NFPA 70B: What are the Best Maintenance Practices

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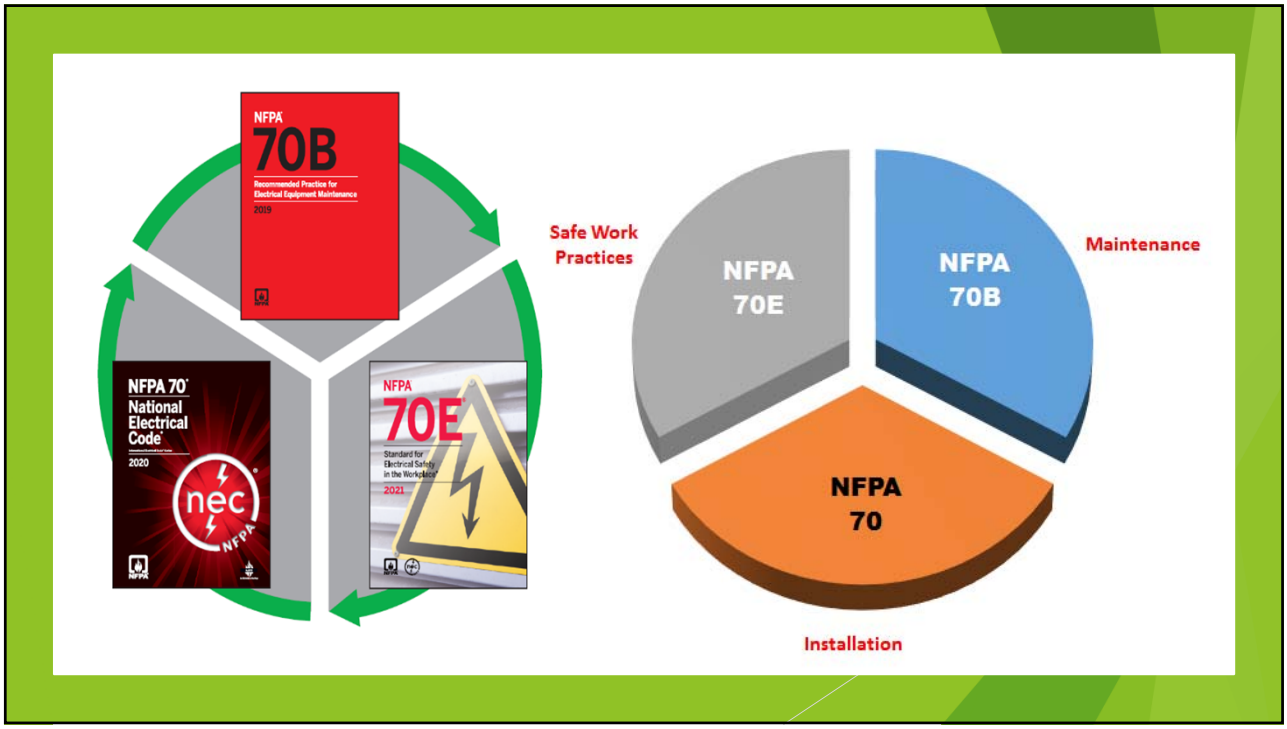

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What is CMMS – Computerized Maintenance Management System

- How do you use your system? 10-30%
- List of Assets
- Work Management
- Task of procedures
- Preventative Maintenance
- Materials Management
- Purchasing
- Add-ons – Mobile, bar coding, fleet, GIS, etc.
- Implementation

