Getting the Most out your Electrical Room

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IEEE SF IAS

2/23/2010

Trends in Power

- Today vs. 20y ago
  - Increase in expectation to reduce space of non-revenue producing footprint
  - Increase in the expectation of value
    - Move toward greater energy efficiency
    - Move toward greater safety
    - Need for information pulled from power system

The energy dilemma is here to stay

The facts

×2

Energy demand

By 2050

Source: IEA 2007

vs.

The need

÷2

CO_2 emissions

to avoid dramatic climate changes

(vs. 1990 level)

Source: IPCC 2007

Energy management is the key to address the dilemma

Expectations

- Address some basic issues of conventional design
  - FAQ's from consultant community
  - UL standards comparison
  - Design consideration for proper selection of specified equipment

Expectations, cont.

- Address advanced issues surrounding value driven equipment
  - Advanced controls
  - De-mystified monitoring
  - Integration of equipment
    - iMCC design considerations
    - Integrated Switchboard considerations

Follow-up

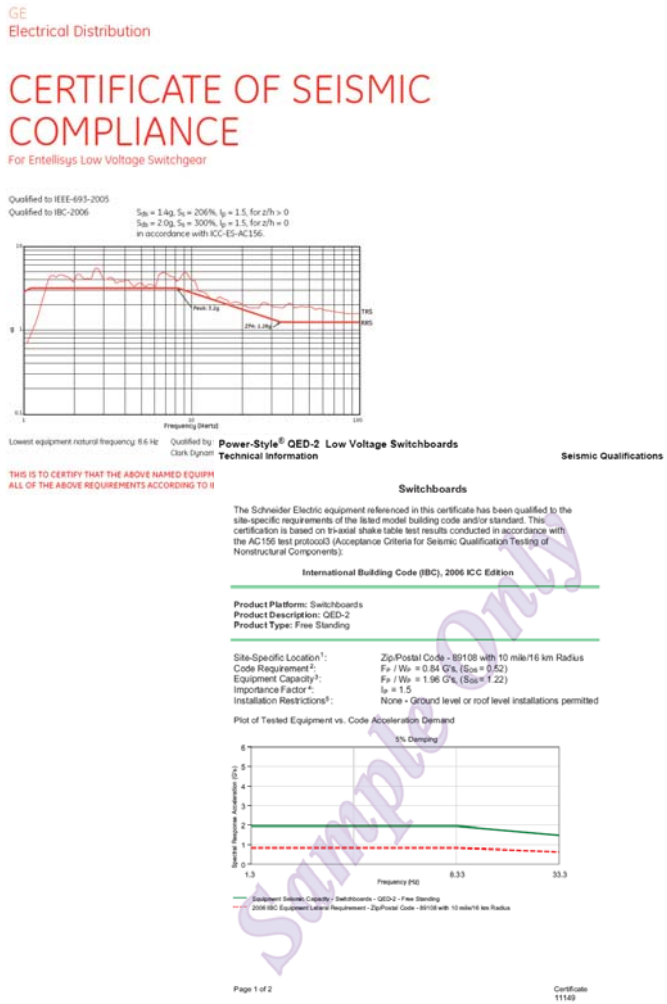
- Many of the details surrounding the topics addressed here-in may have considerations specific to your selected vendor.
- Please follow-up with Gary Fox or Chris Lovin for specific pertaining to Eaton & GE applications

Goals

- Clarify terms & standards
- Increase awareness that drives value to building owner
- Address FAQ’s surrounding the electrical room

Seismic Certification

- Paradigm shift: Probability model and acceptance criteria adopted by structural folks
- Manufacture to provide certification
- Certification to include specific info
  - Seismic standard
  - Force
  - Address
- Civil to complete anchorage detail



GE
Electrical Distribution

CERTIFICATE OF SEISMIC COMPLIANCE

For Entellisys Low Voltage Switchgear

Qualified to IEEE-693-2005
Qualified to IBC-2006

S_{DS} = 1.4g, S_s = 206%, I_p = 1.5, for z/h > 0
S_{DS} = 2.0g, S_s = 300%, I_p = 1.5, for z/h = 0
in accordance with ICC-ES-AC156

Lowest equipment natural frequency: 8.6 Hz

Qualified by: Clark Dynamics

THIS IS TO CERTIFY THAT THE ABOVE NAMED EQUIPM
ALL OF THE ABOVE REQUIREMENTS ACCORDING TO I

Power-Style® QED-2 Low Voltage Switchboards
Technical Information

Seismic Qualifications

Switchboards

The Schneider Electric equipment referenced in this certificate has been qualified to the site-specific requirements of the listed model building code and/or standard. This certification is based on tri-axial shake table test results conducted in accordance with the AC156 test protocol3 (Acceptance Criteria for Seismic Qualification Testing of Nonstructural Components):

International Building Code (IBC), 2006 ICC Edition

Product Platform: Switchboards
Product Description: QED-2
Product Type: Free Standing

Site-Specific Location[1]:	Zip/Postal Code - 89108 with 10 mile/16 km Radius
Code Requirement[2]:	F_P / W_P = 0.84 G's, (S_{DS} = 0.52)
Equipment Capacity[3]:	F_P / W_P = 1.96 G's, (S_{DS} = 1.22)
Importance Factor[4]:	I_P = 1.5
Installation Restrictions[5]:	None - Ground level or roof level installations permitted

Plot of Tested Equipment vs. Code Acceleration Demand

5% Damping

Spectral Response Acceleration (SA)
Frequency (Hz)

Equipment Seismic Capacity - Switchboards - QED-2 - Free Standing
2006 IBC Equipment Lateral Requirement - Zip/Postal Code - 89108 with 10 mile/16 km Radius

Sample Only

Page 1 of 2

Certificate
11149

Circuit Breakers… UL1066 vs UL489

- UL1066 is synonymous with insulated case
  - In past years… “Iron Frame”
  - Solid State sensing means
  - Maintainable
  - Higher cost, AIC ratings
- UL489 is synonymous with molded case
  - Sealed breaker with little to no serviceable parts
  - Thermal Magnetic or Solid State sensing means

UL1066 vs 489

Overload Testing

Overload testing is done to demonstrate making and breaking current values that might be obtained when initially energizing a motor load. Each time the circuit breaker is closed and opened on a high current load (600%), the contact surfaces are subjected to arcing and heat. This action simulates an accelerated life test to make sure the contacts provide adequate conductivity through many operations. The UL 489 Standard tests all circuit breaker ratings with significant operations to ensure the design is capable of a long service life with no maintenance. The ANSI C37 Standard tests circuit breakers rated only up to 2000 A.

UL 489			ANSI C37		
Power Factor: 0.45–0.50			Power Factor: 0.50		
Frame size (A)	Number of operations at rated voltage		Frame size (A)	Number of operations at rated voltage	
50–1600	50	600% current	225–800	50	600% current
1601–2500	25	600% current	1600–2000	38	600% current
2501–6000	3	600% current*	>2000	0	

*An additional 25 operations at 200% current.

UL1066 vs 489

Temperature Testing

The UL 489 Standard allows for two types of ratings. Standard circuit breakers cannot exceed a maximum of 50°C temperature rise at the wire terminal connection at 100% current in 40°C open air. 100% rated circuit breakers may have a temperature rise of 60°C at the wire terminal connection in the smallest allowable enclosure if the circuit breakers are connected with wire rated at 90°C wiring insulation sized to the 75°C chart (Table 310-16, National Electric Code®—NEC®). The ANSI C37 Standard requires a maximum of 55°C temperature rise at 100% in the smallest enclosure and a maximum of 85°C temperature rise on the contacts.

	UL 489	ANSI C37
Temperature	50°C temperature rise at line and load terminals	55°C temperature rise at line and load terminal bus connections and 85°C temperature rise on circuit breaker contacts
Current	Standard circuit breaker: ■ 100% rated current in open air at 40°C ■ 80% rated current in smallest enclosure	100% rated current in smallest enclosure
Exceptions	100% rated circuit breaker: ■ 100% rated current in smallest enclosure ■ Temperature rise may be 60°C if 90°C wire is used sized to the 75°C chart (NEC)	Trip unit defeated

UL1066 vs 489

Endurance Testing

Circuit breakers tested to the UL 489 Standard must pass a significant number of operations without any maintenance. This test verifies that the design is capable of a long service life. The ANSI C37 Standard tests circuit breakers for further operations but then allows for maintenance of the circuit breaker at relatively short intervals.

NOTE: No manufacturer currently offers 225 A or 600 A frame circuit breakers tested to ANSI C37.

UL 489			ANSI C37		
Power factor: 0.75–0.80			Power factor: 0.85		
Maintenance not allowed			Maintenance allowed		
Max. frame size (A)	Number of operations at rated voltage		Max. frame size (A)	Number of operations at rated voltage	
100	6000 4000	At rated current Without current	225	4000 10000 2500	At rated current Without current Between maintenance
225	4000 4000	At rated current Without current	600	2800 9700 1750	At rated current Without current Between maintenance
600	1000 5000	At rated current Without current	800	2800 9700 1750	At rated current Without current Between maintenance
800	500 3000	At rated current Without current	1600	800 3200 500	At rated current Without current Between maintenance
2500	500 2000	At rated current Without current	2000	800 3200 500	At rated current Without current Between maintenance
6000	400 1100	At rated current Without current	3200	400 1100 250	At rated current Without current Between maintenance
			4000	400 1100 250	At rated current Without current Between maintenance

UL1066 vs 489

Short-circuit Testing

The short-circuit tests reflect differences in the philosophies between the UL and ANSI circuit breaker standards. The UL 489 Standard requires that the tests be conducted at several values of short-circuit current. A separate test sequence evaluates the maximum interrupting rating claimed by the manufacturer. Tests are conducted at the rated voltage(s) of the circuit breaker which is typically 240, 480 or 600 V.

