



## **BUSWAY TECH BRIEF**

### **NFPA 70E - Arc Flash and Shock Protection**

#### **Introduction**

This brief will cover Arc Flash and Shock protection topics found in NFPA 70E - Standard for Electrical Safety in the Workplace and how they relate to StarLine Busway produced by Universal Electric Corporation. Focused on electrical installations and practices, NFPA 70E is the standard that instructs companies and individuals in the proper safeguarding of employees. Specific discussions will include Approach Boundaries to live parts and Personal Protective Equipment (PPE) requirements. Another important part of safe work practices that will not be addressed in this paper is Lockout/Tagout procedures.

NFPA 70E contains tables and other general tools that may be used to predict Approach Boundaries and PPE clothing required. However, this may be used only in very specific circumstances or when a detailed arc flash study has not yet been performed. Strict compliance to NFPA 70E calls for a thorough investigation of the complete electrical system, including an arc flash and shock hazard survey. This is required whether Busway is in use or not. Busway is likely to improve the safety of an installation over traditional methods of power distribution.

#### **Approach Boundaries**

##### Limited and Restricted Approach Boundaries (Shock)

One way to protect individuals from exposed live parts is setting boundaries that limit exposure and alert to the need for Personal Protective Equipment (PPE). A *limited approach boundary* is the distance from an exposed live part within which a shock hazard exists. A qualified person may enter this distance. A *qualified person* should have training and knowledge of the construction and operation of the equipment and be educated to recognize and avoid common hazards. Hazards include the need to de-energize a live circuit before removing a plug-in unit. The installation or removal of a plug-in unit should be performed by a qualified person. An unqualified person with general safety training may be continuously escorted by a qualified person into the limited approach boundary having first been informed of the possible hazards present.

A *restricted approach boundary* is the distance from an exposed live part where there is an increased risk of shock due to electrical arc combined with inadvertent movement. Only a qualified person may enter this boundary. Opening the lid of an installed plug-in unit would be an example of this kind of activity. If possible, it is always advisable to remove a plug-in unit before work is done. Taking a voltage or current reading would be an example of work within the restricted approach boundary and should only be performed by a qualified person with V-rated gloves and tools that are rated and tested for the maximum line-to-line voltage present.

Though Starline Busway is 'finger-safe' per UL standards, the limited approach boundary for Busway without closure strip is 42". The conservative assumption is made here that tools or other foreign bodies could compromise the finger-safe nature of the bus bar insulator. If closure strip is used, then the limited approach boundary is no longer in effect. The ease of plug removal aids the end user so that plug-in units may be removed before being worked on. Local circuit disconnects enable the power to be turned OFF before the plug-in unit is removed. Closure strip is advisable

when Busway is installed at 10ft. AFF or below; it is required by NEC when Busway is installed at 8 ft. or below.

#### Arc Flash Approach Boundary (Flash Protection Boundary)

According to NFPA 70E, a *flash protection boundary* is the approach distance from an exposed live part within which a person could receive a second degree burn if an electrical arc flash were to occur. *Arc Blast* is another concern where the concussion of an arcing event causes an individual to be 'pushed' by a blast. At this time, there are no added recommendations outside the arc flash concerns. The main factors that contribute to a flash event are available fault current, transformer capacity, resistance in feed wires and the clearing time of an arc event. Distance is the best protection against an arc flash. An arc flash study is needed to fully understand the present risks in any installed electrical system, Busway or other. If an arc flash study is completed and a hazard does exist, it is in most cases possible to re-engineer the circuit design to reduce the hazard.

Since distance is the best protection against an arc flash, the overhead mounting of Busway has inherent advantages. As stated by Daryn Lewellyn, President of Lewellyn Technology and a specialist in the field of arc flash analysis, "The majority of arc flash injuries occur as a result of accidental contact. The design of the Busway reduces the risk of accidental contact, therefore reducing the risk of such injuries."

