Infrastructure Issues
(More to it than circuit design)

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Outline

- Quality Assurance
  - Doc control, Design guidelines, Reviews, Standards
- Personnel & Equip Safety
  - JHA, RPS, Written procedures, ORCs
- Electrical Infrastructure
  - AC, DC, HV
- Cabling
  - Flammability, Smoke, Elect & Mech considerations, guidelines
- Etc.
  - Grounding & shielding, Networked software, Where to go for guidelines documents
- Summary

Quality Assurance

- Documentation Control
  - Drawings, Engineering notes, PLD source code, etc.
  - Hardcopy or computer files
  - Put someone in charge
  - Do not underestimate the 3-ring binder
- Design Guidelines
  - Electrical Design Standards for Electronics to be used in Experiment Apparatus at Fermilab
    - http://www-d0.fnal.gov/~hance/guidelines.htm
- Design Reviews
  - Conceptual/Requirements
  - Preliminary Specs/Pre-prototype & PCB
- Conformance to Standards
  - Continued --

Conformance to Standards

- FESHM - Fermilab ES&H Manual
  - FESHM 2000 - Planning for safe operations
    - FESHM 2060 Job Hazard Analysis (JHA)
  - FESHM 5000 - Occupational safely & health
    - FESHM 5120 (LOTO - LockOut/TagOut)
    - FESHM 5121 (Configuration control)
    - FESHM 5041 (Utilization equipment)
    - FESHM 5042 (Electrical power distribution)
  - FESHM 3000 - Investigation and reporting
- Fermi Eng. Stds. Man.
  - Cont.

Fermilab Engineering Standards Manual

- Mandatory, Advisory, Guidance
  - Mandatory
    - FESHM (of course)
    - ANSI (American National Standards Institute)
    - ICEA (Insulated Cable Engineers Association)
    - IEEE (Institute of Electrical & Electronic Engineers)
    - NEMA (National Electrical Manufacturers Assoc.)
    - NEC (National Electrical Code)
    - NFPA (Life Safety Code)
    - OSHA (Occupational, Safety & Health Administration)
    - U.L. (Underwriters Laboratory)
    - 10 CFR 435 (Energy conservation)

Personnel & Equip Safety

- JHA
  - FESHM 2060 & PPD JHA Guidelines
- Rack Protection Systems (and on detectors)
  - Smoke, H_2O leaks, air & H_2O flow
  - AC interlocks
  - FIRUS
  - Controls monitoring
- Written Procedures?
  - RPS validations, Silicon utilities control, etc.
  - Keep them simple
- Electrical Safety Reviews
  - PPD ORC of non-commercial or "high profile" apparatus before unattended operation

Electrical Infrastructure

- AC Distribution
  - Standby power? (for silicon cooling & purge)
  - Interlocked distribution boxes
- DC Distribution
  - Plan early regarding power systems
  - Bulk power & distributed regulation or traditional regulated supplies with remote sensing
  - Module fusing
- HV Distribution
  - Start with non-lethal sources
  - Provide interlocks at destination for maint.

Cabling

- Plan early
- Put someone in charge (data base, numbers, routes)
- $$ - Suitability for Intended Purpose
  - Flammability
    - Look for UL, IEEE, IEC, CSA ratings
  - Smoke Density, Toxicity, Corrosives
    - Halogen free – plenum cable?
  - Electrical Considerations
  - Mechanical Considerations
- Guidelines for choosing cables
  - CDF Run II Cable Selection Guidelines
  - D0 Cable Selection Guidelines
  - CERN IS23

Etc.

- Grounding & Shielding
  - Understand it or else
  - Be careful with single-ended circuits
- PPD Networked Software
  - Schematic Capture
  - PSPICE & PSPICE A/D
  - PCB layout
  - PLD design
  - Mechanical drawing
- Guidelines
  - Browse Fermi ES&H for FESHM
  - www-d0.fnal.gov/~hance/guidelines.htm
    - Guidelines for apparatus design
    - Networked software instructions
    - Safety review requirements & sample docs

Summary

- Form Infrastructure for Document Control, Standards, Cabling, & Reviews
- Design & Build within FESHM Standards
- Follow Design Guidelines – Prepare as you go for ORC
- Consider DC Distribution During System Design
- CAREFULLY Consider Grounding & Shielding During System Design