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2008 Schaedler Yesco Expo

2008 Code Changes for Power Distribution

April 17, 2008 / Version 1.0

Contact

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Introduction / Contents

Our goal is today is to learn about changes in the codes and how they affect you.

Topics

TVSS – 2nd Edition *Revision*
Arc Fault Circuit Interrupters
Selective Coordination

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Questions to Answer

TVSS

What is the benefit of UL 1449 2nd Edition *Revision*?
When is 2nd Edition *Revision* in effect?
Why was 2nd Edition *Revision* created?

AFCI's

When are they required?
Where are they required?
What do inspectors look for?

SELECTIVE COORDINATION

Where is it being enforced?
What must I do to comply?
If I miss it in a spec or if the AHJ is enforcing it now, am I in trouble?

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TVSS or SPD

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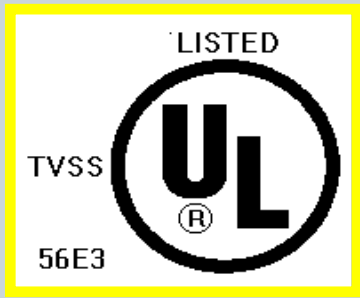
TVSS - UL1449 2nd Edition Revision

UL 1449 Second Edition *Revision* adds Intermediate Fault Current testing, released and effective February 9, 2007



What is the benefit?
- **Limit liability issues and improve safety**

When is it in effect?
- **Effective February 9, 2007. Mandatory on August 9, 2008.**

Why was 2nd Edition Revision created?
- **The upcoming slides will explain it in detail...**

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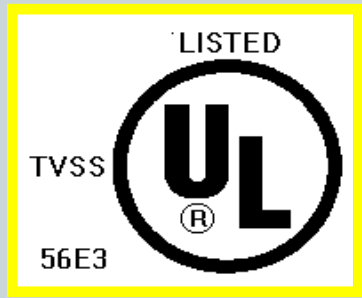
TVSS - UL1449 2nd Edition Revision

What is a TVSS?
What does it do?
What is a surge?
How does a TVSS clear a surge?
Causes of Failures?
Why Fault Current Testing?
Recent History of Revisions
Why Intermediate Fault Test?



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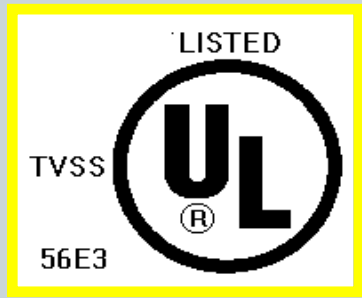

Cause of Failure

- **Poor Voltage Regulation can raise voltage**
- **Faults either Line to Ground or Line to Line**
- **Loss of Secondary Neutral, Missing N-G Bond**
- **Misapplication – Installing a 120V TVSS on a 277V system**
- **Ferroresonance (High Overvoltage + High Harmonics)**
- **Comingling (Contact to HV Circuits)**

Why Fault Current Testing?
Recent History of Revisions
Why Intermediate Fault Test?

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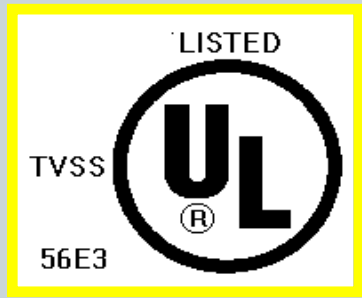

Cause of Failure

Why Fault Current Testing?

- **Is it a Surge or a Fault?**
- **MOV Operation**
- **Temporary Short Circuit**

Recent History of Revisions
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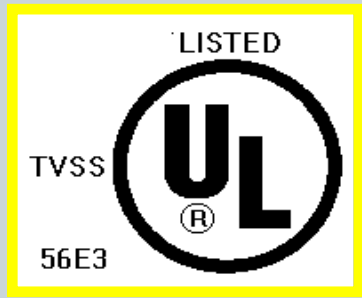

Cause of Failure
Why Fault Current Testing?

Recent History of Revisions

- **1998 – UL 1449 Second Edition Rev 1 is released. It introduced Fault Current Testing 1/8A, 1/2A, 2.5A, 5A, 5000A, 25000A**
- **2002 – Rev 2 - NEC 285.6 (Deletes 5000 & 25000A, must pass withstand test at service entrance. SCCR label required.)**
- **2007 – Rev 2.5 - Added Fault Current Testing at 10, 100, 500 & 1000A. Delete the 1/8A test. The MCOV loophole is closed.**

Why Intermediate Fault Test?

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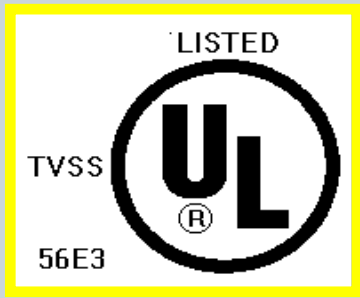

Cause of Failure
Why Fault Current Testing?
Recent History of Revisions

Why Intermediate Fault Test?

- **Field Evidence of Fault Failures in Those Ranges**
- **TVSS's Do Not Draw the Full Fault**
- **SIEMENS TVSS's Have & Will Protect the Intermediate Fault Range**

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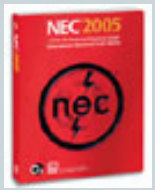
AFCI

Arc Fault Circuit Interrupters

Current AFCI Code Requirements

1999 National Electrical Code® Article 210-12

- ***Dwelling Unit Bedrooms***. *All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere* ***receptacle outlets*** *installed in dwelling unit bedrooms shall be protected by an arc-fault circuit-interrupter(s).*



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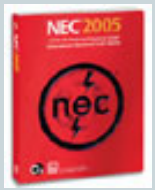
2002 National Electrical Code® Article 210.12

- ***Dwelling Unit Bedrooms***. *All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere* ***outlets*** *installed in dwelling unit bedrooms shall be protected by an arc-fault circuit interrupter listed to provide protection of the entire branch circuit.*



NEC 2005 - AFCI's

What determines if it is a dwelling unit bedroom?

Mattress or Bed?	No.
Box Springs?	No.
Alarm Clock?	No.
Window or Closet?	No.
Pillow?	No.
Microwave?	Yes, but only if it is bolted to the wall.

Dwelling Unit. A single unit, providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, cooking, and sanitation.

210.18 Guest Rooms and Guest Suites.

- Guest rooms and guest suites that are provided with *permanent provisions for cooking* shall have branch circuits and outlets installed to meet the rules for dwelling units.

Current AFCI Code Requirements

1999 National Electrical Code® Article 210-12

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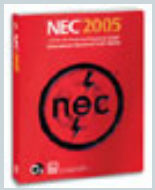

2005 National Electrical Code® Article 210.12

- *All 120-volt, single phase, 15- and 20-ampere branch circuits supplying* ***outlets*** *installed in* ***dwelling unit bedrooms*** *shall be protected by a listed arc-fault circuit interrupter,* ***combination type*** *installed to provide protection of the branch circuit. Branch/feeder AFCIs shall be permitted to be used to meet the requirements of 210.12(B) until* ***January 1, 2008***.

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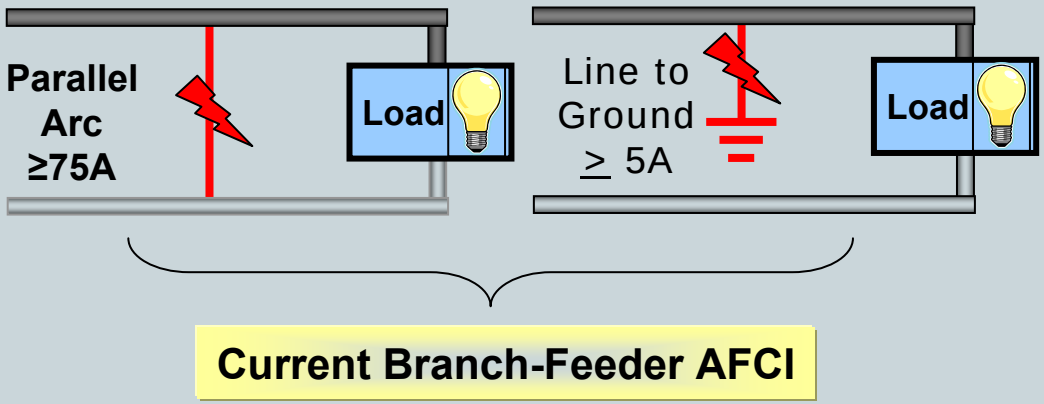
What is an AFCI?

A device designed to lessen the effects of arcing faults by de-energizing the circuit when an arc-fault is detected.

Siemens **Branch/Feeder** AFCI's consist of two sides

- Mechanical
  - Functions as a normal thermal magnetic circuit breaker
- Electronic
  - Detects the arc and activates a solenoid to trip the mechanical side
  - Detects parallel arcs

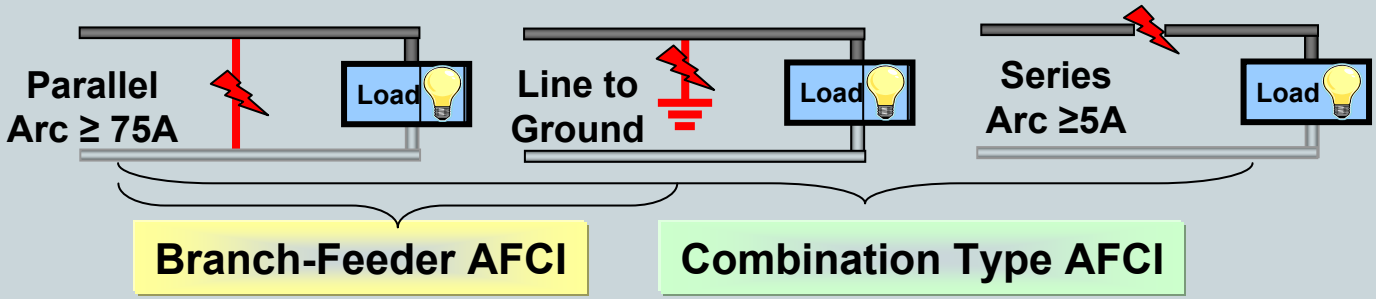


It is **NOT** a replacement for a GFCI (Ground Fault Circuit Interrupter)

Combination AFCI

"Combination" does **NOT** mean an AFCI + GFCI. Complies with the requirements for both branch/feeder and outlet circuit AFCIs. Provides protection against the high-energy parallel arcing and low-energy series arcing.

- **Combination** = parallel + series arcing



Protects downstream branch circuit wiring, cord sets and power-supply cords.

	Branch/Feeder	Outlet Circuit	Combination
Line-to-Neutral	75A	5A	5A
Line-to-Ground	5A	5A	5A
Series with Ground	5A	5A	5A
Series without Ground	-	5A	5A

2008 NEC® AFCI Code

All 15&20A circuits

Original Proposal 2-142 (CMP-2)

- **All 120-volt, single phase, 15- and 20-ampere branch circuits** supplying outlets installed in dwelling units shall be protected by a listed arc-fault circuit interrupter, combination type installed to provide protection of the branch circuit.

  - **Exception**: The location of the arc-fault circuit interrupter shall be permitted to be at other than the origination of the branch circuit in compliance with (a):
    (a) The arc-fault circuit interrupter installed within 1.8 m (6 ft) of the branch circuit overcurrent device as measured along the branch circuit conductors.

2008 NEC® AFCI Code

All non-GFCI

15&20A circuits

Expected Modification to Proposal 2-142 (CMP-2)

- **All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit bedrooms, family rooms, living rooms, parlors, libraries, dens, sun rooms, recreation rooms or other similar rooms shall be protected by a listed arc-fault circuit interrupter, combination type installed to provide protection of the branch circuit.**

  - **Exception**: The location of the arc-fault circuit interrupter shall be permitted to be at the location of the first outlet from the origination of the branch circuit when the wire to that outlet is protected in EMT or Type AC cable, steel type.

Questions to Answer

TVSS
What is the benefit of UL 1449 2nd Edition *Revision*?
When is 2nd Edition *Revision* in effect?
Why was 2nd Edition *Revision* created?

AFCI's
When are they required? Now in Pennsylvania.
Where are they required? Dwelling unit bedrooms. 2010 whole home.
What do inspectors look for? Combo type if permitted in 2008.