Short Circuit	UL 489		ANSI C37
Power factor	≤10,000 A 10,001–20,000 A ≥ 20,000 A	0.45–0.50 0.25–0.30 0.15–0.20	0.15 Unfused 0.20 Fused
Voltage and current	Rated voltage with low-, medium- and high-level current		Rated current at the three voltage levels: 254, 508 and 635 Vac
Operations	Open—close/open on all three poles		Open—close/open on all three poles. First open at closing angle to ensure peak current of 2.3 x rated current in one phase
	Open—close/open on each individual pole at reduced current level		Open—close/open individual pole at 87% of rated current
			Short-time withstand—first ON cycle, closing angle must ensure a peak current of 2.3 x rated current in one phase. Circuit breaker remains closed, tripping disabled—0.5 sec. ON, 15 sec. OFF, 0.5 sec. ON

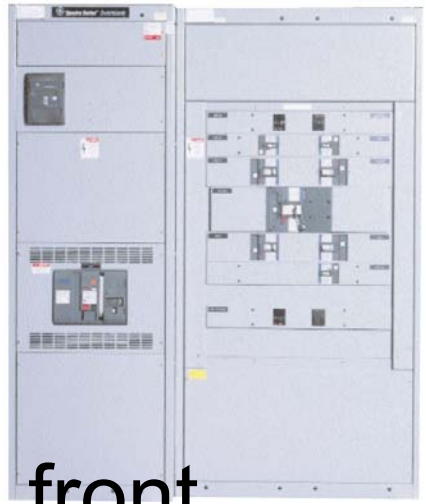
UL1066 vs 489

- Typically breakers selected are dictated by distribution equipment used. For example, UL1558 gear uses 1066 cb.
- Squares and rectangles… you may find 1066 breakers in 891 switchboards, you won't find 489 cb.
- 1066 are thought to provide greater circuit protection. This is can be false as some use identical trip units.
- CB's with identical TU's may have different performance characteristics due to clearance time.

UL1558 vs UL891

- Generally speaking, UL1558 is rear access with higher costs
- 1558 is compartmentalized
- 1558 carries other requirements such as insulated bus and 800af min
- 1558 typically applied where serviceability is driving consideration

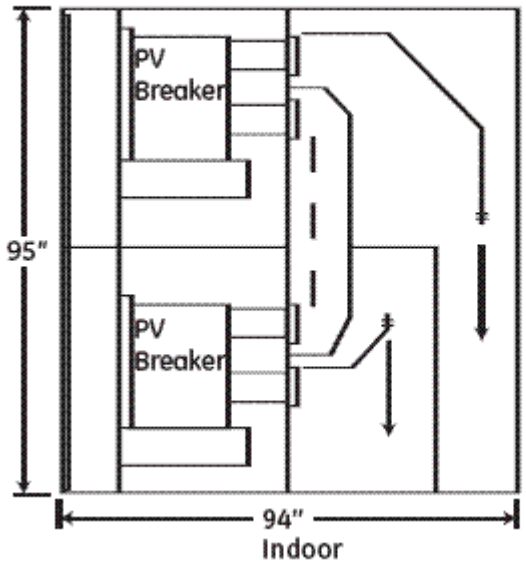
UL1558 vs UL891

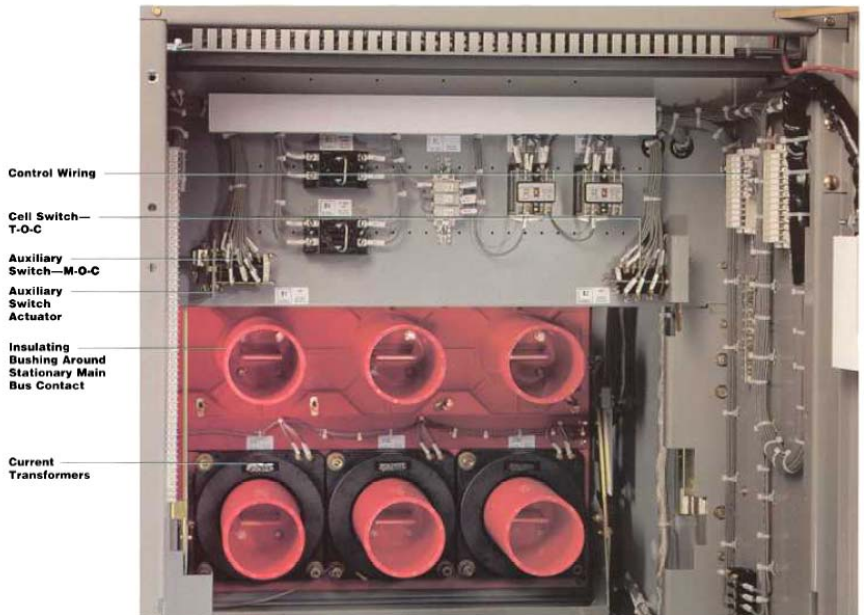


- Also generally speaking, 891 is front access and placed along a wall
- Typ 1558 is commonly referred to as “switchgear” where 891 goes by the handle of “swichboard”
- Elements of one standard may appear in product labeled under other standard such as with Eaton’s front access 1558 product and GE & Square D’s 891 offering

Metal Clad vs. Metal Enclosed

- High degree of apprehension with MV Switchgear
- MC synonymous with Vacuum Breaker
- ME synonymous with LIS or Fused





Metal Clad vs. Metal Enclosed

- MC gives higher degree of circuit protection at higher cost
- ME ratings often dependant on fusing, but watch for combined ratings

Figure 2

Figure 3

Table D: Integrated Ratings for 1200 Ampere Switches with Boric Acid Expulsion Fuses★

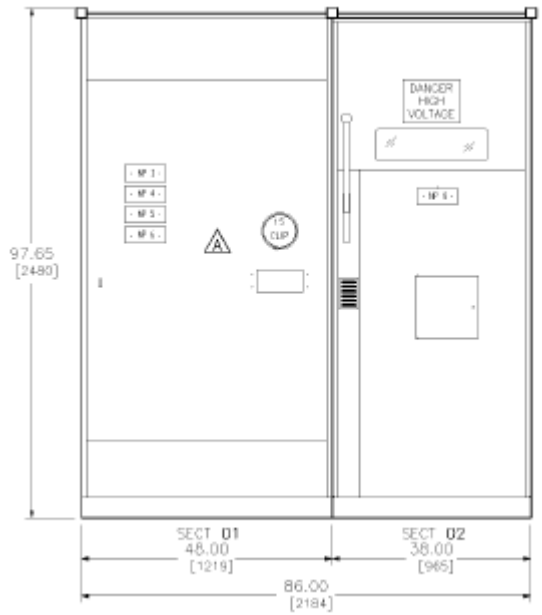
Manufacturer		Westinghouse			S & C		
Fuse Type →		RBA–200 with Discharge Filter	RBA–400 with Discharge Filter	RBA–800 with Discharge Filter	SM–4Z	SM–5S	SM–5SS
Nominal System Voltage (kV)↓	Max Design Voltage (kV)↓	Integrated Short Circuit Rating in RMS Symmetrical Amperes Integrated Short Circuit Rating in MVA Maximum Continuous Fuse Current					
2.4	5.5	19,000A 80 MVA 200E	37,500A 155 MVA 400E	37,500A 150 MVA 720E	17,200A 70 MVA 200E	37,500A 155 MVA 400E	Not Available
4.16	5.5	19,000A 137 MVA 200E	37,500A 270 MVA 400E	37,500A 270 MVA 720E	17,200A 125 MVA 200E	37,500A 270 MVA 400E	Not Available
4.8	5.5	19,000A 158 MVA 200E	37,500A 312 MVA 400E	37,500A 310 MVA 720E	17,200A 145 MVA 200E	27,000A 225 MVA 400E	Not Available
7.2	8.25	16,600A 205 MVA 200E	29,400A♦ 367 MVA 400E	29,400A♦ 365 MVA 720E	15,600A 195 MVA 200E	25,000A 310 MVA 400E	34,600A 430 MVA 400E
12.0	15.0	14,400A 299 MVA 200E	29,400A♦ 611 MVA 400E	29,400A♦ 611 MVA 720E	12,500A 260 MVA 200E	25,000A 520 MVA 400E	34,600A 720 MVA 400E
12.47	15.0	14,400A 311 MVA 200E	29,400A♦ 635 MVA 400E	29,400A♦ 635 MVA 720E	12,500A 270 MVA 200E	25,000A 540 MVA 400E	34,600A 750 MVA 400E
13.2	15.0	14,400A 329 MVA 200E	29,400A♦ 672 MVA 400E	29,400A♦ 672 MVA 720E	12,500A 285 MVA 200E	25,000A 570 MVA 400E	34,000A 780 MVA 400E
13.8	15.0	14,400A 345 MVA 200E	29,400A♦ 703 MVA 400E	29,400A♦ 700 MVA 720E	12,500A 300 MVA 200E	25,000A 600 MVA 400E	34,000A 815 MVA 400E

