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Safe Electrical Work Practices

1.0 Purpose and Scope

To ensure compliance with the Occupational Health and Safety Administration (OSHA) General Industry Regulations (29 CFR 1910.133 and 1910 Subpart S) and the National Fire Protection Agency Standard for Electrical Safety in the Workplace (2015 NFPA 70E) and the National Fire Protection Agency National Electrical Code (2014 NFPA 70).

To provide a practical safe working area for employees and contractors relative to the hazards arising from the use of electricity at all Waupaca Foundry, Inc. locations. [2015 NFPA 70E Art 90.1](#)

2.0 Definitions

2.1 Arc Flash Hazard

A dangerous condition associated with the possible release of energy caused by an electrical arc. [2015 NFPA 70E Article 100](#)

2.2 Arc Flash Hazard Analysis

A study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices, arc flash boundary, and the appropriate levels of personal protective equipment (PPE). [2015 NFPA 70E Article 100](#)

2.3 Arc Rating

The value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in cal/cm² and is derived from the determined value of the Arc Thermal Performance Value (ATPV), or Energy Breakopen Threshold (EBT) (Should a material system exhibit a Breakopen response below the ATPV value). [2015 NFPA 70E Article 100](#)

2.4 Barricade

A physical obstruction such as tape, cones, or A-frame type wood or metal structures intended to provide a warning about and to limit access to a hazardous area. [2015 NFPA 70E Article 100](#)

2.5 Barrier

A physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts or to prevent unauthorized access to a work area. [2015 NFPA 70E Article 100](#)

2.6 Boundary, Arc Flash

When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur. The arc flash boundary for systems 50 volts and greater shall be the distance at which the incident energy equals 1.2 cal/cm². A second degree burn is possible by an exposure of unprotected skin to an electric arc flash above the incident energy level of 1.2 cal/cm². [2015 NFPA 70E Article 100](#)

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2.7 Boundary, Electrical Shock

The three (3) boundaries protecting personnel from an exposure to energized parts. The shock protection boundaries identified as (a) limited approach, (b) restricted approach and (c) prohibited approach boundaries shall be applicable where approaching personnel are exposed to energized electrical conductors or circuit parts. 2015 NFPA Table 130.4(C)(a) and Table 130.4(C)(b) shall be used for the associated voltages. [2015 NFPA 70E 130.4\(B\)](#)

2.7.1 Limited Approach Boundary: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists. [2015 NFPA 70E Article 100](#)

2.7.2 Restricted Approach Boundary: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc-over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part. [2015 NFPA 70E Article 100](#)

2.7.3 Prohibited Approach Boundary: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which work is considered the same as making contact with the electrical conductor or circuit part. [2015 NFPA 70E Article 100](#)

2.8 De-Energized

Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth. [2015 NFPA 70E Article 100](#)

2.9 Electrical Hazard

A dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn or blast. [2015 NFPA 70E Article 100](#)

2.10 Energized

Electrically connected to, or is, a source of voltage [2015 NFPA 70E Article 100](#)

2.11 Exposed

Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are NOT suitably guarded, isolated, or insulated. [2015 NFPA 70E Article 100 and 2014 NFPA 70 Article 100](#)

2.11 Ground-Fault Circuit-Interrupter (GFCI)

A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device. Class A ground-fault circuit-interrupters trip when the current to ground is 6mA or higher and do not trip when the current to ground is less than 4 mA. [2015 NFPA 70E Article 100 and 2014 NFPA 70 Article 100](#)

2.12 Ground-Fault Interrupter (GFI)

A GFI is an equipment protector, unlike the GFCI which is a personnel protector. It is intended to protect the equipment from damaging line-to-ground fault currents by opening all ungrounded conductors of the faulted circuit.

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2.12 Ground

An electrically conducting connection between equipment or an electric circuit and the earth or to another conducting body. A properly designed grounding system provides a reliable conducting path to earth or some other conducting body in place of the earth. This system provides a low impedance path for electric short circuits and faults enabling over-load protective devices to open the circuit. The grounding system maintains a common potential for grounded equipment at or near earth's potential level. It also provides a low impedance path for electrical short circuits, permitting large currents to pass through over-load protective devices permitting them to open.

2.13 Qualified Person

2.13.1 One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. *2014 NFPA 70 Article 100.*

2.13.2 A qualified person shall be trained and knowledgeable of the construction and operation of equipment or a specific work method and be trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method. A person can be considered qualified with respect to certain equipment and methods but still unqualified for others.
2015 NFPA 70E Article 110.2(D)(1)

2.14 Shock Hazard

A dangerous condition associated with the possible release of energy caused by contact or approach to energized electrical conductors or circuit parts. *2015 NFPA 70E Article 100*

2.15 Working On

Intentionally coming in contact with energized electrical conductors or circuit parts with hands, feet, or other body parts, with tools, probes or with test equipment, regardless of the personal protective equipment a person is wearing. There are two categories of “working on”:

2.15.1 Diagnostic (testing): is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment.
2015 NFPA 70E Article 100

2.15.2 Repair: is any physical alteration of electrical equipment, such as making or tightening connections, removing or replacing components, etc. *2015 NFPA 70E Article 100*

3.0 Procedure

3.1 This Compliance Work Instruction is designed to provide guidance and encompass safety-related work practices for qualified persons who work on or near exposed energized electrical conductors or circuit parts and familiarize unqualified persons with electrical safety work practices. It is the role of management to enforce this work instruction, including discipline for non-conformance.

