Implementing an Energized Electrical Work Program

SESHA Hill Country Chapter

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Brett Jay Davis, PE

Zephyr Environmental Corporation

bdavis@zephyrenv.com, 512 879-6628

Presentation Outline

1. Codes and Regulations
2. Terms and Definitions
3. Relevant Comments
4. OSHA Letter of Interpretation
5. Survey Results
6. Industry Best Practice
7. Decision Tree for Energized Electrical Work
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Codes and Regulations

- OSHA General Industry: 29 CFR 1910 Subpart S - Electrical
- OSHA Construction: 29 CFR 1926 Subpart K - Electrical
- NFPA 70E – Standard for Electrical Safety in the Workplace

Definitions

Arc Flash Hazard Analysis - Determines worker's potential exposure to arc-flash energy, to determine safe work practices, arc flash protection boundary, and the appropriate levels of PPE. (NFPA 70E)

Arc Flash Protection Boundary –Boundary designed to protect against arc flash hazards, established by an arc flash hazard analysis or as prescribed in NFPA 70E

Construction – "Construction, alteration, and/or repair, including painting and decorating." (29 CFR 1926.32(g) and 29 CFR 1910.12(b)). Can include the repair of existing facilities or the replacement of structures and their components.

Continuous Industrial Process - Used in the context of situations where the orderly shut down of integrated processes and equipment would introduce additional or increased hazards. (Per OSHA)

De-energized - Free from any electrical connection to a source of potential difference and from electrical charge. (NFPA 70E)

Energized - Electrically connected to, or is a source of, voltage. (NFPA 70E)

Infeasible - In the context of energized electrical work, tasks not capable of being performed in a de-energized state. As used by NPFA and OSHA, considerations such as cost or convenience are not relevant. Applies to equipment operational limitations and is generally intended to apply to testing and troubleshooting

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Definitions

Maintenance - Making or keeping a structure, fixture or foundation in proper condition in a routine fashion. This definition implies "keeping equipment working in its existing state".

Shock Hazard Analysis - Determines the voltage to which personnel will be exposed, boundary requirements, and PPE to minimize the possibility of electric shock to personnel. (NFPA 70E)

Shock Protection Boundaries – One of three (limited, prohibited and restricted) boundaries for protection from shock hazards due to energized electrical work. Distances in NFPA 70E Table 130.2(C) Approach Boundaries to Live Parts for Shock Protection.

Testing and Troubleshooting – Typically includes taking voltage measurement, taking current measurement, phase rotation or phase comparison testing, motor starter troubleshooting.

Working Near (live parts) - Any activity inside a Limited Approach Boundary. (NFPA 70E)

Working On (live parts) - Coming in contact with live parts with body parts, tools, probes, or test equipment, regardless of PPE. Includes:

Diagnostic (testing) – Taking readings or measurements of electrical equipment with approved test equipment without physical change to the equipment.

Repair – Any physical alteration of electrical equipment such as making or tightening connections, removing or replacing components, etc. (NFPA 70E)

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OSHA Letter of Interpretation

Date: December 16, 2006
From: OSHA Directorate of Enforcement Programs
To: Fairchild Semiconductor International

Scenario: We have ten pieces of manufacturing equipment fed out of a 480-volt three-phase panel. A new project requires that additional feeders and a 225-ampere circuit breaker be added to the panel to supply a new piece of equipment. To perform the work in a de-energized state, it requires the power to the panel must be disconnected and appropriate LOTO devices applied. This activity would result in the shutdown of the ten pieces of equipment, causing a significant interruption to our ability to manufacture integrated circuits.

Question: Is the panel considered part of a "continuous industrial process," thus allowing the work to be performed while the panel was energized using electrical safe work practices, as per Note 2 in §1910.333(a)(1)?

Response: It appears that your panel is not part of a "continuous industrial process." The term "continuous industrial process" was derived from its use in the National Electrical Code (NEC). In the NEC "continuous industrial process" is used in the context of situations where the orderly shut down of integrated processes and equipment would introduce additional or increased.