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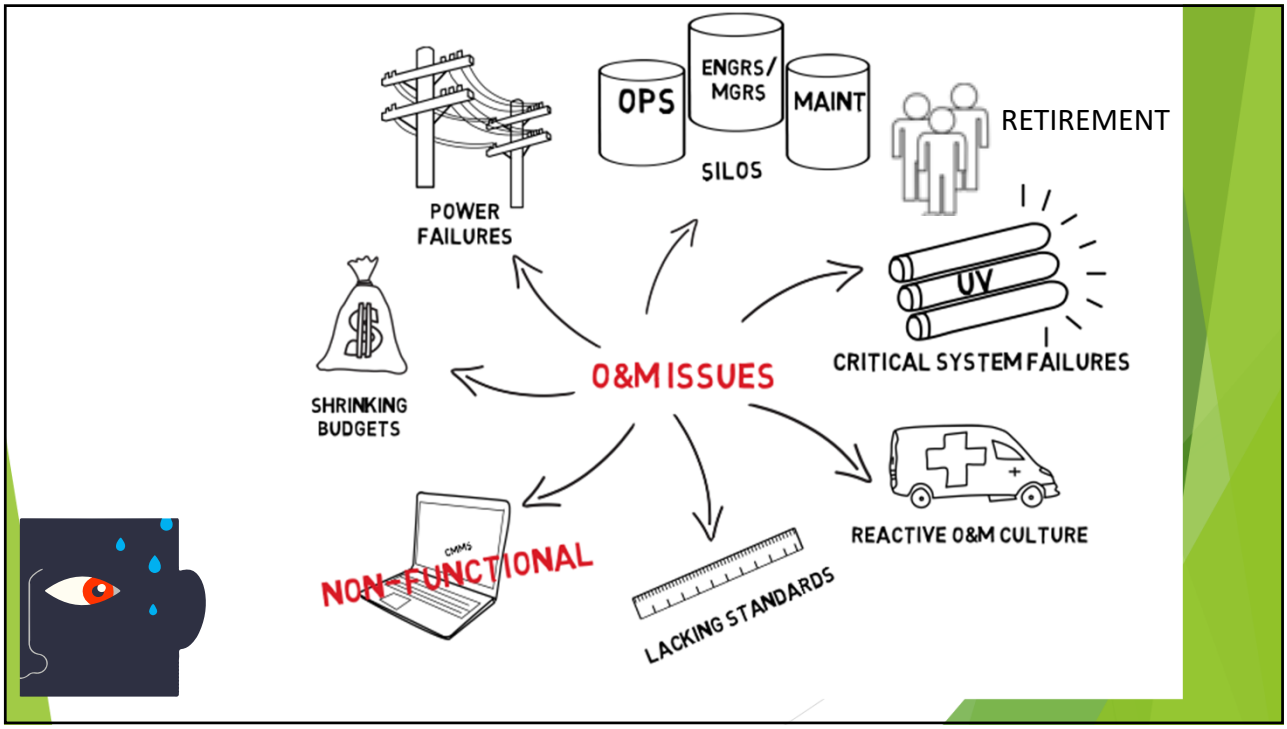

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Modes of Maintenance

Breakdown:

- Run to failure
- Purely reactive maintenance is often called "fire fighting"

Preventive Maintenance:

- Consists of periodic parts inspection and replacement
- Requires a large parts inventory

Predictive Maintenance:

- Consists of continuous machine monitoring
- Tracks and Trends machine conditions
- Allows you to schedule repairs when most convenient

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What is RCM – Reliability Centered Maintenance

- Started in the late 1940's, really rolled when the Jet engine came around—
- Function oriented
- System focused
- Looks at Design
- Looks at Safety
- Failure is any Unsatisfactory condition
- Uses a logic tree
- Tasks address failures
- Uses 3 types of maintenance tasks- PM's, PdM's and Failure finding
- Is a living system

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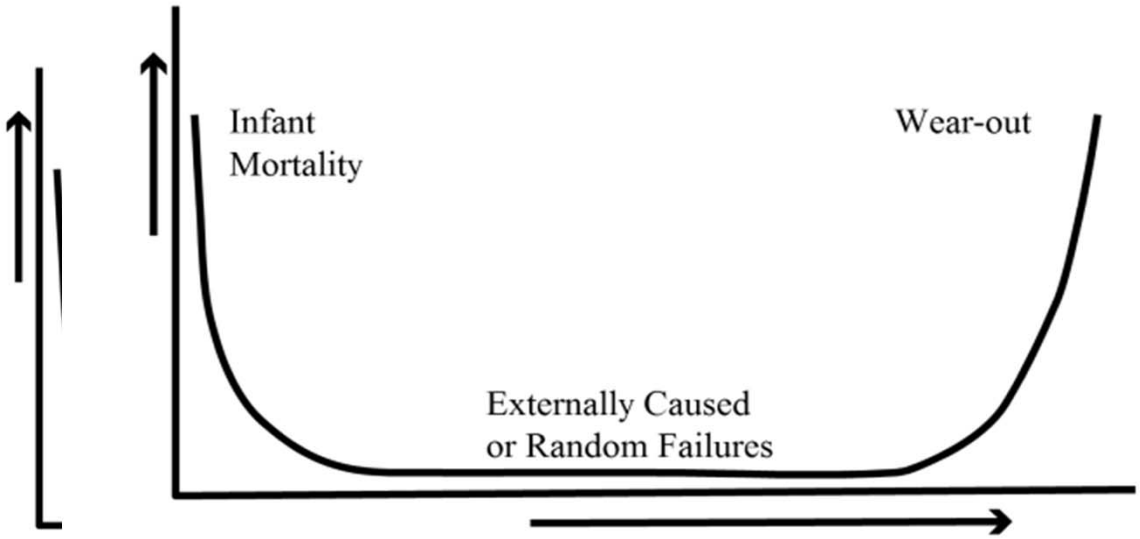
BATHTUB CURVE



