

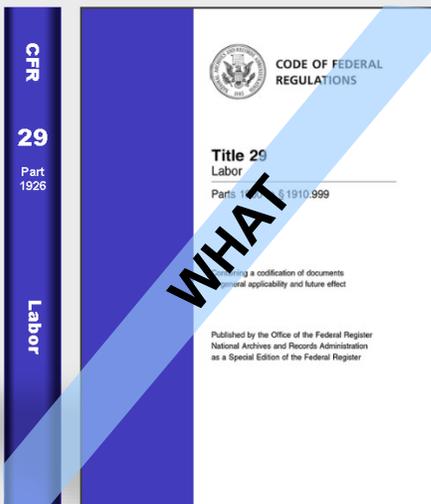


# Building an Electrical Maintenance Program

**e-Hazard**

*Based on NFPA 70B  
Derek Vigstol  
E-Hazard Management, LLC*

# Applicable Regulations and Standards for Electrical Industry



## OSHA (CFR 1910.)

### SUBPART

|          |                                   |                         |   |
|----------|-----------------------------------|-------------------------|---|
| <b>I</b> | 132-140                           | PPE                     | } <i>General Industry</i>               |
| <b>S</b> | 301-399                           | Electrical              |   |
| <b>R</b> | 261-272<br><i>Special Indust.</i> | 269 Electric Power GT&D | } <i>Utilities / Like Installations</i> |

- Enforceable as law
- Performance-based language
- Not updated on a regular basis

