ELECTRICAL COMMISSIONING
(CONSTRUCTION PHASE)
PRESENTED BY
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OBJECTIVES

- The Standard Commissioning Process for Electrical Equipment (Construction Phase)
- CBEMA, NETA ATS, NETA MTS, NFPA standards
- Commissioning on:
  - Standard Packaged Electrical Equipment
  - Standard Electrical Equipment
  - Medium Voltage and Complex Electrical Systems
- Electrical Safety, Electrical Contractors, Electrical Testing, and the Electrical Commissioning Roles and Responsibility
Electrical Commissioning Standard Process

Every industry is a little different in what is expected versus what is considered standard practice

- The hospital Industry relies primarily on the NFPA 99 and NFPA 110 specifications. These specifications are fairly robust and need to be considered whenever taking on a new project.
- The data center industry tends to move from one extreme to the next, but follows BCA standard guidelines more often then not.
- The utility industry has designed their own version of the commissioning process, but is a major driving force in NETA
• NETA ATS (Acceptance Testing Specification)
  – Acceptance Testing is the very first electrical testing that should ever occur on a project site.
  – Acceptance testing allows in almost every requirement an option to follow manufacture’s testing practices.
  – An electrical commissioner should understand what the acceptance testing values mean.

• NETA MTS (Maintenance Testing Specification)
  – Maintenance Testing is electrical testing after installation and significant completion.
  – Maintenance testing is more relaxed in values and testing requirements than the Acceptance Testing Specification.
  – When an electrical commissioner is tasked with helping set up a maintenance program, NETA MTS should be the first book opened.

• NETA ECS (Electrical Commissioning Specification)
  – First written in 2015 to help shift the use of the word “Commissioning” toward the BCA standard commissioning process.
## NETA ECS Versus BCA Cx Process

<table>
<thead>
<tr>
<th>BCA Cx Process</th>
<th>NETA ECS</th>
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<tbody>
<tr>
<td>• Builds the process from conception through Pre-design, design, construction, and Warranty Periods</td>
<td>• Concentrates on a process to move a project from Construction to Significant Completion</td>
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<td>• Concentrates more on roles that could be performed by a non-engineer based responsible party such as an Owner</td>
<td>• Relies on the process being performed by a technical expert or engineer</td>
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<td>• Does not dictate absolute requirements</td>
<td>• Specifies requirements that should be performed to verify any electrical system unless manufacturer states otherwise</td>
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CBEMA Curve
Information Technology Industry Council

- Power Acceptability Curve for Information Technology Equipment
- ITIC curve is a modified version of the CBEMA curve
- Applicable to 120V nominal voltages obtained from 120V, 208V, or 240V systems
- Most Power Quality Meters allow for automatic tracking of variance from this curve
NFPA (NEC)
National Fire Protection Association

● NFPA 99 – Health Care Facilities Code
  – Explains assembly and testing of every electrical component in a hospital including by not limited to electrical outlets and light fixtures.

● NFPA 110 – Standard for Emergency and Standby Power Systems
  – Standard for components such as Generators and Generator switchboards
  – The 10 second rule vs. Generator Industry
Standard Packaged Electrical Equipment in this presentation is defined as electrical systems that come fully built.

- Easiest equipment to use the commissioning process on.
- Operator comes with the equipment that protects you from doing anything wrong.
- Manual comes with the equipment that describes every nuance of the equipment
- Start-up Engineers often refer to what they do as commissioning, but it is important that as a commissioner, you trust that they set up the equipment, but verify that it is set-up the way the owner requested.
- Examples of this gear would be PDUs, PMMs, UPSs, ATSs, and some generator control cabinets.
Commissioning Standard Packaged Electrical Equipment

- Review the submittal to verify that the chosen equipment can satisfy all of the OPR associated with that project
- Use the submittal to write up the Level 2 Verifications (Pre-functional Checklist)
  - Recommend having a “Compliance” portion and a “Installation & Readiness” portion in the PFC
- Request Acceptance Testing documentation from the 3rd Party Testers (Level 2 testing)
- If both the PFC and the acceptance testing are found acceptable, then proceed to Level 3
- Request Start-up documentation from the Start-up Engineer (Level 3 Testing)
- Use the start-up documentation, submittal, and OPR to write-up your Level 4 Tests (Functional Performance Tests)
- Use a second visit with the Start-up Engineer to perform the Level 4 testing.
- Once all equipment in the electrical system have had level 4 testing performed satisfactorily and all necessary punch list items have been completed, then proceed to level 5 testing (Integrated Systems Test)
- Electrical system only tests are often substituted in for the IST and the term is used lightly (e.g. Blackout Test, Sequence of Operation Tests, etc.)
Standard Electrical Equipment

for this presentation is defined as individual electrical components often assembled together to create a system.