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Use the "5 Why" Tool to Dig Up Root Causes

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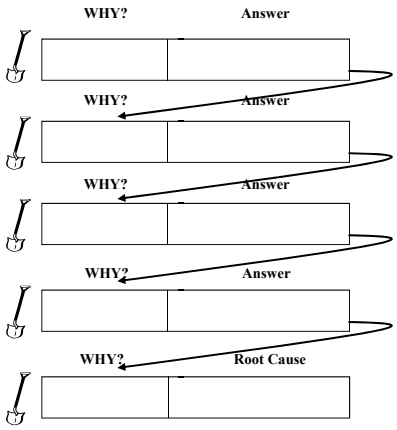
Troubleshooting often doesn't solve the real causes of problems.

Asking "why" repeatedly helps to uncover root causes so we can prevent them.



Problem: The cylinder moves slowly

Why is movement slow?
Because there's a clog in the strainer.

Why is the strainer clogged?
Because the oil is contaminated.

Why is the oil contaminated?
Because chips and debris enters through holes and gaps on the upper plate of the tank.

Why are there holes on top of the tank?
Because the cover plate came off after maintenance was done.

Solution: Prevent chips and debris from getting in by properly replacing the tank cover plate.

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When to Use the Megger

- To test for suspected ground faults
- Routinely when troubleshooting
- Routine Troubleshooting and Preventive Maintenance of
  - Motors and Generators
  - Cables and Conductors
  - Switchgear
  - Circuit Breakers

CAUTION:
Never
apply a megohmmeter to electronics

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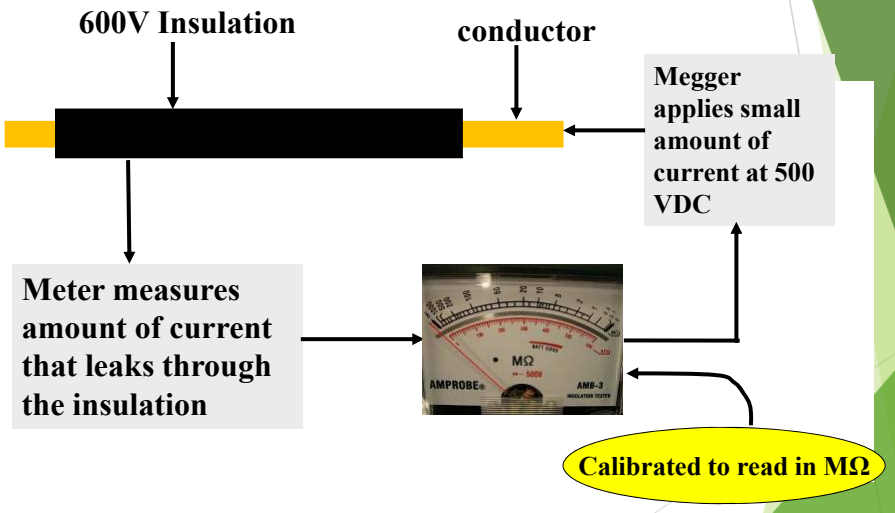
Insulation Resistance Testing



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Understanding Time-Resistance Readings

The resistance reading on the megger is the total of three currents:

1. Charging current is a result of the capacitive effects as the components being measured build up capacitance
2. Absorption current: insulation initially stores electrons as DC voltage is applied
3. Leakage current: this is the current that leaks through the insulation and is the value we want to know. The meter will give us "MΩ"

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Insulation Resistance Testing

- "Short -time" or "Spot Reading" test most common
  - Apply DC voltage and take reading at 60 seconds
- Reading will be affected by:
  - Temperature
  - Humidity
  - Condition of insulation
  - 2 Meg per horsepower is good @480v

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Understanding Time-Resistance Readings

Taking one resistance reading at 30 seconds and one at 60 seconds provides data to determine the "Dielectric Absorption Ratio"

Example: 30 second reading = 100 MΩ
60 second reading = 120 M Ω

DAR = 60sec/30sec = 120/100 = 1.2

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Understanding Time-Resistance Readings

Taking one resistance reading at 1 minute and one at 10 minutes provides data to determine the "Polarization Index"

Example: 1 minute reading = 100 MΩ
10 minute reading = 130 M Ω

PI = 10min/1 min = 130/100 = 1.3

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Dielectric Absorption Testing
based on NFPA 70B

Insulation	60:30		10:1
Condition	second ratio		minute ratio
Dangerous			less than 1
Poor	less than 1.1		less than 1.5
Questionable	1.1 - 1.25		1.5 - 2
Fair	1.25 - 1.4		2 - 3
Good	1.4 - 1.6		3 - 4
Excellent	above 1.6		above 4

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A good idea??

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Alignment tools

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Vibration tools

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Crankcase Breathers

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How does your room look?

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Is there enough grease?

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A new way of greasing a motor or pump by Ultrasonic

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An easy fix

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Save my pump

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Save my pump #2

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What is the correct tool?

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The right PPE and testers

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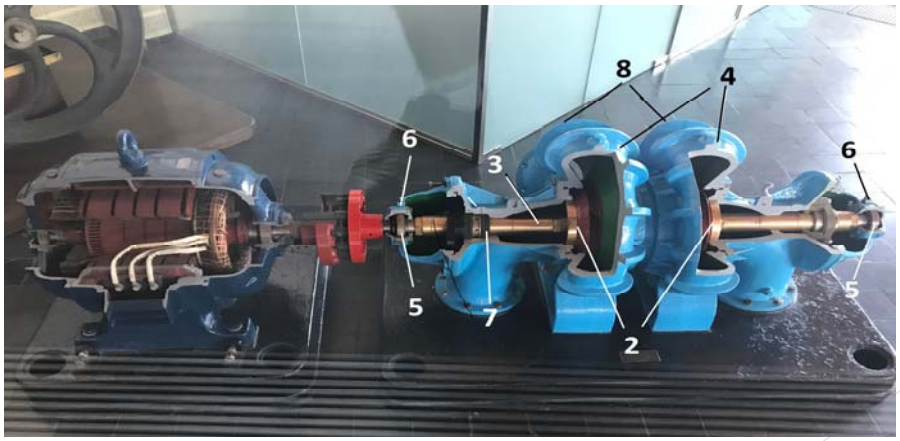
A teaching tool



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Do you Know?

- What is NFPA 70B????
- What is the name of your ESC? Your EPM Manager?
- What is your Risk in not having a plan on Electrical Maintenance?
- Have you performed a risk analysis or Hazard study for your plant?
- What is a Qualified person?
- What is an Arc Flash incident?
- What is RCM and PDM??? How about Asset Management? FMEA?
- Who/What is OHSA? Do you even care?
- Do you provide training to employees?

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What is NFPA 70B?

- NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.
- The purpose of this recommended practice is to reduce hazards to life and property that can result from failure or malfunction of industrial-type electrical systems and equipment.
- A well administered (EPM) Electrical Preventative Maintenance Program
- Arc Flash Safety/Qualified person and an EPM Manager
- How to commission new equipment
- How to properly ground equipment
- How to avoid bad Harmonics and Transients (Surges, Spikes or impulses)

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What is Electrical Preventative Maintenance or EPM?

- It is the process of Inspecting, Testing, Analyzing, Servicing and Mitigating Risks Associated with Electrical Systems and Equipment with the purpose of maintaining safe operations and production by reducing or eliminating system interruptions or equipment breakdowns.

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Why have an EPM plan?