### Support Standards

- NETA MTS
- ANSI
- ASTM
- IEC

### Comparable Canadian Standards

- OH&S
- CSA: Z462, CEC, Z463



## National Electrical Code (NFPA 70 – NEC)

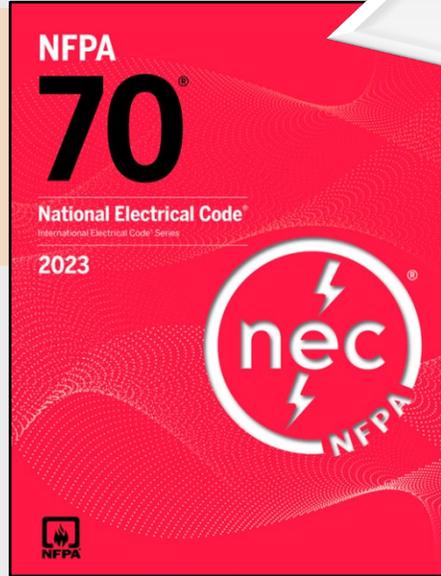
NFPA 70E

### NFPA 70B

- Specifies maintenance assessment and requirements
- Updated on 3-year cycle

# NFPA's Electrical Safety Ecosystem

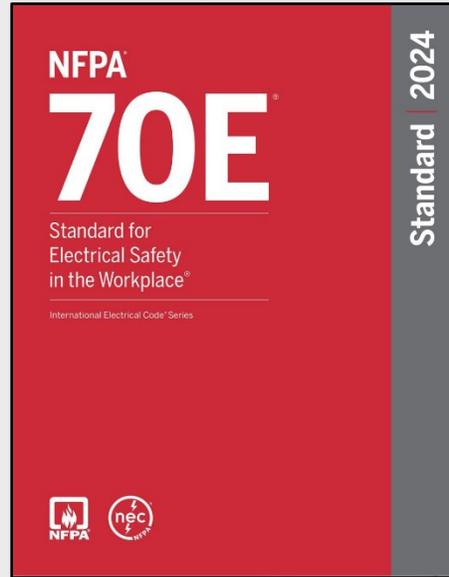
HOW



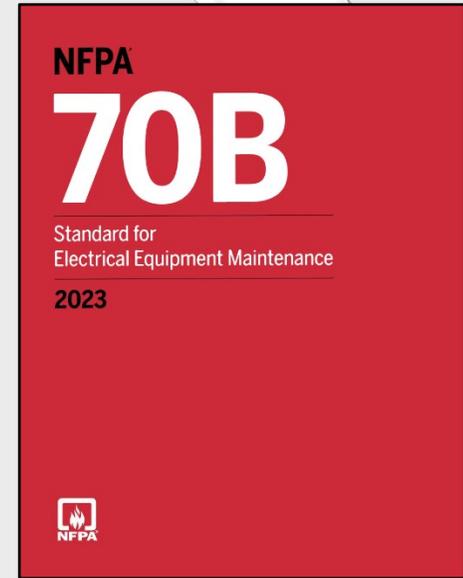
**BUILD** it safely

*Upgrade/replace*  
latest NEC applies

*Maintain/repair*  
latest 70E applies



**WORK** on it safely



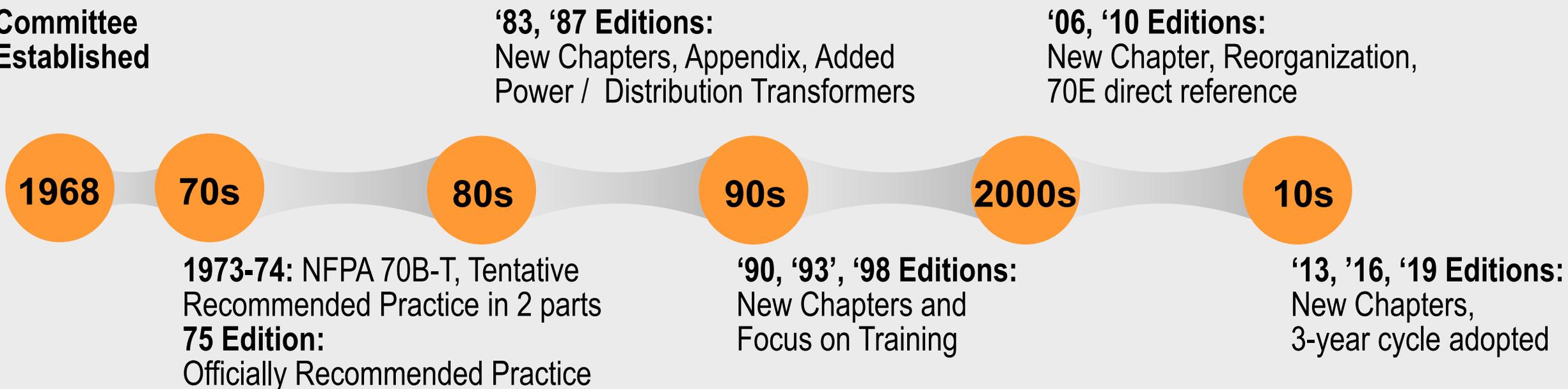
**MAINTAIN** it properly



# NFPA 70B Evolution

- NEC requests for maintenance
- Recommended practice for electrical equipment maintenance
- Existed in a space that is 100% optional
- Was not ready for primetime

Committee  
Established



# Practical Compliance Strategies



## Industry Consensus Standard

HOW



Requires equipment owner to have **Electrical Maintenance Program (EMP)**

Provides current guidance for companies to develop best work practice policies

HOW

Company Policies

ABC Facility

**Electrical Maintenance Program**

(Documented)

**(EMP)**

- Verify inspection and compliance
- Consider condition of maintenance
- Identify principles (specific elements)
- Identify controls by which it is measured and monitored
- Include method for capturing all relevant reports and feedback
- Require audits of EMP
- Work in conjunction with *Electrical Safety Program*

## EMP Key Elements



- Alignment with ESP for considering condition of maintenance
- Identified personnel responsible for implementing each element
- Survey and analysis of electrical equipment and systems to determine maintenance requirements and priorities
- Developed /documented maintenance procedures for equipment
- Plan for inspecting, servicing, and testing
- Policy for documentation/records retention for maintenance, equipment and personnel
- Process to prescribe, implement and document corrective measures
- Process for incorporating design for maintainability in electrical installations
- Continuous review/revision process
  - Incorporates all reports/feedback from failures, incidents, malfunctions, unintended operations or alarms and operation of protective devices



# Getting Started

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# EMP Coordinator

*The individual responsible for coordinating the implementation and operation of the EMP. –NFPA 70B 3.3.18*



- Develops and implements the Electrical Maintenance Program
- Determines scope of work and develops maintenance plan
- Performs EMP audits and reviews of system studies
- Ensures maintenance personnel are qualified to perform tasks

# Performing Maintenance Assessment

## **Assessment shall include the following elements:**

- Physical condition of equipment
- Periodic testing and inspection results
- Maintenance history and indications
- Operating environment and load conditions
- Predictive maintenance indicators
- Continuous monitoring data, if available

## Physical Condition

### CONDITION

|   |   |
|---|---|
| 1 | <ul style="list-style-type: none"><li>• Appears in like new condition</li><li>• Enclosure is clean, dry, and tight</li><li>• No notifications or unaddressed issues</li><li>• Previous maintenance in accordance with EMP</li></ul> |
| 2 | <ul style="list-style-type: none"><li>• Deviation from previous results indicate higher frequency</li><li>• Active recommendations or notifications</li></ul>   |
| 3 | <ul style="list-style-type: none"><li>• Missed two previous cycles</li><li>• Urgent actions required</li></ul>  |