- These components often come with little to no information or manuals
- No technician comes with the gear
- Installation of components is determined by the NEC and Manufacturers.
- Examples of this equipment would be Dry Type transformers, circuit breakers, disconnect switches
Commissioning Standard Electrical Equipment

- Review the submittal and design documents to determine if the OPR is being satisfactorily accomplished.
- Use the submittal to write up the Level 2 Verifications (Pre-functional Checklist)
  - Recommend having a “Compliance” portion and a “Installation & Readiness” portion in the PFC
  - Typically consists of an entire switchboard, not just the individual component
- If the PFC is found acceptable, then proceed to Level 3.
- Request Start-up documentation from the Start-up Engineer (Level 3 Testing)
  - Acceptance Testing documentation is often accepted as Level 3 testing in this situation as long as there isn’t a control system involved (see Medium Voltage and Complex Electrical Systems) Use the start-up documentation, submittal, and OPR to write-up your Level 4 Tests (Functional Performance Tests) Use a second visit with the Start-up Engineer to perform the Level 4 testing.
  - Electrical Coordination Studies and Arc Flash Protection need to be implemented and preferably verified by Acceptance Testers.
- Level 4 testing, this is normally fairly simple and what most electrical commissioners come in contact with. It consists of taking meter readings, verifying trip settings, and pushing the “Push to Trip Button” on a breaker, verifying NEC codes, grounding, etc.
- Once all equipment in the electrical system have had level 4 testing performed satisfactorily and all necessary punch list items have been completed, then proceed to level 5 testing (Integrated Systems Test)
- Electrical system only tests are often substituted in for the IST and the term is used lightly (e.g. Blackout Test, Sequence of Operation Tests, etc.)
- **Liability and ignorance** can cause a pit hole for money if one isn’t aware of complexities
MV and Complex Electrical Systems

are defined in this presentation as any electrical gear greater than 480V or has a piecemealed control system.

- Any equipment that requires piecemealing of control, even if the manufacturer performed the configuration, has many areas to have cost detrimental problems

- Problems can come in, but not limited to:
  - Electrical versus Mechanical interlocks
  - Utility requirements versus Owner Requirements
  - Utility verifications and additional testing
  - Acceptance Testers knowledge and nuances between products
  - What is acceptance tested versus what isn’t acceptance tested
  - Sequence of Operation expectations between engineer, owner, and utility
  - ect.

- If you are not an electrical engineer with a field background, I would recommend getting a sub-contracted commissioner to assist.

- Not going to provide a commissioning process for this (see Standard Electrical Equipment)
Questions and Comments

(This is not the end)

- Molded Case Circuit Breaker
- Power Circuit Breaker
- Medium Voltage Circuit Breaker
- Power Distribution Unit
- Current Transformer
- Potential Transformer
- Control Power Transformer
- Dry Type Transformer (small)
- Dry Type Transformer (large)
- Oil Filled Transformer
- Electrical Safety (roles and responsibilities)
Designers looking at their own work, see what they expect to see.

Acceptance testers looking at their own work, don’t have the ability to add to their scope.
Molded Case Circuit Breakers

- Coordination Study
  - Frame Rating
  - Plug Rating
  - Adjustable Instantaneous Trip
- Push to Trip
- Shunt Trip
- Terminations
- Lug Sizes
- Cable and connection spacing
- Neutrals
- Grounds
- National Electric Code (NEC)
- Acceptance Testing?
POWER CIRCUIT BREAKERS

- Coordination Study
  - Frame Rating
  - Plug Rating
  - Adjustable Settings
- Push to Trip
- Shunt Trip
- Terminations
- Lug Sizes
- Cable and connection spacing
- Neutrals
- Grounds
- National Electric Code (NEC)
- Acceptance Testing?
• Current/Potential/Control Power Transformers
  • Ratio Verifications
  • Accuracy Verifications
  • Saturation Verifications (Current Transformer Only)
  • Insulation Resistance Testing (Megger)

• Dry Transformers
  • Ratio Verifications
  • Insulation Resistance Testing (Megger)
  • Winding Resistance Testing

• Oil Filled Transformers
  • Ratio Verifications
  • Insulation Resistance (Megger)
  • Winding Resistance Testing
  • Power Factor Testing or Tan Delta
• Current/Potential/Control Power Transformers
  • Meter Checks (recommend Calibrated Instrument Verifications)
• Dry Transformers (small vs. large)
  • Controller Verifications
  • Meter Checks (recommend Calibrated Instrument Verifications)
• Oil Filled Transformers
  • Controller Verifications
  • Meter Checks (recommend Calibrated Instrument Verifications)

So what am I looking for?
When Electrical equipment is energized, it should have:

• A **qualified** operator
  • the owner of the equipment doesn’t always meet this requirement
    • Electrical Contractor may have put it together and owns it, but it doesn’t mean he understands it.
  • the qualified operator may require a liability sign-off
    • Acceptance Testers are normally a good choice, but the contractor should need to sign away liability

• ARC Flash Labels
  • Proper PPE may require that all people in the area be wearing class 2 clothing (OSHA requirement)
  • Equipment used to put into Electrical Vaults for a reason

• Permanent Labeling
  • Electrical equipment often gets forgotten after it is turned on
  • Not having a permanent label becomes a safety hazard for LOTO once you walk away

• Proper equipment to operate the equipment (PPE, Remote Rackout Tools)
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