SELECTIVE COORDINATION
Where is it being enforced?
What must I do to comply?
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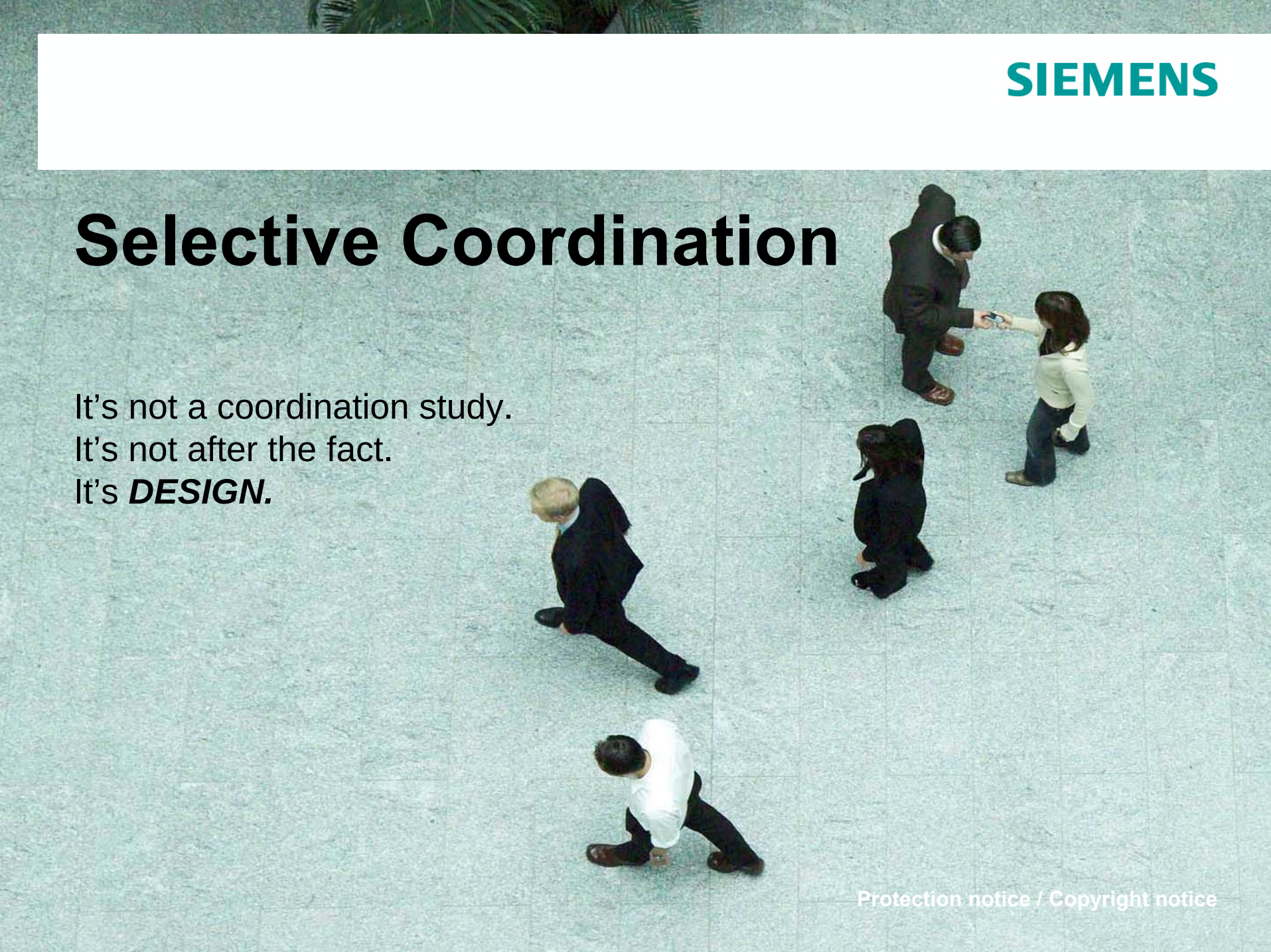
Selective Coordination



It’s not a coordination study.
It’s not after the fact.
It’s ***DESIGN.***

What is Selective Coordination?

The present Selective Coordination issue

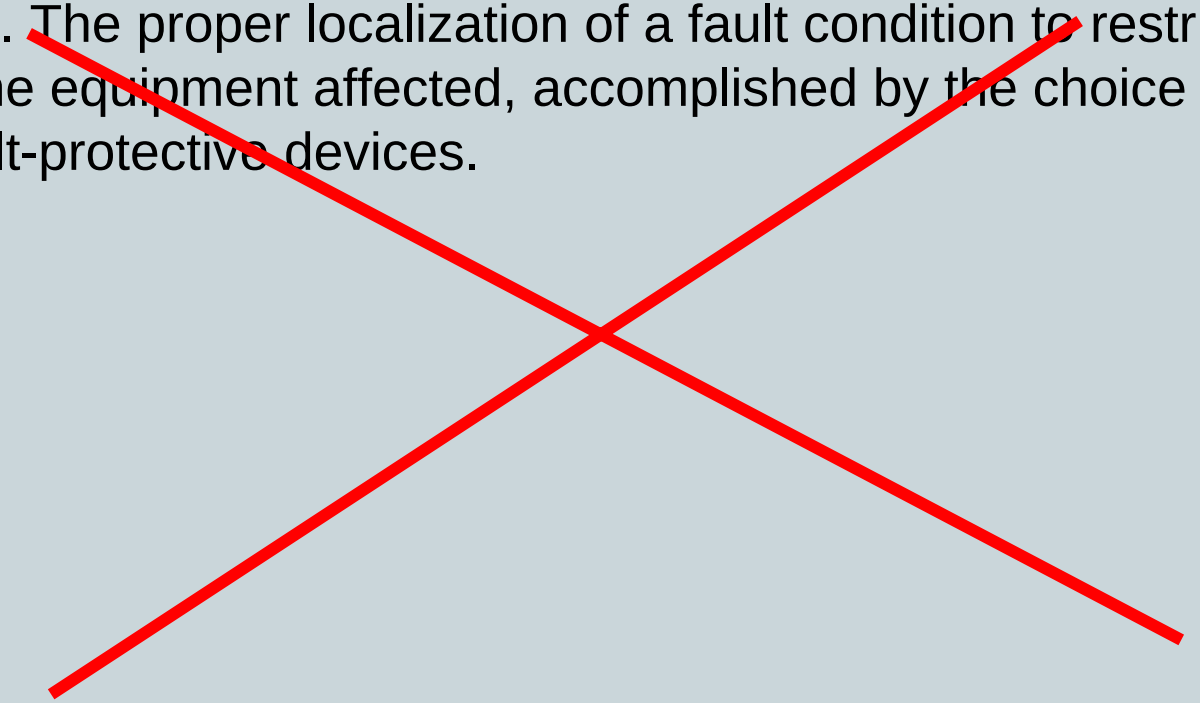
IS NOT the same as normal coordination.

HAS NOTHING TO DO WITH coordination studies or field settings done during or after construction.

HAS NOT been required NEC in the past except in rare elevator jobs.

Article 240 – Overcurrent Protection

240.2 Definitions.
Coordination. The proper localization of a fault condition to restrict outages to the equipment affected, accomplished by the choice of selective fault-protective devices.



2005 NEC

Article 100

Coordination (Selective). Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the choice of overcurrent protective devices and their ratings or settings.

Brad's Definition: *On a fault, only the first upstream devices trips.*

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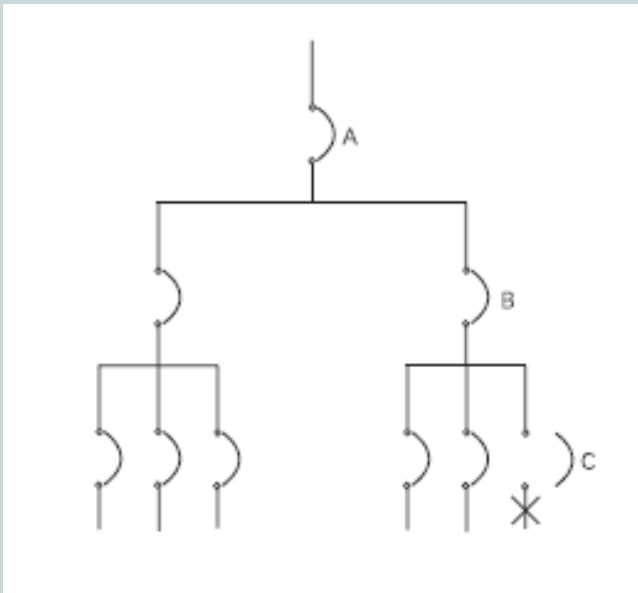
What is Selective Coordination?

Normal coordination (coordination studies) attempts to reduce nuisance tripping by adjusting breakers – some overlap still occurs (more than one breaker could trip due to a fault)
Selective coordination guarantees that only one breaker trips so that only the affected branch circuit is opened



2005 NEC

Elevators, Dumbwaiters, Escalators, Moving Walks, Wheelchair and Stairway Lifts where more than one disconnecting means is supplied by the same feeder (620.62)

Emergency Systems (700.27)

Legally Required Standby Systems (701.18)

Essential Electrical Systems (517.26)

Critical Operations Power Systems (708.1)

Article 620 – Elevators, etc.

620.62 Selective Coordination. Where more than one driving machine disconnecting means is supplied by a single feeder, the overcurrent protective devices in each disconnecting means shall be selectively coordinated with any other supply side overcurrent protective devices.

How do I solve this?
One elevator per circuit.

2008 NEC

Now you also need to worry about the COPS

What is COPS?

708.1 Scope.
... **C**ritical **O**perations **P**ower **S**ystems are those systems so classed by state, federal, municipal or other codes by any governmental agency having jurisdiction or by facility engineering documentation establishing the necessity for such a system. These systems include but are not limited to power systems, HVAC, fire alarm, security, communications, and signaling for designated critical operations areas.

