

*April 23, 2021*

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# Electrical Safety Audit

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Prepared for:

**ABC Company**  
**Maintenance Department**  
**Any City, USA**

Prepared by:

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*Electrical Engineer*

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## Introduction

A management systems and operational audit was performed at ABC Company Maintenance Department with a focus on electrical safety. This was the first electrical safety audit performed at the department after an updated Electrical Safety Program (ESP) was rolled out in and electrical safety training offered to certain employees. Personal protective equipment for shock and arc flash was also recently implemented. The audit was based on the requirements of the NFPA 70E® 2018 Standard for Electrical Safety in the Workplace as this was last revision used for the ESP.

The audit was performed by Zarheer Jooma and attended by Employee #1 and Employee #2. All systems, procedures, and operational activities that have been well established and documented by the maintenance department were audited in detailed. Each requirement was first verified to exist in a management system, then the workers or the leadership (as appropriate) were interviewed to demonstrate understanding of the rule and provide documented (or observable) compliance. A brief discussion regarding contractors and projects was held with Employee #3.

Noncompliant observations may consist of two types, those where no evidence was found or where noncompliance was clearly observed. The report attempts to differentiate between these two types of observations. The recipients of this report are encouraged to identify omissions and provide documented evidence to remediate noncompliant findings.

Not all compliant observations are listed in this report, instead, only a select few that are known high risk items are presented.

Certain sections of the audit were not covered since the maintenance department is in the process of rolling out newly required work practices as per the ESP. As such, some audit questions were answered verbally as documentation is still being developed. Examples are the Energized Electrical Work Permit (EEWP) and supervisory work inspection for working inside the restricted approach boundary. This part of the audit was discussed with the team to create awareness of what future audits will be examining.

The maintenance department appears to be working under adequate policies and procedures, however, some time is still required for the electrical safety principles to become part of the work culture. The observations presented below appear more to be learning and practice challenges than deep rooted systemic deficiencies. The results of the audit are presented in the next section and detail the appropriate article of the NFPA 70E® - 2018, the observation, and recommendations where applicable.

The audit results are presented in three sections: (i) Energy Control, (ii) Visual Observations, and (iii) General Compliance. The conclusion and recommendations on general items then follows in the final section.

## Electrical Safety Audit – Visual Audit

Requirement	Observations, Recommendation, or Notes
Care of PPE properly maintained, inspected before use, and properly stored	(i) Home laundering is permitted by the employer. In such cases OSHA and NFPA 70E requires training on home laundering in line with the manufacturers care instructions. It is recommended that a brief training program based on the manufacturers label be established and implemented through NetLearning.
Insulating gloves	(i) Gloves procured are compliant with ASTM D120 (ii) Test dates are within specification (iii) No glove program exists – recommend that a documented program be implemented (iv) During demonstration on the use of the glove, employees donned the glove without a pre-inspection (v) No glove storage bag provided to employees (vi) Employees are provided with Class 0 gloves that are rated for a maximum 1000V AC. A class 00 glove rated for a maximum 500V AC will be more comfortable for workers. (vii) It is recommended that a two color glove program be implemented for ease of identification of six monthly electrical glove test compliance.
Leather protectors	(i) During the observation, the employee did not inspect the leather over protector before the glove was donned.
Arc rated leather gloves	Not used
Arc rated clothing	(i) Employees appeared to use arc rated clothing adequately: buttoned up, sleeved rolled down, shirt tucked in. (ii) Employee observed using polyester cotton blend T-Shirts that are not allowed by OSHA and NFPA 70E. (iii) Metal belt buckles should not be used inside the arc flash and shock boundaries – employees indicated that belts are being used inside these boundaries.
Face shields; have wrap-around guarding protecting the face chin, forehead, ears, and neck area.	(i) Face shields are still being rolled out and a sample was inspected and found compliant to existing standards. (ii) Employees appeared unclear on when to use face shield – arc flash study should be updated. (iii) Presently face shields are being shared until such time that individual face shields can be provided. This is not recommended and must be resolved as soon as possible.
Balaclavas	(i) Balaclava – compliant
Test Instruments and Equipment; Voltmeters are Cat III	(i) Voltmeters inspected were compliant. (ii) There is unofficial calibration program for meters. It is recommended that the program be extended and formalized to include all meters and include an electrical insulation test as well.
Test leads and instrument checked visually before use	Test leads were not inspected by employee during the visual observation.
Employees wear arc rated clothing that completely covers all flammable clothing	(i) Balaclava – compliant
Employees wear non-conductive Class E hard hats	Hard hats are Class E
Employees wear face shields as required	Not observed

