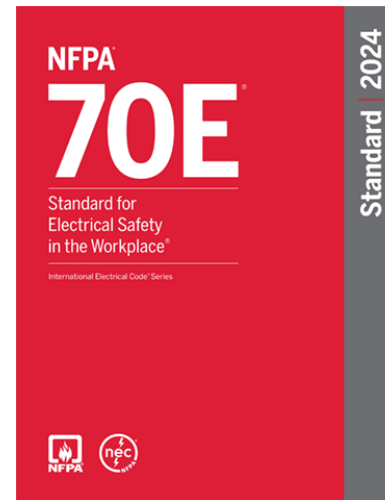




Electrical Equipment Maintenance & Electrical Safety in the Workplace: Integrating NFPA 70B & 70E Standards

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 **Zoubek Consulting, LLC**
Workplace Safety Solutions

Outline

- Background on codes & standards
- Highlight overlapping standard requirements
 - 5 steps for electrical PM & safety program implementation
- Additional information & guidance
- Summary





Things are not always what they appear.

Background

Code vs. Standard



NFPA Technical Meeting 6/22/23 in Las Vegas

Background

Code vs. Standard

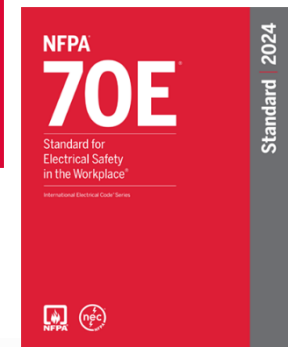
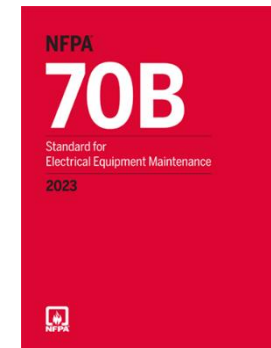
- **Code**

- Model
- Set of rules recommend for others to follow.
- Not a law but can be adopted into law.



- **Standard**

- Detailed elaboration.
- The nuts and bolts of meeting code requirements.



Background

- OSHA does not enforce NFPA standards.
- OSHA may use NFPA to support citations for violations.
- Example: Requirements for personal protective equipment found in OSHA Regs.

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Subchapter 5. Electrical Safety Orders
Group 1. Low-Voltage Electrical Safety Orders
Article 3. Work Procedures

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§2320.2. Energized Equipment or Systems.

(a) Work shall not be performed on exposed energized parts of equipment or systems until the following conditions are met:

- (1) Responsible supervision has determined that the work is to be performed while the equipment or systems are energized.
- (2) Involved personnel have received instructions on the work techniques and hazards involved in working on energized equipment.
- (3) Suitable personal protective equipment and safeguards (i.e., approved insulated gloves or insulated tools) are provided and used.

EXCEPTION: The use of approved insulating gloves or insulated tools or other protective measures are not required when working on exposed parts of equipment or systems energized at less than 50 volts provided a conclusive determination has been made prior to the start of work by a qualified person that there will be no employee exposure to electrical shock, electrical burns, explosion or hazards due to electric arcs.

(A) Rubber insulating gloves shall meet the provisions of the American Society for Testing Materials (ASTM) D120-09, Standard Specification for Rubber Insulating Gloves, and be maintained in accordance with ASTM F496-08, Standard Specification for In-Service Care of Insulating Gloves and Sleeves, which are hereby incorporated by reference.

NOTE: The ASTM F 496-08 standard contains provisions regarding the care, inspection, testing and use of insulating gloves and sleeves. Among other requirements, this standard provides that electrical tests shall not exceed 6 months for insulating gloves and 12 months for insulating sleeves and that insulating gloves and sleeves that have been electrically tested but not issued for service shall not be placed into service unless they have been electrically tested within the previous twelve months.

(B) Insulated tools shall meet the provisions of the American Society for Testing Materials (ASTM) F 1505-01, Standard Specification for Insulated and Insulating Hand Tools, which is hereby incorporated by reference.

(4) Approved insulated gloves shall be worn for voltages in excess of 250 volts to ground.

(5) Suitable barriers or approved insulating material shall be provided and used to prevent accidental contact with energized parts.

(6) Suitable eye protection has been provided and is used.

(7) Where required for personnel protection, suitable barricades, tags, or signs are in place.