3.2 A qualified person shall be familiar with the proper use of the special precautionary techniques, Personal Protective Equipment (PPE), 29 CFR1910.137 (Electrical Protective Equipment), including arc flash suit; insulating and shielding materials; and insulated tools and test equipment. A person may be considered qualified with respect to certain equipment and methods but still unqualified for others.
2015 NFPA 70E Article 110.2(D)(1)(a)

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3.3 An employee, who is undergoing on-the-job training for the purpose of obtaining the skills and knowledge necessary to be considered a qualified person and who, in the course of such training, has demonstrated an ability to perform specific duties safely at his or her level of training, and who is under the direct supervision of a qualified person, shall be considered to be a qualified person for the performance of those specific duties. [2015 NFPA 70E Article 110.2\(D\)\(1\)\(c\)](#)

3.4 Such persons permitted to work within the limited approach boundary of exposed energized conductors or circuit parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following [2015 NFPA 70E Article 110.2\(D\)\(1\)\(b\)](#):

3.4.1 Skills and techniques necessary to distinguish exposed energized electrical conductors or circuit parts from other parts of electrical equipment. [2015 NFPA 70E Article 110.2\(D\)\(1\)\(b\)\(1\)](#)

3.4.2 Skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors or circuit parts. [2015 NFPA 70E Article 110.2\(D\)\(1\)\(b\)\(2\)](#)

3.4.3 Approach distances specified in NFPA Table 130.4(C)(a) and Table 130.4(C)(b) and the corresponding voltages to which the qualified person will be exposed.
[2015 NFPA 70E Article 110.2\(D\)\(1\)\(b\)\(3\)](#)

3.4.4 Decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.
[2015 NFPA 70E Article 110.2\(D\)\(1\)\(b\)\(4\)](#)

4.0 Electrical Hazard Analysis

4.1 If the energized electrical conductors or circuit parts operating at 50 volts or more are not placed in an electrically safe work condition, other safety-related work practices shall be used to protect employees who might be exposed to electrical hazards involved. Such work practices shall protect each employee from arc flash and from contact with energized electrical conductors or circuit parts operating at 50 volts or more directly with any part of the body or indirectly through some other conductive object. [2015 NFPA 70E Article 130.3\(B\)\(1\)](#)

4.2 Before an employee works within the limited approach boundary or arc flash boundary of exposed energized electrical conductors or circuit parts that are not put into an electrically safe work condition, work, excluding diagnostics, to be performed shall be considered energized electrical work and shall be performed by written permit only. [2015 NFPA 70E Article 130.2\(B\)\(1\)](#)

4.3 Work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of energized electrical conductors or circuit parts.
[2015 NFPA 70E Article 130.3\(B\)\(1\)](#)

4.4 Appropriate safety-related work practices shall be determined before any person is exposed to the electrical hazards involved by using both shock hazard analysis and arc flash hazard analysis.
[2015 NFPA 70E Article 130.3\(B\)\(1\)](#)

5.0 Arc Flash Hazard Analysis

5.1 An arc flash hazard analysis shall determine the arc flash boundary, the incident energy at the working distance, and the personal protective equipment that people within the arc flash boundary shall use.
[2015 NFPA 70E Article 130.5](#)

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5.2 The arc flash hazard analysis shall be updated when a major modification or renovation takes place. It shall be reviewed periodically, not to exceed five (5) years, to account for changes in the electrical distribution system that could affect the results of the arc flash hazard analysis. [2015 NFPA 70E Article 130.5](#)

5.3 If the analysis is not available or has not been completed, the requirements of 2015 NFPA 70E 130.7(C)(15) and 130.7(C)(16) shall be used in lieu of determining the incident energy at the working distance. [2015 NFPA 70E Article 130.5 Exception](#)

6.0 Electrical Hazard Protection Boundaries

6.1 A shock hazard analysis shall determine the voltage to which personnel will be exposed, the boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electric shock to personnel. [2015 NFPA 70E Article 130.4\(A\)](#)

6.2 Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized electrical conductors or circuit parts. Barricades shall be placed no closer than the limited approach boundary. [2015 NFPA 70E Article 130.7\(E\) \(1\) & \(2\)](#)

6.3 If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazard. [2015 NFPA 70E Article 130.7\(E\)\(3\)](#)

7.0 Personal Protective Equipment

2015 NFPA 70E Table 130.7(C)(16) shall be used to determine the required personal protective equipment for the specific task, once the Hazard/Risk Category has been identified from the Arc Flash Hazard Analysis or 2015 NFPA 70E Table 130.7(C)(15)(a) and Table 130.7(C)(15)(b), including associated notes, and requirements of 2015 NFPA 70E 130.7(C)(15). [2015 NFPA 70E Article 130.7](#)

7.1 The personal protective equipment requirements of 2015 NFPA 70E are intended to protect a person from arc flash and shock hazards. While some situations could result in burns to the skin, even with the protection described in 2015 NFPA Table 130.7(C)(16), burn injury should be reduced and survivable. [2015 NFPA 70E Article 130.7\(C\)\(16\) Informational note No. 2](#)

7.2 One of the first lines of defense when it comes to preventing contact with energized electrical components and/or electrical power lines are rubber insulating gloves, commonly known as High Voltage Gloves. High Voltage Gloves must meet the requirements of the current ASTM D120 specifications and NFPA 70E standards. OSHA enforces these requirements as a part of their CFR 1910.137 regulation. These standards dictate manufacturing criteria as well as testing and retesting requirements for Lineman Gloves.