...Continued: Visual Audit

Requirement	Observations, Recommendation, or Notes
Employees wear balaclavas as required	Not observed
Employees wear AR hair and beard nets	Employees indicated that no Arc Rated hair nets or beard nets exist. Caution should be exercised when working exposed to arc flash hazards in clean condition areas.
Employees wear safety glasses	Not observed
Employees wear appropriate hearing protection	Not observed
Barricade Tape and other barricades are placed at the outermost boundary, whether shock of arc flash; states the level of the hazard; states what the hazard is; states what action is required	Barriers as shown in the picture below are used. The employees raised uncertainty regarding the fire resistance of such barricades. Since barricades are used at the arc flash boundary, this isn't seen as too much of a risk. However, until the arc flash study is undertaken, the arc flash boundary is unknown.
Single Line Diagrams are maintained in an updated condition	Non-compliant drawings and unavailable to employees.
Access to working spaces are kept clear and unobstructed	Noncompliant both in terms of storage and maintaining of NEC clearances. See pictures.
Warning signs are visible, securely attached and in a legible condition	
Circuit identification is securely affixed and maintained in an updated and legible condition	Noncompliant. See pictures
Illumination for and around electrical equipment sufficient to perform work safely	Not observed, however, safety department was requested to perform an illumination audit when workers begin the use of the arc rated face shields.
General Safety Requirements	(i) Grounding and bonding tests are not performed. (ii) No engineering specification for new projects and arc flash studies
Warning labels: State 'WARNING ARC FLASH HAZARD' in compliance with NEC® Article 110.16	(i) Arc flash study is outdated and has not been reviewed. An updated study is an immediate priority.
Warning labels state Nominal Voltage	(ii) Many panels not provided with Arc Flash and Shock Labels (iii) A sticker type label was coming loose – recommend that only engraved labels be used to identify equipment
Warning labels state Arc Flash Boundary	(iv) Panels dual-labeled (contradictory) and handwritten labels observed – both incorrect and not allowed
Labels prior to September 30, 2011 include Category Level or Incident Energy	(v) Incorrect voltages indicated on multiple panels. This is a serious finding and must be remediated urgently. (vi) Arc flash study labels attached on certain equipment is incorrect indicated 0cal/cm <sup>2</sup> incident energy when the actual energy is much higher. This is a serious finding. (vii) ELRB Panel door was left opened. See pictures. (viii) Transformer labeled – not recommended due to dual voltage and dual arc flash hazard. (ix) The panel identification labels appeared well developed and installed. Employees indicated that not all panels have identification labels. (x) Visited A-Wing Corridor Panels, E-Wing 2 <sup>nd</sup> Floor, B-Wing Basement, and C-Wing Basement