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Summary of Energized Electrical Work Survey

	Activities Other Than Testing and Troubleshooting						
Company Type	Written Justification	Written Procedures	Construction	Continuous Process	Work Permit	Arc Flash	Short Circuit
Electrical Contractor	Y	Y	Y	Y	Y	N	N
Computer Manufacturer	Y	-	N	N	Y	Y	Y
Polymer Chemical Company	Y	Y	N	N	Y	Y	Y
Automative Manufacturer	Only Troubleshooting						
Medical Systems Company	N	N	Y	Y	N	Y	Y
Semiconductor Manufacturer	Y Not MTM	Y Not MTM	Y	Y	Y	Y	Y
Semiconductor Manufacturer	Y	N	Y	Y	Y	Y	N
Semiconductor Manufacturer	Y	Y	Y	Y	Y	Y	Y
Semiconductor Manufacturer	N	N	Y	N	Y	Y	Y
Semiconductor Manufacturer	Y	Y	Y	N	Y	Y	N
Semiconductor Manufacturer	Y	N	Y	N	Y	Y	Y
Semiconductor Manufacturer	Y	Y	Y	Y	Y	Y	Y
Specialty Chemical Manufacturer	Y	Y	Y	Y	Y Not Breaker	Y	Y
Semiconductor Manufacturer	N	Y	Y	Y	Y	Y	Y
Semiconductor Manufacturer	Y	N	Y	Y	Y	Y	Y
Semiconductor Manufacturer	Y	Y	Y	Y	Y	N	Y
Semiconductor Equipment Manufacturer	Only Troubleshooting						
Semiconductor Manufacturer	N	Y	Y	N	Y	N	N

Two primary justifications: continuous industrial process and construction. Are both tenuous?

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Relevant Comments

- Chemical Manufacturer Safety: These issues addressed by electricians, not Safety Department
- Automotive Manufacturer: Energized removal and installation of plug-in breakers and bus plugs is standard industrial practice.
- Master Electrician: “I would not allow any "Hot" work in any panel”. He said he formed this opinion after several co-workers were burned due to arc flashes from 480 volt and higher systems.
- Member NFPA 70E Committee: Use of continuous process justifications is only valid if shut-down “poses additional hazards”
- Power Generator and Transmitter Safety : Do not perform energized electrical work, even on transmission system.
- Computer Manufacturer Safety: The risk and the consequences seem too great to not go to great lengths to avoid energized electrical work.
- Semiconductor Manufacturer Safety: Emergency alarm systems designed to protect life from the effects of fire and systems designed to protect life from the effects of toxic gases and vapors should be considered NFPA 101 Life Safety Systems (LSS)

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Energized Electrical Work

Proposed activities as *"Maintenance"*

a) Shutdown Is Infeasible
   1) Testing, Troubleshooting, IR Scanning, etc.
   2) Remove/Install Circuit Breaker – when shutdown coordination is not possible

b) De-Energizing Poses Additional Hazards
   1) Work on Life Safety Systems (LSS)
   2) Install New Uninterruptible Power Supply (UPS) Service

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Energized Electrical Work

Proposed activities as *“Construction”*

a) Route, Install and Terminate Raceway
b) Remove/install circuit breaker to panel board
c) Pulling/Inserting Switches
d) Jacking/Racking Motor Control Center (MCC) Bucket
e) Closed Tie-In Main-Tie-Main
f) Terminate Cable on Circuit Breaker
g) Demolition to Breaker
h) “Unique Situations”
i) Install Circuit Breaker in Process Tool
j) Install Process Tool

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NFPA 70E Recommendations for EEW

Industry Best Practices

- Select and use personnel protective equipment, per NFPA 70E table,
- Perform a shock analysis,
  - Establish shock protection boundaries,
  - Use signs and barricades and/or attendants
- Perform short circuit and arc flash hazard analysis
  - Establish a Flash Protection Boundary
- Issue an Energized Electrical Work Permit

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NFPA 70E Specifications for EEW Permit

Energized Electrical Work Permit* includes the following elements:

- Description and location of the circuit and equipment worked on
- Justification for performing in an energized condition
- Description of the safe work practices to be employed
- Results of the shock hazard analysis
- Determination of shock protection boundaries
- Results of the arc flash hazard analysis
- The Flash Protection Boundary
- Personal protective equipment needed to safely perform the assigned task
- Means of restricting access by unqualified persons
- Evidence of job briefing addressing job-specific hazards
- Energized work approval signature(s) (authorizing or responsible management, safety officer, or owner, etc.)

