Making Sense of Electrical PPE for Water Utilities

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OSHA has increased compliance activities related to electrical safety regulations and standards over the past few years. This began with the heightened interest in arc flash hazards increasing with the 2000 NFPA 70E standard and became more active after the 2004 edition was published. On February 14, 2007 OSHA updated a portion of Subpart S (1910.302-308) and soon after Compliance Officers attended training on electrical regulations and associated NFPA 70E standards. In 2009, the NFPA published a more polished and clear 70E standard and has continued with the 2012 edition covering shock and arc flash hazards for DC systems. Now, the 2015 edition has made some significant changes that have made electrical safety more clear. A major part of OSHA's effort continues to focus on employee protection, first by eliminating the hazard through proper lockout tagout and other administrative controls or barriers, and secondly by the use of personal protective equipment (PPE). The interpretation on the use of PPE along with the definition of a "qualified worker" is now more clear than ever. PPE is required to protect qualified workers from electrical hazards that have not been mitigated by elimination or engineering controls and may be effectively implemented through the direction of an effective written electrical safety program.

QUALIFIED WORKER

Many companies hire licensed electricians to fill their maintenance needs making the assumption that they are qualified. This may be true, but more often than not, the electricians are not safety qualified. On the flip side, a qualified electrical worker does not need to hold an electrician license or similar certification. Another misconception involves a person working in maintenance doing regular electrical testing to ensure the equipment is functioning properly. Some feel this person would not be considered qualified so rules for qualified workers related to the level of training are not required. In both cases, there are minimum requirements set forth by OSHA. A qualified worker is defined by OSHA in 2007 and NFPA 70E in 2015 as, "One who has received training in and has <u>demonstrated</u> skills and knowledge in the construction and operation of electric equipment and installations and the hazards involved". The term that is critical in the development of an effective training program and which requires regular employee observation is the word "demonstrated". OSHA will look for documentation to determine if your qualified employees have demonstrated their skills and knowledge especially if they identified a deficiency in work practices or procedures during their annual observation.

Part I ASSESSING THE HAZARDS

There are two levels of assessment to consider including a general hazard assessment for PPE requirements as outlined in 29 CFR 1910 Subpart I, Section .132 and a pre-work personal hazard assessment or "job briefing". Qualified workers must also have the skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment, determine the nominal voltage of exposed live parts, know the clearance distances for the various nominal voltages (NFPA Restricted Approach Boundary) and also understand several specific special precautions related to capacitors, CT's, lighting requirements, gradient potential (medium voltage or over 600 volts), PPE requirements and emergency response related to electrical contacts. These issues are part of a qualified worker's daily work and require that an assessment is done prior to beginning work whether they are an electrician, facilities maintenance worker, or production line worker performing electrical tests. The level of this "job briefing" depends on if the work is routine or non-routine and the complexity or level of risk of injury to the employee. With this requirement, each qualified worker should determine the shock hazard by identifying the exposure to electrical parts, the nominal voltage of those parts, and shock PPE required for adequate protection within the determined minimum approach (or restricted approach – NFPA70E) boundary. Protection from arc flash/blast hazards are determined by examining arc flash labels or by going by their company written electrical safety program criteria where the arc flash hazard level has been determined by the employer.

A personal protective equipment assessment shall be performed by all employers. Electrical PPE requirements are broad and do not contain specific PPE particularly related to arc flash hazards. OSHA will cite companies based on non-compliance with this regulation 29 CFR 1910.132, or go to the Subpart S, 1910.335(a)(1) or 1910.269 for work related to generation, transmission or distribution of electricity (usually associated with medium and high voltage). To cite specific electrical PPE requirements, OSHA has cited NFPA70E under the General Duty Clause.

Part II SHOCK PROTECTION

During the job briefing hazard assessment, the nominal voltage is identified. This will provide information needed to determine the shock prevention measures. First, try to completely de-energize the enclosure before opening doors or removing covers. If this is infeasible, then some level of PPE will be required before removing covers depending on the voltage. Most common voltages in the US are 120/240 volts single phase and 120/208 and 277/480 volts 3 phase, and in Canada the 575 volts is the most common 3 phase power system. It's important to know that ANY VOLTAGE CAN KILL. There have been fatalities on 48 volt controls. To protect against shock hazards some basic equipment should be available and used. Remember that the goal is to increase the resistance through the circuit including the body where a contact could cause electricity to flow. Clean air is a great insulator so distance and non-conductive barriers are best to avoid contact and in some cases eliminate the need for electrical