708.54 Coordination. Critical Operations Power System(s) overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices.

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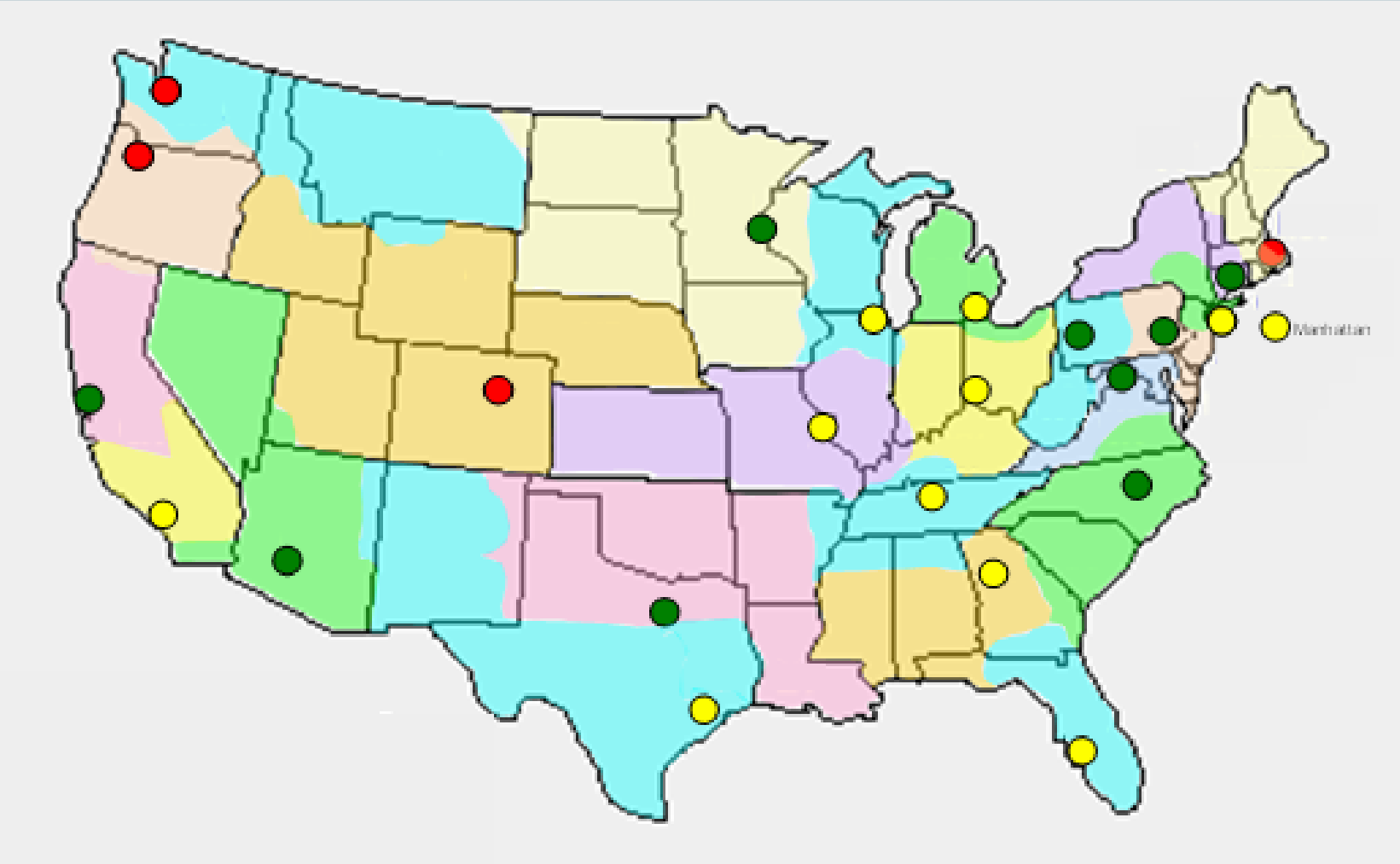
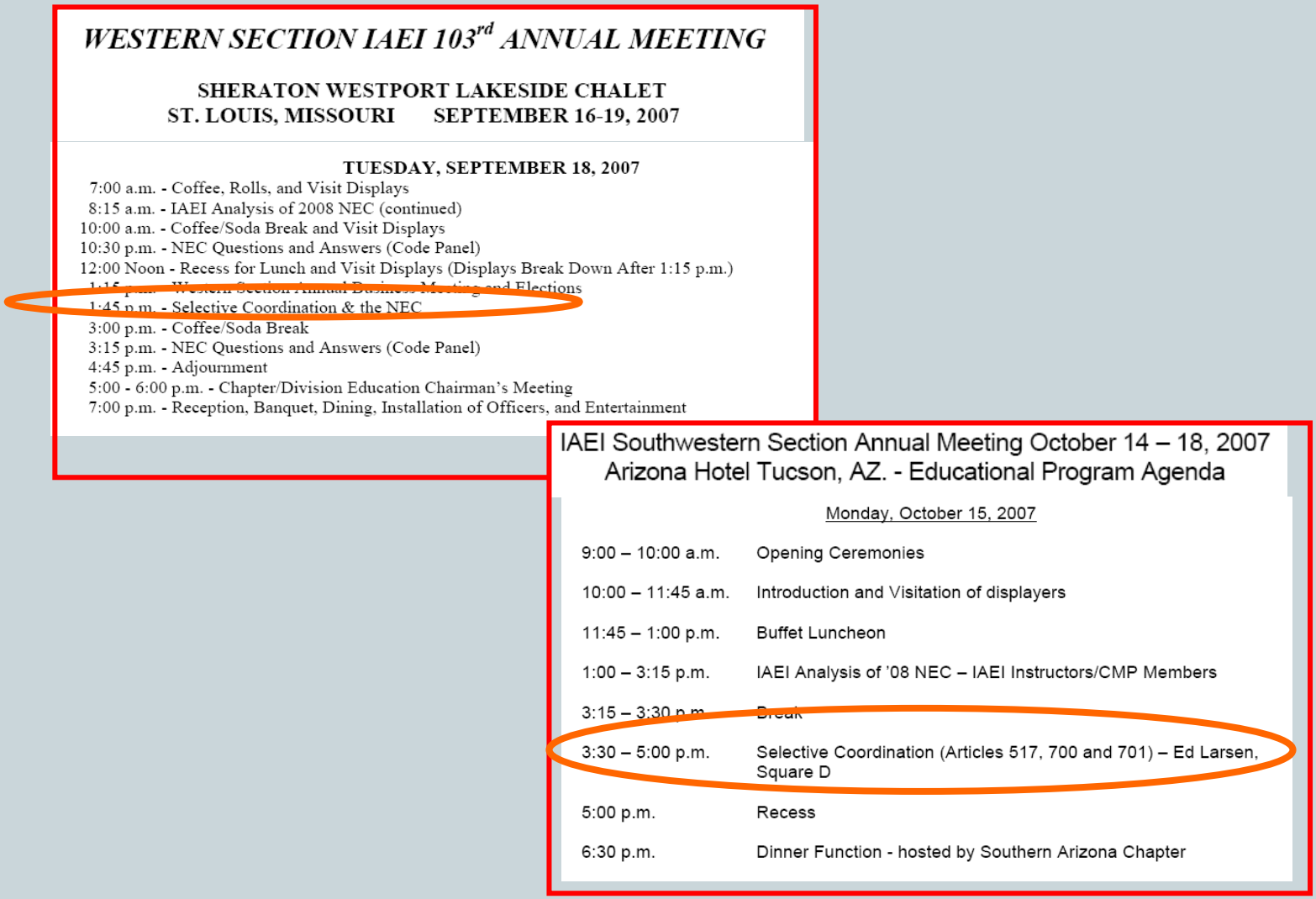
Enforcement Activity as of January 2008



Electrical Inspectors



WESTERN SECTION IAEI 103rd ANNUAL MEETING

SHERATON WESTPORT LAKESIDE CHALET
ST. LOUIS, MISSOURI SEPTEMBER 16-19, 2007

TUESDAY, SEPTEMBER 18, 2007

7:00 a.m. - Coffee, Rolls, and Visit Displays
8:15 a.m. - IAEI Analysis of 2008 NEC (continued)
10:00 a.m. - Coffee/Soda Break and Visit Displays
10:30 p.m. - NEC Questions and Answers (Code Panel)
12:00 Noon - Recess for Lunch and Visit Displays (Displays Break Down After 1:15 p.m.)
1:15 p.m. - Western Section Annual Business Meeting and Elections
1:45 p.m. - Selective Coordination & the NEC
3:00 p.m. - Coffee/Soda Break
3:15 p.m. - NEC Questions and Answers (Code Panel)
4:45 p.m. - Adjournment
5:00 - 6:00 p.m. - Chapter/Division Education Chairman's Meeting
7:00 p.m. - Reception, Banquet, Dining, Installation of Officers, and Entertainment

IAEI Southwestern Section Annual Meeting October 14 – 18, 2007
Arizona Hotel Tucson, AZ. - Educational Program Agenda

Monday, October 15, 2007

9:00 – 10:00 a.m.	Opening Ceremonies
10:00 – 11:45 a.m.	Introduction and Visitation of displayers
11:45 – 1:00 p.m.	Buffet Luncheon
1:00 – 3:15 p.m.	IAEI Analysis of '08 NEC – IAEI Instructors/CMP Members
3:15 – 3:30 p.m.	Break
3:30 – 5:00 p.m.	Selective Coordination (Articles 517, 700 and 701) – Ed Larsen, Square D
5:00 p.m.	Recess
6:30 p.m.	Dinner Function - hosted by Southern Arizona Chapter

Tools

Charts and Calculators

240Vac			
Main Amps	Main Breaker	Branch Coordination Level	1, 2, and 3 Pole Branch Breakers
100A	ED4, ED6 100A	1kA	15-60A BL, BLH, BLF, BLHF, BAF, BAFH, QP, QPH, QF, QFH, QAF, QAFH
	FD 175A	1.5kA	15-80A BL, BLH, BLF, BLHF, BAF, BAFH, QP, QPH, QF, QFH, QAF, QAFH
			15-70A ED
250A	FD 250A	3kA	15-100A BL, BLH, BLF, BLHF, BAF, BAFH, QP, QPH, QF, QFH, QAF, QAFH
	JD 250A		15-125A ED
			70-150A FD
400A	JD 400A	10kA	15-70A BL, BLH, BLF, BLHF, BAF, BAFH, QP, QPH, QF, QFH, QAF, QAFH
	LD 400A	8kA	80-100A BL, BLH, BLF, BLHF, BAF, BAFH, QP, QPH, QF, QFH, QAF, QAFH
		3.6kA	15-125 ED
			70-250A FD
			200-250A JD
	SLD6-A	10kA	15-100A BL, BLH, BLF, BLHF, BAF, BAFH, QP, QPH, QF, QFH, QAF, QAFH
	600/400A	6.4kA	15-125 ED
			70-250A FD
			200-300A JD, LD
	SBS1200/400A	30kA	15-125A NGB, NGG
	LS Trip	25kA	15-125A ED
			70-250A FD
			200-250A JD
		22kA	15-100A BLH, BLHF, BAFH, QPH, QFH, QAFH
		10kA	15-100A BL, BLF, BAF, QP, QF, QAF
	SBS2000/400A	42kA	15-125A NGB, NGB
	LS Trip	35kA	15-125A ED
			70-250A FD
			200-250A JD
		22kA	15-100A BLH, BLHF, BAFH, QPH, QFH, QAFH

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Tools

Charts and Calculators

Time Current Curves are improving. The difficulty is that they do not show the dynamic impedance of the arc or the current limiting properties of the breaker.

Old style TCC's unnecessarily penalize breaker manufacturers.

The true performance is dependent on the upstream device.

Manufacturers charts or the Siemens Selective Coordination Tool are the better ways to determine if your system is in compliance.

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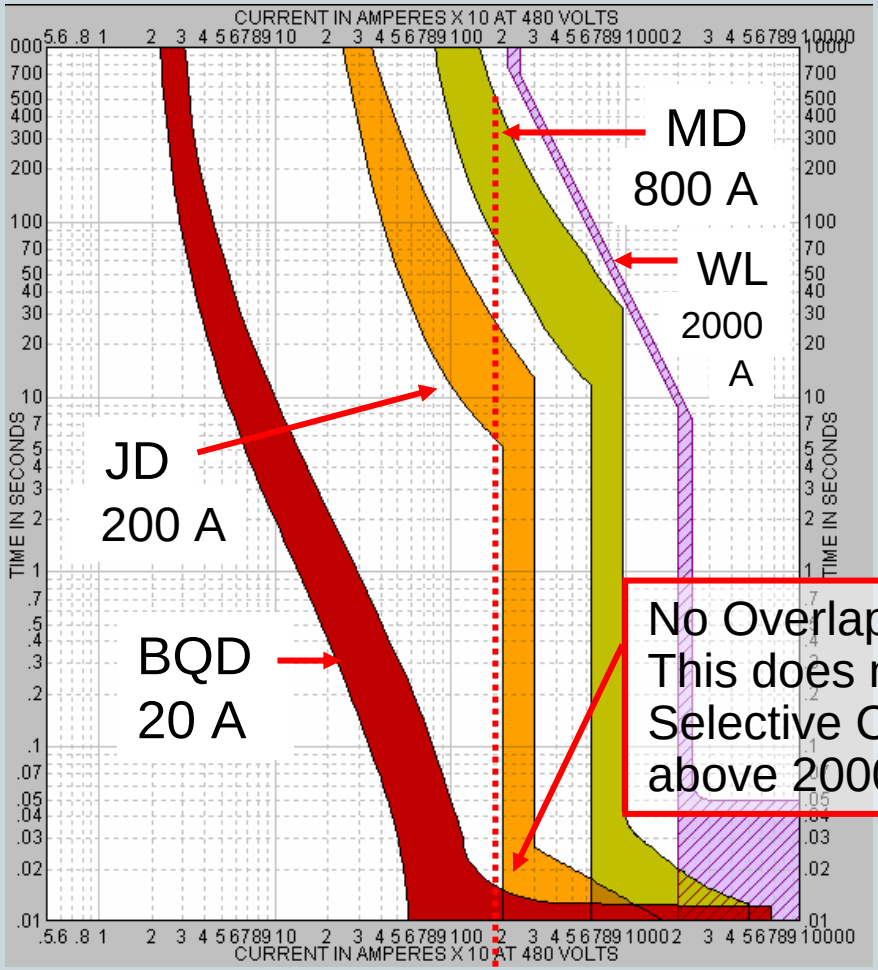
Typical Condition