- Electrical Systems begin to deteriorate once they are installed.
- Performance and life expectancy of Electrical Systems decline with Environmental Conditions, Overload Conditions, and Excessive Duty Cycles.
- Principle reason for Electrical System failure is failure to maintain.
- Dependable Designs require maintenance to keep them dependable.
- Failure rate is three times (3X) higher for Electrical Equipment that is not part of an Electrical Preventative Program.
- The risk of an unscheduled Electrical Failure can be reduced by 66% with an effective Preventative Maintenance Program.

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Risk Assessment

- Identify and Analyze Electrical Hazards
- Identify Tasks to be performed
- Document hazards associated with each task
- Estimate the risk for each hazard
- Determine the appropriate protective measure needed to adequately reduce the level of risk
- Risk control includes: Elimination, Substitution, Engineering controls, Awareness, Administrative controls and PPE.

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Planning your program

- Commitment from management
- Over 2000 electrical injuries from Arc Flash related issues last year
- Cost normally over $1M
- Survey all your systems and equipment
- Perform a Failure Mode Effects Analysis (FMEA)
- Have a good CMMS/RCM program
- Consider safety of personnel and your system, How do we train staff?
- Impact to production and your service to customers

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Planning your program continued

- Determine Maintenance intervals base on the following:
  - Importance/Critical nature of equipment.
  - Requirements of the Manufacturer.
  - Age and condition of equipment.
  - Duty cycle or number of operations.
  - Load conditions and Demand.
  - Environment, Temperature, Humidity, Carmel to Chicago to Las Vegas.
  - Staffing, Safety and Training.
  - Insourcing or Outsourcing.

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Electrical Preventative Maintenance or EPM Practices:

- 1. Compile a listing of all plant equipment and systems.
- 2. Determine which equipment and systems are the most critical and most important.
- 3. Develop a system of preventive/predictive maintenance. RCM, PDM, etc.
- 4. Train your staff, contract for special services.
- 5. One-line drawings of your Electrical System.
- P&ID drawings of your system

- This standard covers equipment ranging from substations and switchgear assemblies to power and distribution transformers; wiring devices; Instrumentation devices and even portable electrical tools and equipment.

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EPM Fundamentals

- Keep it Tight– Vibration, Expansion/Contraction under load, increases contact resistance and produces abnormal reactions in the electrical system.
- Keep it Dry– Humidity, Condensation, Chemical, Oils, Etc. This causes accelerates the Oxidation process, increases resistance and failures increase.
- Keep it Clean– Dirt, Dust, Lint, Chemicals, Metallic particles, Oils, Etc. This causes clogged cooling means, creates fire hazards, increased resistance.
- Keep it Fiction Free– Prohibits free movement of electrical devices, increases Arc Flash hazards and is unforgiving.
- Check your incoming power
- Check all your control loops

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EPM Fundamentals takeaways

- Use torque wrenches to test the manufacturers specs.
- Use infrared to survey for hot spots.
- Test busway, motors, cables etc. with the proper test equipment and record all findings: Megger, Infrared, Vibration, Oil analysis, etc.
- Use lint free rags when cleaning and all cleaning agents must be Non-Flammable and Non-Corrosive to electrical materials
- Never use compressed air to blow out units, Vacuum and brush
- Change out filters, cover all holes and unused penetrations
- Use the correct grease for all applications: motors, terminals, Di-electric grease, etc.

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EPM Fundamentals takeaways Cont.

- Vibration analysis
- Ultra-Sonic Amplification
- Infrared analysis
- Oil analysis
- Motor conditioning analysis
- Bearing analysis
- Seal failure analysis
- Root cause analysis

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Benefits of Electrical Maintenance Safety Devices EMSD

- One such device is an IR window; this device will standardize the inspection routes as they become data collection points for test equipment. They also ensure that all the inspection parameters are fixed and that all collected data is standardized ensuring that any trend analysis data is accurate. Other benefits include:
- Maintain switchgear in an enclosed and guarded condition
- Remove risk of electrocution and Arc Flash
- Removal of high-risk behaviors
- Conduct valuable, fully loaded online inspections
- Access Inaccessible equipment

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EMSD Safety

- Infrared windows are intended to allow safer, more efficient access to the thermographic data recommended in NFPA 70B.
- Infrared inspections of electrical systems are beneficial to reduce the number of costly and catastrophic equipment failures and unscheduled plant shutdowns. These inspections of energized electrical systems should be performed annually prior to shutdown.
- It is significant that most electrical maintenance and safety standards value the use of Condition Based Maintenance (CBM) inspections such as IR surveys, ultrasound inspections and the like to help your plant stay in compliance and give your staff a head start on the right road of safety.