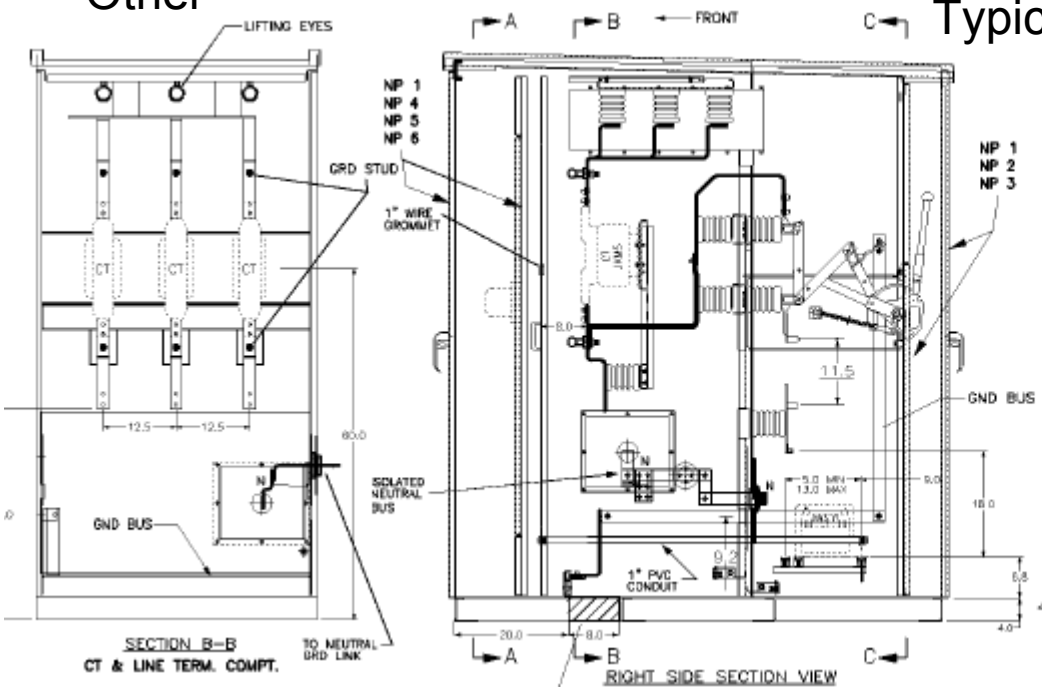
Typical Service Requirements MV

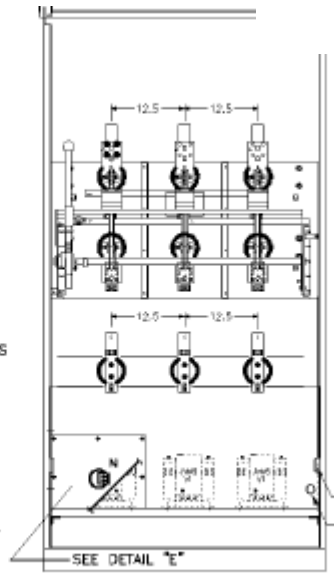
PGE Greenbook Section 11.2 B:
"Applicant must ensure that manufacturers contact PG&E before fabricating the switchboards and request the specific information listed below."

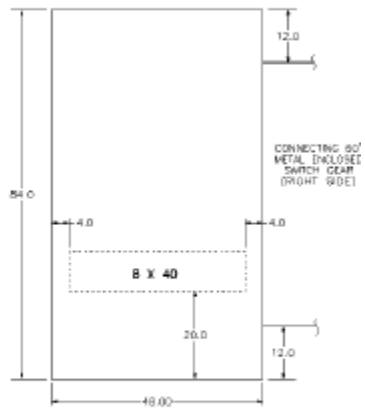
- Service voltage, phase, and wiring
- Meter panel requirements for applicable rate sched
- Service-termination location
- Switchboard and/or meter location
- Size and number of service conductor
- Other

Typical of 12,470









Dimensions of meter bay

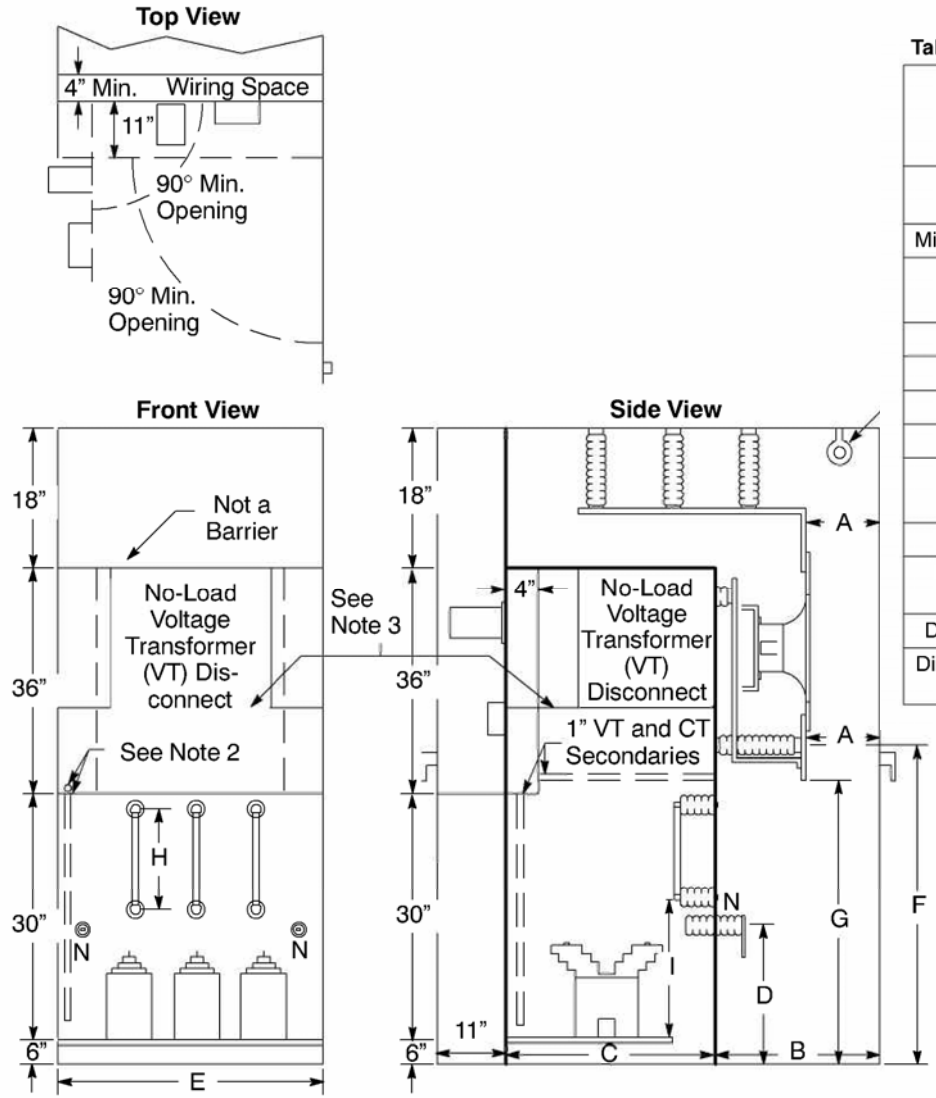


Figure 11-1
Typical, High-Voltage Metering Enclosure: 2,400-Volt Through 25,000-Volt Service

Table 11-1 Dimensions for High-Voltage Meter Enclosures

Specifications	Voltage Rating			
	2,400	4,160/4,800	7,200/17,000	20,800/25,000
	(In Inches)			
Minimum, Bare-Bus Clearance ∅ to Ground	3-1/2	3-1/2	6	7-1/2
Minimum, Bare-Bus Clearance ∅ to ∅	5	5	7-1/2	9
Dimension A	5 Min. 10 Max.	5 Min. 10 Max.	8 Min. 10 Max.	9 Min. 15 Max.
Dimension B	24 Min.	24 Min.	24 Min.	36 Min.
Dimension C	24 Min.	24 Min.	24 Min.	36 Min.
Dimension D	12 Min.	12 Min.	12 Min.	12 Min.
Dimension E	36 Min.	48 Min.	48 Min.	60 Min.
Dimension F	42 Min. 48 Max.	42 Min. 48 Max.	42 Min. 48 Max.	56 Min. 60 Max.
Dimension G	36 Min.	36 Min.	36 Min.	48 Min.
Dimension H Fuse-Mounting Clip: Center	8-1/2	8-1/2	11-1/2	16-1/8
Dimension H Fuse Ferrule Diameter	1-5/8	1-5/8	1-5/8	1-5/8
Dimension I To Bottom of Fuse Clip or Bus Extension	18	18	18	18