2000A Main, 800A Distribution, 200A Panel, 20A Branch



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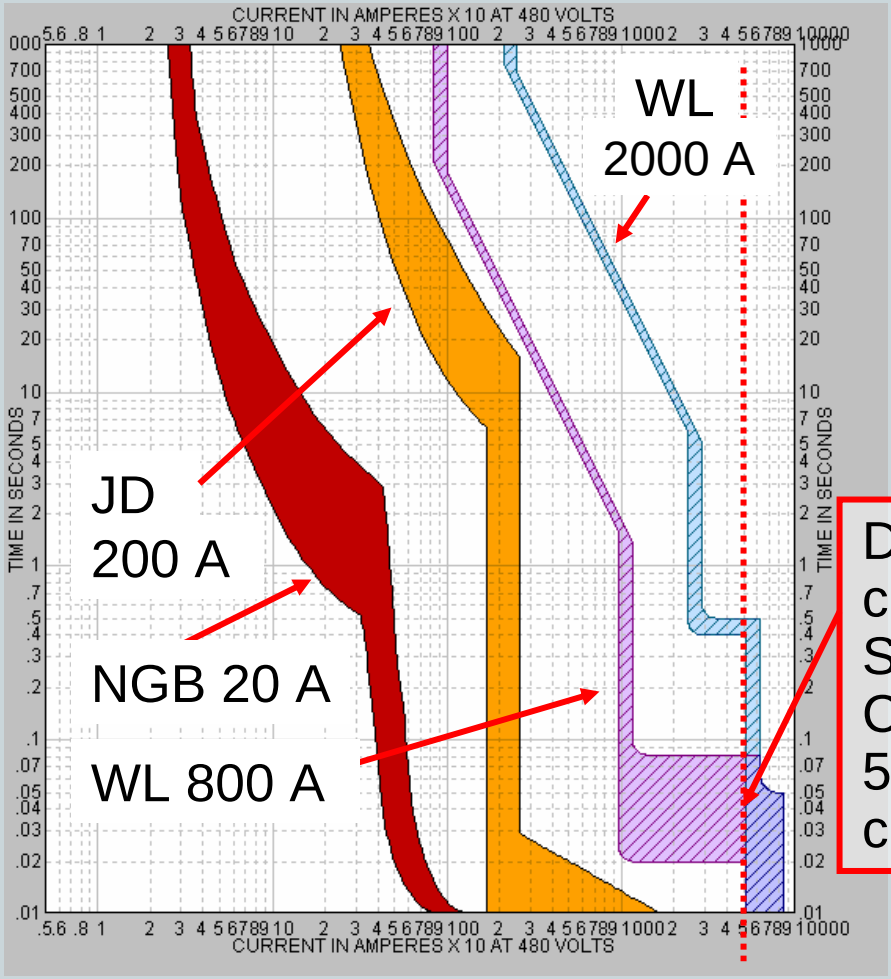
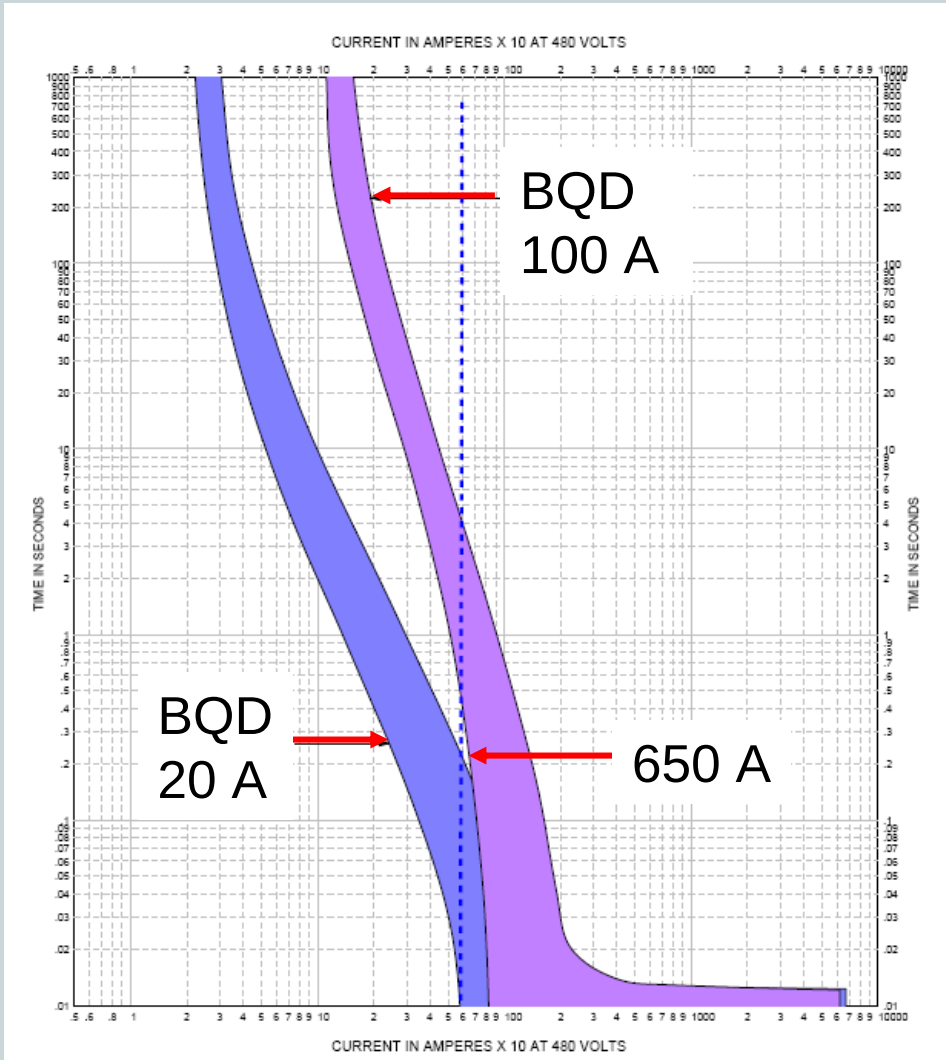


Different devices chosen to allow Selective Coordination up to 50kA available fault current

Typical Condition



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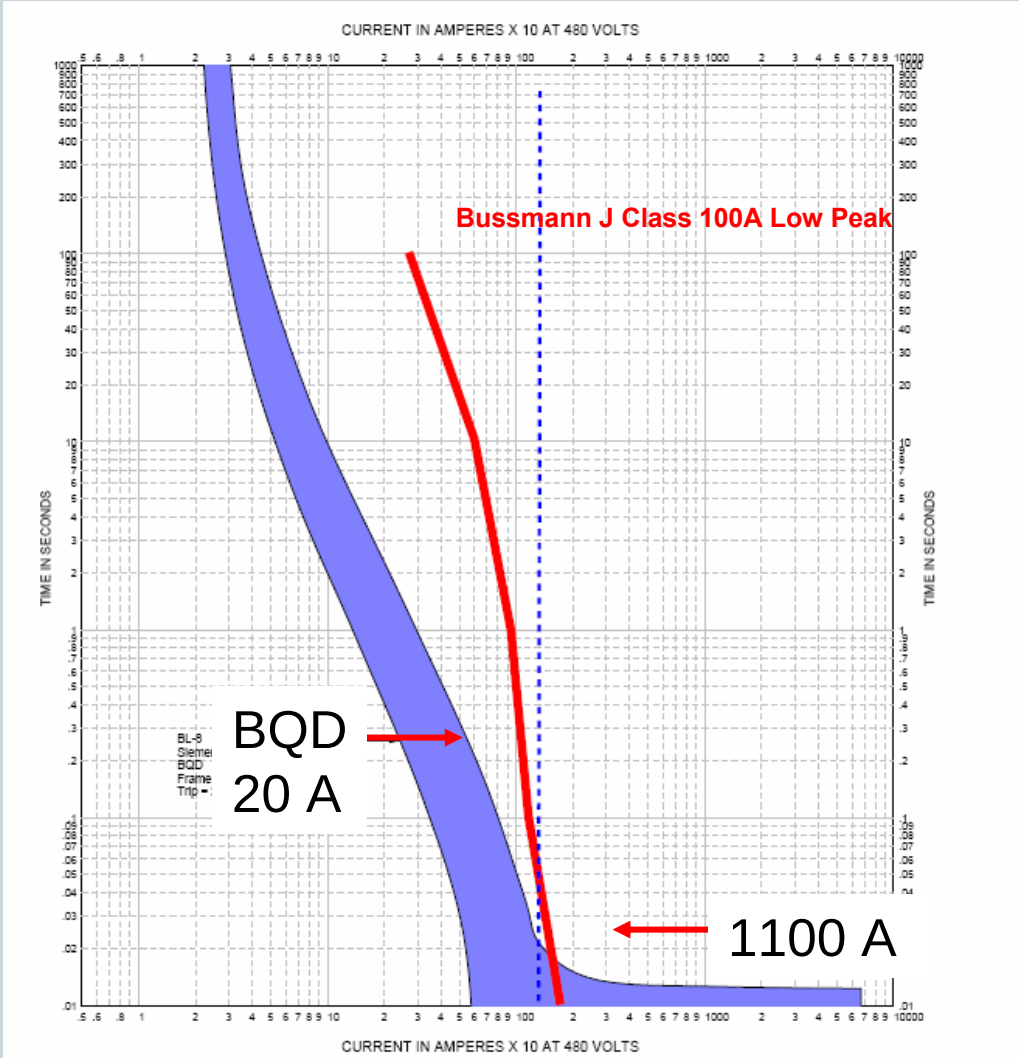

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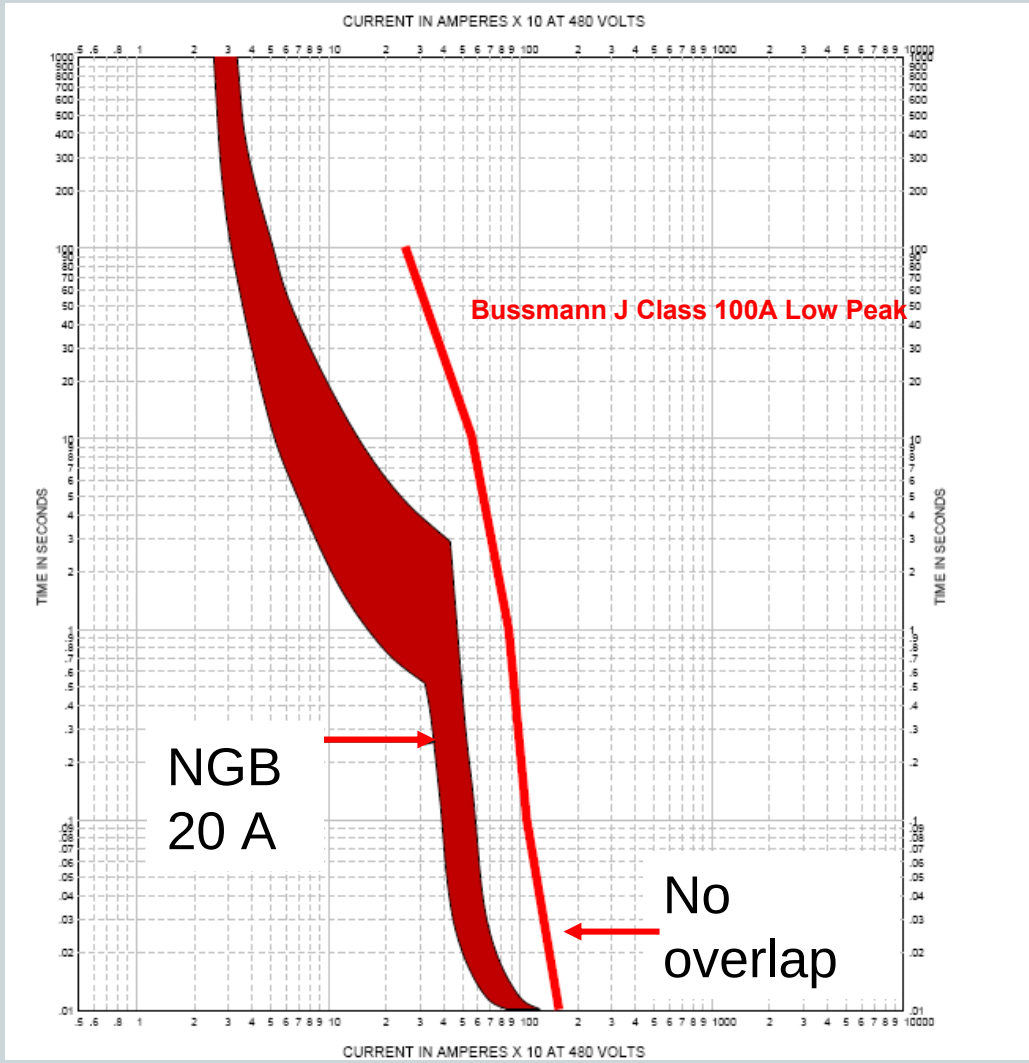

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Are Fuses the Solution?