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The main benefits of a good NFPA 70B program

- Asset protection– Experience shows that equipment last longer and preforms better when covered by an EPM program.
- Risk management- An EPM program is a form of protection against accidents, lost production and promotes a safety culture.
- Energy Conservation- Equipment that is well maintained operates more efficiently and utilizes less energy.
- Increase uptime of equipment- Through reduced failures and better workmanship.

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Is your Electrical Maintenance Program just overhead or an asset?

- Electrical power is the lifeblood of our everyday needs, dependable electrical power is not an option. What can you say about the following:
- An unannounced disruption of your operations, what happens when the lights go out?
- Damage to critical equipment, how long to repair?
- The potential for fire, arc flash, safety of personnel?
- Negative impact to the environment?
- Damage to customer satisfaction?

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Top 3 Challenges for your EPM

- Inadequate information about assets and your group skills, along with their ability to maintain and operate your system
- Maintenance is not a top corporate priority
- Disjointed, non-standard maintenance procedures are commonplace

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How to overcome these 3 challenges!

- Implement an aggressive proactive maintenance strategy such as RCM, PDM and Asset Management
- Use Analytics software to measure actual asset performance vs. established goals
- Build a case for your Board/CFO of the importance of investing to support proper service and maintenance practices.

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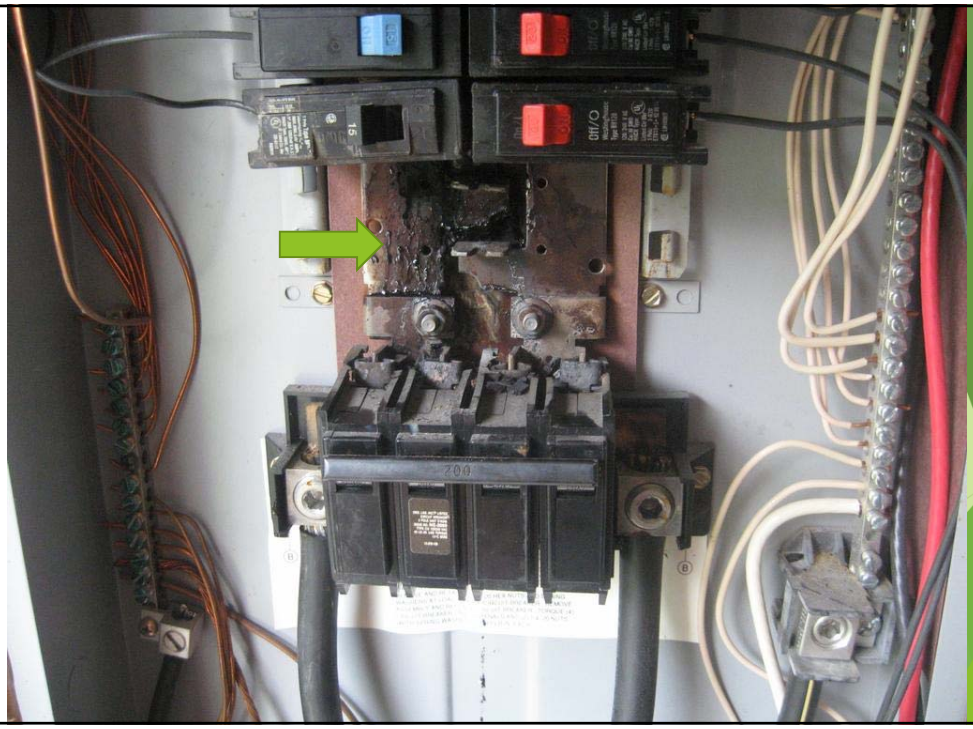