7.2.1 OSHA requires the use of rubber insulated gloves for those persons working on or near energized circuits and/or other electrical sources that are considered either high or low-voltage applications. That means there are many other occupations that need to use rubber insulated gloves as well, such as HVAC Technicians, Automotive Technicians, Electricians, Maintenance Mechanics, Railway Technicians, and even Telecommunications personnel.

7.2.2 OSHA regulation [29 CFR 1910.137](#) requires that all insulating gloves must be electrically tested before first issue and retested every six months thereafter. OSHA 1910.268 (Tele-com) – Natural rubber insulating gloves must be electrically tested before first issue, twelve months after first issue, and every 9 months thereafter. Any unused glove that has not been tested within twelve months must be retested before being used.

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7.3 At Waupaca Foundry, Inc. each electrician has been issued (2) pairs of electrical gloves - one black, one red. On a rotation of every 6 months one set of gloves are collected and sent in for testing, while the others remain in use. Currently George Caldwell at Corporate administers the glove collection for testing. April through September RED gloves should be used, and October through March BLACK gloves should be used.

7.4 Daily Safety Inspections: Rubber insulating gloves should be visually inspected before each day's use and also after any situation that may have possibly caused damage to the gloves. Care and maintenance is critical to ensure an insulated glove retains its protection properties.

7.4.1 Manufacturers suggest gloves be stored out of direct sunlight, in a cool and dry location away from sources of ozone. They should be stored in a glove bag (one pair per bag) and then hung-up versus being laid down on a flat surface. Rubber insulated gloves should never be folded in the storage bag. Creasing insulated gloves may cause cracking which could shorten the useful life of the gloves.

7.4.2 Before use, gloves should be visually inspected for tears, holes, signs of abrasion, ozone damage or possible chemical contact. (ASTM,F1236 standard provides inspection details). In addition, OSHA requires an air-glove inflation test as a part of the inspection process.

8.0 Electrical Hazard Approach Boundaries

The shock protection boundaries identified as limit approach, restricted approach, and prohibited approach boundaries shall be applicable where approaching personnel are exposed to energized electrical conductors or circuit parts. 2015 NFPA 70E Table 130.4(C)(a) and Table 130.4(C)(b) shall be used for the distance associated with system voltages. [2015 NFPA 70E Article 130.4\(B\)](#)

In certain instances, the arc flash boundary might be a greater distance from the energized electrical conductor or circuit parts than the limited approach boundary. The shock protection boundaries and the arc flash boundary are independent of each other. [2015 NFPA 70E Article 130.4\(B\) Informational note](#)

8.1 Limited Approach Boundary. When one or more unqualified persons are working at or close to the limited approach boundary, the designated person in charge of the work space where the electrical hazard exists shall advise the unqualified person(s) of the electrical hazard and warn him or her to stay outside of the limited approach boundary. [2015 NFPA 70E Article 130.4\(D\)\(1\)](#)

8.1.1 Unless permitted by 2015 NFPA 70E 130.4(D)(2), no unqualified person shall be permitted to approach nearer than the limited approach boundary of energized electrical conductors or circuit parts. [2015 NFPA 70E Article 130.4\(D\)](#)

8.1.2 Where there is a need for an unqualified person(s) to cross the limited approach boundary, a qualified person shall advise him or her of the possible hazard and continuously escort unqualified person(s) while inside the limited approach boundary. [2015 NFPA 70E Article 130.4\(D\)\(2\)](#)

8.2 Restricted Approach Boundary. Under no circumstance shall the escorted unqualified person(s) be permitted to cross the restricted approach boundary. [2015 NFPA 70E Article 130.4\(D\)\(2\)](#)

8.2.1 An employee who is undergoing on-the-job training for the purposes of obtaining the skills and knowledge necessary to be considered a qualified person and who, in the course of such training, has demonstrated an ability to perform specific duties safely at his or her level of training, and who is under the direct supervision of a qualified person, shall be considered to be a qualified person for the performance of those specific duties. [2015 NFPA 70E Article 110.2\(D\)\(1\)\(c\)](#)

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8.2.2 No qualified person shall approach or take any conductive object closer to exposed energized electrical conductor or circuit parts operating at 50 volts or more than the restricted approach boundary set forth in 2015 NFPA 70E Table 130.4(C)(a) and Table 130.4(C)(b), unless the requirements are met for the specific listed applications of 2015 NFPA 70E 130.4(C). [2015 NFPA 70E Article 130.4\(C\)](#)

8.2.3 To cross the restricted approach boundary and enter the restricted space, qualified persons must do the following: [2015 NFPA 70E Annex C. C.1.2.3](#)

- 1) Have a plan that is documented and approved by authorized foreman or supervisors
- 2) Use PPE that is appropriate for working near exposed energized conductors or circuit parts and is rated for the voltage and energy level involved
- 3) Be certain that no part of the body enters the prohibited space
- 4) Minimize the risk from inadvertent movement by keeping as much of the body out of the restricted space as possible, using only protected body parts in the space necessary to accomplish the work

8.3 Prohibited Approach Boundary. Crossing the prohibited approach boundary and entering the prohibited space is considered the same as making contact with exposed energized conductors or circuit parts. [2015 NFPA 70E Annex C C.1.2.4](#)

8.3.1 To cross the prohibited approach boundary, qualified persons must do the following:

[2015 NFPA 70E Annex C C.1.2.4:](#)

- (1) Have specified training to work on energized conductors or circuit parts
- (2) Have a documented plan justifying the need to work close to exposed energized conductors or circuit parts
- (3) Perform a risk analysis
- (4) Have the plan and the risk analysis approved by authorized foreman or supervisor
- (5) Use PPE that is appropriate for working near exposed energized conductors or circuit parts and is rated for the voltage and energy level involved