Traditional disadvantages of fuses remain:

Additional hazard to owner and requires training

Misapplications can occur

Single phasing hazard

Spares and storage required

Proper coordination

Additionally, arc flash hazards can occur for any device

Table 3-3.9.1 Hazard Risk Category Classification

Panelboards and Switchboards rated 241V to 600V

	Hazard/Risk Category	V-rated Gloves	V-Rated Tools
Circuit Breaker (CB) or Fused switch operation with cover on	0	No	No
Circuit Breaker (CB) or Fused switch operation with cover off	1	No	No
Work on energized parts including voltage testing.	2*	Yes	Yes

Selective Coordination and Arc Flash

Selective Coordination is required by NEC 2005.
Curves must not overlap or the devices must be a listed pair.
One method is to raise the time delay or set instantaneous higher which allows increased arc flash energy.

Example	Bolted Fault (kA)	Arcing Fault (kA)	Clearing Time (sec)	Incident Energy/PPE
A	30	15.72	0.13	
B	24	13.06	1.25	

Selective Coordination and Arc Flash

Selective Coordination is required by NEC 2005.
Curves must not overlap or the devices must be a listed pair.
One method is to raise the time delay or set instantaneous higher which allows increased arc flash energy.

Example	Bolted Fault (kA)	Arcing Fault (kA)	Clearing Time (sec)	Incident Energy/PPE
A	30	15.72	0.13	7.0 cal/cm^2 Level 2.
B	24	13.06	1.25	53.7 cal/cm^2 Level > 4.

Selective Coordination and Arc Flash

Perhaps your solution is ... “I’ll just use the tables in NFPA 70E – Table 3-3.9.1.”

Example	Arcing Fault (kA)	Table 3-3.9.1		Actual
208V Panelboard	4.2 kA	1		?
480V MCC	16.0 kA	2		?

Table Category 1 (FR Shirt and Pants)
Table Category 2 (FR Shirt, Pants, Gloves, Hearing Protection, with Double Layer Hood)

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Selective Coordination and Arc Flash

Perhaps your solution is ... “I’ll just use the tables in NFPA 70E – Table 3-3.9.1.”

Example	Arcing Fault (kA)	Table 3-3.9.1	Clearing Time (sec)	Actual
208V Panelboard	4.2 kA	1	>2 sec	?
480V MCC	16.0 kA	2	0.01 sec	?

Table Category 1 (FR Shirt and Pants)
Table Category 2 (FR Shirt, Pants, Gloves, Hearing Protection, with Double Layer Hood)

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Selective Coordination and Arc Flash

Perhaps your solution is ... “I’ll just use the tables in NFPA 70E – Table 3-3.9.1.”

Example	Arcing Fault (kA)	Table 3-3.9.1	Clearing Time (sec)	Actual
208V Panelboard	4.2 kA	1	>2 sec	4
480V MCC	16.0 kA	2	0.01 sec	0

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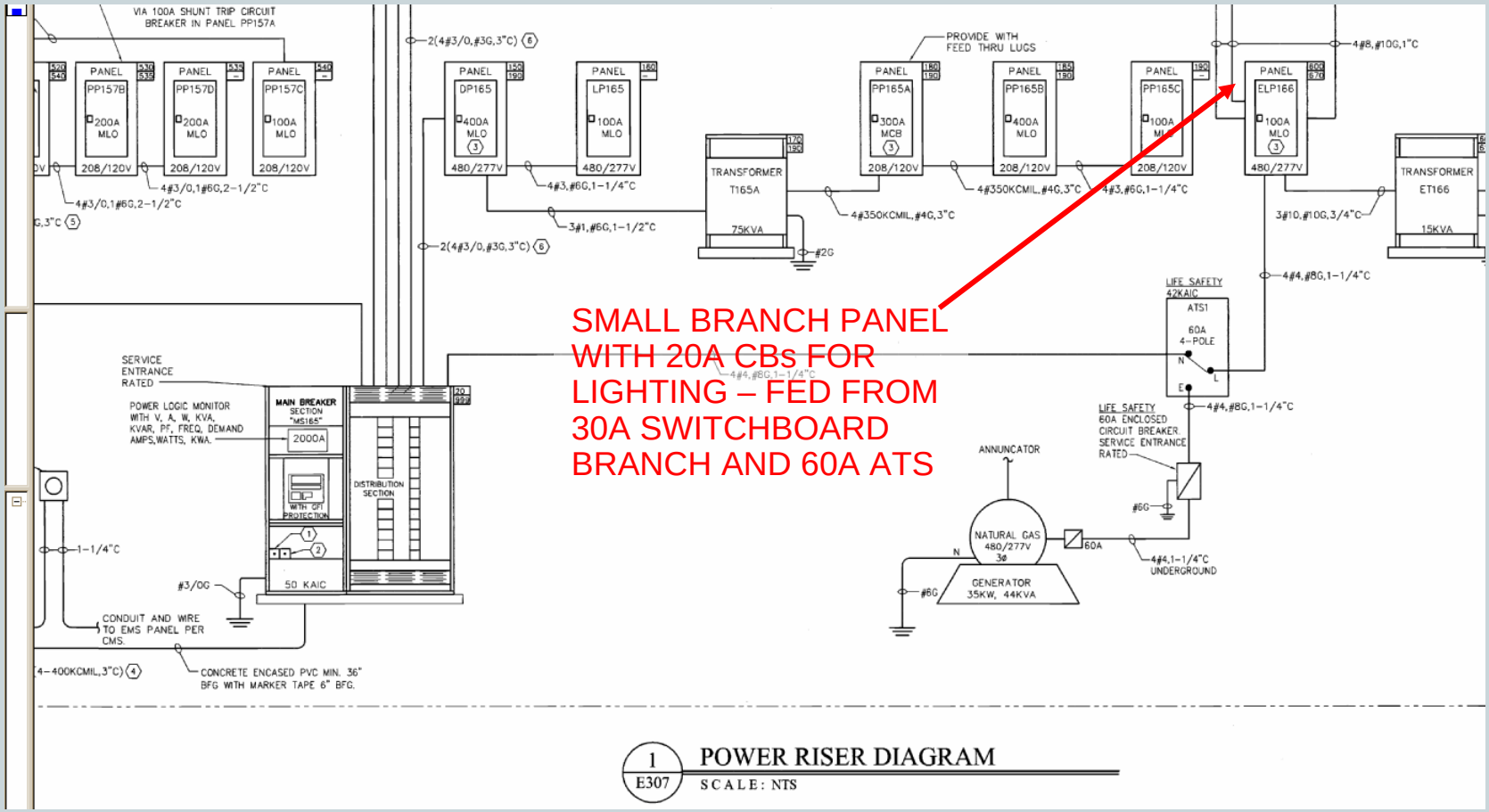
OSHA Mandates Compliance

OSHA announces employer-paid PPE final rule

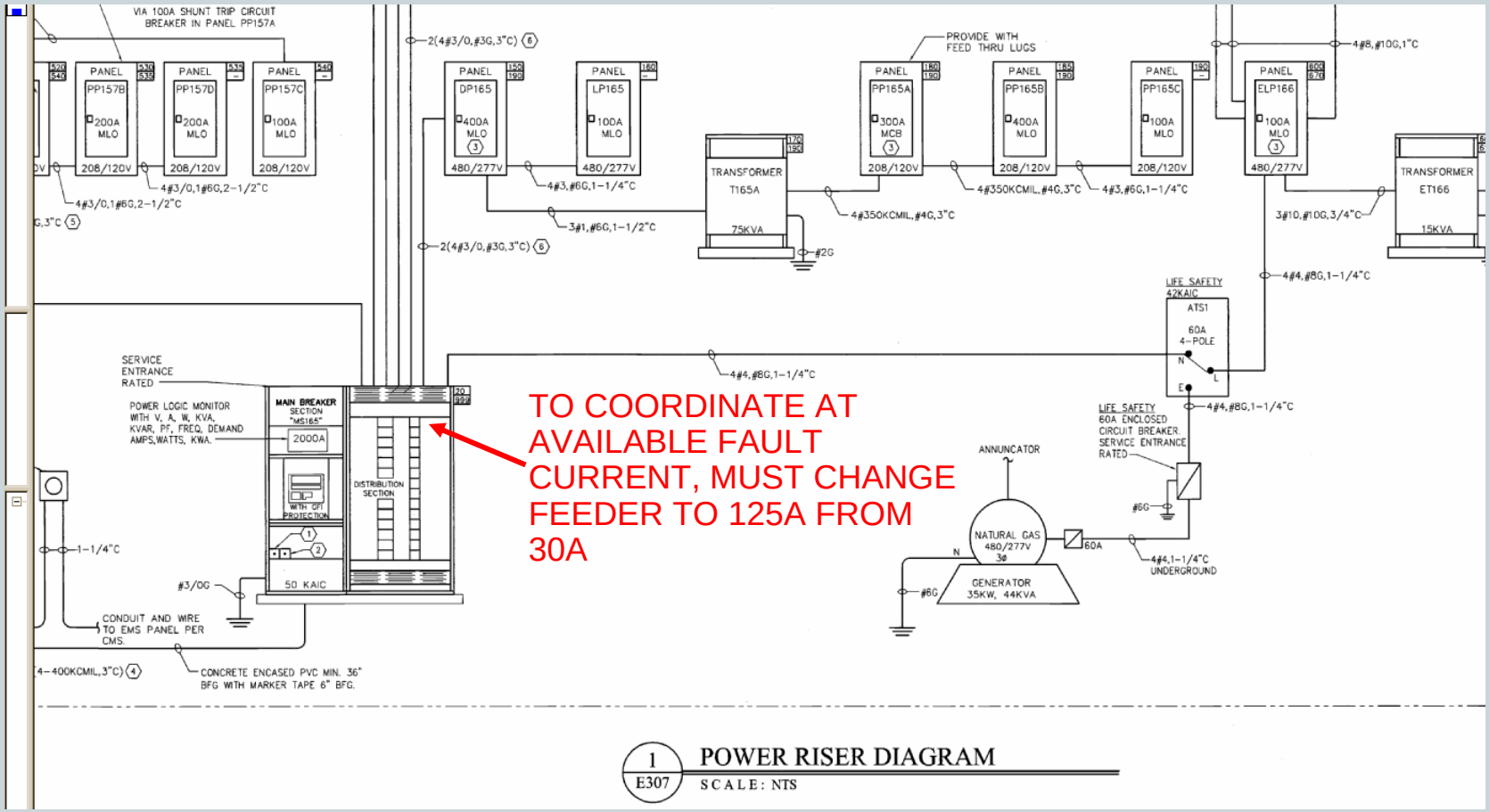
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=NEWS_RELEASES&p_id=14739

WASHINGTON -- OSHA announced [on November 14, 2007] ... all PPE, with a few exceptions, will be provided at no cost to the employee. The rule will be published in the Federal Register on November 15, 2007. The rule also provides an enforcement deadline of six months from the date of publication to allow employers time to change their existing PPE payment policies to accommodate the final rule. "Employees exposed to safety and health hazards may need to wear PPE to be protected from injury, illness and death caused by exposure to those hazards," said Assistant Secretary of Labor for OSHA Edwin G. Foulke Jr. "This final rule will clarify who is responsible for paying for PPE, which OSHA anticipates will lead to greater compliance and potential avoidance of thousands of workplace injuries each year."

