Commissioning Electrical Systems: An Expansion of LEED®

IEEE-SF-IAS
April 26, 2011

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Outline

- LEED commissioning.
- What clients are actually requesting.
- The Commissioning process.
- Experience in recent projects.
- The importance of commissioning.
LEED® and Commissioning

• EA Prerequisite
  Fundamental Commissioning of Building Energy Systems

• EA Credit 3
  Enhanced Commissioning
  2 Points
Fundamental Commissioning

- Designate an individual as the commissioning authority (CxA)
  - CxA must have documented CxA experience.
  - CxA must be independent of the project design and construction management.
  - CxA must report results, findings and recommendations directly to the Owner.
  - For projects smaller than 50,000 gross square feet, the CxA may be a qualified person on the design or construction team who has the required experience.
Fundamental Commissioning

• The owner must prepare Owner’s Project Requirements (OPR).
• The design team must develop the Basis Of Design (BOD).
• The CxA must review these documents for clarity and completeness.
• The owner and design team must be responsible for updates to their respective documents.
Fundamental Commissioning

• Develop and incorporate commissioning requirements into the construction documents.
• Develop and implement a commissioning plan.
• Verify the installation and performance of the systems to be commissioned.
• Complete a summary commissioning report.
Fundamental Commissioning

• Commissioning process activities must be completed for the following energy-related systems:
  – HVACR
  – Lighting and Daylighting Controls
  – Domestic Hot Water Systems
  – Renewable Energy Systems (e.g. wind, solar)
Enhanced Commissioning

• EA Credit 3  (2 Points)
• Begin the commissioning process early in the design and execute additional activities after systems performance verification is completed.
Enhanced Commissioning

• The commissioning authority (CxA):
  – Must have documented CxA experience.
  – Must be independent of the project design and construction management.
  – Must not be an employee of the design firm, but may be contracted through them.
  – Must not be an employee of, or contracted through, a contractor or CM holding construction contracts.
  – May be a qualified employee or consultant of the Owner.
Enhanced Commissioning

- Must conduct 1 or more commissioning design reviews of the OPR, BOD, and design documents prior to the mid-CD phase and back-check the review comments in the subsequent design submission.
Enhanced Commissioning

• Must review contractor submittals applicable to systems being commissioned for compliance with the OPR and BOD. This review must be concurrent with the review by the architect or engineer and submitted to the design team and the owner.
Enhanced Commissioning

• Must develop a Systems Manual that gives future operating staff the information needed to understand and optimally operate the commissioned systems.
Enhanced Commissioning

• Must verify that the requirements for training operating personnel and building occupants have been completed.
Enhanced Commissioning

• Must be involved in reviewing the operation of the building with operations and maintenance (O&M) staff and occupants within 10 months after substantial completion. A plan for resolving outstanding commissioning related issues must be included.
Clients Request

• Basic Cx (required)
  – Lighting Control

• Enhanced Cx (EA Credit 3 for 2 points)
  – Lighting Control
  – Electrical equipment testing
  – Automatic system operation
The Process

• Design review
• Product submittals
• Construction observation
• Testing procedures
• Owner training
• Final reports
Design Review

• Review OPR
• Review BOD
• Review Design Development Docs
• Review 50 or 75% Construction Docs and backcheck previous comments
Product Submittals

• Review product submittals
  – for compliance with design documents
  – from Cx perspective
Construction Observation

• CxA acts as another observer
• Does not replace observation by designer
• Does not replace AHJ
Testing Procedures

• Formalizes the usual electrical testing
• Prepares written test procedures
  – Step-by-Step
  – Action and expected response
  – Test everything it is supposed to do
  – Test it does not do what it is not supposed to do
• Based on written “Sequence Of Operation”
Owner Training

• Document that training occurred
Final Reports

• O&M manual for Owner
• Final report for LEED submission
Recent Experience

• 12kv Dual Loop Distribution
• Paralleling Switchgear
• Load Shed Switchgear
• UPS Systems
• Lighting Control
Design 12KV Diagram
12KV Dual Loop Distribution
12KV Dual Loop Distribution
12KV Dual Loop Distribution

- Source cable connected to feeder switch
- Cables were crossed between loops
- Phase rotation of North Utility and South Utility were different
Test 12KV Phase Rotation
Test of 12KV  Switchgear
### Functional Performance Test