* Not required for testing and troubleshooting

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Protocol for *EEW* on Breakers

1. Obtain authorization through a Energized Electrical Work Permit,
2. Identify the two person team - attendant and person performing work
3. Obtain appropriate personal protective equipment (PPE) – per NFPA 70E table
   - The same PPE is worn by both members of team
4. Inspect the breaker to be installed for any mechanical flaws,
5. Insure that the breaker is switched to “off”
6. Establish Approach Boundaries and Arc Flash Boundary, per NFPA 70E
   - Demark limited approach boundary with appropriate barriers
7. Both team members don PPE
8. Attendant takes position outside of limited approach boundary
9. Person performing work does the following:
   a. Open the electrical panel doors
   b. Remove cover at location of breaker to be installed
   c. While holding breaker on the wire connector end, insert breaker into position, such that connectors contact bus bars,
   d. Use screwdriver to manually ratchet the breaker into place
   e. Pull wires from the top of the electrical panel alongside the new breaker
   f. Connect the wires to the breaker
   g. Switch the breaker to “on”
   h. Close the electrical panel doors
10. Remove the limited approach boundary barriers

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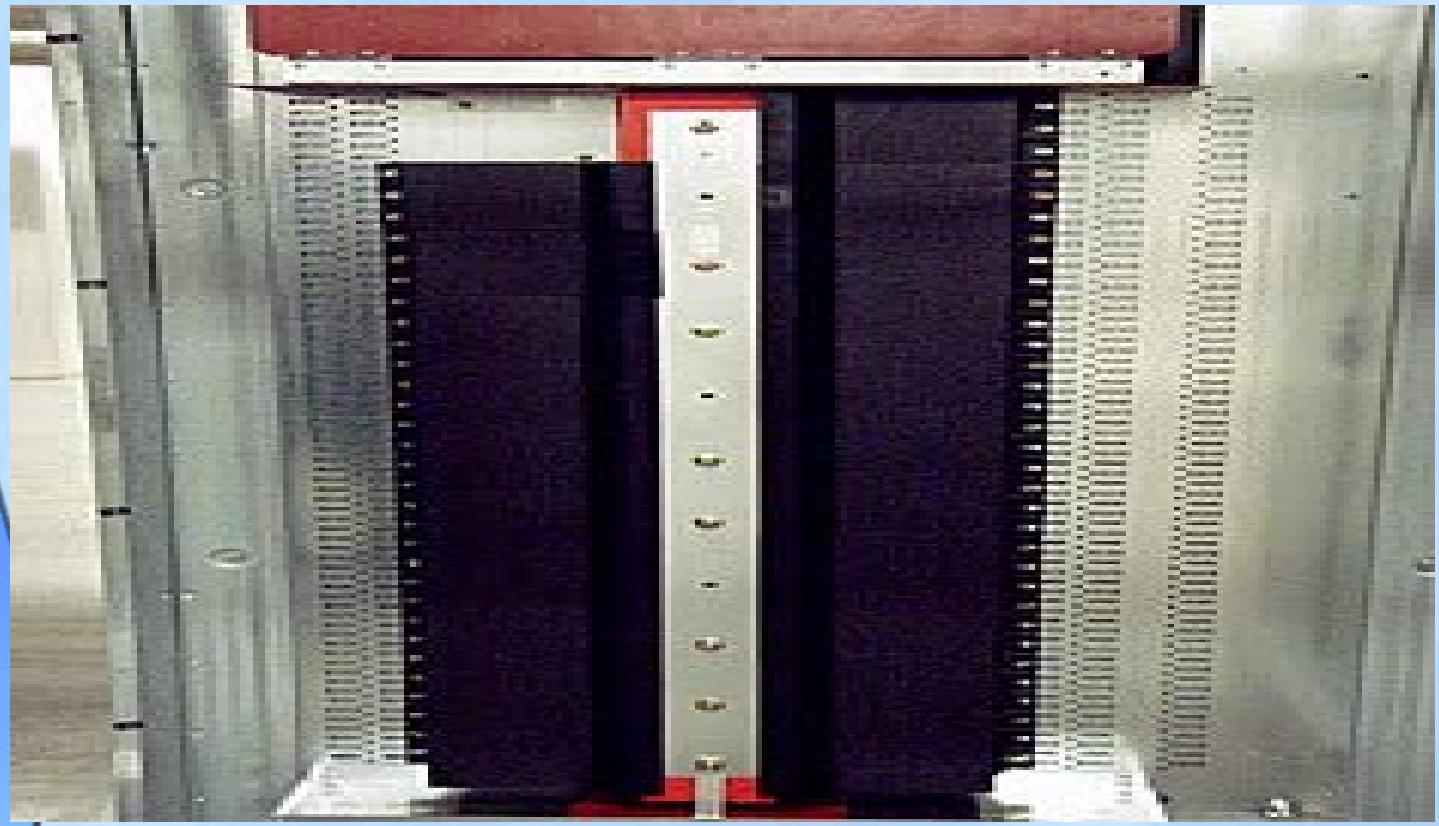
Circuit Breaker Installation Demo
Electrical Panel with Open Door