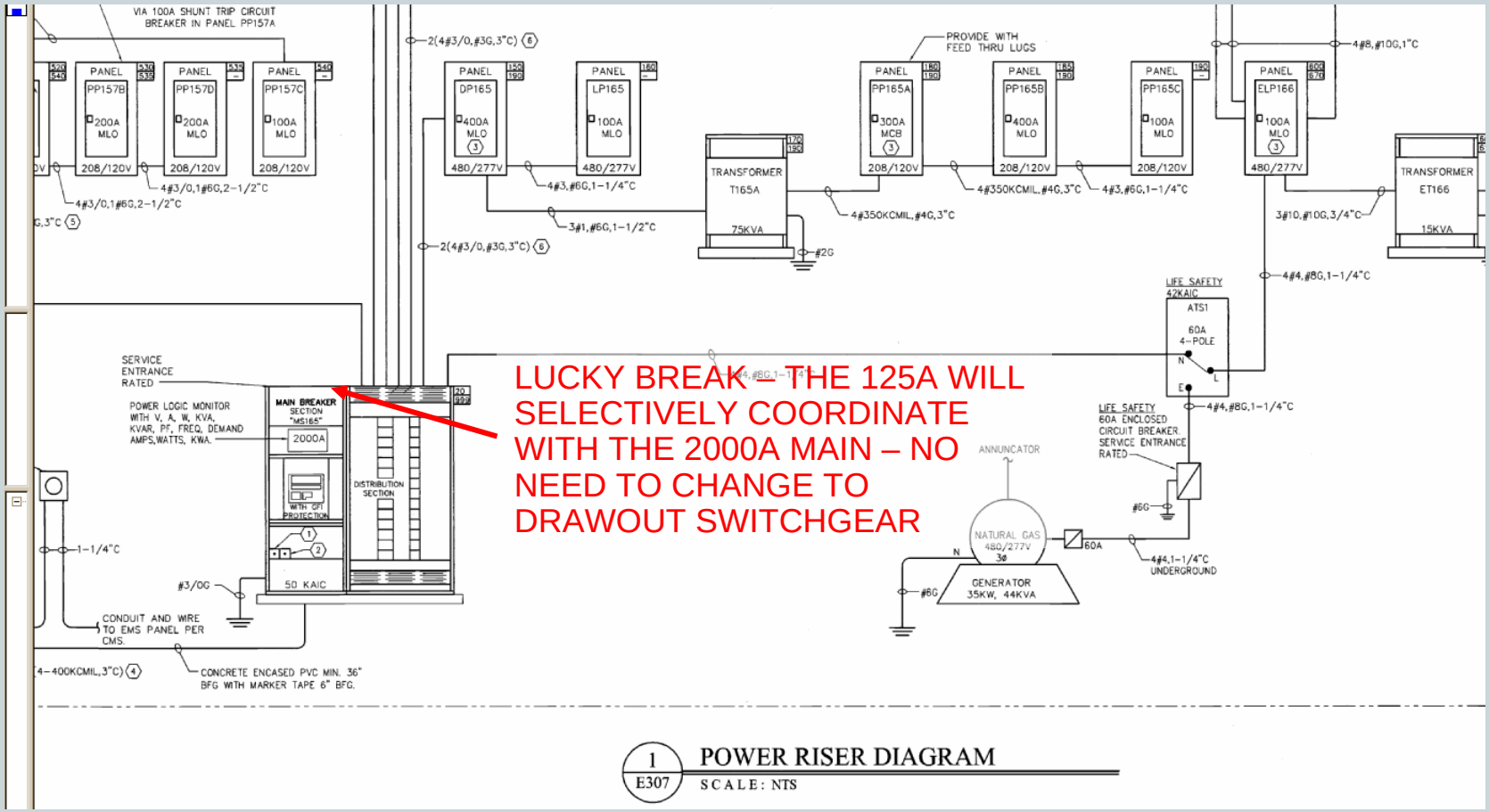
Example



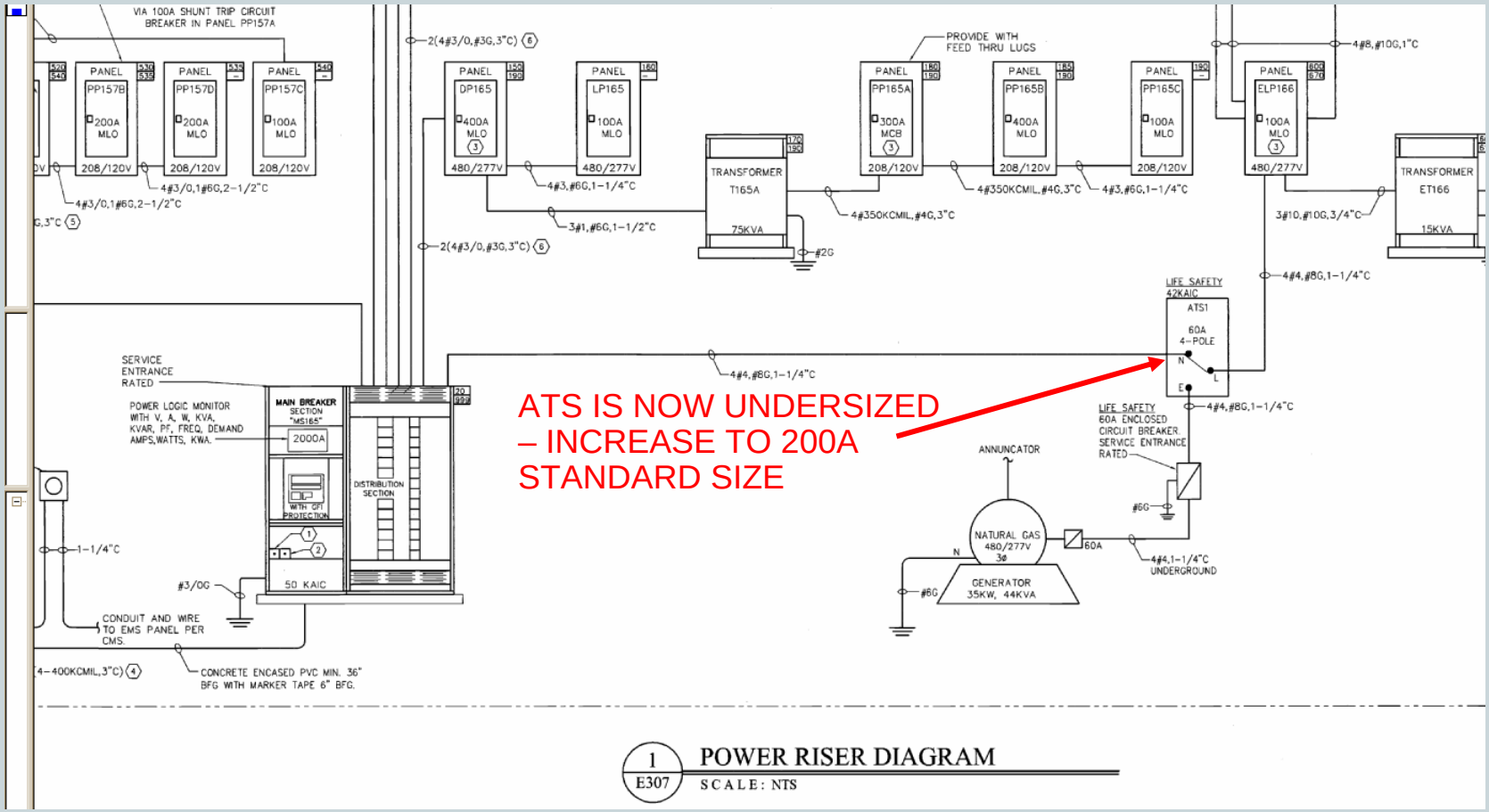
Example



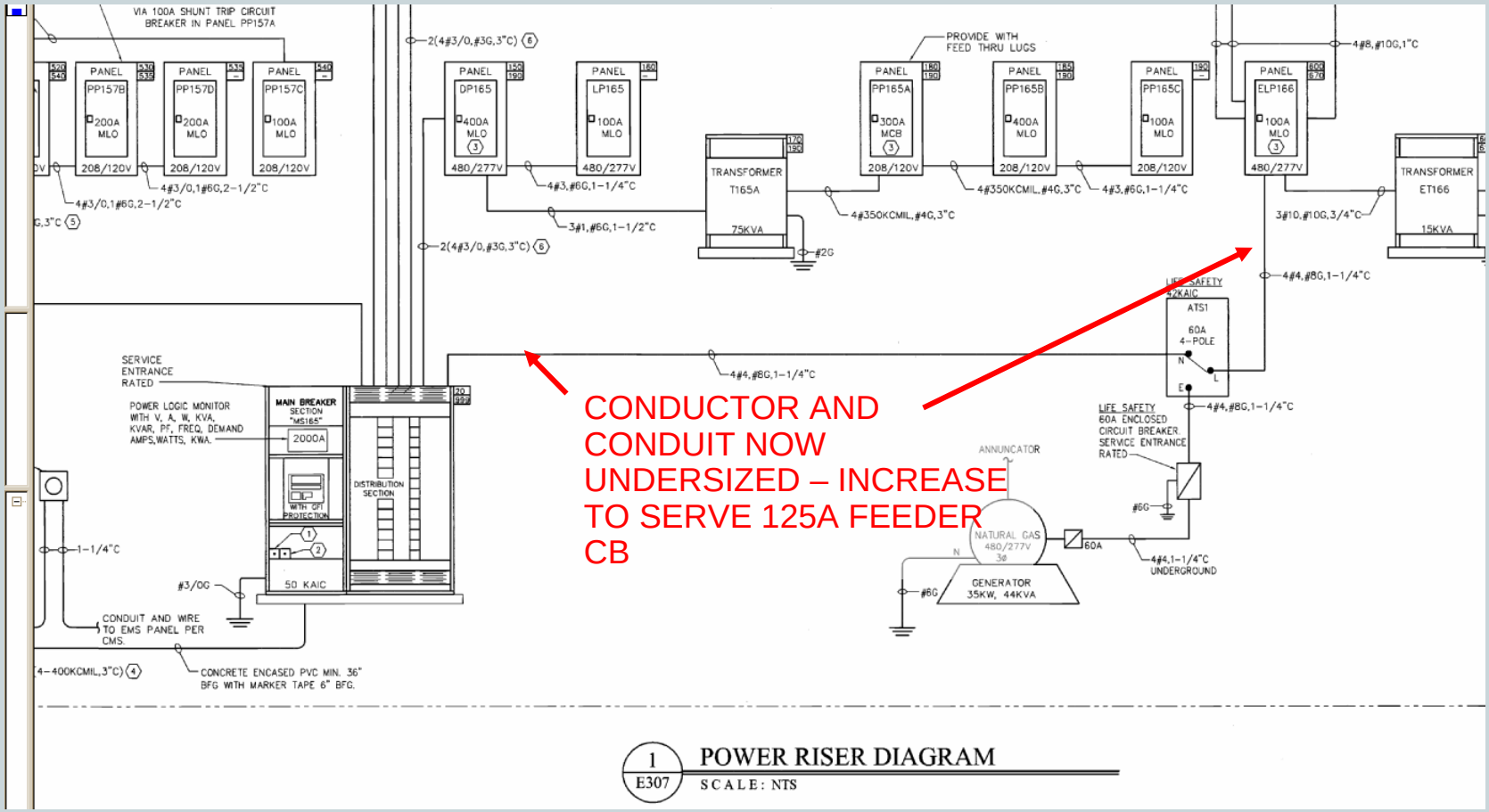
Example



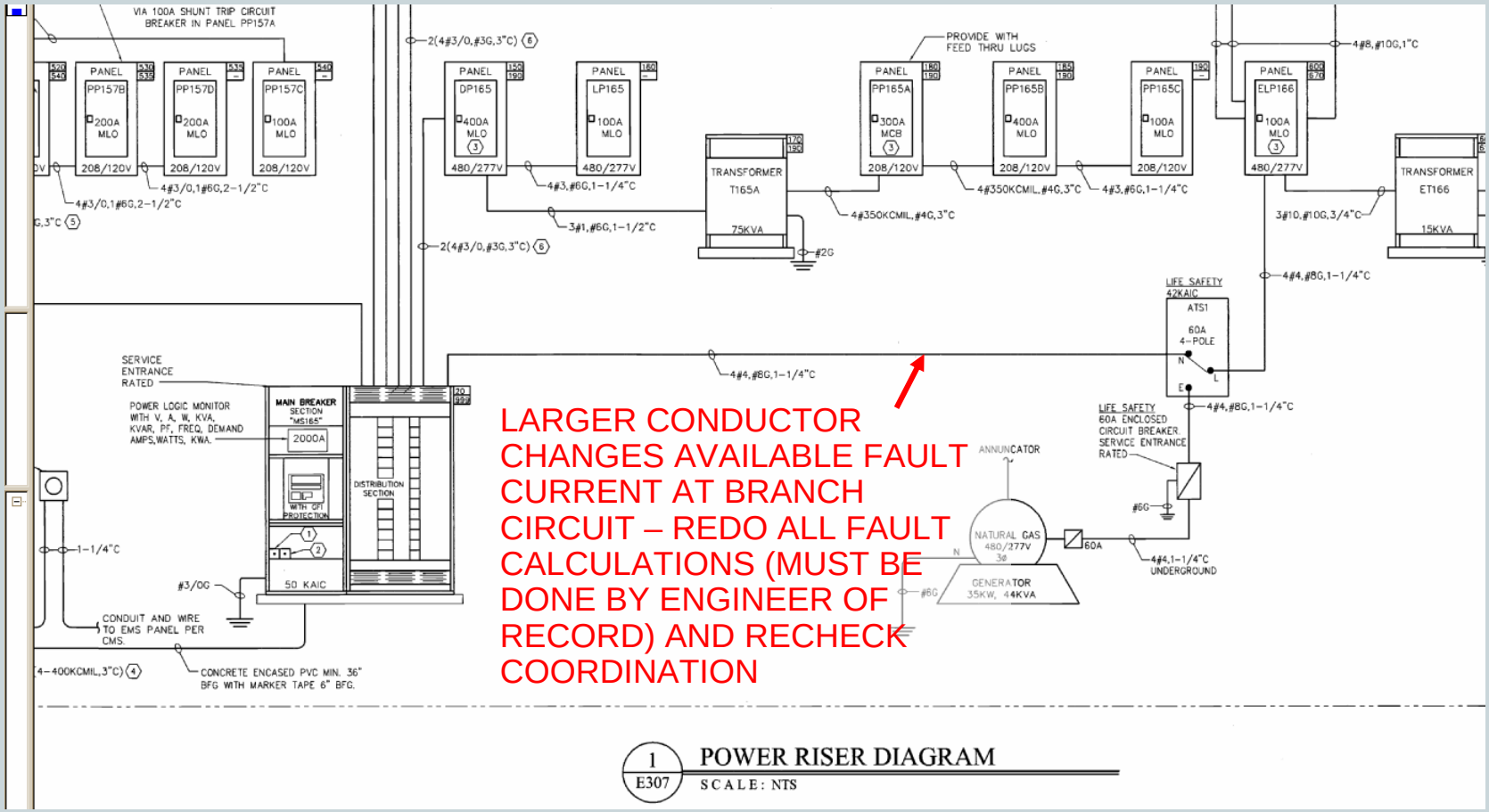
Example