Pay attention to B+C & E

Interconnect requirements 0-600v

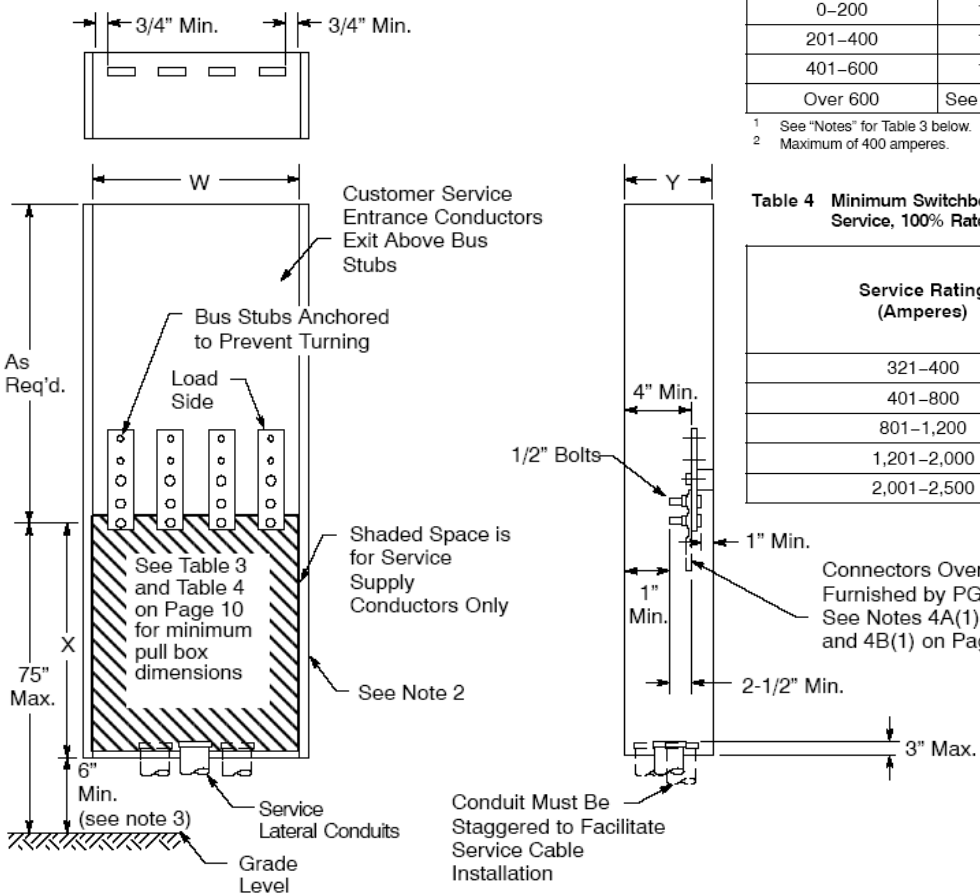


Figure 10
Typical Underground Service Termination Pull Box (wall-mounted or floor-standing)

Table 3 Minimum, Wall-Mounted, Pull-Box Dimensions: 80% Rated Service, Residential, Single-Phase and 100% Rated Service, Commercial/Industrial, Single-Phase [1] or Three-Phase [2]

Service Rating (Amperes)	Minimum Access Opening "W"		X		Y	
	3-Wire	4-Wire	Bottom Entry	Side/Rear Entry	Bottom Entry	Rear Entry
	All Measurements in Inches					
0–200	10-1/2	14	11	36	6	15
201–400	10-1/2	14	22	42	6	24
401–600	16-1/2	22	26	48	11	24
Over 600	See Table 4 below for Over 600-Ampere, Single-Phase Services Rated at 100%.					

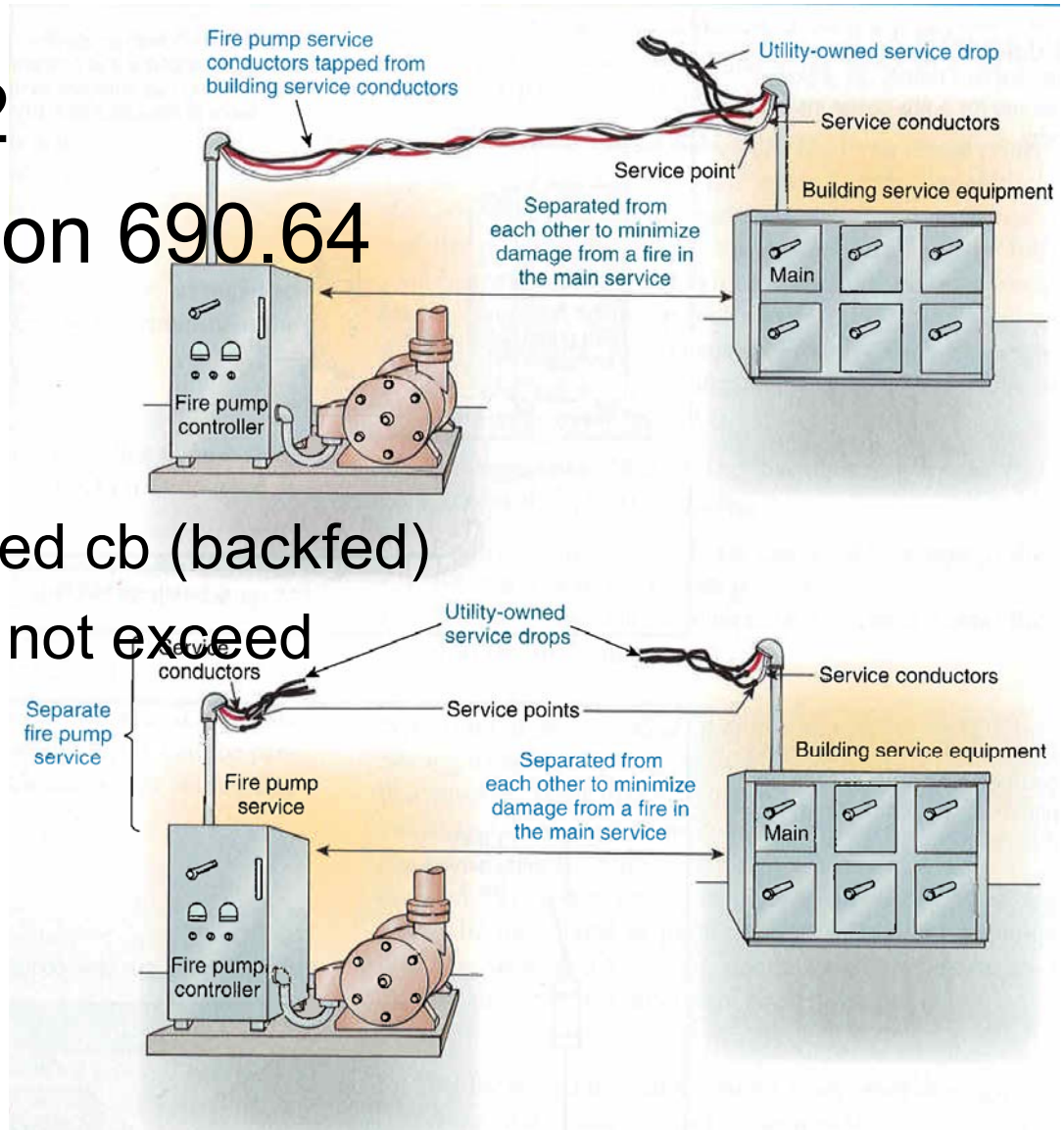
1 See "Notes" for Table 3 below.
2 Maximum of 400 amperes.

Table 4 Minimum Switchboard (floor-standing) Pull-Section Dimensions: Over 600 Amperes, Single-Phase Service, 100% Rated and Commercial/Industrial, Three-Phase Service

Service Rating (Amperes)	Minimum Access Opening "W"		Termination Height "X"
	3-Wire	4-Wire	
	All Measurements in Inches		
321–400	24	24	42 Min.–72 Max.
401–800	24	24	
801–1,200	24	30	
1,201–2,000	30	35	
2,001–2,500	—	42	60 Min.–72 Max.