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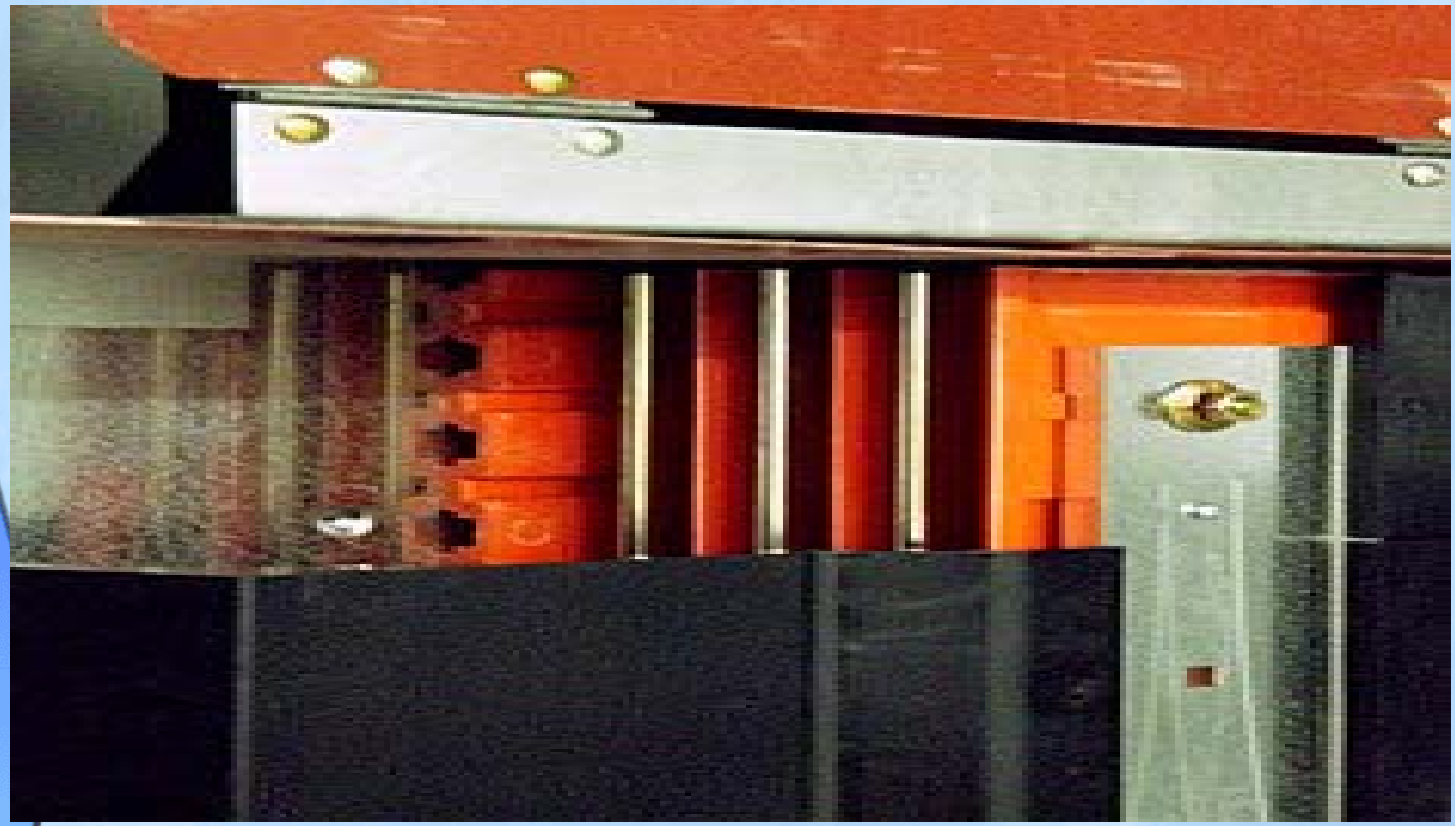
Circuit Breaker Installation Demo
3-Phase Bus Bar