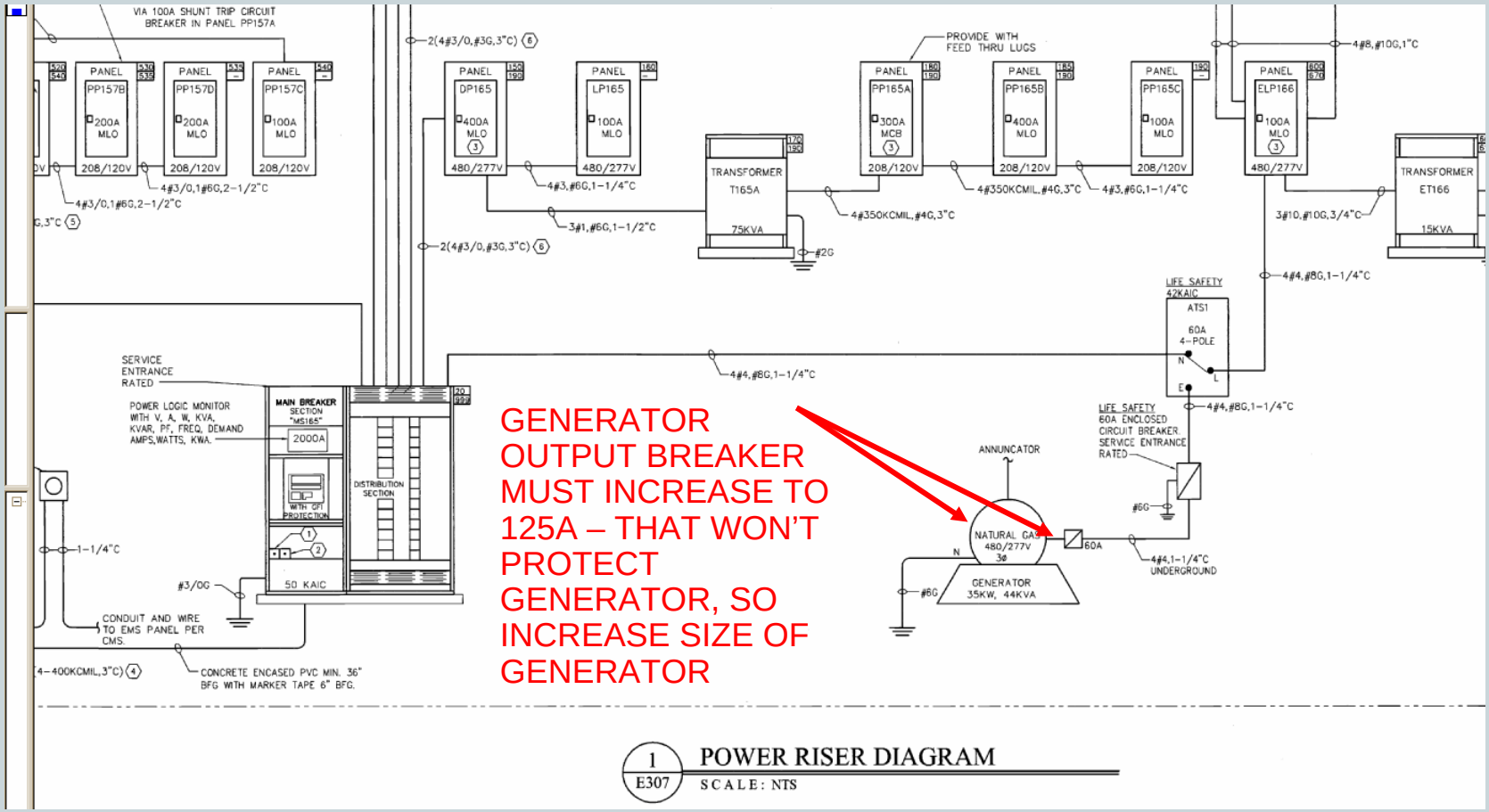
Example



Example



Example



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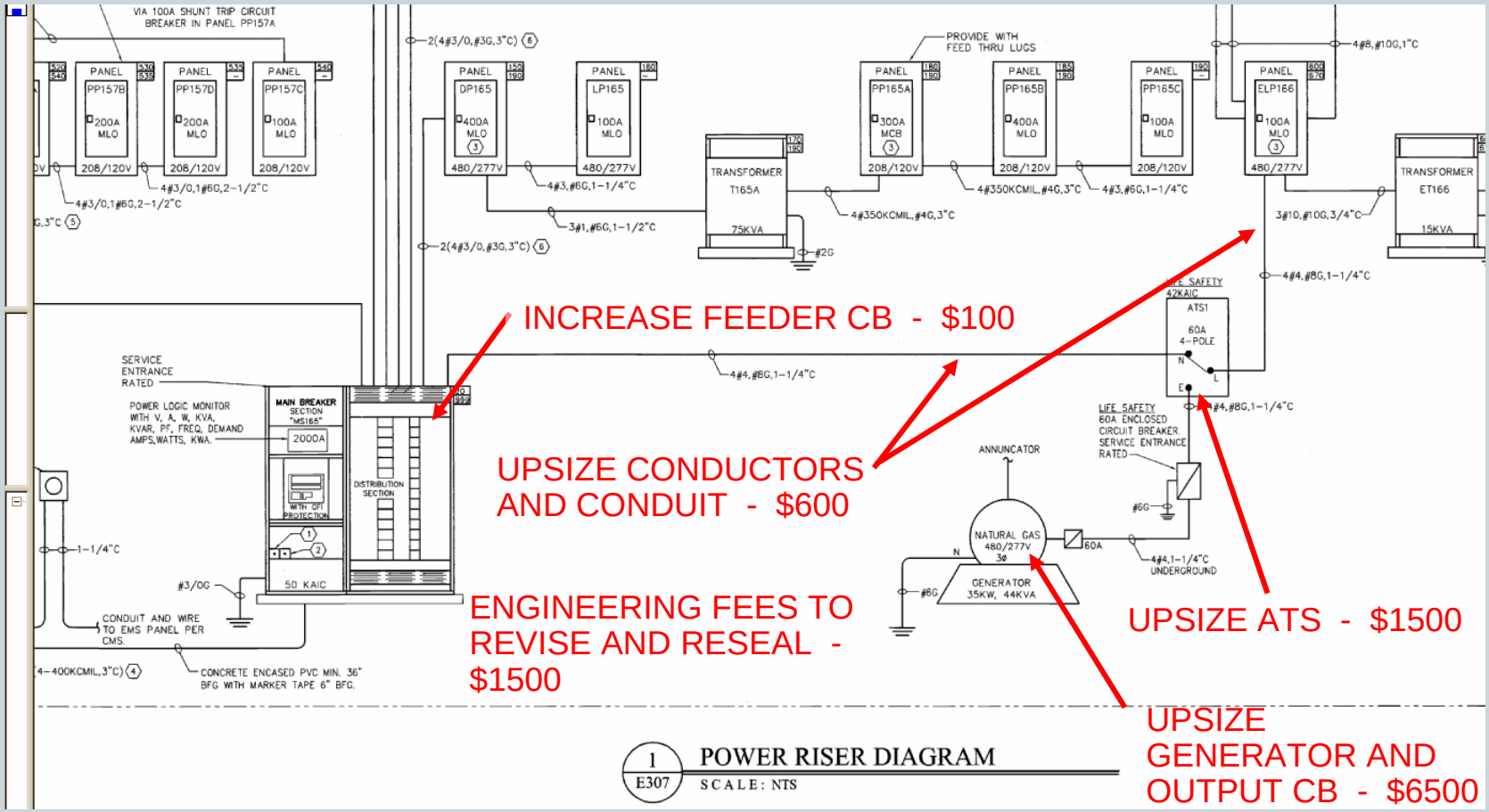
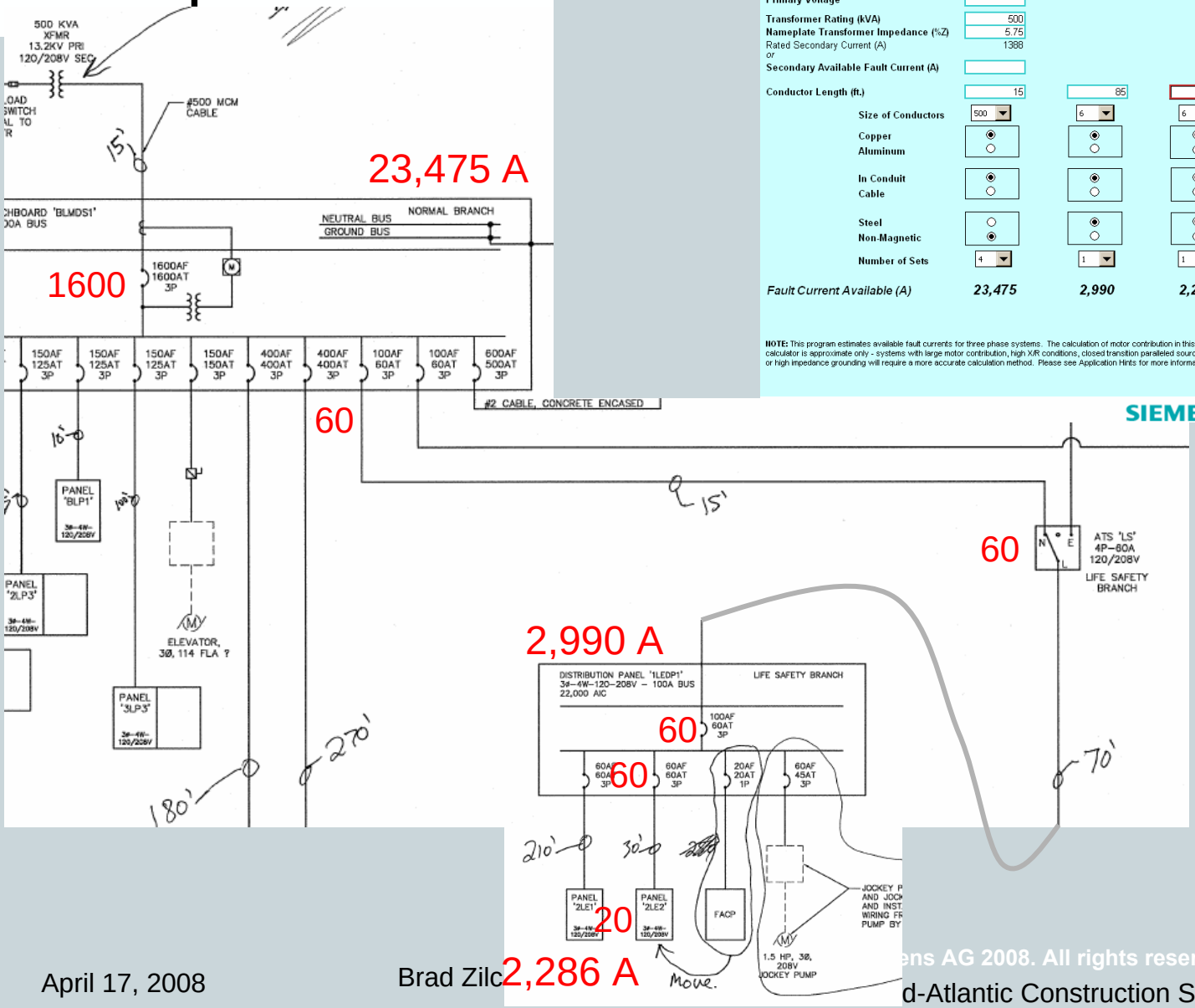
Example