### Non-Serviceable Equipment



# Criticality Condition

## CONDITION

|   |  |
|---|--|
| 1 | } Can be assigned if failure will not endanger personnel |
| 2 |  |
| 3 | Must be applied if failure can cause injury to workers   |



# Operating Environment Condition

## CONDITION

|   |  |
|---|--|
| 1 | Can be assigned if the equipment is rated for the environment in which it's installed <ul style="list-style-type: none"><li>• NEMA 4 enclosure where subject to hose down conditions</li></ul> |
| 2 |  |
| 3 | Must be assigned when equipment is in a harsh environment for which it's <u>not</u> rated  |



# Maintenance Intervals: Additional Information

## Types of *Scope of Work* Specified

- Infrared thermography
- **Visual inspection**
- **Cleaning**
- **Lubrication**
- **Mechanical servicing**
- **Electrical testing**
- Special
- Mechanical checks
- Special procedures

*Example:*

| Product | Scope of Work        | Condition 1 | Condition 2 | Condition 3 |
|---------|----------------------|-------------|-------------|-------------|
| Fuses   | Visual inspection    | 60 months   | 36 months   | 12 months   |
|         | Cleaning             | 60 months   | 36 months   | 12 months   |
|         | Lubrication          | 60 months   | 36 months   | 12 months   |
|         | Mechanical servicing | 60 months   | 36 months   | 12 months   |
|         | Electrical testing   | 60 months   | 36 months   | 12 months   |

*Most Common Scopes and Intervals  
(+70% of Table)*

## Range of Intervals

- Before each use
- 1, 3, 4, 6, **12**, 24, **36**, or **60** months
- In accordance with manufacturer's instructions

## Modifications to Maintenance Frequency

- Manufacturer's recommendations
- NFPA 70B is not intended to duplicate or supersede manufacturer's instructions
- Chapter 9 frequency intervals apply in the absence of guidance from the manufacturer
- EMP must incorporate maintenance requirements and recommendations from manufacturer

## Modifications to Maintenance Frequency

### Previous test results

- Table 9.2.2 adherence for minimum of 2 cycles
- If failures experienced, reduce intervals of maintenance
  - Perform 2 cycles at reduced interval
  - If no additional failures, resume original intervals
- If no issues after 2 maintenance cycles, intervals permitted to exceed those in Table 9.2.2



# Indication of Condition of Maintenance

| <b>Serviceable</b>  | <b>Limited Service</b>   | <b>Non-Serviceable</b>  |
|---|--|---|
| Passes all tests and is electrically and mechanically sound | Has problems but not detrimental to protective operation or design characteristics | Problems are detrimental to electrical or mechanical operation of equipment |
| <b>SERVICEABLE</b><br>Date: _____<br>By: _____              | <b>LIMITED SERVICE</b><br>Date: _____<br>By: _____                                 | <b>NON-SERVICEABLE</b><br>Date: _____<br>By: _____                          |