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Circuit Breaker Installation Demo
Bus Bar Connectors

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Circuit Breaker Installation Demo
Breaker Wire Connectors

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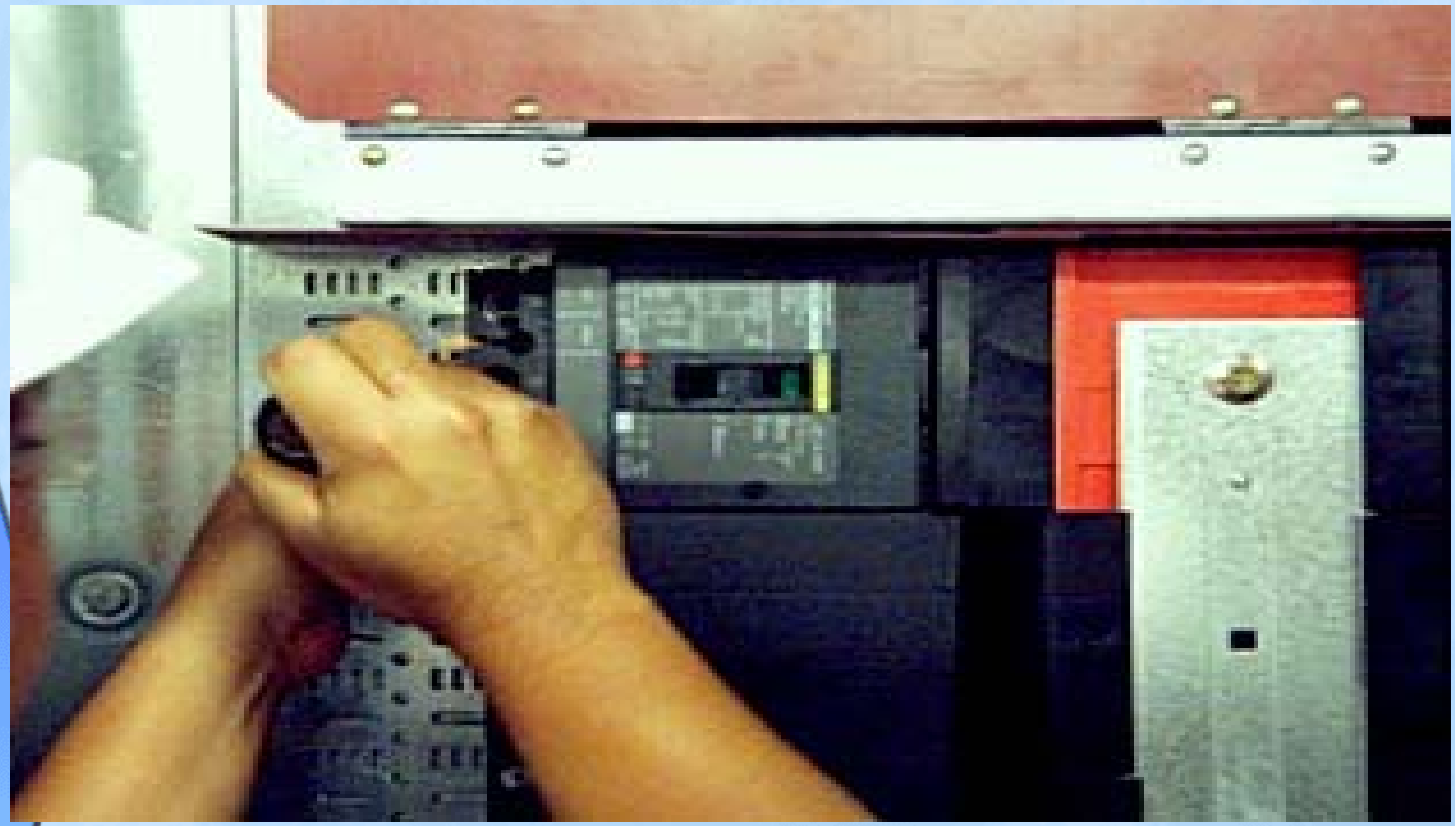
Circuit Breaker Installation Demo
Racking-In Breaker