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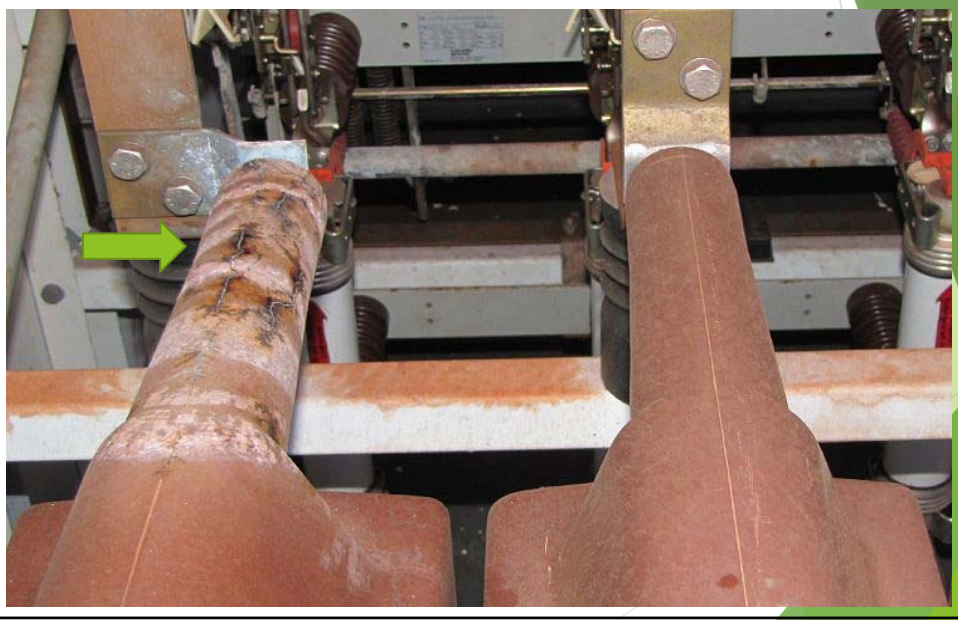

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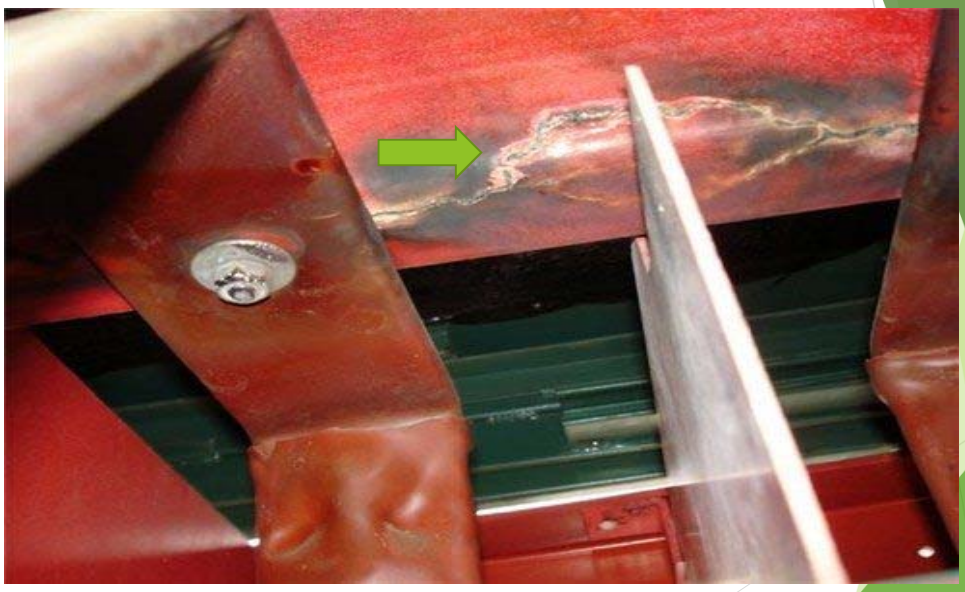