(8) Each employee who is exposed to the hazards of flames or electric arcs wears apparel that, when exposed to flames or electric arcs, does not increase the extent of injury that would be sustained by the employee. This subsection prohibits clothing made from the following types of fabrics, either alone or in blends, unless the employer can demonstrate that the fabric has been treated with flame retardant: acetate, nylon, polyester, and rayon.

NOTE: to subsection (a)(8): See Section 2320.11 for protection from flames and electric arcs that apply to power generation, transmission and distribution.

(b) Making Connections. The employer shall ensure that employees make connections as follows:

- (1) In connecting deenergized equipment or lines to an energized circuit by means of a conducting wire or device, an employee shall first attach the wire to the deenergized part.
- (2) When disconnecting equipment or lines from an energized circuit by means of a conducting wire or device, an employee shall remove the source end first; and
- (3) When lines or equipment are connected to or disconnected from energized circuits, an employee shall keep loose conductors away from exposed energized parts.

(c) After the required work on an energized system or equipment has been completed, an authorized person shall be responsible for:

- (1) Removing from the work area any temporary personnel protective equipment, and
- (2) Reinstalling all permanent barriers or covers.

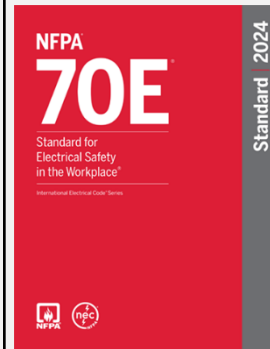
(d) Minimum Approach Distance. The employer shall ensure that no employee takes a conductive object closer to exposed energized parts than the established minimum approach distances unless:

Background



Standard for Electrical Equipment Maintenance

Electrical preventive maintenance
programs



Standard for Electrical Safety in the Workplace

Safe work practices when working
on electrical systems

1

Maintenance Programs

- NFPA 70B lists requirements for elements of an electrical maintenance program.
- NFPA 70B, Article 4.2



Standard Requirements

Program Requirements

	Article 4.2		Chapter 1, Article 110.3
Responsible personnel.			
Survey of electrical equipment for maintenance requirements and priorities.		Risk Assessment & Job Planning.	
Maintenance procedures & plan of servicing.		Maintenance of equipment.	
Plan of inspections, servicing, and suitable tests.		Equipment inspection.	
Process to implement & document corrective measures.		Procedures.	

Standard Requirements

2

**Equipment
Condition**

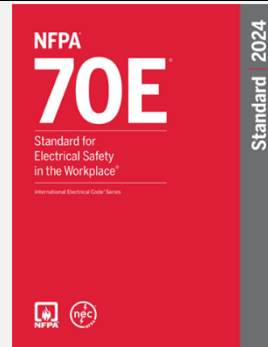
- NFPA 70B requires an equipment condition assessment.
- Determined by the equipment owner or their designee.
- NFPA 70B, Chapter 9.3

**Normal vs. Abnormal
Operating Condition**

Standard Requirements



Article 9.3: Equipment Condition Assessment



NFPA 70E, Chapter 1, Article 110.4(A)-(C)