9.0 De-Energized Parts (Electrically Safe Work Condition)

Energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee performs work. [2015 NFPA 70E Article 130.2](#)

All electrical circuit conductors and circuit parts shall be considered energized until the source(s) of energy is (are) removed, at which time they shall be considered de-energized. All electrical conductors and circuit parts shall not be considered to be in an electrically safe work condition until all of the applicable requirements of paragraph 10.3 have been met. [2015 NFPA 70E Article 120.2\(A\)](#)

9.1 Energized electrical conductors or circuit parts that operate at less than 50 volts shall not be required to be de-energized where the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burns or to explosion due to electric arcs. [2015 NFPA 70E Article 130.2 \(A\)\(3\)](#)

9.2 During the time an employee may be exposed to contact with parts of fixed electrical equipment or circuits which have been de-energized, the circuits energizing the parts shall be locked out in accordance with Waupaca Foundry, Inc. Compliance Work Instruction HSCWI 3-0011 "Energy Control and Lockout".

9.3 Conductors and parts of electric equipment that have been de-energized but have not been locked out shall be treated as energized. [2015 NFPA 70E Article 120.2\(A\)](#)

9.4 Interlocks for electric equipment shall not be used as a substitute for lockout procedures.

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10.0 Work on De-energized Equipment

10.1 Waupaca Foundry Inc. shall identify, document and implement (HSCWI 3-0011) lockout/tagout procedures conforming to 2015 NFPA 70E Article 120 to safeguard employees from exposure to electrical hazards. The lockout/tagout procedure shall be appropriate for the experience and training of the employees and conditions as they exist in the workplace. [2015 NFPA 70E Article 120.2](#)

Energized electrical conductors or circuit parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee performs work if either of the following conditions exists: [2015 NFPA 70E Article 130.2](#)

- (1) The employee is within the limited approach boundary
- (2) The employee interacts with equipment where conductors or circuit parts are not exposed, but an increased risk of injury from an exposure to an arc flash hazard exists

When a qualified person is working within the limited approach boundary or the arc flash boundary that are not placed into an electrically safe work condition, an energized electrical work permit shall be completed [2015 NFPA 70E Article 130.2 \(B\)](#)

Examples of *increased or additional hazards* include, but are not limited to, interruption of life support equipment, deactivation of emergency alarm systems, and shutdown of hazardous location ventilation equipment. [2015 NFPA 70E Article 130.2 \(A\)\(3\) Informational Note 1](#)

Example of work that may be performed on or near energized circuit parts because of *infeasibility due to equipment design or operational limitations* include performing diagnostics and testing of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would otherwise need to be completely shutdown in order to permit work on one circuit or piece of equipment. [2015 NFPA 70E Article 130.2 \(A\)\(3\) Informational Note 2](#)

10.1.1 Electrical conductors or circuit parts that have been disconnected, but not under lockout; tested; and grounded (where applicable) shall not be considered to be in an electrically safe work condition, and safe work practices appropriate for the circuit voltage and energy level shall be used.

Lockout requirements, HSCWI 3-0011 shall apply to fixed, permanently installed equipment; to temporarily installed equipment; and to portable equipment. [2015 NFPA 70E Article 120.2\(A\)](#)

10.2 All electrical conductors or circuit parts shall be considered energized until the source(s) of energy is (are) removed, at which time they shall be considered de-energized. All electrical conductors and circuit parts shall not be considered to be in an electrically safe work condition until all of the applicable requirements of 2015 NFPA 70E Article 120.1 have been met. [2015 NFPA 70E Article 120.2\(A\)](#)

10.3 Establishing an electrically safe work condition: [2015 NFPA 70E Article 120.1](#)

10.3.1 Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags

10.3.2 After properly interrupting the load current, open the disconnecting device(s) for each source.

10.3.3 Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position

10.3.4 Apply lockout/tagout devices in accordance with HSCWI 3-0011

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10.3.5 Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.

10.3.6 Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

10.4 Re-Energizing Equipment. Prior to re-energizing circuits or equipment, even temporarily, the following requirements shall be met in the order listed: [19 CFR 1910.147\(e\)](#)

10.4.1 A qualified person shall verify that all tools, electrical jumpers, shorts, grounds, and other similar devices have been removed so the circuits and equipment can be safely energized, including removal of equipment interlock-defeating devices. [2015 NFPA 70E Article 120.2\(F\)\(2\)\(m\)](#)

10.4.2 Individuals exposed to the hazards associated with re-energizing the circuit or equipment shall be warned to stay clear of circuits and equipment. [2015 NFPA 70E Article 120.2\(F\)\(2\)\(m\)](#)

10.4.3 All lockout equipment shall be removed as specified in HSCWI 3-0011 "Energy Control and Lockout".

10.4.4 A visual check shall be made to ensure all individuals are clear of the circuits and equipment.

10.4.5 Where appropriate, protective covers, shields, shrouds and other guarding shall be secured, unless specific maintenance guidance states otherwise.

11.0 Energized Electrical Work Exception

11.1 If the exposed energized parts cannot be de-energized, an equivalent level of safety shall be provided to protect employees who may be exposed to the electrical hazards involved.

Only qualified personnel may work within the Limited Approach Boundary on electrical conductors or circuit parts or equipment that have not been de-energized.

They shall be properly trained regarding working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials and insulated tools as stated in [29 CFR 1910.333 \(c\)\(2\)](#).