Other connections

- Fire Pump 695.2
- PV interconnection 690.64
  - (a) Supply
  - (b) Load
    - Dedicated marked cb (backfed)
    - ∑I of OPD shall not exceed
    - Line side of GF
- Tap rules



Tap Rules

- <3ft
  - Not less than combined calculated load on the circuits supplied by the tap conductors, and
  - Not less than the rating of the device supplied by the tap conductors or not less than the rating of the OPD at the termination
  - Do not extend beyond the swbd, pnlbd or disconnect
  - In a raceway

Taps continued

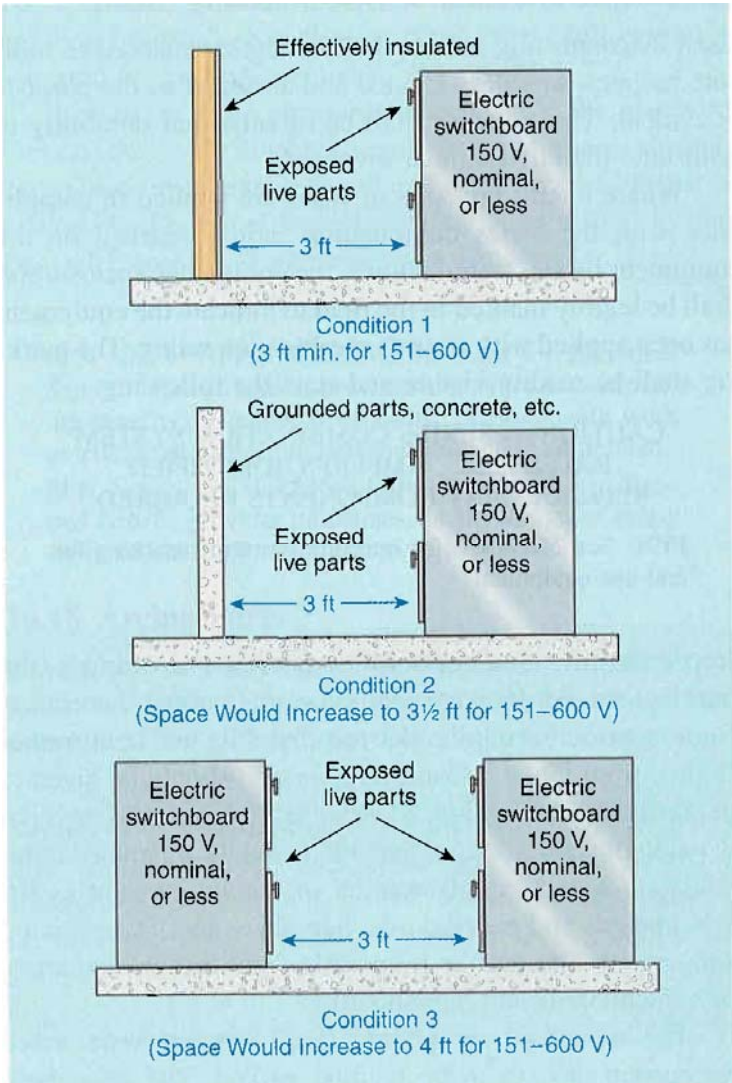
- 11-25
  - Distance from terminal to terminal doesn't exceed 25ft
  - Terminates in CB limiting load to conductor rating
  - Raceway
  - Conductor needs to be not less than1/3 of the protective device

Taps supplying XF (pri & sec cb's)

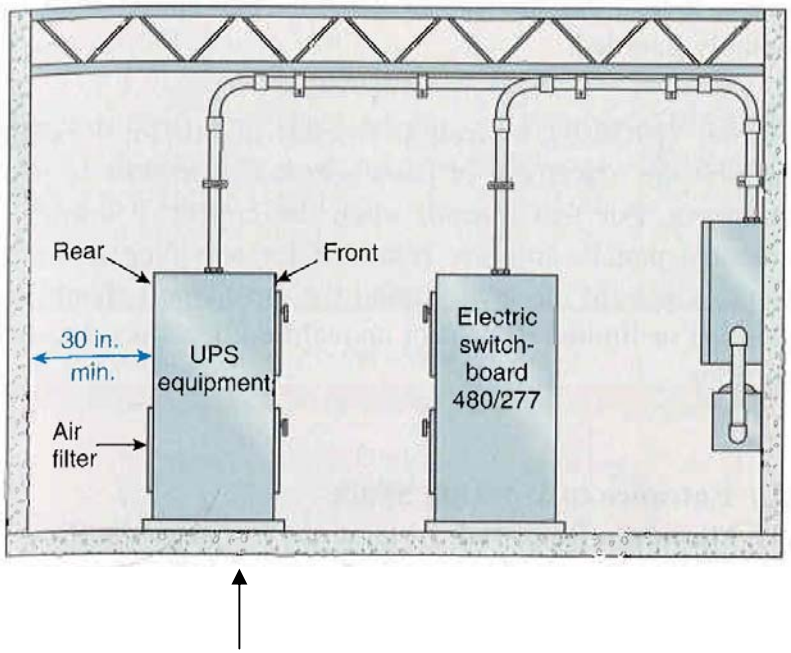
- Conductor at least 1/3 of feeder breaker
- Secondary conductor not less than 1/3 multiplied by pri-to-sec
- "Total length of one pri plus one sec conductor , excluding any portion of the primary conductor that is protected at its ampacity, is not over 25ft"
- Raceway
- Secondary conductor terminating in single cb limiting load to no more than what's shown 310.15

Working Spaces

Table 110.26(a)(1)
- 0-150v all conditions 3ft
- 151-600
  - Condition 1 3ft
  - Condition 2 3.5
  - Condition 3 4
- Only required if access is needed