Example Condition of Maintenance Test Decals

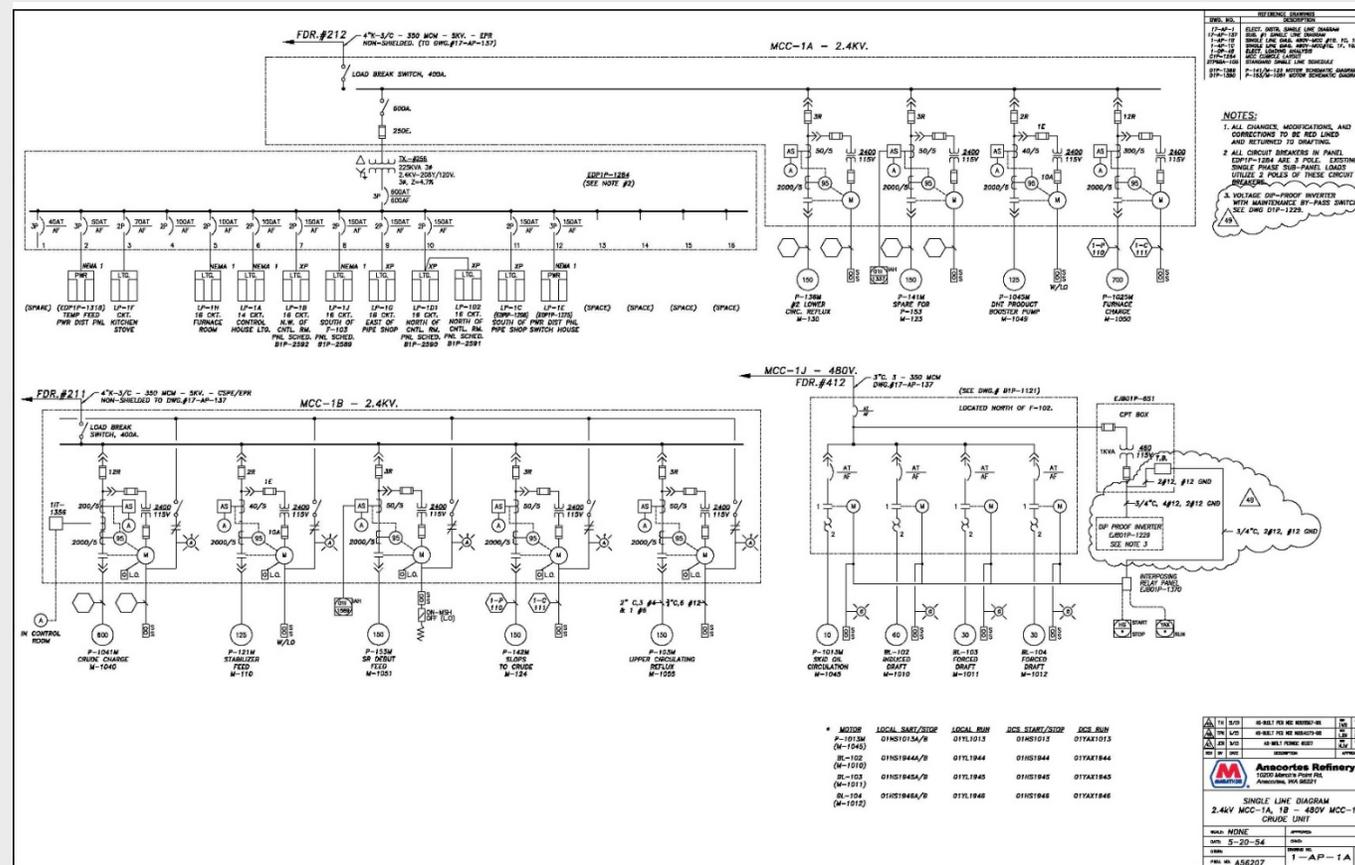


# Equipment Documentation

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# One-Line Diagrams

- Needed info about the electrical system
- Helps identify sources of power
- Must be kept in legible condition
- Must be accurate
- Include the last revision date





# System Studies

- Short-circuit study to support arc flash study and equipment evaluations
- Coordination study to support risk assessment and design goals
- Load-flow and Reliability studies as needed
- Kept accurate and updated every 5 years
- Available to EMP Coordinator



# Incident Energy Analysis

## Arc Flash Study

- Incident Energy (IE) at the working distance
- Arc Flash Boundary
- Reviewed every 5 years for accuracy
- Most recent study must be available to EMP coordinator



### Arc Flash and Shock Hazards

1.28 cal/cm<sup>2</sup> @18 in

|   |                                    |
|---|------------------------------------|
| 19 in   | Arc Flash Hazard Boundry           |
| 240 VAC                                       | Shock Hazard when cover is removed |
| 42 in   | Limited Approach Boundary          |
| 12 in   | Restricted Approach Boundary       |
| Glove Class                                   | 00                                 |
| PPE Level 1                                   | Minimum 4 cal/cm <sup>2</sup>      |
| Arc-rated shirt & pants or arc-rated coverall |                                    |

Equipment: PANEL LPG MAIN BREAKER

Fed From: PNL-HE BRK 25

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03 July 2021

**Must maintain both the study *and* equipment labels**



# Personnel Qualifications

# Think About It

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**What Makes a Person  
Qualified?**



## What Makes a Person Qualified...

NFPA 70E defines it as a two-part process:

“One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk.”

*NFPA 70E, Article 100, pg. 13*

A person may be “task qualified” – qualified to perform a certain task or qualified to maintain certain equipment – but not others.

**Only the employer can determine if someone is qualified.**

*NFPA 70E 110.4(A)(1)(b) and (f)*

## Qualified Maintenance Personnel Training:

- Specific maintenance tasks, test methods, and test equipment
- Applicable electrical policies and procedures
- Proper use of PPE, including arc flash, insulating, and shielding materials
- Proper use of insulating tools and test equipment
- Trained in specific hazards associated with equipment being serviced
- Determine nominal voltage



## Qualified Maintenance Personnel



A person 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 demonstrates 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.

