaneous failure of electrical equipment.

To illustrate, consider the area immediately below a dispenser mounted on a pump island. Gasoline is moving through the dispenser. According to the NEC classifica-tion scheme, gasoline vapors belong in Class ID.

The next question to answer is whether the area beneath the dispenser should be categorized as Division 1 or Division 2. It is categorized as Division 1 for the following reasons: Gasoline moves through this location on a daily basis; and any repairs made on the vertical check valve beneath the dispenser, or a leak occurring when a filter is changed inside the dispenser, can cause ignitable concentrations of gasoline vapors to collect in this location.

Division 2

Areas classified as Division 2 are mainly locations where flammable gases are handled but normally confined inside a closed system, where escape can only happen as a result of accidental rupture. An unjointed section of pipe that carries gasoline from the storage tank to the pump island, for example, is normally a closed system. Vapors cannot escape from it unless the pipe ruptures.

There is another reason a location may be classified as Division 2: when a mechanical ventilation system is pre-sent that removes hazardous concentrations of vapors. In such a case, a problem with the ventilation system could cause vapors to accumulate to a hazardous concentration, but that would be an abnormal circumstance.

There is a third circumstance that might cause a location to be classified as Division 2: the possibility that ignitable concentrations of vapors might occasionally stray to a particular area, mainly because the location is next to or near a Division 1 location.

An example would be the air space around the end of a service station vent pipe. As the tank served by the vent "breathes," gasoline vapors flow out the end of the vent into the atmosphere. These vapors issue from the vent all day, every day. Because they come from gaso-line, the vapors are identified as a Class ID product. The concentration of these vapors within a threefoot radius around the open end of the vent pipe is so heavy that this location must be identified as a Division 1 area.

Ordinarily, the vapors issuing from the end of the vent pipe quickly dissipate. Occasionally, some of the con-centrated vapors will linger within the threefoot Divi-sion 1 radius, and then move another foot or two beyond this radius. For this reason, the area two feet beyond the Division 1 area is classified as a Division 2 area.

Flammable vs. Combustible

To fully understand the NEC classification process, tank installers should be familiar with the criteria used by the NFPA to identify flammable and combustible liquids. Some liquid fuels handled by petroleum marketers are referred to as flammable liquids. Others are referred to as combustible liquids. Procedures for handling the two can be different, so an understanding of the distinction between the two is important.

NFPA 30 Flammable and Combustible Liquids Code [1993] describes combustible and flammable liquids. Essentially, a combustible liquid has a flash point above 100 degrees F, while a flammable liquid has a flash point below 100 degrees F and a vapor pressure not exceed-ing 40 psig.

NFPA 30 also includes several subcategories for flammable and combustible liquids. These are important only if a variety of liquid fuels will be handled. Otherwise, the important point to remember is that the difference between flammable and combustible liquids is technical and that the distinction is mainly established by flash point—the minimum temperature at which the liquid gives off vapors in sufficient concentration to form an ignitable mixture. Gasoline, methanol, and ethanol are examples of flammable liquids. Home heating oil and diesel fuel are examples of combustible liquids.

Electrical Area Classifications

For details on how service station locations are classi-fied, consult Table 7 of NFPA 30A Automotive and Marine Service Station Code [1993]. Table 7 lists spe-cific locations in a service station and identifies whether the location is classified as Division 1 or Division 2.

Although Table 7 of NFPA 30A applies only to service stations, NFPA 30 [1993] includes a similar table, Table 5-3.5.3. It covers a number of other locations at which flammable or combustible liquids are stored and dispensed: aboveground tanks, drum-filling facilities, tank vehicle loading racks, piers, wharves, and so on. Consult the table in NFPA 30 for any installation project that involves a flammable and/or combustible liquid storage facility other than a service station. The following are examples, based on information in Table 7 of NFPA 30A.

Underground Tank Opening

A pit, box or other space below grade level is considered a Division 1 location, because vapors tend to accumulate in low areas. One example is a manway at a tank, located below grade level, with a remote pump inside; the area is low and gasoline vapors are likely to accumulate.

The area above grade level at an underground tank opening would be a Division 2 location. NFPA 30A Table 7 specifies that Division 2 includes the area from the ground level up to a height of 18 inches, and covering a horizontal radius of 10 feet when openings have a loose fill connection; or 18 inches above the opening and within a horizontal radius of only 5 feet when openings have a tight fill connection.

Figure 1: Vent Openning

Upward Discharging Vent Opening

The area within 3 feet of the opening of an upward discharging vent, extending in all directions, is classified as Division 1. The area within 3-5 feet of the vent opening, extending in all directions, is classified as Division 2. See Figure 1.

Inside a Pump-Island Dispenser

The area within the dispenser enclosure is a Division 1 location. Other locations described in Table 7 include overhead dispensing devices, lubrication service rooms and vapor processing pits. Two schematic illustrations that graphically depict the classification of areas adja-cent to island dispensers accompany the table.

One of these illustrations is reproduced in Figure 2. It shows a side view of a pump island at which gasoline (a Class 1 product) is dispensed. Note that the shaded area, classified as Division 1, includes the area beneath the pumps, and the open spaces below grade level. The striped area, classified as Division 2, rises 18 inches above the driveway level and extends to a perimeter of 20 feet around the pump island.

figure 2: Side View of a Pump Island

Wired for Safety

Finding and understanding the correct NEC classifica-tions, groups and divisions for your project takes a little time and patience. However, it is the only way to know what electrical equipment and wiring requirements are applicable. Look for more information on this topic in the February 1998 issue of PE&T.

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