Energized electrical conductors or circuit parts are to be de-energized in accordance with the HSCWI 3-0011 Energy Control procedure, unless one of the following conditions applies:

11.1.1 Energized work shall be permitted where it can be demonstrated that the task to be performed introduces additional hazards or increased risk. [2015 NFPA 70E Article 130.2\(A\)\(1\)](#)

Examples of additional hazards or increased risk include, but not limited to, interruption of life-support equipment, deactivation of emergency alarm systems, and shutdown of hazardous location ventilation equipment. [2015 NFPA 70E Article 130.2 Informational note No. 1](#)

11.1.2 Energized work shall be permitted where it can be demonstrated that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations. [2015 NFPA 70E Article 130.2\(A\)\(2\)](#)

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11.1.3 Energized electrical conductors or circuit parts that operate at less than 50 volts shall not be required to be de-energized where the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burns or to explosion due to electric arcs. [2015 NFPA 70E Article 130.2\(A\)\(3\)](#)

11.2 Energized Electrical Work Permit (HSF 4-0234): When working within the limited approach boundary or the arc flash boundary of exposed energized electrical conductors or circuit parts that are not placed in an electrically safe work condition, work to be performed shall be considered energized electrical work and shall be performed by written permit only. The intent of the permit is to ensure that all appropriate safety precautions have been taken prior to starting energized electrical work. [2015 NFPA 70E Article 130.2\(B\)\(1\)](#)

11.2.1 Work performed within the limited approach boundary of energized electrical conductors or circuit parts by qualified persons related to tasks such as testing, troubleshooting, and voltage measuring shall be permitted to be performed without an energized electrical work permit, if appropriate safe work practices and PPE are provided and used. [2015 NFPA 70E Article 130.2\(B\)\(3\)](#)

If the purpose of crossing the limited approach boundary is only for visual inspection and the restricted approach boundary will not be crossed, then an energized electrical work permit shall not be required. [2015 NFPA 70E Article 130.2\(B\)\(3\)](#)

11.2.2 The permit must be completed by the employee(s) participating in the work, and signed by a foreman or supervisor who has completed the Qualified Person Training within the last twelve (12) months.

11.2.3 The permit must be posted in the area of the work throughout the duration of the task.

11.2.4 The completed permit shall be provided to the Plant Safety Coordinator at the completion of the task for retention.

12.0 Overhead Lines

12.1 Work near overhead lines shall be avoided whenever possible. If work near overhead lines must be performed, the lines shall be considered to be energized and the requirements for working near energized equipment shall be followed. [2015 NFPA 70E Table 130.4\(C\)\(a\) and \(b\)](#)

12.2 Emergency switches must be located to shut down the grid to overhead lines that employees will be working on or near.

12.3 When working near an energized overhead line, no part of a vehicle and/or mechanical equipment shall come within 10 feet of the line. This distance shall be increased by 4 inches for every 10 kV over 50kV.

13.0 Lighting

13.1 Where lack of illumination or an obstruction precludes observation of the work to be performed, employees shall not perform any task within the limited approach boundary of energized electrical conductors or circuit parts operating at 50 volts or more or where an electrical hazard exists. [2015 NFPA 70E Article 130.6 \(C\)\(2\)](#)

13.2 A portable light can be used to provide light and should be made of non-conducting material to avoid shorting conductors together. The flexible cord of a portable light should not be pinched, kinked, cracked or cut, exposing live wires or parts.

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13.3 An individual shall not reach blindly into areas that may contain energized electrical conductors or circuit parts where an electrical hazard exists. [2015 NFPA 70E Article 130.6 \(B\)](#)

14.0 Confined or Enclosed Work Spaces

14.1 Individuals working in a confined or enclosed space that contains exposed energized electrical conductors or circuit parts operating at 50 volts or more, or where an electrical hazard exists, the employee shall use protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts and the effects of the electrical hazard. [2015 NFPA 70E Article 130.6 \(F\)](#)

Example: Individual working inside of a main feed cabinet, the conductors feeding the cabinet must be covered to prevent accidental contact.

14.2 Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized electrical conductors or circuit parts operating at 50 volts or more or where an electrical hazard exists if movement of the door, hinged panel, and the like is likely to create a hazard. [2015 NFPA 70E Article 130.6 \(G\)](#)

15.0 Conductive Materials and Equipment

15.1 Conductive materials, tools and equipment that are in contact with any part of an employee's body shall be handled in a manner that prevents accidental contact with energized electrical conductors or circuit parts. [2015 NFPA 70E Article 130.6 \(E\)\(1\)](#)

15.2 Means shall be employed to ensure that conductive materials approach exposed energized conductors and circuit parts no closer than that permitted by 2015 NFPA 70E 130.2. [2015 NFPA 70E Article 130.6 \(E\)\(2\)](#)

15.3 Conductive Articles of jewelry and clothing (e.g., watch bands, bracelets, rings, key chains or metal headgear) shall not be worn where they present an electrical contact hazard with exposed energized electrical conductors or circuit parts. [2015 NFPA 70E Article 130.6 \(D\)](#)

16.0 Use of Portable Electric Equipment

16.1 Portable electric equipment such as drills, saws, grinders, and portable lights shall be used in a safe manner and be connected to a circuit protected by GFCI capability if being used in a wet or damp environment (i.e., circuit breaker or separately enclosed, portable GFCI). The following guidelines provide minimum requirements for the use of this type of equipment. [2015 NFPA 70E Article 110.4 \(B\)\(3\)\(d\)](#)