#### Personal Protective Equipment (PPE) Requirements

NFPA 70E covers electrical safety-related work practices and procedures aimed at protecting an employee working on or near a live part. NFPA 70E discourages this kind of work and states it should only be undertaken when determined that the needed work is not feasible otherwise. Appropriate Personal Protective Equipment (PPE) must be provided to perform these tasks. These activities often involve maintenance issues intrinsically not present in StarLine Busway. For example, the Busway joints utilize spring-pressure contacts that do not require maintenance.

PPE types correspond to the Hazard/Risk number system 0-4, with a larger number representing a greater presence of danger. Special FR (fire resistant) clothing has similar wear and feel to normal clothes or overalls, but is made of special material. PPE ratings are given in calories per square centimeter ( $\text{cal}/\text{cm}^2$ ). This is the amount of incident energy the clothing can sustain. More specific information may be seen in Tables 130.7(C)(10 & 11) in NFPA 70E. A brief summary of the loose fitting clothes needed per the Hazard/Risk category follows.

Cat 0 – Non-melting materials (untreated cotton, wool, rayon, silk)

Cat 1 ( $4 \text{ cal}/\text{cm}^2$ ) – FR shirt and pants (untreated denim jeans acceptable)

Cat 2 ( $8 \text{ cal}/\text{cm}^2$ ) – Cotton underwear, FR shirt and pants

Cat 3 ( $25 \text{ cal}/\text{cm}^2$ ) – Cotton underwear, FR shirt and pants, FR coverall

Cat 4 ( $40 \text{ cal}/\text{cm}^2$ ) – Cotton underwear, FR shirt and pants, Multi Layer Flash Suit with Hood

After a study is performed, Category 3 and 4 findings often bring to light areas that may be improved by re-engineering circuit protection or transformer selection. Opening an end power feed or other box to do a thermal scan or voltage test are examples where some PPE and voltage rated tools will be needed. In contrast, power take-off plug-in units are easily de-energized and removed when more extensive tasks are needed.

## **Case Study**

Universal Electric Corp. commissioned a study of a completed Busway installation at the Southern Indiana Career and Technical Center. All electrical components were considered, starting with the transformer that brings power into the building, the main distribution panel, sub panels, secondary transformers, wire and ultimately to the various Busway systems installed. Attention to the circuit breaker ratings and trip settings were examined as is proper for a thorough survey. The majority of the category ratings found at the Busway was Cat 0 or 1. This analysis helped to verify that Busway is much like traditional distribution methods and did not contribute to arc flash potentials. In fact, having the Busway mounted overhead and plug-in flexibility resulted in a safer system than other methods would have produced.

## **StarLine Busway Advantages**

Upon investigation of the NFPA 70E, it is apparent that Busway has several advantages that result in safer power distribution.

- 1) Adding and removing circuits in a panel board requires working on exposed live parts. With Starline, this instead becomes a simple matter of adding or removing a plug-in unit. Any and all plug-in unit work is done uninstalled. Avoiding exposure to live parts protects the user from shock and flash hazards.
- 2) Local circuit disconnects are useful to insure that units are not installed or removed while under load. This is a particular concern to avoid arcing.
- 3) Remote Power Panels (RPP) use similar methods as panel boards. StarLine plug-in units will not only make adding and removing circuits safer, but faster as well.
- 4) Mounting Busway overhead often provides likely distance from unqualified persons. Easily added closure strip improves the protection even more.
- 5) StarLine plug-in units place the circuit protection closer to the load compared to traditional methods. This will shorten the clearing time of the protective device increasing safety.
- 6) Because StarLine Busway is essentially maintenance free, the common tasks requiring work on or near live parts are removed, thereby accomplishing a primary objective of NFPA 70E.

## **Summary**

As with any power distribution system, an arc flash analysis yields the best information to protect employees from hazards and risks. Limiting exposure to live parts and providing protection against accidental contact are at the heart of NFPA 70E. Compared to conventional methods, StarLine Busway reduces the risks of exposure while providing the flexibility of continuous power access. As Daryn Lewellyn states: "The greatest safety benefit of the Starline Busway is that arc and shock hazard is reduced due to less risk of accidental contact." The knowledge and application of NFPA 70E will ensure that safety remains a paramount objective.

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