## Electrical Safety Audit – Energy Control

NFPA 70E® - 2018 Reference	Requirement	Observations	Recommendation or Notes
120.2 p.20	The employer has a lockout/tagout program	Compliant	ABC COMPANY has a detailed energy control procedure. The organization has further provided detailed procedures for more complex processes. Each procedure was not audited in detail.
120.2 (B)(1) p.20	All persons who may be exposed directly or indirectly to a source of electrical power are involved in the lockout/tagout process	Noncompliant	The procedure requires that the supervisor be responsible but does not indicate “how” this requirement is achieved. Feedback/clarification required.
120.2 (B)(2) p.20	All persons who could be exposed or affected by the lockout/tagout are trained in the lockout/tagout program	Partially compliant	Department Responsibilities #6. Annual training is provided to authorized employees who are also affected employees.  Evidence of training records were unavailable to audit. Further, evidence that contractors are covered under this clause should be provided.
120.2 (B)(4)(a) p.20	The employer had documented each employee has received training in lockout/tagout  Documentation contains the content of the training, the employee’s name, and dates of the training	Partially compliant	Although the team mentioned that this is in place, documented evidence should be provided in future.
120.2 (B)(4)(b) p.20	Documentation is made after employees demonstrate that they are proficient in the lockout/tagout practice	Compliant	The Demonstration of Skills for LOTO file compiled of the NetLearning program is commendable
120.2 (B)(7) p.20	The lockout/tagout device is unique and readily identifiable as a lockout/tagout device	Compliance to be verified	Lockout padlocks are colored blue and have a unique key.  Team suggested that the lockout box used at the boilers be cross checked for inclusion in the SAF Lockout Tagout Policy.
120.2 (C)(1) p.20	The employer provides lockout/tagout training	Compliant – possible improvement	PowerPoint training is available, however, GAP training for new recruits doesn’t appear to be mentioned in the existing SAF Lockout Tagout Policy.
120.2 (C)(3) p.20	The lockout/tagout procedure is audited annually and includes inspecting a lockout/tagout procedure in progress noting details	Partially compliant	Although demonstration of skills is observed annually, it appears that the SAF Policy is only reviewed once every three years through the OSHA VPP. Last reviewed 03/16

...Continued: Energy Control

NFPA 70E® - 2018 Reference	Requirement	Observations	Recommendation or Notes
120.2 (D)(2)(e) p.21	The complex lockout/tagout plans identify the method to account for all persons who might be exposed to electrical hazards, whether directly or indirectly, in the course of the lockout/tagout	Noncompliant	“Special Procedures”: Group LOTO 3.i and 3ii address identifying the group members but fail to identify the method of achieving this. The SAF LOTO form has space to fill in affected employees names, but this is not clearly stated in the group / complex lockout section in the SAF Policy
120.2 (E)(5) p.22	Employees have up-to-date single line diagrams to ensure that no electrical circuit interlock operation can result in reenergizing the circuit being worked on	Noncompliant	Employees have indicated that tracing electrical sources is time intensive and difficult to trace through walls and partitions. This exposes to organization to human factor elements, an unnecessary risk to the business.
120.2 (F) p.22	The lockout/tagout procedure is available to all employees	Noncompliant	Cannot be verified.
120.2 (F)(1)(a) p.22	The employer provides an effective means of locating all sources of energy when single line drawings are out of date	Noncompliant	Employees rely on labeling for the identification of equipment. Where labels do not exist, physical tracing of circuits takes place, but these are undocumented
120.2 (F)(2)(a) p.22	The lockout/tagout procedure identifies the person who performs the switching and where and how to de-energize the electrical equipment or circuit	Noncompliant	Unaware of whether such a procedure exists.

## Electrical Safety Audit – Compliance Audit

NFPA 70E® - 2018 Reference	Requirement	Observations	Observations
110.1(A) p.15	Employer has a written safety program	Compliant	Although a written electrical safety program exists, the employer should ensure communication and dissemination of this information. The work practices required in the ESP should be reviewed and audited annually.
110.1(H) p.16	Before starting work on electrical equipment an employee in charge is identified and conducts a job briefing	Compliant	Take Five JSA policy exists. Recommend that examples of the different probabilities be provided to help workers understand the risk in a or uniformed manner
110.2(A) p.16	Safety Training; For those that face electrical hazards and risks	Compliant	NetLearning transcripts provided
110.2(B) p.16	Type of Training; OJT or formal	Compliant	Formal training
110.2(C)(3) p.16	The employer verifies annually that employee training required by Section 110.2(C) is current	Compliant	Electrical Safety Training is documented through the NetLearning Program and managed by the Workforce Development Department on an annual schedule.
110.2(C)(4) p.16	The employer documents that the training in Section 110.2 has occurred		
110.2(D)(1) p.16	Qualified Person: Skills demonstration	Noncompliant	Need to develop a competency matrix and ensure that a demonstration of skills procedure is formalized. This activity should also allow for various levels of qualification and the reservation of work in line with demonstrated skills.
110.2(D)(1)(b)(4)(a) p.17	Trained in the ability to identify electrical hazards	Compliant	Take five JSA Training
110.2(D)(1)(b)(4)(b) p.17	Trained in the ability to assess electrical risks	Compliant	e-Hazard Electrical Safety Training
110.2(D)(1)(d) p.17	Employees are trained on tasks performed once per year before work begins	Noncompliant	No system in place to track which worker has performed what task in the past year