16.2 All cord and plug-connected electrical equipment, flexible cord sets (extension cords), and portable electric equipment shall be handled in a manner that will not cause damage. [2015 NFPA 70E Article 110.4 \(B\)\(1\)](#)

16.3 Multiple outlets shall not be "daisy-chained" to one another.

16.4 Use of extension cords in combination with power strips shall not be permitted.

16.5 Flexible electrical cords connected to equipment shall not be used for raising or lowering the equipment. [2015 NFPA 70E Article 110.4 \(B\)\(1\)](#)

16.6 Flexible cords may not be fastened with staples or otherwise hung in a fashion that could damage the outer jacket or insulation. [2015 NFPA 70E Article 110.4 \(B\)\(1\)](#)

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16.7 Portable cord- and plug-connected equipment and extension cords shall be visually inspected for external defects such as loose parts, deformed and missing pins, burns or scorch marks, or damage to the outer jacket or insulation as evidence of possible internal damage such as signs of pinching or crushing before use. [2015 NFPA 70E Article 245](#)

16.8 If there is evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service and not used until repaired and tested to ensure the equipment is safe. [2015 NFPA 70E Article 245](#)

16.9 Whenever an attachment plug is to be connected to a receptacle (including extension cords), the plug end and the receptacle shall be checked to ensure they are of proper configurations and the fit is snug. [2015 NFPA 70E Article 245](#)

16.10 An extension cord used with grounding-type equipment shall contain an equipment grounding conductor. [2015 NFPA 70E Article 245](#)

16.11 Plugs and receptacles may not be connected or altered in a manner that would prevent proper continuity of the equipment grounding conductor at the point where plugs are attached to receptacles. (Do not cut off the ground prong on a plug) Additionally, those devices may not be altered to allow the grounding pole of a plug to be inserted into slots intended for connection to the current-carrying conductors. [2015 NFPA 70E Article 110.4 \(B\)\(2\)\(b\)](#)

16.11.1 Adapters that do not allow continuity of the equipment grounding connection may not be used. [2015 NFPA 70E Article 110.4 \(B\)\(2\)\(c\)](#)

16.12 Portable electric equipment and extension cords used in highly conductive work locations (such as areas with standing water), or in job locations where employees are likely to contact water shall be approved for those locations and GFI protected.

16.13 Employees' hands may not be wet when plugging and unplugging flexible cords and cord- and plug-connected equipment if energized equipment is involved. [2015 NFPA 70E Article 110.4 \(B\)\(4\)\(a\)](#)

16.13.1 Energized plug and receptacle connections may be handled only with insulated gloves if the condition of the connection could provide a conducting path to the employee's hand. For example, a cord connector is wet from being immersed in water. [2015 NFPA 70E Article 110.4 \(B\)\(4\)\(b\)](#)

16.14 Locking-type connectors shall be properly secured after connection. [2015 NFPA 70E Article 110.4 \(B\)\(4\)\(c\)](#)

16.15 All equipment shall have U.L. approval.

16.16 Safety inspections in the plant shall include testing and inspection of electrical receptacles, cords and plugs to ensure that all ground circuits, pins, and sockets are properly wire and are in good repair and operating condition. Adapters that permit the ground pin of an electrical plug to be by-passed shall not be used. All electrical cords must not be frayed and must be in good repair.

17.0 Electric Power and Lighting Circuits

17.1 Load rated switched (light switch), electrical disconnects, and circuit breakers specifically designed as a disconnecting means shall be used for the routine opening, reversing, or closing of circuits under load conditions. [2015 NFPA 70E Article 130.6 \(K\)](#)

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17.2 Cable connectors not of the load-break type, fuses, terminal lugs, and cable splice connections may not be used to disconnect a circuit under load except in an emergency. [2015 NFPA 70E Article 130.6 \(K\)](#)

17.3 After a circuit is de-energized by the automatic operation of a circuit protective device, the circuit shall not be manually re-energized until it has been determined that the equipment and circuit can be safely energized. [2015 NFPA 70E Article 130.6 \(L\)](#)

17.4 Repetitive resetting of circuit breakers or re-energizing circuits through replaced fuses is prohibited. [2015 NFPA 70E Article 130.6 \(L\)](#)

17.5 Over current protection of circuits and conductors may not be modified, not even on a temporary basis, beyond that permitted by applicable portions of electrical codes and standards dealing with overcurrent protection. [2015 NFPA 70E Article 110.4 \(E\)](#)

18.0 Test Instruments and Equipment

18.1 Only qualified persons shall perform tasks such as testing, troubleshooting and voltage measuring within the limited approach boundary of energized electrical conductors or circuit parts operating at 50 volts or more or where an electrical hazard exists. [2015 NFPA 70E Article 110.4\(A\)\(1\)](#)

18.1.2 Test instruments, equipment, and their accessories shall be rated for the circuits and equipment to which they will be connected. Test instruments and equipment and all associated test leads, cables, power cords, probes and connectors shall be visually inspected for external defects and damage before each use. [2015 NFPA 70E Article 110.4\(A\)\(2\)](#)

18.1.3 If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee shall use it until repairs and tests necessary to render the equipment safe have been made. [2015 NFPA 70E Article 110.4 \(A\)\(3\)](#)

19.0 Personal Protective Equipment

19.1 Individuals shall be provided and shall use electrical protective equipment that is appropriate for the type of work to be performed. [2015 NFPA 70E Article 105.3, Article 130.7\(A\) and 29 CFR 1910.335\(a\)\(1\)\(i\)](#)