# Maintenance Personnel Supervision

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## Annually evaluate all qualified maintenance personnel

Observations do the following:

- Document proficiency
- Prove procedures work
- Identify:
  - Procedures that don't work
  - Changes that should be made
  - Retraining needs



# Additional Training Required

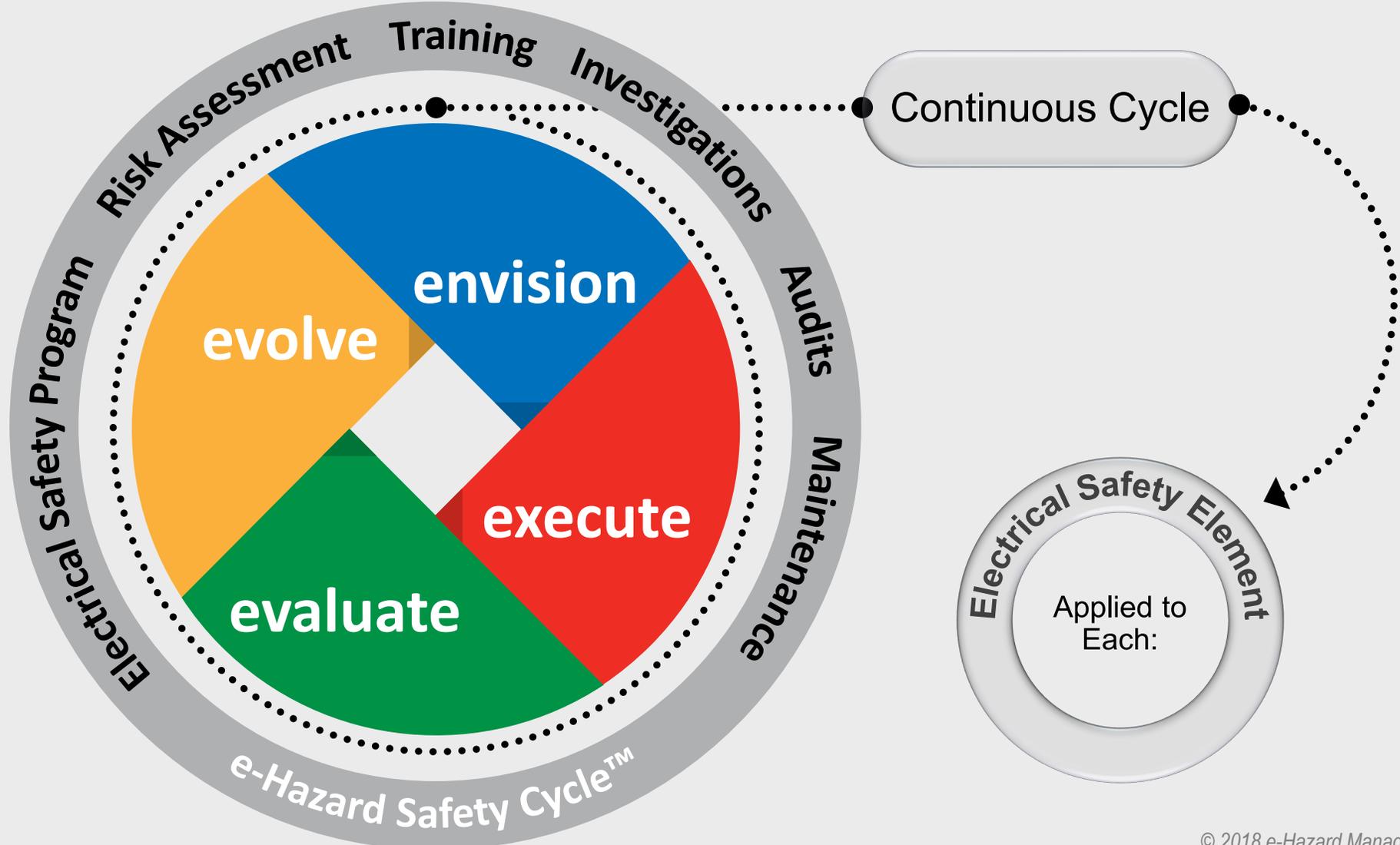
Retraining if new edition is adopted



## Retraining also required:

- Review tasks performed less than once per year or not in regular job duties
- Supervision or annual inspection indicates non-compliance with maintenance procedures
- New technology, new equipment, or changes in procedures
- Job duties change

# Electrical Safety: A Comprehensive Approach



# Questions? Want More Information

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