Estimated Cost Of Changes To Selectively Coordinate



Even Worse Example

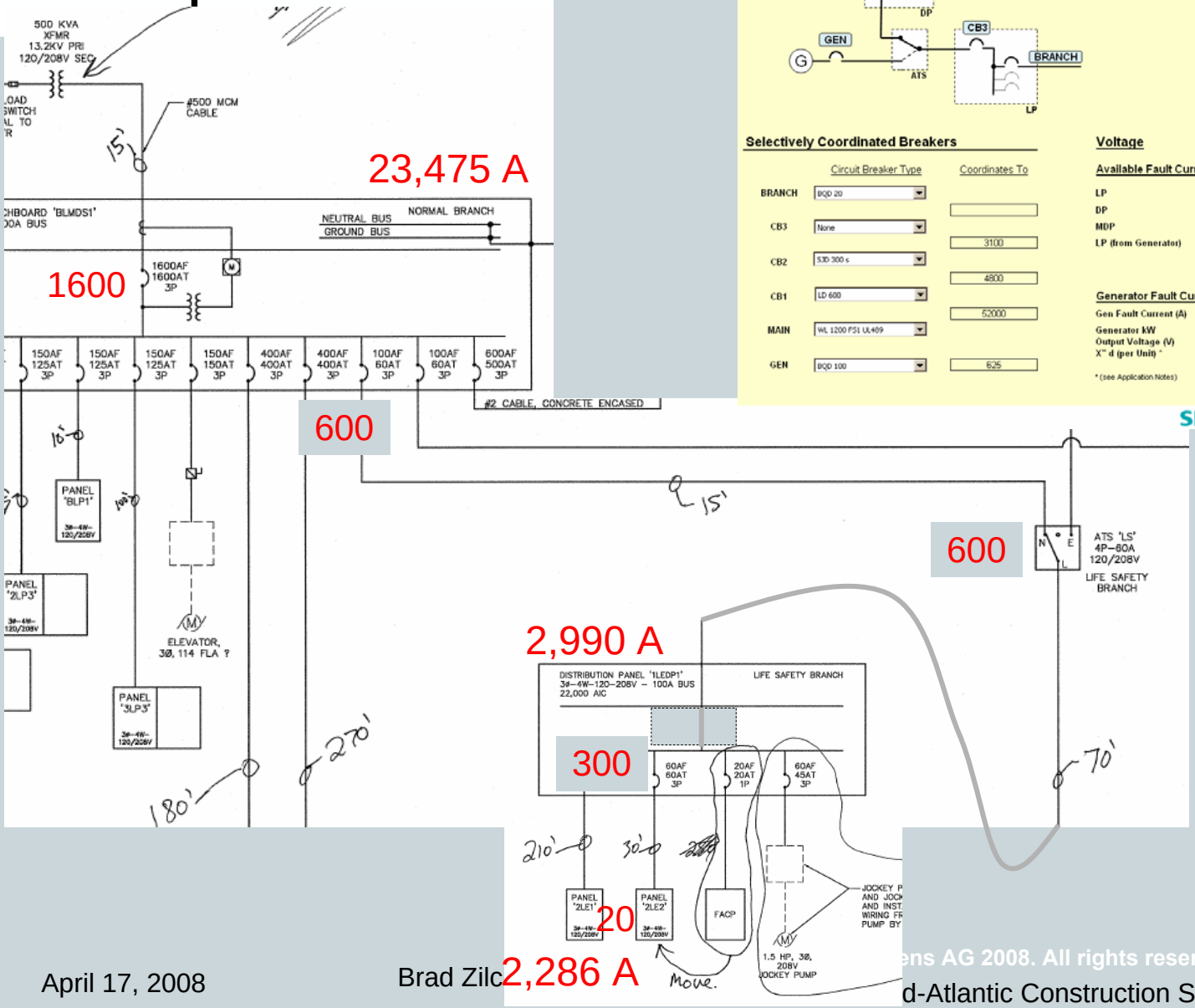


April 17, 2008

Brad Zilc

d-Atlantic Construction Sales

Even Worse Example



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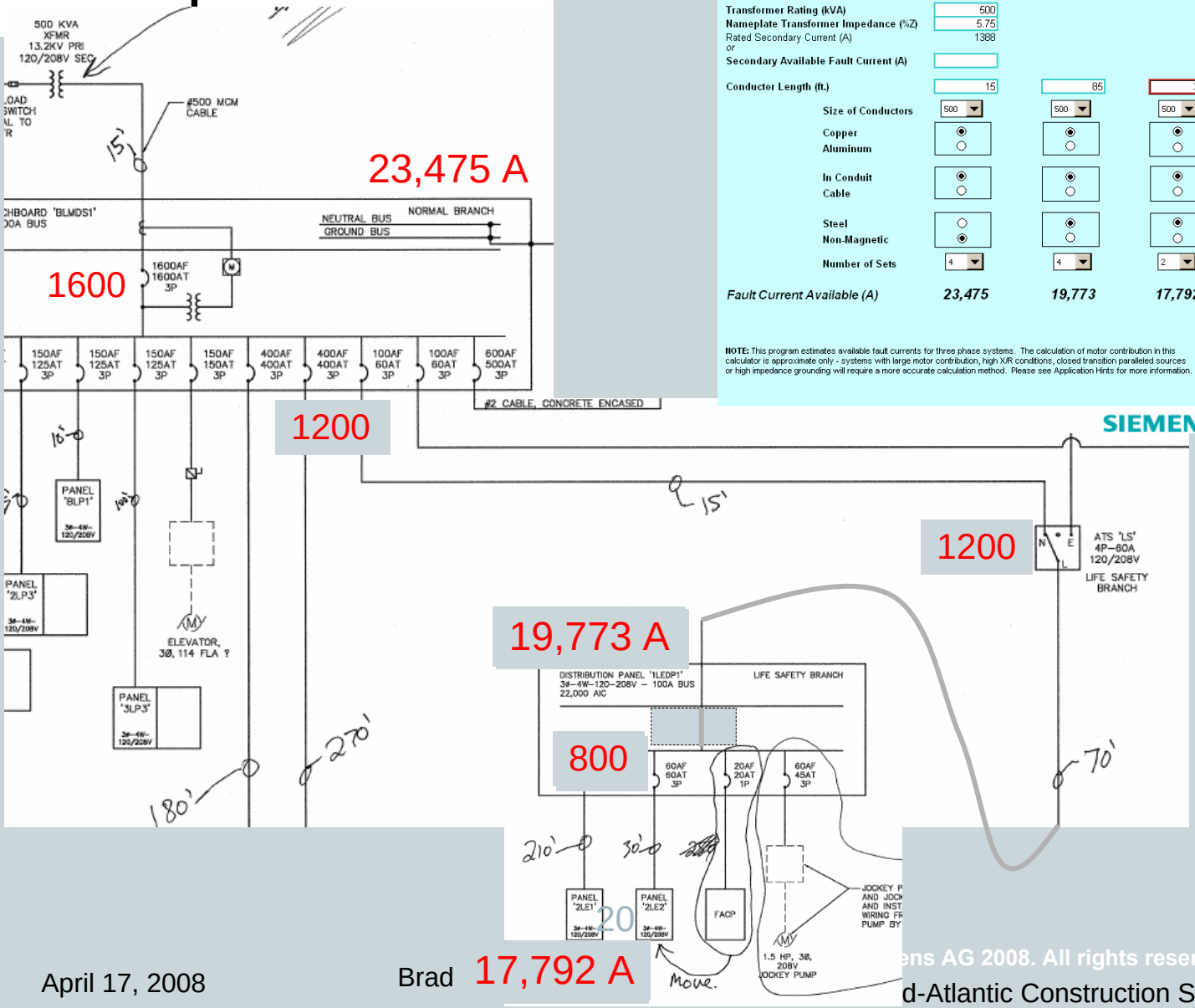
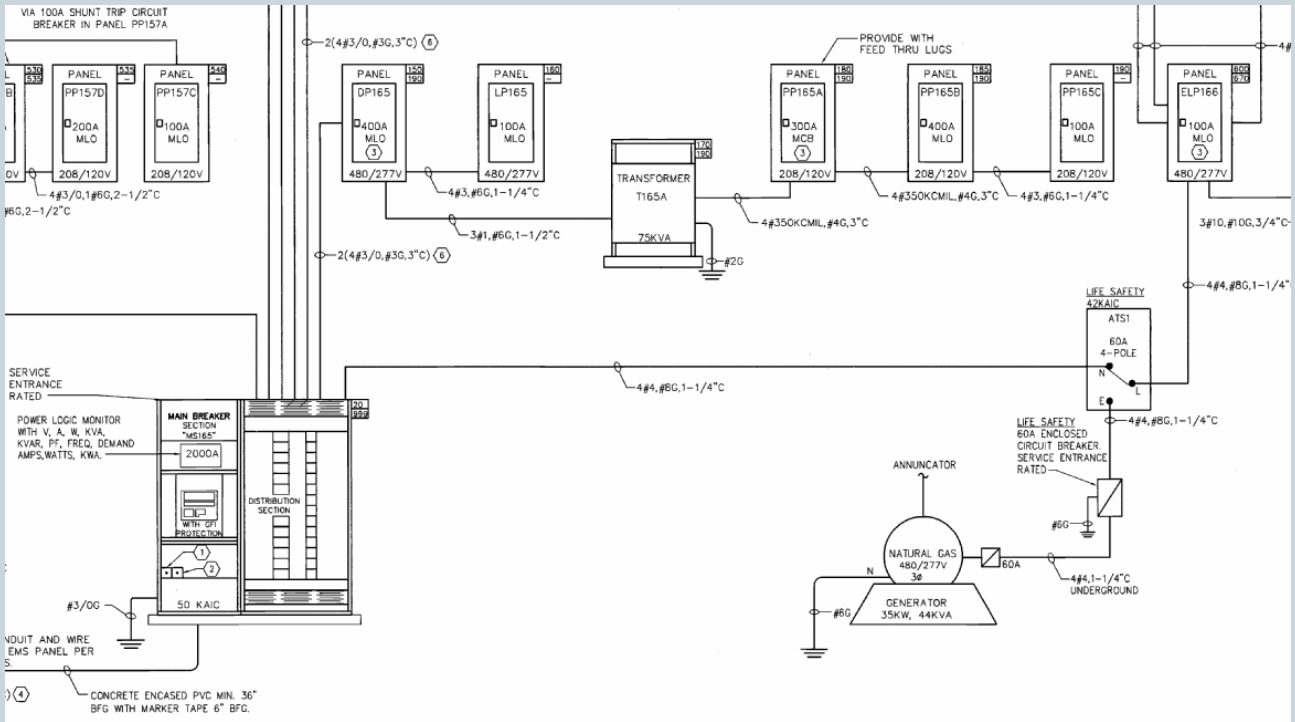


April 17, 2008

Brad

Mitigation

Less levels – feed from main switchboard



Solutions

John Brezan – Lehigh Valley Inspectors says...
Calculations must be done by the engineer at review time.

- Pre-Permitting
- Pre-Shell

Plans available on-site at the time of inspection.

Larry Griffith, Central PA Chapter, IAEI says...
Emergency systems require plan reviews with a copy of the plans present. The engineering firm must state on letterhead that Selective Coordination is done. The panels need to be marked with the make and model of the selectively coordinated upstream breaker(s).

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Solutions

1. Transformers per NEC 701.18 -- NEC 2005 vs. NEC 2008
2. Transformers per NEC 450.3B
3. Transformer Impedance
4. Cable Impedance
5. NGB Breakers from SIEMENS VL Breaker Line
6. Double Mains
7. Battery Packs

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Questions to Answer

TVSS
What is the benefit of UL 1449 2nd Edition *Revision*?
When is 2nd Edition *Revision* in effect?
Why was 2nd Edition *Revision* created?

AFCI's
When are they required?
Where are they required?
What do inspectors look for?

SELECTIVE COORDINATION
Where is it being enforced?
What must I do to comply?
If I miss it in a spec or if the AHJ is enforcing it now, am I in trouble?

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Thank you for your attention!