Visual Inspection

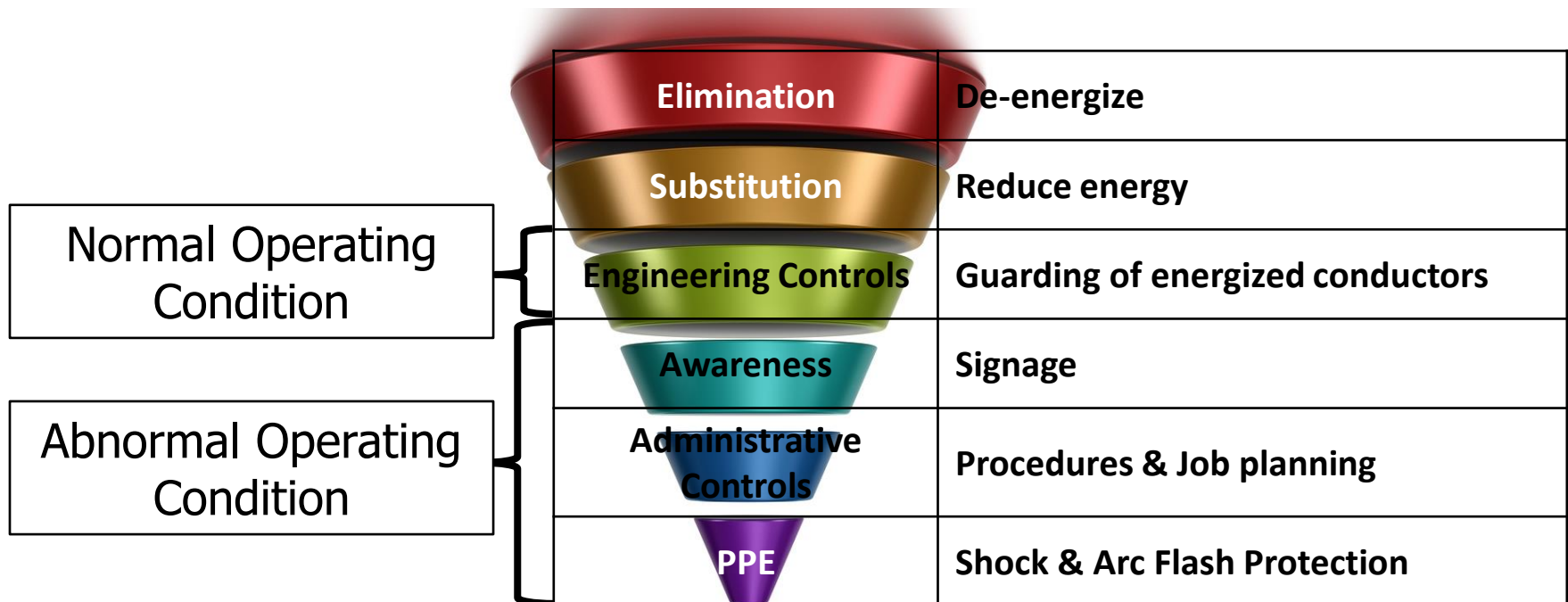
Mechanical Inspection

Electrical Testing

Defines normal operating condition.

- Equipment is properly installed.
- Equipment is properly maintained.
- Equipment is used in accordance with instructions included in list and labeling.
- Equipment doors are closed and secure.
- Equipment covers are secure and in place.
- No evidence of failure.

Standard Requirements



Standard Requirements



3

Field Testing

- Field testing shall be conducted to assess the overall *condition of electrical equipment*.
- NFPA 70B, Chapter 8
- Type of test depends on electrical equipment.

Standard Requirements

- Field tests are outlined according to equipment type.

Table 13.3.5 Panelboard and Switchboard Electrical Testing

No.	Task	Test Type*
1	Check electrical hardware connections	NA
2	Measure insulation resistance of the main bus	2
3	Measure insulation resistance of control wiring	2A
4	Test protective devices and systems	2
5	Perform system operational tests	1 or 2
6	Test control power transformers, instrument transformers, and metering to ensure correct operation	2
7	For individual components, refer to the appropriate chapter(s) of this standard	NA
8	Where environmental controls are provided, check for correct operating condition	1 or 2



Example: Panelboards (configuration for circuit breakers) are one of the most common types of electrical equipment

Standard Requirements

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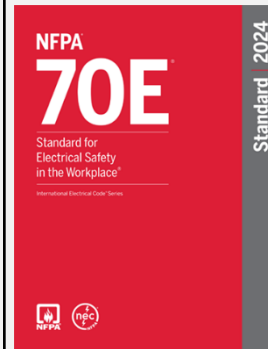
Some testing operations may need to be performed with equipment energized.



Background



Article 8.3 Chapter 10-38 (Specific Equipment)



**Article 110.5(I)
Article 110.5(H)(1)
Article 130.5
Article 130.4
Article 130.7
Article 110.6(A)(1))
Article 120
Article 110.6(A)(1)(e)
Article 110.8(A)**

1 – Online standard test
1A – Online enhanced test
2 – Offline standard test
2A – Offline enhanced test

Job Safety Planning & Job Briefing Risk
Assessment Procedure
Arc Flash Boundaries
Shock Boundaries
PPE
Training
Lockout/Tagout
Test Instruments

Standard Requirements

4

Maintenance Intervals

- NFPA 70B provides maintenance intervals by equipment type and condition.
- NFPA 70B, Article 9.2



Example: Panelboards

Standard Requirements

Scope of Work (Panelboard Example)

	Article/Table 9.2.2		Article 120 (LOTO) Chapter 1 (Safety Related Work Practices)
Visual inspection	May or may not be done energized.		
Cleaning	Done de-energized.		
Lubrication	Done de-energized.		
Mechanical inspections	May be energized or de-energized.		
Electrical testing	Done Energized.		

Standard Requirements

Scope of Work (All Equipment Example)



Article/Table 9.2.2



Table 130.5(C)

IR Thermography

Done Energized.