#### 5. Automatic Transfer Operation

<table>
<thead>
<tr>
<th><strong>Place Auto/Manual mode selector switch (43) to “Auto”</strong></th>
<th><strong>Control power should be available on both sections.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“Source 1 Voltage Available” amber light should be illuminated (S01 Sec 3).</td>
</tr>
<tr>
<td></td>
<td>“Source 2 Voltage Available” amber light should be illuminated (S01 Sec 3).</td>
</tr>
<tr>
<td></td>
<td>“Auto Mode” green light should be illuminated (S01 Sec 3)</td>
</tr>
<tr>
<td></td>
<td>“Auto Ready” green light should be illuminated (S01 Sec 3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Loss of utility power to S01</strong></th>
<th><strong>After 5 seconds time delay “Main 1” breaker should open.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>After 2 seconds time delay “Tie” breaker should close.</strong></td>
</tr>
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<table>
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<tr>
<th><strong>Simulate loss of utility power to S01 by removing all 3 fuses in the secondary circuit of VT1 (S01 Sec 2)</strong></th>
<th><strong>Return of lost power to S01</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>After 10 minutes time delay “Tie” breaker should open.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>After 2 seconds time delay “Main 1” breaker should close.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Loss of utility power to S02</strong></th>
<th><strong>After 5 seconds time delay “Main 2” breaker should open.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>After 2 seconds time delay “Tie” breaker should close.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Simulate loss of utility power to S02 by removing all 3 fuses in the secondary circuit of VT2 (S02 Sec 5)</strong></th>
<th><strong>Return of lost power to S02</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>After 10 minutes time delay “Tie” breaker should open.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>After 2 seconds time delay “Main 2” breaker should close.</strong></td>
</tr>
</tbody>
</table>
Compartmental Transformer
Transformer Monitors
Primary Selector Switch
480V One Line Diagram
Paralleling Switchgear
Load Shed Switchgear
Load Shed Switchgear
<table>
<thead>
<tr>
<th>#</th>
<th>Status</th>
<th>Tag</th>
<th>Description</th>
<th>Responsible</th>
<th>Noted</th>
<th>Updates</th>
<th>Action Items</th>
<th>Resolved</th>
<th>Verified</th>
</tr>
</thead>
</table>
| 21 | Unresolved | TB1CEMS0 1 | Rockwell PM 3000 meters in each switchgear need a label clearly identifying what section of the switchgear is this meter monitoring (line, bus, etc) | Rosendin Electric | 07/30/10 | 12/08/10 - REI update - Two week eta for install.  
10/27/10 - REI stated that labels will be provided.  
10/20/10 - Completed onsite review of meters and Enovity feels that labels are necessary. | REI to provide labeling |          |          |
| 22 | Unresolved | TB1CEMS0 1 | Kirk-Key interlock sequence of operations should be posted on each switchgear using the interlocking system. | Rosendin Electric | 07/30/10 | 12/08/10 - WIP - being laminated ETA end of December.  
10/08/10 - WIP | REI to post the sequence next to the equipment. May be located on a wall/side of the equipment due to space limitation on the main panel. |          |          |
| 36 | Unresolved | TB1CEMS0 5 | This switchgear is supposed to send a gen start and transfer (at S01) at loss of utility. The sequence of operations for S05 needs to be clarified so it can be programmed, tested and commissioned accordingly by the contractor and CoA. | Rosendin Electric | 10/05/10 | 12/08/10 - This item to be discussed in meeting coordinated by AMJV.  
10/27/10 - WIP work in progress  
10/01/10 - Issue noted in field report LS-CoFR28 on 10/1/10 | TEE to clarify the SOO for the loss of power on S05 |          |          |
| 52 | Unresolved | UPS TB01   | FPT for UPS-TB01 and TB02 Partially completed. A number of items were not installed, ready for FPT, or did not perform as desired. Detailed report CoFR34 | Rosendin Electric | 01/11/11 | | Items to be completed/corrected and FPT to be scheduled. |          |          |
UPS Maintenance Bypass
Lighting Control

• Biggest issue is lack of a written sequence of operation.
• Next issue is lack of details
Lighting Control
Lighting Control
A Tale of Two Projects
A Tale of Two Projects

• School #1 had a total of 19 warranty requests over a period of a year. These 19 requests were related to 38 issues of which eight were recurring issues.
A Tale of Two Projects

• School #1 had a total of 19 warranty requests over a period of a year. These 19 requests were related to 38 issues of which eight were recurring issues.
• School #2 had 4 warranty requests related to 4 issues – none of which were repeats.
A Tale of Two Projects

• School #1 had a total of 19 warranty requests over a period of a year. These 19 requests were related to 38 issues of which eight were recurring issues.

• School #2 had 4 warranty requests related to 4 issues – none of which were repeats.

• Which school used the LEED Cx process?
In Conclusion

• Commissioning is important
In Conclusion

- Commissioning is the most important
In Conclusion

• Commissioning is the **most** important
• Saves energy
• Reduces O & M costs
• Enhances safety
Credits

• Enovity
• Greg Cunningham
• Vivek Mittal
• Zinovy Gutman
The End