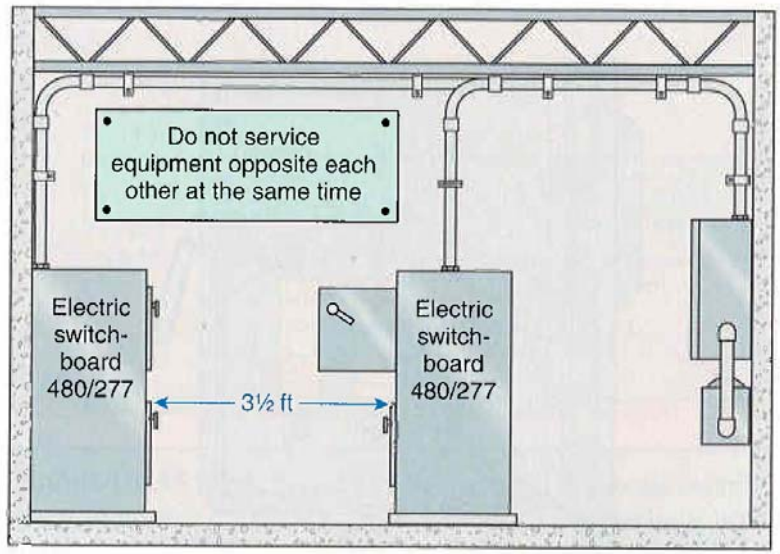


Working space exceptions

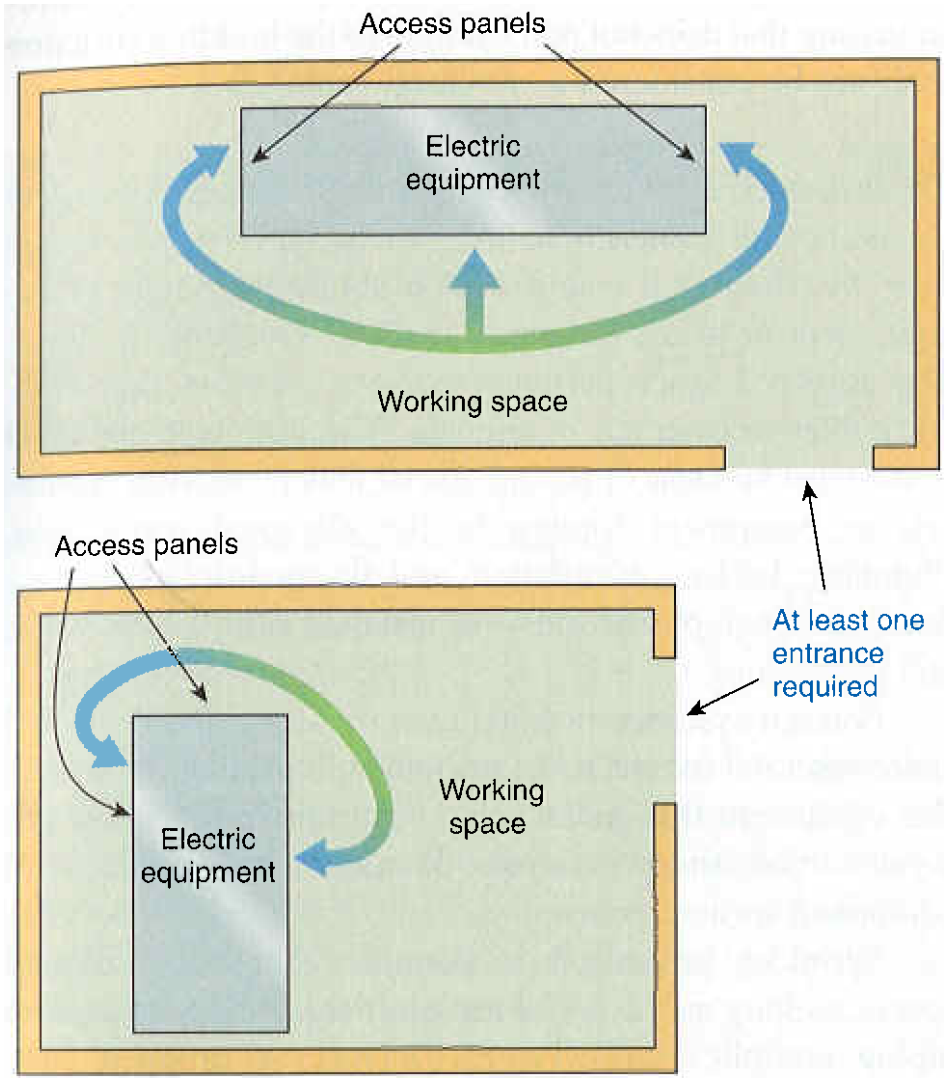


Non-electrical

Building retro-fits w/procedure

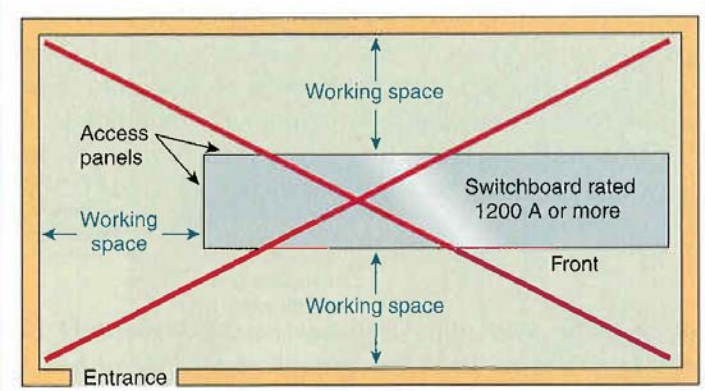


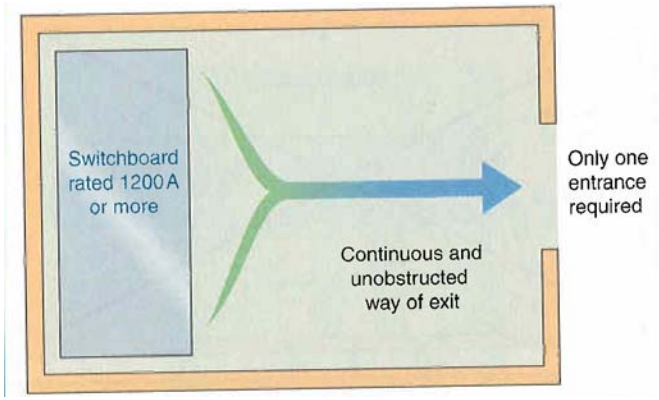
Egress

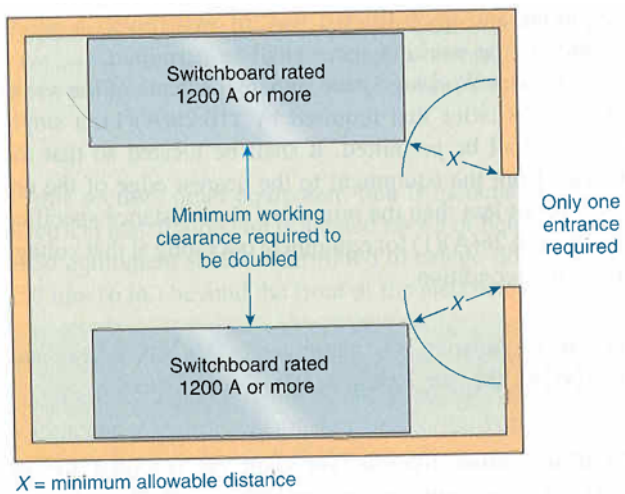


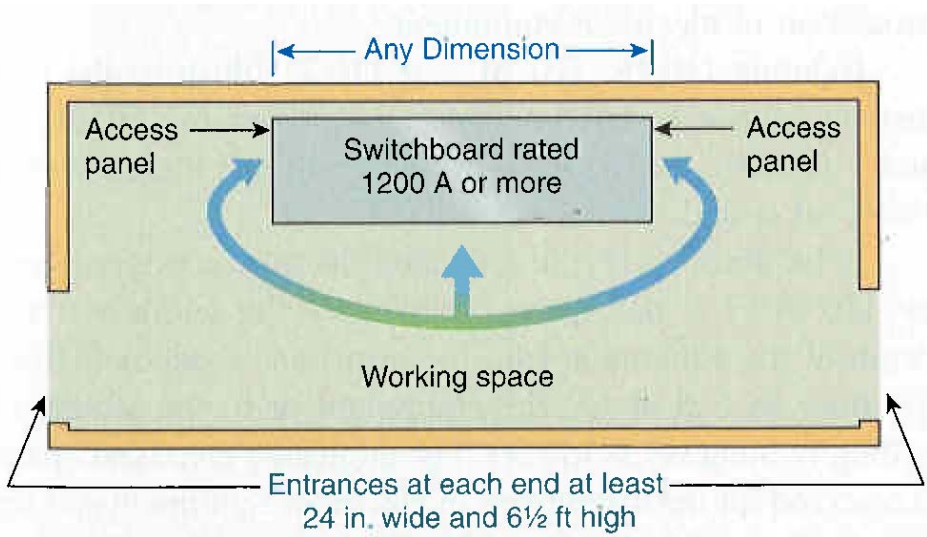
Acceptable for <1200a

Egress >1200a



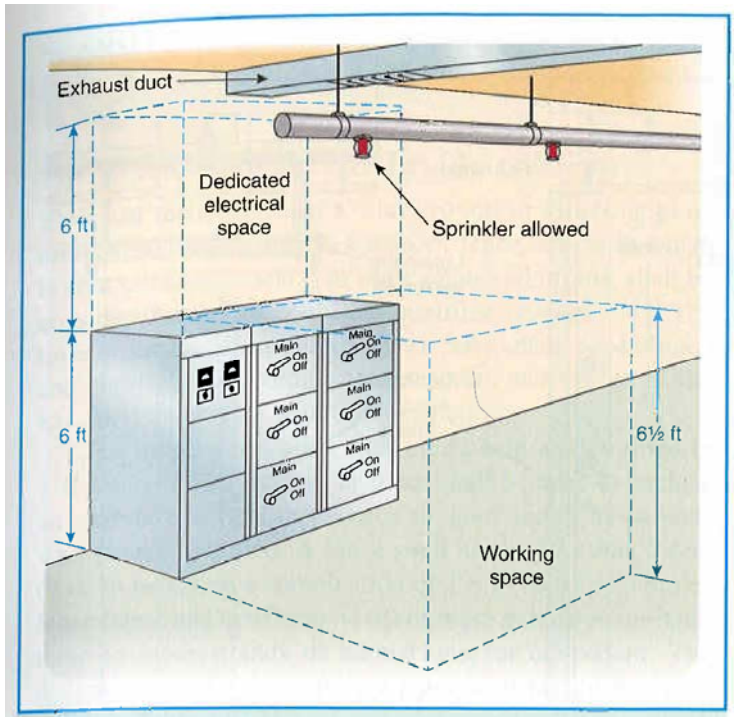


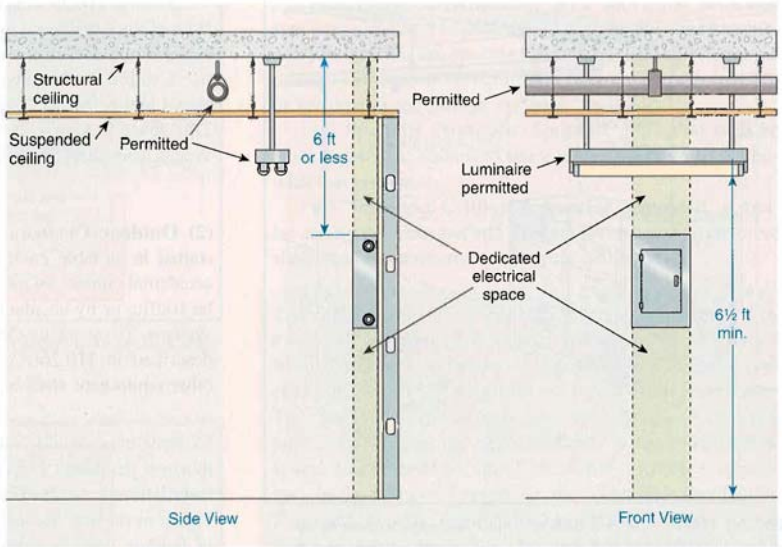




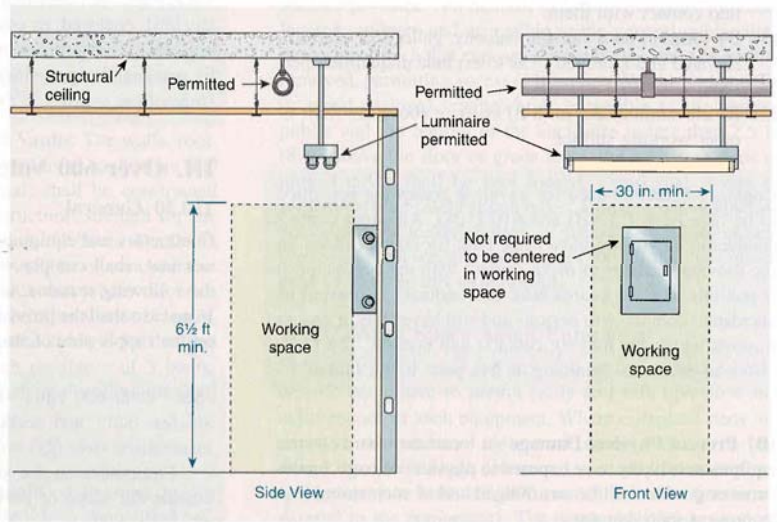
Dedicated electrical space

For equipment >30”