19.2 If the insulating capability of protective equipment may be subject to damage during use, the insulating material shall be protected, for example, an outer covering of leather when it is used for the protection of rubber insulating material. [29 CFR 1910.335\(a\)\(1\)\(iii\)](#)

19.3 Employees shall wear non-conductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed energized parts. [29 CFR 1910.335\(a\)\(1\)\(iv\)](#)

19.4 Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion. [29 CFR 1910.335\(a\)\(1\)\(v\)](#)

19.5 Employees shall wear protective face and body equipment when working on equipment using chemicals such as battery acid or caustic fluids. [2015 NFPA 70E Article 320](#)

19.6 Employees shall wear approved protective equipment when working on equipment with live voltages over 50 volts. [2015 NFPA 70E Article 130.7\(C\)\(7\) and 29 CFR 1910.335](#)

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19.7 Employees shall wear Arc Rated clothing with sleeves rolled down. [2015 NFPA 70E Article 130.7\(C\)\(9\)](#)

20.0 General Protective Equipment and Tools

20.0 Before an employee works within the limited approach boundary, energized conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition, unless work on energized components can be justified. According to 2015 NFPA 70E Article 130.2(A). [2015 NFPA 70E Article 130.3\(A\)\(1\)](#)

20.1 Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition. [2015 NFPA 70E Article 130.3 \(A\)\(2\)](#)

20.2 Fuse handling equipment, insulated for the circuit voltage, shall be used to remove or install fuses when the fuse terminals are energized. [2015 NFPA 70E Article 130.7\(D\)\(1\)\(b\)](#)

20.3 Before removing any fuse from a circuit, be sure the switch for the circuit is open or disconnected. When removing fuses, use an approved fuse puller and break contact on the hot side of the circuit first. When replacing fuses, install the fuse first into the load side of the fuse clip, then into the line side. [2015 NFPA 70E Article 130.7\(K\)](#)

20.4 Ropes and "fish tapes" used near exposed energized parts shall be non-conductive. [2015 NFPA 70E Article 130.7\(D\)\(1\)\(c\)](#)

20.5 Protective shields, protective barriers or insulating materials shall be used to protect individuals working near exposed energized parts which might be accidentally contacted or where dangerous electric heating or arcing might occur. [2015 NFPA 70E Article 130.7\(D\)\(1\)\(f\)](#)

20.6 Portable ladders used by employees, in areas where the employee or ladder could contact the exposed energized parts, shall have nonconductive side rails and comply with OSHA 1910.25 and 1910.26. [2015 NFPA 70E Article 130.7\(D\)\(1\)\(e\)](#)

21.0 Alerting Techniques

The following techniques shall be used to warn and protect employees from hazards which could cause injury due to electric shock, burns, blasts or failure of electric equipment parts.

21.1 Safety signs, safety symbols, or accident prevention tags shall be used, where necessary, to warn individuals about electrical hazards in their work area. Signs, symbols and tags shall conform to the requirements of 29 CFR 1910.145, "Specifications for Accident Prevention Signs and Tags."

Typical signs warning of electrical hazards include Red, Danger signage with the words:

"Danger - Arc Flash" (To be determined by Arc Flash analysis)

"Caution – Arc Flash" (To be determined by Arc Flash analysis)

"Danger - High Voltage" (All equipment with voltages exceeding 600 volts)

"Danger - High Voltage - Authorized Personnel Only" (Entrances to areas with voltages exceeding 600 volts)

"Danger - Electric Shock Hazard, When Door Open" (All panels that have door/interlock)

21.2 Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas exposing individuals to non-insulated energized equipment.

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21.3 Conductive materials shall not be used for barricades where they might cause an electrical contact hazard.

21.4 If signs and barricades do not provide sufficient warning and protection from electrical hazards, a safety observer or qualified person shall be stationed to warn and protect individuals from the potential hazard.

2015 NFPA 70E Article 130.7(E) and 2014 NFPA 70 Articles 110.16 and 110.21(B)

22.0 Clearances

22.1 A minimum of three (3) feet shall be maintained in front of all 0-150 volt electrical panels that may be accessed periodically to perform maintenance on a circuit or to de-energize a circuit in an emergency. A minimum of four (4) feet clear access to the front of all 151-600 volt panels shall be maintained. *2014 NFPA 70 Article 110.26(A)*

22.2 Outside of an electrical panel, the workspace may not be less than thirty (30) inches wide in front of the electric panel, and six (6) feet six (6) inches from ground to overhead. Distances will be measured from the front of the enclosure (or opening) of the enclosed live parts. The door must be able to fully open. *2014 NFPA 70 Article 110.26(A)(2) and 2014 NFPA 70 Article 110.26(A)(3)*

23.0 Grounding

23.1 Grounding systems are intended to decrease risk of electric shock to the human body from equipment and wiring.

23.2 An Equipment Grounding Conductor (EGC) originating at the service equipment entrance or at the location of a separately derived system shall connect all non-current carrying metal equipment, enclosures, conduits, fittings, and metal outlets. This will provide the necessary electrical continuity required for the over-current devices to trip. *2015 NFPA 70E Article 100*

23.3 The ground conductor shall be color coded green, green with a tracer color, or bare copper in accordance with the National Electrical Code (NEC). *2014 NFPA 70 Article 400.23*

23.4 Grounding conductors must be installed on all electrical equipment, including metal outlets and junction boxes, to comply with NEC and 29 CFR 1910.304 requirements. *2014 NFPA 70 Article 250*

23.5 The only neutral-to-ground bond shall be at the service entrance and any separately derived source. The neutral and ground should be kept separate at all sub-panel boards and junction boxes. The only two locations where the neutral and ground are bonded together is at the main service entrance and at the secondary side of a separately derived system. *2014 NFPA 70 Article 250.92 & 250.94*

23.6 Down line neutral-to-ground bonds result in parallel paths for the load return current where one of the paths becomes the ground circuit. This can cause a malfunction of protective devices and is a direct violation of the NEC. *2014 NFPA 70 Article 250*

23.7 The Ground Electrode Conductor (GEC) will connect this neutral-to-ground bond to the facilities ground reference. *2014 NFPA 70 Article 250*

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24.0 Ground-Fault Circuit-Interrupter (GFCI)

24.1 GFCI devices shall be used in wet or damp environments, or any other similar conditions, where the human body could accidentally come into contact with energized wiring or equipment and ground.