...Continued: Compliance Audit

110.2(D)(1)(e) p.17	Employees trained in selecting appropriated test instrument and demonstrate that that they know how to use the device to verify the absence of voltage and can interpret indications	Noncompliant	Although employees have been trained on general safety, voltmeter training has not taken place. From the visual observation audit of “testing”, the work practices were not adequate. It is recommended that this skill be observed and documented.
110.2(D)(1)(e) p.17	Trained in all limitations of each test instrument used	Noncompliant	Observations/comments: Voltmeter training should be undertaken
110.2(D)(1)(f) p. 17	Supervisors inspect the work of employees to determine compliance with Safety Program and 70E® on an annual basis.	Noncompliant	Recommendation: Develop Electrical Skills Demonstration checklist
110.2(D)(2) p.17	Unqualified Persons are trained in any electrical safety practices for their safety	Compliant	Biomedical and fire stop department trained on the low voltage refresher class. Risk assessment required to identify all unqualified persons such as Information Services.
110.2(D)(3) p.17	Retraining every three years	Compliant	Workforce Development Section – after training requirements is uploaded to NetLearning
110.2(D)(3) p.17	Retraining implemented with observed non-compliance with safety program, new technology, new types of equipment, changes in safety related work practices, and safety related work practices not normally used	Noncompliant	Verbal indication from leadership is that this type of training is sometime provided and sometimes not provided. It is recommended that the project manager ties this type of training to the project deliverables.
110.2(E) p.17	Employer documents the training and retains records	Compliant	NetLearning
110.4(A)(1) p.18	Only qualified persons use test instruments and equipment	Noncompliant	Qualified worker program not establish
110.4(A)(2) p.18	Test Instruments and equipment; Multi-meters are Cat III/1000 v or Cat IV/600 volts	Compliant	Randomized visual inspection performed.
110.4(A)(4) p.18	Test leads, instruments, and equipment are checked visually before use	Noncompliant	Visual observation – worker did not inspect test leads

...Continued: Compliance Audit

110.4(A)(4) p.18	Test leads, instruments, and equipment are tagged out and removed from service if found defective	Noncompliant	No system exists at present
110.4(A)(4) p.18	Only Qualified persons repair any defects found on test instruments and equipment	Partially compliant	There is an external party that tests the meter. The challenge is that there is no formal system to ensure that all meters are tested.
110.4(A)(5) p.18	Voltage detector tested by "Live-Dead-Live" Test	Noncompliant	No program implemented as yet to verify this activity, although it was communicated verbally that it does occur.
110.4(B)(1) p.18	Plug and cord connected equipment stored properly	Noncompliant	Areas of non-compliance observed during site visit (Vacuum in basement substation)
110.4(B)(2)(a) p.18	Plug and cord connected equipment: All cords have equipment ground conductor	Compliant	Random visual inspection performed.
110.4(B)(2)(b) p.18	Receptacles and plugs not damaged	Compliant	Random visual inspection performed.
110.4(B)(4) p.19	Job locations with water, etc., GFCI's in use	Compliant	In practice but not documented. Locations audited once every six months (Environmental Tour Audit) looking for such items specifically.
110.4(C)(1)p.19	GFCI's used on extension cords during construction, maintenance, remodeling, repair of buildings, structures or equipment	Partially compliant	Team indicated that it is being done and it is included in the ESP – formal audits have started but it is not comprehensive across all installations.
110.4(C)(1)p.19	Portable GFCI's used	Partially compliant	Procured ten units already and will be buying more in the future.

