Arguments for Standard Wiring Drawings in PIP-II Design

Jim Steimel
Don Mitchell
<table>
<thead>
<tr>
<th>Status of PIP-II CAD Documentation</th>
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<tbody>
<tr>
<td><strong>Circuit Boards</strong></td>
</tr>
<tr>
<td>• Currently no standard drawing package.</td>
</tr>
<tr>
<td>• Documentation enforced by industry standards (can’t get a board made with a napkin drawing).</td>
</tr>
<tr>
<td>• Must contact designer or department for access to information.</td>
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<td><strong>Wiring Diagrams</strong></td>
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<tr>
<td>• Currently no standard drawing package.</td>
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<tr>
<td>• Drawings only available for high power or high voltage systems.</td>
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<tr>
<td>• Some web access to documents for some divisions.</td>
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<td><strong>Piping &amp; Instrument Diagrams</strong></td>
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<tr>
<td><strong>Mechanical</strong></td>
</tr>
<tr>
<td>• NX is labwide standard.</td>
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<tr>
<td>• Drawings and information coordinated in Teamcenter.</td>
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<tr>
<td>• Easy access to drawing views for non-designers.</td>
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How Do We Wire Without Diagrams?

- AD standard cable database maintained. It can be used to print standard labels.
- Used primarily for inter-rack and beam line component connections.
- Electricians can make connections if origin and destination labels are clear.
- Database maintained by a single, cable “czar” that is rarely involved in system design.
- Penetration usage is documented with an independent spreadsheet.
- Intra-rack wiring must be closely managed by system designer.
Safety Issues

• LOTO procedure legitimacy requires accurate knowledge of power flow.
• LOTO procedures cannot be approved without review of design documents.
• FESS maintains single wire diagrams for facility power distribution.
• EE Support maintains wiring diagrams for high voltage systems requiring special LOTO procedures.
Benefits of Wiring Diagrams

- Don’t rely on a system designer to complete system wiring.
- Have the ability to diagnose larger scale wiring issues (ground loops, EMI, etc.).
- Similar systems can be wired more reliably.
- More predictable wiring standards for easier maintenance.
- System upgrades are easier to plan and implement.
How Does PIP-II Benefit

• PIP-II involves installing many copies of complex, cryomodule systems. Wiring diagrams will make installation more robust.
• We will likely move PXIE equipment to PIP-II tunnel, and it would be more efficient to reconstruct with a wiring diagram.
• They will improve communication between collaborators. (They could reveal missing specifications or components.)
• Benefit to PXIE – Better coordination of rack space with LCLS-II.
### Proton Improvement Plan-II

#### Linac Technology Map

<table>
<thead>
<tr>
<th>Section</th>
<th>Freq (MHz)</th>
<th>Energy (MeV)</th>
<th>Cav/mag/CM</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFQ</td>
<td>162.5</td>
<td>0.03-2.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HWR ($\beta_{\text{opt}}=0.11$)</td>
<td>162.5</td>
<td>2.1-11</td>
<td>8/8/1</td>
<td>HWR, solenoid</td>
</tr>
<tr>
<td>SSR1 ($\beta_{\text{opt}}=0.22$)</td>
<td>325</td>
<td>11-38</td>
<td>16/8/2</td>
<td>SSR, solenoid</td>
</tr>
<tr>
<td>SSR2 ($\beta_{\text{opt}}=0.51$)</td>
<td>325</td>
<td>38-177</td>
<td>35/21/7</td>
<td>SSR, solenoid</td>
</tr>
<tr>
<td>LB 650 ($\beta_{\text{G}}=0.61$)</td>
<td>650</td>
<td>177-480</td>
<td>30/20/5</td>
<td>5-cell elliptical, doublet</td>
</tr>
<tr>
<td>HB 650 ($\beta_{\text{G}}=0.9$)</td>
<td>650</td>
<td>480-800</td>
<td>24/10/4</td>
<td>5-cell elliptical, doublet</td>
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Goals of Wiring Diagram Standard

- Allow for more consistent safety review.
- Broader potential audience for internal review.
- Easier compliance with funding source document standards.
- Make PIP-II cost less.
Next Steps: Cost/Benefit Analysis

• Creating wiring diagrams is not free; we will need people to work on this. We should remain cognizant of the possibility this could cost more than we could gain.

• We don’t know how much we can save PIP-II at this stage. We will need to develop a different benchmark to measure success.
Next Steps: Wiring CAD Software Specifications

- Include PLC ladder logic in drawings?
- Include look and placement of relay racks?
- Define cable wire tray and penetration route?
- Include ACNET controls information?
- What set of documents do we want automatically generated (i.e. BOM)?
- Make compatible with circuit simulation software?
Next Steps: Scope and Boundary of CAD System

Circuit Boards

Wiring Diagrams

Piping & Instrument Diagrams

Mechanical

OrCAD? Mentor Graphics?

AutoCAD? Mentor Graphics?

NX
Next Steps: Accessibility, Maintenance, and Review

• Where are drawings stored and what is the accessibility/protection level?
• How is drawing integrity maintained (backup and version control)?
• What kind of review is required before release?
• Who maintains the CAD software and standards for documents?
• Who is the primary user of the drawing software (engineers, drafters)?
Final Suggestions

• Form working group to reach consensus on specifications and boundaries of software.
  – Group should include users from other applications.
  – Group should include representatives from other construction projects.

• Make as goal: wiring CAD standards in place and tested for HWR installation.