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Circuit Breaker Installation Demo Example 1

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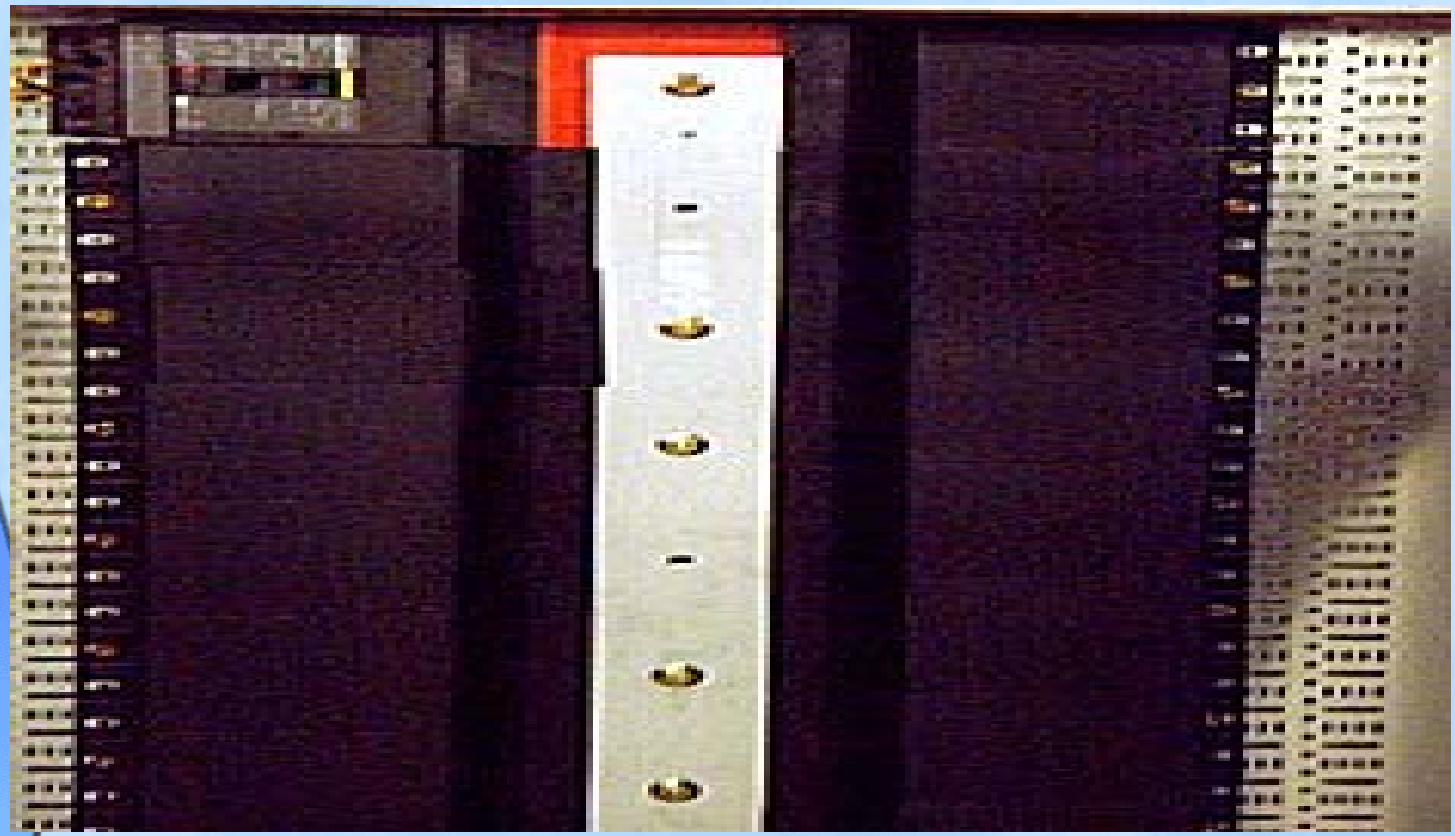
Circuit Breaker Installation Demo Example 2