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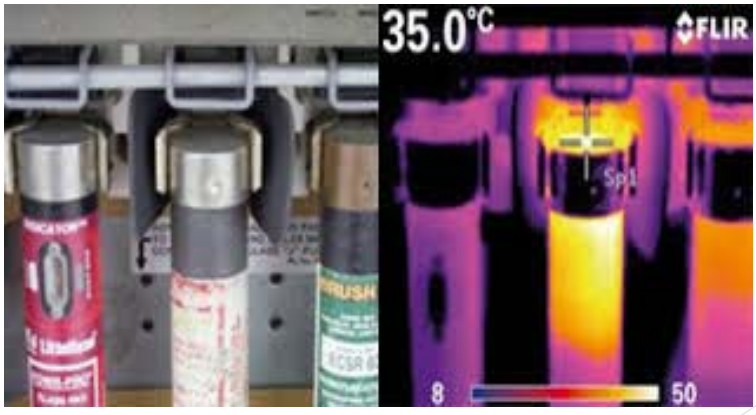

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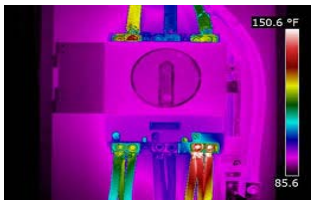
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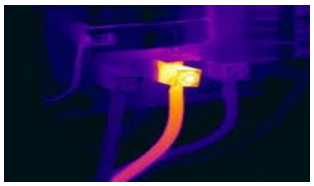

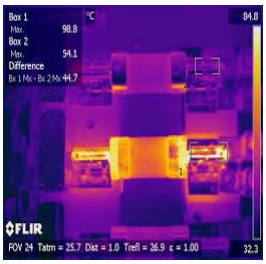
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Max. 98.8
Box 2
Max. 54.1
Difference
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WAY 4
WAY 5
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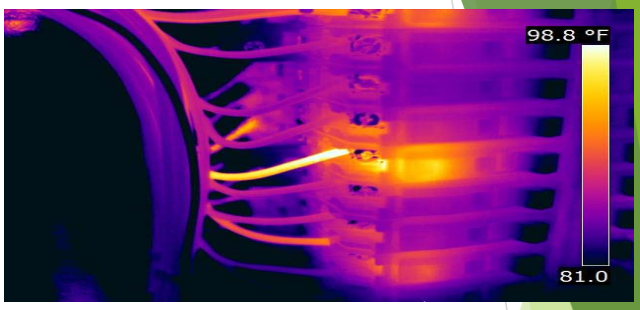
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Safety Practices
Have a 5 star safety day!

- Detailed method of Procedure, SOP Etc.
- Must be equipment specific.
- Qualify all staff and have a Electrical System Coordinator (ESC).
- All procedural tasks shall be directed by the ESC.
- Conduct Procedural Overview with a safety meeting prior to start of work.
- No equipment shall be energized or de-energized without ESC approval.
- No equipment covers shall be removed without approval of ESC.
- Maintenance should be performed by “Qualified Persons”.
- Proper PPE for the level needed.

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Safety Practices continued

- Verify equipment is de-energized following an approve procedure.
- LOTO and the 3 point method.
- Category 1-4 meters and proper rating for what you are testing.
- Discharge equipment, wait 10 min. for store electrical energy to discharge.
- Ground equipment.
- Double check everything, is there a back-up generator or a timed source?
- Do you need a Energized Electrical Work Permit?
- Electrical safety program– audit every 3 years.
- Ground assurance program.

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Qualified person and an Electrical Safety Program

- 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 and avoid the hazards involved.
- Training must include the specific hazards associated with electrical energy; safety related work practices and procedures needed to protect the worker from electrical hazards associated with the job or task.
- Electrical safety programs must be documented, must include job briefings, hazards of the job to be performed, work procedures and PPE needed.
- Employers must identify a risk assessment procedure to be used before work is performed within the limited approach boundary.

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Ground Assurance Program, Grounding and an Energized Work Permit

- GFCI shall be provided when an employee is outdoors or using cord-plug connected equipment supplied by 125v, 15, 20, or 30 amp circuits.
- Grounding means intentionally creating a low resistance path that connects to the earth.
- A Service or Equipment ground is designed to protect operators and machines.
- Temporary protective grounding must meet ASTM F 855.
- An Energized work permit is for work that is not in an electrically safe condition and that is energized electrical work. Would you sign it?
- Proper PPE, Arc rated clothing, tools and testers.
- Two exceptions: if de-energizing would increase the hazard or an iron lung.
- Not needed when testing, troubleshooting, thermography, housekeeping.

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Questions??

Thank You!!!!

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