Standard Requirements

Estimate of Likelihood of Occurrence of Arc Flash NFPA 70E-Table 130.5(C), page 27

TASK	Equipment Condition	Likelihood of Occurrence of arc flash
Opening of hinged doors or covers or removal of bolted covers to exposed electrical conductors.	<i>Any</i>	<i>Yes</i>



Applicable Standards

Job Safety Planning & Job Briefing (**NFPA 70E-Article 110.5(I)**)
 Risk Assessment Procedure (**NFPA 70E-Article 110.5(H)(1)**)
 Arc Flash Boundaries (**NFPA 70E, Article 130.5**)
 Shock Boundaries (**NFPA 70E, Article 130.4**)
 PPE (**NFPA 70E, Article 130.7**)
 Training (**NFPA 70E-Article 110.6(A)(1)**)



Standard Requirements

Frequency of maintenance is based on condition of equipment (panelboard example).

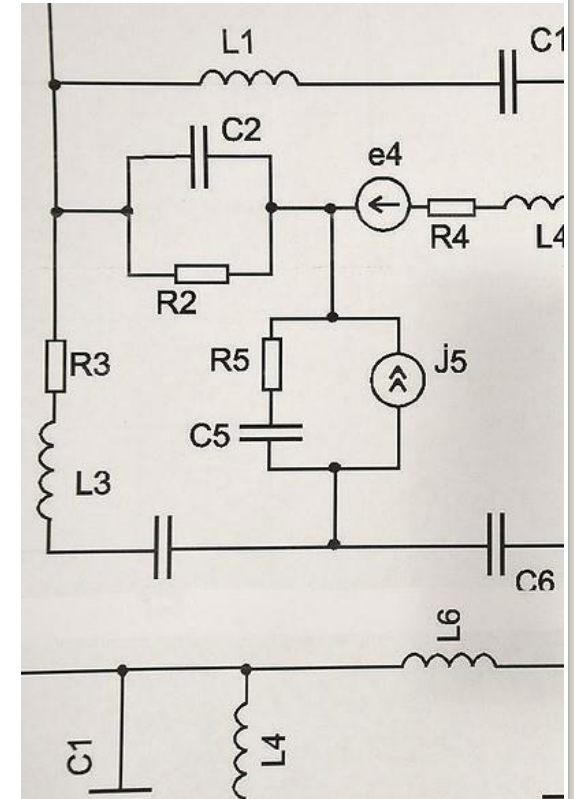
Condition	Assessment Results	Maintenance Frequency
1	Maintained at required intervals.	60 months
2	Previous maintenance cycle revealed issues requiring the repair or replacement of major equipment components.	36 months
3	Equipment has missed the last two successive maintenance cycles.	12 months

5

System Study Intervals

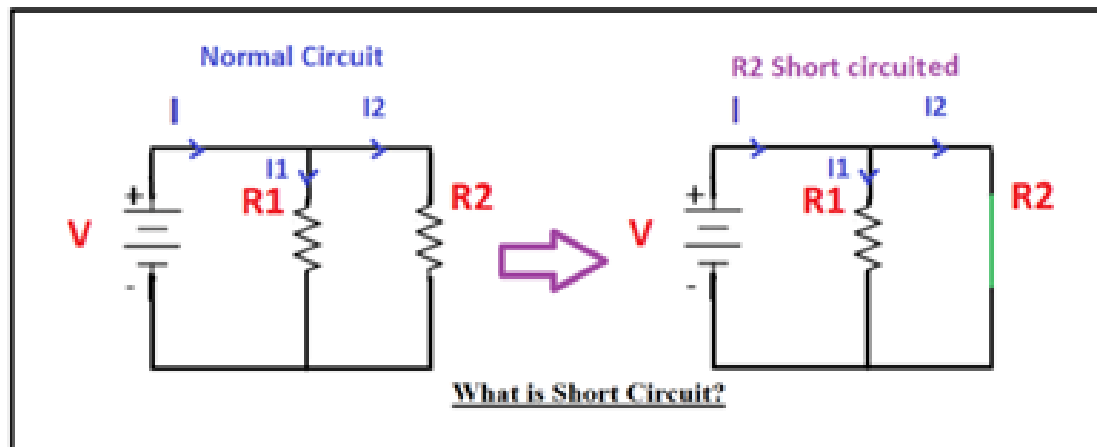
Standard Requirements

- NFPA 70B Chapter 6 provides
 - Detailed requirements for system studies,
 - Include up-to-date single-line diagrams and short-circuit studies.