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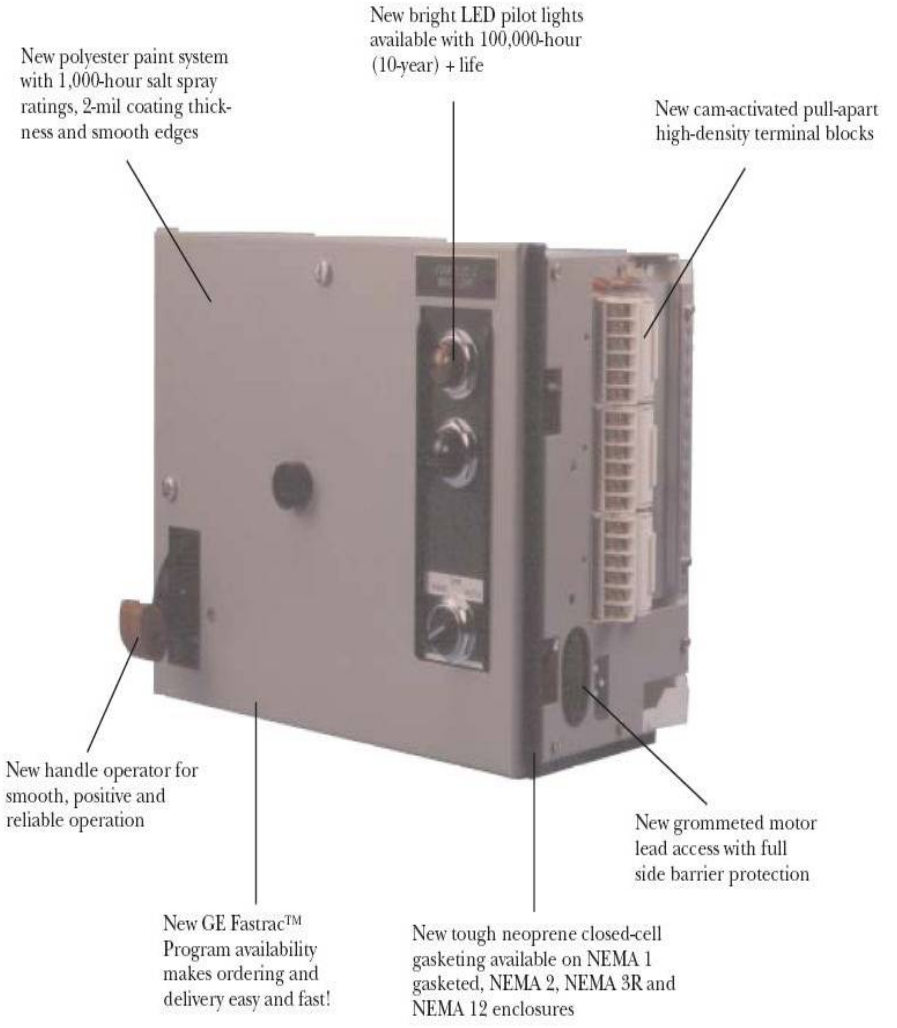
Motor Control Center Bucket