...Continued: Compliance Audit

130.2(A) p.24	Energized Work Permitted? If so, under what conditions?	Uncertain	Used: Emergency power installed at registration. The EEWP was not audited. Pete Keller to audit as per guidelines supplied by the auditor.
130.4(B) p.25	Shock Protection Boundaries are observed	Compliant	Observed at A1 Boiler Room
130.5 p.26	Arc flash risk assessment has been performed	Noncompliant	Arc flash assessment is incomplete and certain labels are not per specification.
130.5(2) p.26	Arc Flash Risk Assessment is reviewed periodically not exceeding five years	Noncompliant	Labels and study outdated
130.5(3) p.26	Arc Flash Risk Assessment takes into consideration the condition of equipment maintenance	Noncompliant	Audit of maintenance programs on equipment is not performed. The team did indicate that infrared thermal imaging scans are performed and more detailed maintenance is planned in 2018, however, not all equipment is under a maintenance program.
130.6(A)(3) p.28	Employees are alerted for any changes in the scope of the job or task	Complaint	Stop work policy exists but this has not been audited.
130.6(B) p.28	Blind Reaching not permitted	Uncertain	Team unaware of areas where blind reaching would be possible
130.6(C)(1) p.27	Illumination for and around electrical equipment sufficient to perform work safely	To be completed	Team advised to audit illumination when first using newly rolled out face shields
130.6(D) p.28	Conductive Articles are not permitted to be worn within the Restrictive Approach Boundary	Noncompliant	Worker belt buckles should be considered together with metal safety eyeglasses.
130.6(H) p.29	Clear spaces are maintained	Noncompliant	See pictures taken from basement substation

...Continued: Compliance Audit

130.7(C)(7)(a) p.30	Employees wear rubber insulating gloves and leather protectors when crossing the Restrictive Approach Boundary	Partially compliant	Not observed through work practice inspections. During the once off observation, worker did not use the glove. It is recommended that ABC COMPANY implement a glove program
130.7(C)(8) p.30	EH footwear is worn in dry conditions	In progress	Program being rolled out at present.
130.7(C)(9)(c) p.31	Underclothing is flammable, non-melting apparel; underlayer of meltable fibers are not permitted to be worn	Noncompliant	Found electrician using Polycotton
Table 130.7(C)(15)(A)( a) p.37	Is electrical equipment installed in accordance with applicable industry codes and standards and the manufacturer's recommendations?	Noncompliant	Not every installation is checked by an NEC inspector or double checked to manufacturer's instructions. For e.g. Mobile MRI / Mobile Cath
Table 130.7(C)(15)(A)( a) p.37	Is electrical equipment maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards?	Compliant	March 18. 2018 planned maintenance operate, clean, tighten, and lubrication program on 12.47kV and 480V breakers. Every 2 years IR scan. Transfer switches cleaned every year.
130.7(D)(1) p.40	Insulated tools are used when crossing the Restricted Approach Boundary	Compliant	Has not been audited, although insulated tools are available for use. Tools meet IEC 60900 and not ASTM F1505.
130.7(D)(1)(c) p.41	Ropes and handlines used within the LAB are non-conductive	Not applicable	No areas requiring ropes near energized parts,
130.7(D)(1)(e) p.41	Portable ladders have nonconductive side rails	Compliant	Portable ladders are all fiberglass
130.7(E)(2) p.41	Barricade Tape and other barricades are placed at the outermost boundary, whether shock of arc flash	Compliant	Visually inspected
130.7(E)(2) p.41	Barricade Tape gives warning of the hazard	Compliant	Yellow plastic barricades are used. See pictures
130.7(E)(3) p.41	Attendants are used if signs and barricades do not provide sufficient warning	Compliant	Indicated by the team