24.2 All out-of-doors maintenance work must be done with GFCI connections. At a minimum, NEC and local electrical code requirements shall be followed. [2014 NFPA 70 Article 210.8\(B\)](#)

24.3 It is recommended that GFCI devices be self-tested with the testing indicator on GFCI device before each use to determine at what amperage the circuit trips.

25.0 Ground-Fault Protection

GFP shall be used when there is a requirement to protect equipment from damaging line-to-ground fault currents by opening all ungrounded conductors of the faulted circuit. [2014 NFPA 70 Article 230.95](#)

GFI devices shall be used in wet or damp locations. GFP is addressed in the NFPA 70, which requires the installation of all solid-grounded wye electrical services of more than 150 volts to ground, but not exceeding 1000 volts, phase to phase for each service disconnect rated 1000 amperes or more. [2014 NFPA 70 Article 230.95](#)

26.0 Training

Training applies to all employees who face a risk of electrical shock or injury when they are working on or near exposed energized parts, or parts that may become energized. Initial training shall be given upon assignment to a position requiring an individual to work with or in close proximity to exposed electrical parts, equipment, or conductors as a regular part of his/her job. Refresher training shall be given if there is a significant change in this procedure or work practices. [2015 NFPA 70E Article 110.2](#)

26.1 Employees shall, at a minimum, be trained in, possess the knowledge of, and/or be familiar with the following to become "**Qualified**" **personnel** [2015 NFPA 70E Article 110.2\(D\)\(1\) & 110.2\(D\)\(2\)](#):

26.1.1 The skills and techniques necessary to distinguish exposed live parts from other parts of electrical equipment. Understanding the specific hazards associated with electrical energy, to include the results of the Arc Flash Hazard Assessments. [2015 NFPA 70E Article 110.2](#)

26.1.2 The skills and techniques necessary to determine the nominal voltage of exposed live parts.

26.1.3 The clearance distances specified in 29 CFR 1910.33, NFPA 70E Table 130.2(C)(a) and Table 130.4(C)(b) and the corresponding voltages to which the "Qualified Person" will be exposed.

26.1.4 Safety related work practices required by 29 CFR 1910.331-335 that pertain to his/her respective job assignments.

26.1.5 The requirements specified in this Work Instruction.

26.1.6 Proper Lockout and Energy control procedures for the equipment they are working on.

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- 26.1.7 To identify and understand the relationship between electrical hazards and possible injury. [2015 NFPA 70E Article 110.2\(D\)](#)
- 26.1.8 Instructions on how to read and interpret the Arc Flash warning labels. [2015 NFPA 70E Article 130.5\(C\)](#)
- 26.1.9 The PPE required for each Hazard Risk Category. How to use and care for the PPE properly. [2015 NFPA 70E Article 130.5\(C\)](#)
- 26.1.10 First Aid training dealing specifically with victims of electrical accidents. [2015 NFPA 70E Article 110.2\(C\)](#)
- 26.2 **"Unqualified" employees** must have awareness level training that includes:
[2015 NFPA 70E Article 110.2\(A\) and \(D\)](#)
- 26.2.1 Warning signs indicating electrical hazards.
 - 26.2.2 The safe use of portable equipment.
 - 26.2.3 Emergency notification procedures.
 - 26.2.4 Any electrical safety-related practices necessary for their safety.
- 27.0 **Host and Contract Employers Responsibilities 2014 NFPA 70E, Article 110.3**
- 27.1 Waupaca Foundry, Inc. shall inform contractors performing work on or near exposed energized electrical conductors or circuit parts of the hazards and safe related work practices as outlined in this document. All approved contractors participate in annual training and a copy of this work instruction is provided on the company web site.
- 27.2 Contractors are instructed to advise Waupaca Foundry, Inc. of the following:
- 27.2.1 Any unique hazards presented by the contract employer's work
 - 27.2.2 Hazards identified during the course of work by the contract employer that were not communicated by the host employer.
 - 27.2.3 The measures the contractor took to correct any violations reported by the host employer to prevent it from recurring.
 - 27.3.4 New conditions related to contracted work..
- 27.3 Contractors are also required to complete a documented Pre Job Meeting (documented)
- 27.3.1.1.1 Exchange of electrical safety programs
 - 27.3.1.2 Means/methods for reporting violations
 - 27.3.2 Requirement for energized work permit
 - 27.3.2.1 Energized Electrical Work Permit (HSF 4-0234): **When working within the limited approach boundary or the arc flash boundary of exposed energized electrical conductors or circuit parts that are not placed in an electrically safe work condition, work to be performed shall be considered energized electrical work and shall be performed by written permit only.** The intent of the permit is to ensure that all appropriate safety precautions have been taken prior to starting energized electrical work
 - 27.3.3 Required additional PPE