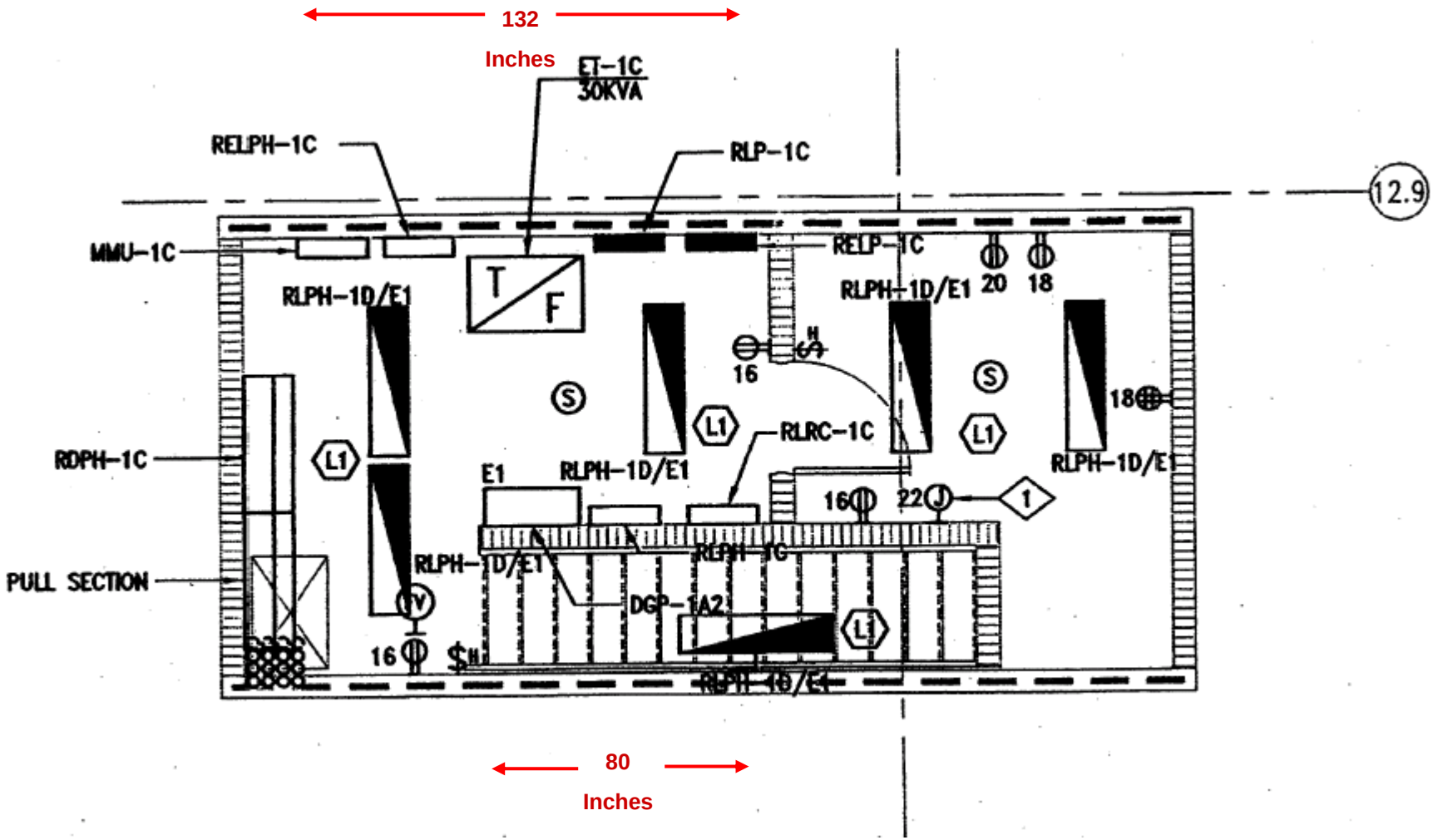




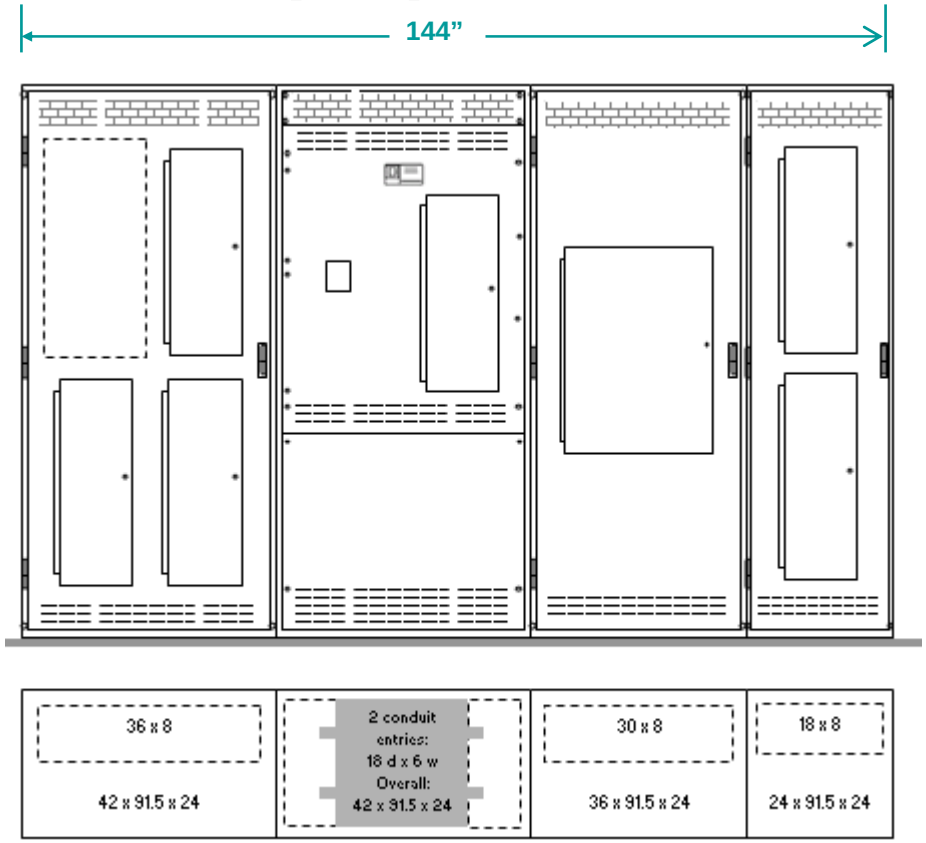
<30”



Typical electrical room



Same layout using integrated equipment



Wall Space Savings = 68 inches (32%)