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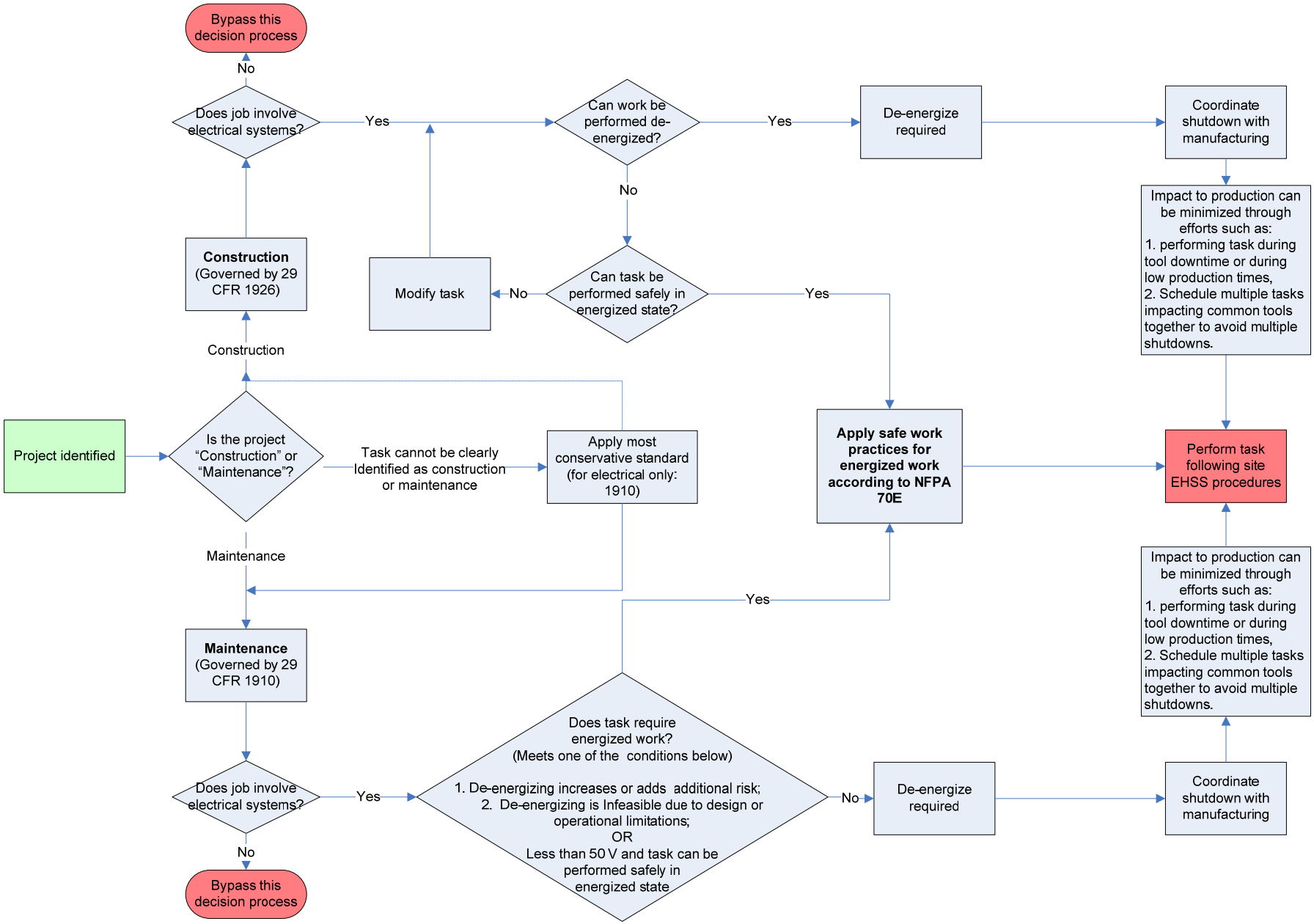
Electrical Task Decision Process



Conclusions

1. Energized electrical work should be minimized
2. Safety departments should be involved in decision making
3. Hot work permits should be obtained for work that is not troubleshooting
   a. Be able to defend defining work as “construction”
   b. Be able to defend use of the “continuous industrial process” justification
4. There appears to be a need for better engineering design of electrical panels – Is a standard/guideline/best practice merited? Should Safety review and approve?

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Discussion

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