Standard Requirements

- Section 6.3 – Short-circuit studies
 - Determine the available short circuit current at each point in the system.



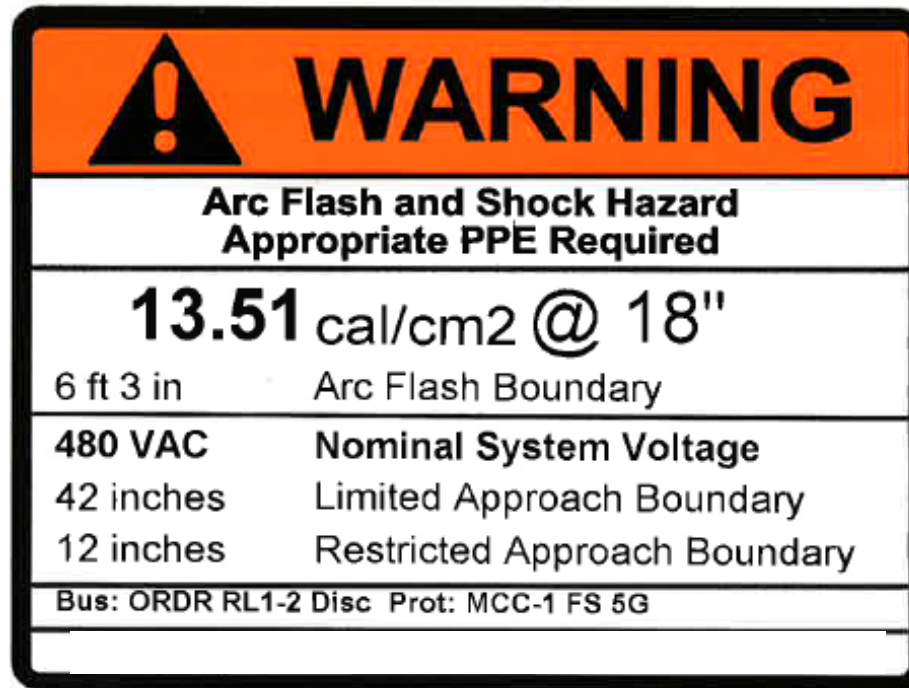
Standard Requirements

- Section 6.4 – Coordination studies
 - Evaluation of faults in an electrical system/analysis of circuit interrupting devices to ensure functionality.
 - e.g.: Is a circuit breaker used as a light switch?



Standard Requirements

- Section 6.7 – Incident Energy Analyses
 - Determine the risk of an arc flash and the distance of the arc flash boundary.



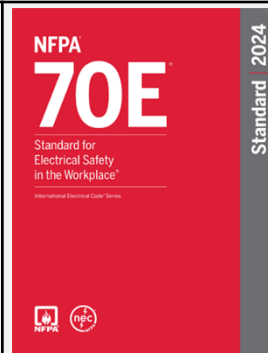
Standard Requirements

System Study Intervals



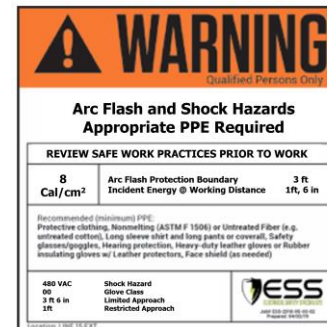
Article 6.3, 6.4, 6.7

- Short-circuit studies
- Coordination studies
- Incident Energy Analyses



Article 130.5(E)(1) Article 130.5(F) Article 130.5(G)/(H)

Requires incident energy analysis be performed for administrative and PPE controls.



Performed every 5-years

Additional Information/Guidance

Guidance on Equipment Maintenance*

	Chapter 10-38*		Chapter 2-3*
Hazardous Locations Panelboards & Switchboards Circuit Breakers Ground Fault Protection Systems Motor Control Equipment Photovoltaic Systems		Safety Related Maintenance Requirements Special Equipment	

***Not intended to supersede manufacturer instructions for equipment maintenance**

Summary

Step	Action		
1	Establish Maintenance Program	Overall Electrical Safety Program	
2	Determine Equipment Condition	Normal vs. Abnormal Condition	
3	Perform Field Testing	Based on equipment with worker safety	
4	Determine Maintenance Intervals		
5	Implement System Study Intervals	Studies every 5 years	

Business Case for Safety

An effective electrical safety program, along with an electrical maintenance program, will lead to

- Higher reliability
- Longer life of equipment
- Lower cost