Estimated Installation Labor & Material Handling Hours Savings = 90 hours

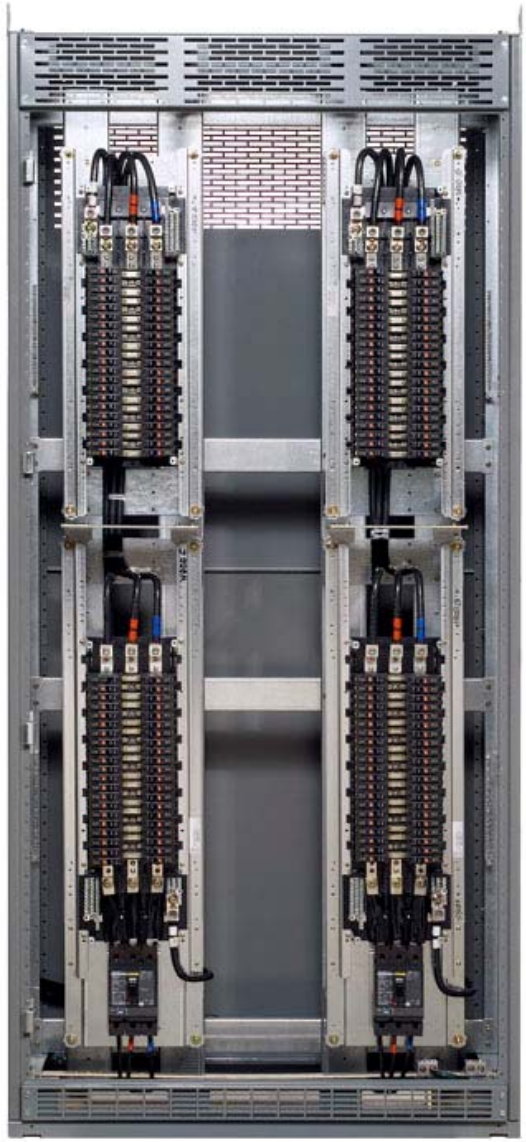
Stick built vs. integrated

*

Integrated switchboards

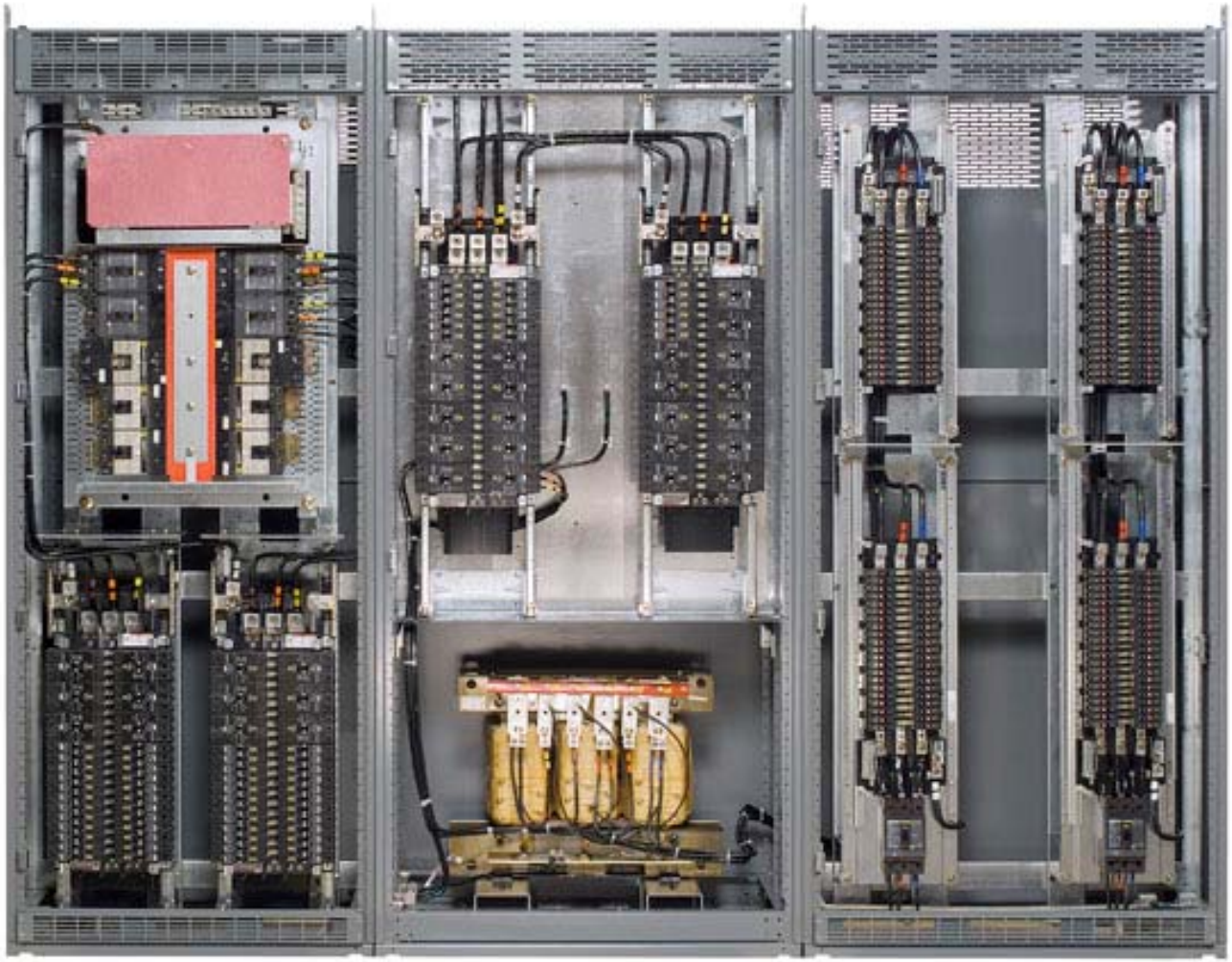
- **Enclosures**
  - N-1
  - N-1 w/ Driphood
  - N-3R
  - Sprinklered Equipment
- **Customer Metering**
  - Power Meters & Circuit Monitors; BCM's
- **Individually Mounted Circuit Breakers (600A max)**
- **Equipment Spaces**
  - 1/4, 1/2 and Full Height spaces
- **24"D @ 24"W, 30"W, 36"W, 42"W, 48"W**

- **NQOD Panel – 225A MB w/ FTLugs**
- **NQOD Panel – 225A MLO**
- **NQOD Panel – 225A MB w/ FTLugs**
- **NQOD Panel – 225A MLO**

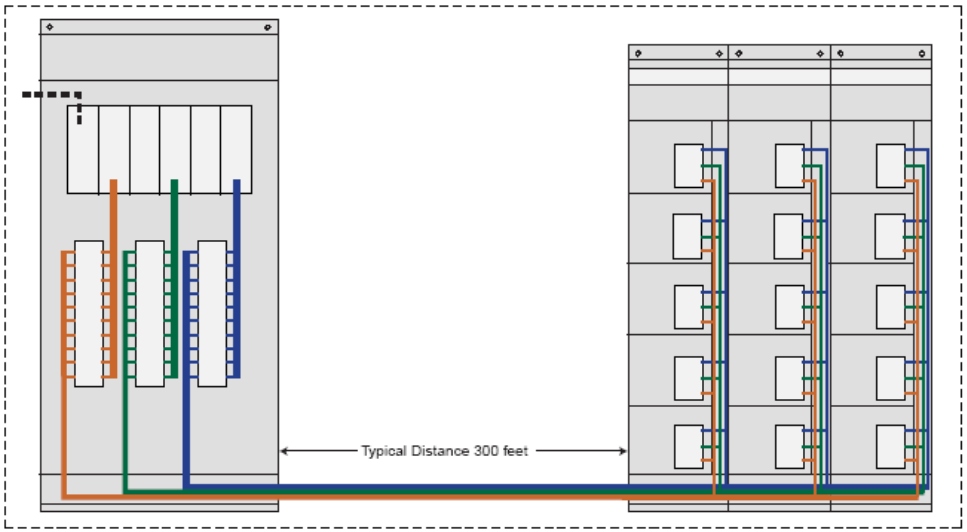


3 Section Lineup – Covers On

3 Section Lineup – Covers Off



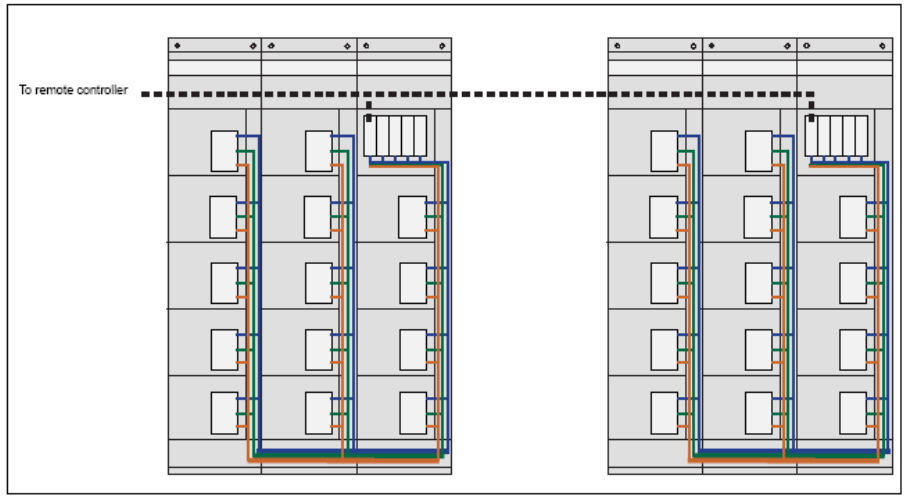
iMCC

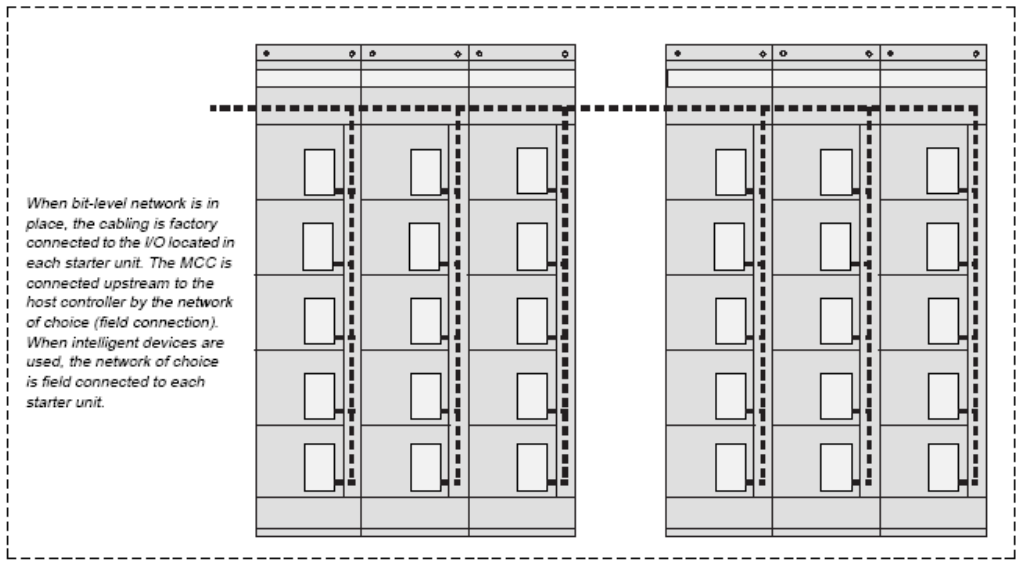


- Trend has been towards solid state starting from FVR/FVNR
- Conventional I/O field wire replaced by device level networks

iMCC

- Distributed I/O islands
- Bit level networks
- Reduced footprint through elimination of logic devices such as relays, timers, etc.





Device level networks

Thank you!

Questions