## ...Continued: Compliance Audit

130.9 p.43	Underground Electrical Lines and Equipment are located before excavation	Compliant	Ground penetrating radar used for detecting services. To be included with engineering technical specifications
205.10 p.44	Identification of Components and equipment is securely attached and maintained in a legible condition	Compliant	Stickers peeling off on a panel and one contradicting label observed. However, all other panels are labels and the labels appeared to be in good condition.
205.2 p.44	Single Line Diagrams are maintained in an updated condition and are legible.	Noncompliant	Not updated
205.5 p.44	Spaces about electrical equipment comply with the NEC	Noncompliant	Observed panel close to wall and storage noncompliant with OSHA requirements.
205.6 p.44	Grounding and Bonding continuity is maintained continuous	Noncompliant	No grounding and bonding test are performed.

## Conclusion

The audit was performed with the understanding that ABC COMPANY has just recently adopted certain electrical safety work practices. As these safe work practices are implemented by the employees, more detailed audits should follow. There are several methods that can be used to resolve the noncompliant observations presented in this report. It is recommended that ABC COMPANY discusses possible solutions and prioritizes the order in which these solutions are implemented.

An updated audit should be performed once the NFPA 70E – 2018 Standard is implemented at ABC COMPANY. In the interim, it is recommended that this audit be performed at other departments, including the Laundry Department – preferably within the next six months.

The following are general recommendation and are considered critical requirements:

1. Undertake arc flash engineering study and provide labels. This is an OSHA requirement based on 1910.132(d) that requires the employer to identify the electrical hazard and provide PPE. This section further requires that the workplace hazard (arc flash) be documented and certified [1910.132(d)(2)].
2. Provide written guideline covering the:
  - a. Glove Program
  - b. Electrical drawings and arc flash engineering study updates when projects with electrical parts are planned, executed, and completed
  - c. Demonstration of skills to determine Qualified Electrical Worker
3. Ground Grid assessment and test

A follow up audit should be performed in 2019 at the Maintenance Department at ABC COMPANY.

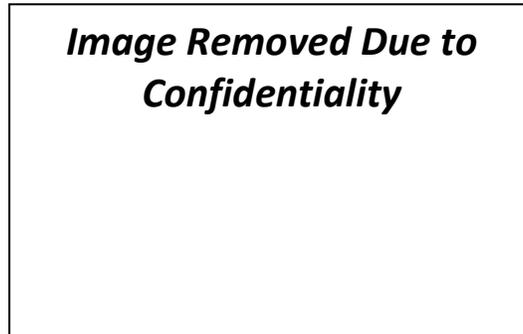
Audit report compiled by:

### Zarheer Jooma

Electrical Engineer Pr. Eng. SMIEEE SMSAIEE

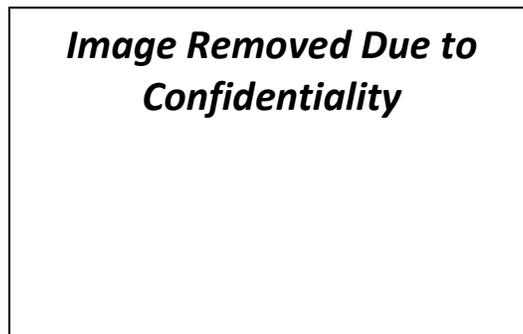
Zarheer@e-Hazard.com

## Appendix: Pictures from the Site Audit



**PICTURE 1: ARC FLASH LABELING INADEQUATE**

This picture shows the main breaker section labeled but the downstream sections are not labeled with the arc flash and shock risk assessment details. Generally, the downstream breakers will have a lower arc flash energy. It should also be noted that arc rated PPE above 55 cal/cm<sup>2</sup> is available, however, the existing labels indicated "No PPE Found".



**PICTURE 2: ARC FLASH LABELING OUT OF DATE**

This picture shows the arc flash study was performed in 2012. The plant indicated that no study has been performed since. This violates the NFPA 70E<sup>®</sup> - 2018 five-year review cycle of the arc flash hazard analysis.