PPE. If PPE is required, head to toe protective equipment includes electrical related hardhat Type 1 Class E and/or Type 2 Class G, rubber insulated gloves and EH-rated boots (suggested only as a best practice). For 480 and 575 volt work, the minimum approach distance (MAD) is 12 inches from uninsulated body parts. OSHA explains this MAD as "arms reach plus 12" so rubber gloves are required to be on before opening the door or removing a cover to exposed parts. This is required even if de-energized because it must be tested to be sure it is de-energized. Class 0, 14" rubber gloves with leather protectors are the best option because class 00 are rated for 500 volts and, because utilities are allowed +/- 5% on the voltage provided, 480 volt systems may exceed 500 volts. The length is important because 12" rubber gloves have a rolled cuff so the lower arm will be within the minimum approach boundary when testing using a meter. Rubber gloves are required to be air tested before each days use and lab tested at least every 6 months. To make the testing easier, have one person in charge of all rubber glove testing. Ask your test lab to stock your second pair of gloves, then test and ship them in 5 months so that employees only need to change them when received and ship them back. It may also help to have 2 different colors of gloves. So as an example the yellow gloves are the summer gloves and the red gloves are the winter gloves. The will help to ensure that the test has been done within the defined timeframe. Thin cotton liners are nice to soak up sweat or if gloves are shared (i.e. test or assembly areas with shift workers). Leather protectors should be used to protect the class 0 rubber gloves (required for classes 1-4 gloves). Medium voltage requires higher rated gloves in addition to the use of hot sticks and grounding equipment. This includes some crushers or other large equipment. Other tools that every electrical worker should have include insulated hand tools, insulated fuse pullers, portable GFCI cord or pigtail for cord and plug tools, rubber barrier material, and UL listed CAT III and/or CAT IV test meter.

Part III ARC FLASH PROTECTION

Arc flash and blast hazards present more of a challenge. Motor control centers which are very prevalent in the water industry, are one of the most common places for arc flash incidences. As discussed above, a hazard assessment is required by all employers to determine PPE. The level of hazard related to the arc flash depends a few variables; the available bolted fault current supplied from the source, the clearing time (time at which a breaker opens or fuse blows), and the impedance between the point of the flash and the source. How these are determined can vary. Some companies contact the utility to determine fault current, and then use the NFPA 70E tables if within the fault current specified in the notes. This may meet minimum OSHA requirements for PPE assessment but is not the best way to decide on protection levels for your employees. Often this method results in overkill for PPE but occasionally, it's not enough. The better approach is to calculate the incident energy levels in calories per square centimeters (cal/cm^2) and determine boundaries at which the incident energy level drops to 1.2 cal/cm^2. This is called the flash protection boundary. Above this level will cause a second degree burn to bare skin. The study will also determine exactly what the cal/cm^2 at the working distance (typically 18" for 480 or 575 volt work). Now we actually know precisely what level to protect both qualified employees and non-qualified employees. We will require our qualified employees to wear arc rated clothing that has a rating in cal/cm^2 that is greater or equal or calculated level at the working distance, and barricade for the non-qualified workers at the arc

flash boundary if it exceeds the limited approach boundary (shock boundary allowing qualified workers only). This is in addition to the shock protection required in the previous paragraph. The simplest way to comply with arc-rated clothing requirements is to have qualified workers wear 8 cal/cm² for day-to-day work (or a less effective but functional option is coveralls of the same rating over cotton clothing), and wear an arc shield for any work where the incident energy was determined to be less than 8 cal/cm². An arc rated balaclava hood is required where the calculated hazard exceeds 4 cal/cm² for added face and neck protection. For work with higher identified hazard levels often related to main switch gear, large medium voltage equipment, motor control centers and lengthy high amperage bus duct, a 40 cal/cm² suit should be worn. Any work required on equipment where the hazard level is greater needs to be de-energized or engineer out the hazard via remote working procedures. Other PPE related to the arc flash or blast is to consider wearing plastic rimmed safety glasses and arc rated ear plugs. The qualified worker should also install DANGER tape or similar barricade at the flash protection boundary to protect non-qualified employees from arc flash hazards.

SUMMARY

So that's it! Have a written program to outline hazards and procedures required to effectively eliminate or engineer out, all possible electrical hazards. NFPA 70E also now required that the host employee instruct all contractors of the hazard levels and document this communication. If eliminating the hazard is not feasible, then protecting employees with proper PPE is critical for both employees and contracted employees. PPE required includes rubber gloves, EH-rated boots (suggested), hardhat with arc shield, plastic rimmed glasses, ear plugs and arc rated clothing to the level of the hazard. It doesn't have to be a stressful process. Train all qualified workers which may include HVAC, maintenance, electricians, test technicians, design engineers, etc. Remember that ignorance of these regulations will not work as a defense of an OSHA citation or when answering questions in a tort case following an electrocution. To be defensible, any company must develop a written program based on a hazard assessment, train employees, verify the program works and enforce the program.

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