***Image Removed Due to Confidentiality***

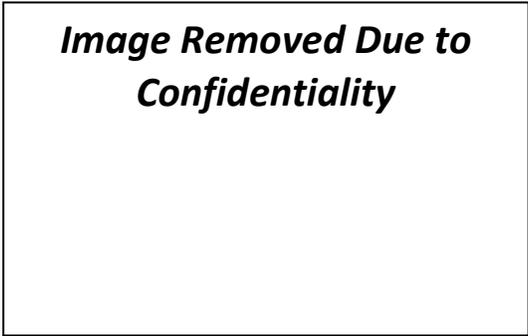
**PICTURE 3: PANEL DOOR LEFT AJAR**

Panel doors should be closed to prevent unnecessary hazard exposure to personnel and ensure the dust ingress of the panel.

***Images Removed Due to Confidentiality***

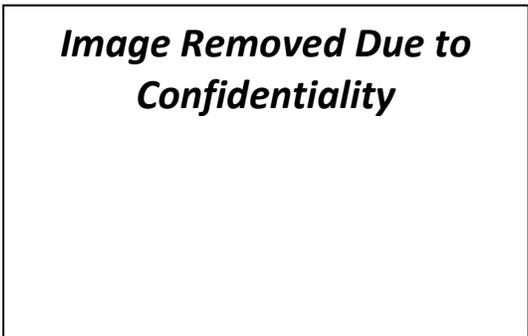
**PICTURE 4: STORAGE AROUND ELECTRICAL PANELS**

Several examples of storage or items located within 36 inches of electrical equipment which is prohibited by OSHA and the NFPA 70E® - 2018.



**PICTURE 5: PANEL CLEARANCES**

Panel clearances not maintained in line with the NEC, OSHA, and the NFPA 70E® - 2018 requirements.



**PICTURE 6: INCORRECT LABELING**

A panel rated at 12.47kV is labelled as 480V.

***Image Removed Due to Confidentiality***

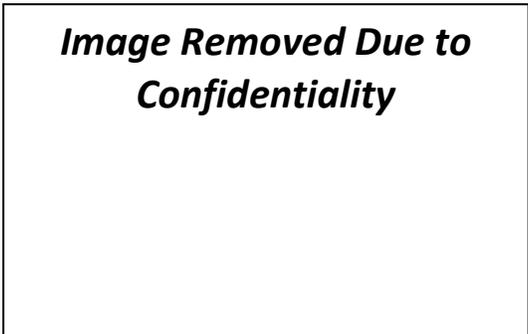
**PICTURE 7: BARRICADING**

Good practice of barricading.

***Image Removed Due to Confidentiality***

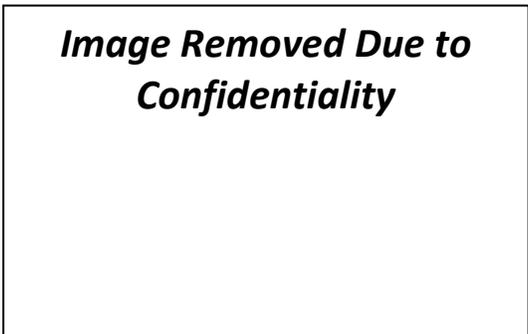
**PICTURE 8: PANEL OPENINGS**

All opening on panels and motor control centers must be covered. This is an NEC requirement.



**PICTURE 9: PANEL LABEL ATTACHMENTS**

Plant inspections should identify labels that are peeling off and replace with engraved labels.



**PICTURE 10: HAND WRITTEN PANEL LABELS**

Hand written panel labels are prohibited by the NEC.

***Image Removed Due to Confidentiality***

**PICTURE 11: TRANSFORMER LABELS**

The red labels on the electrical panels are commendable. It is not required that transformers be labeled due to the dual hazard differing at each of the windings.

***Image Removed Due to Confidentiality***

**PICTURE 12: VOLTAGE INDICATION LAMPS**

Voltage indication lamps have failed indicating a false absence of voltage. It is recommended that these be replaced with multiple LEDs for each phase.

***Image Removed Due to  
Confidentiality***

Picture 13: No arc flash and shock labels

Several panels and disconnects are found to not have the arc flash and shock risk assessment labels.