ELECTRICAL SYSTEMS DESIGN FOR HEALTHCARE
MIKE McGANN, PE, LEED AP

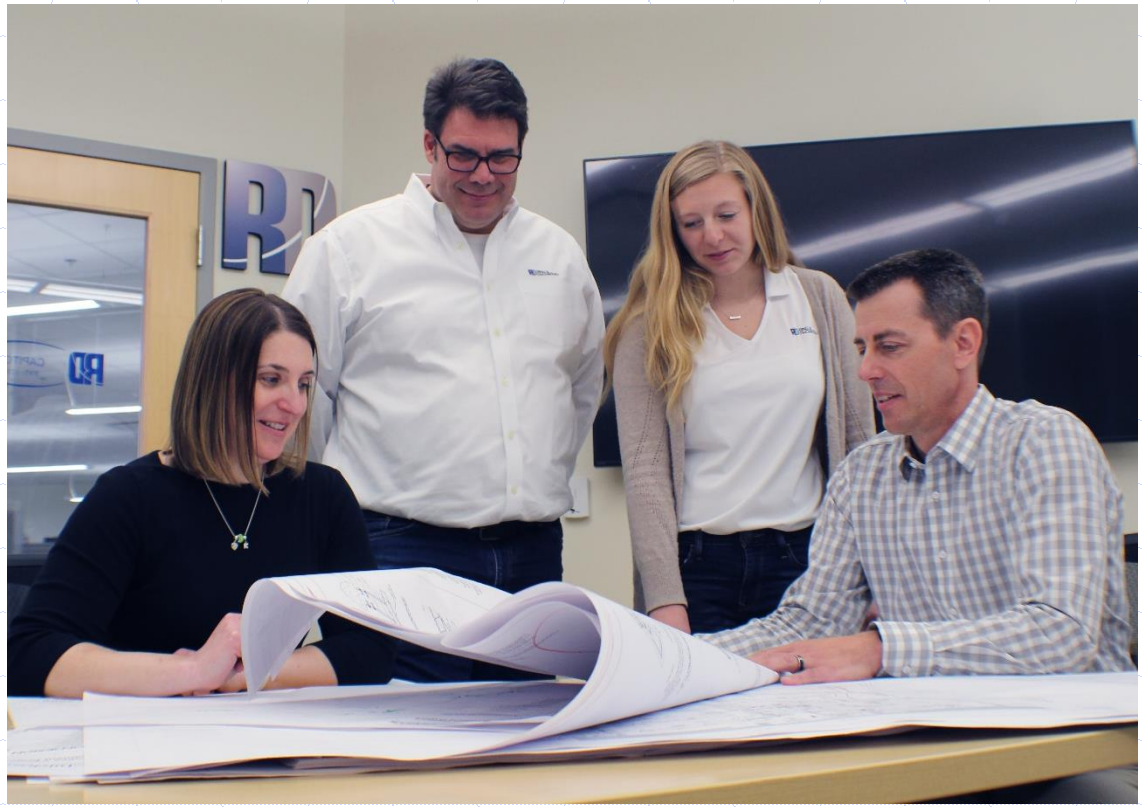
RING & DUCHATEAU
CONSULTING ENGINEERS

- 18 Years MEPT Engineering Consulting
- 10 Years Electrical Contracting

- 5 Years MSOE - AE Adjunct Professor
- Master of Science UWM - Engineering
- Bachelor of Science UWM - Architecture

- Specializes in:
  - Healthcare
  - Power Distribution

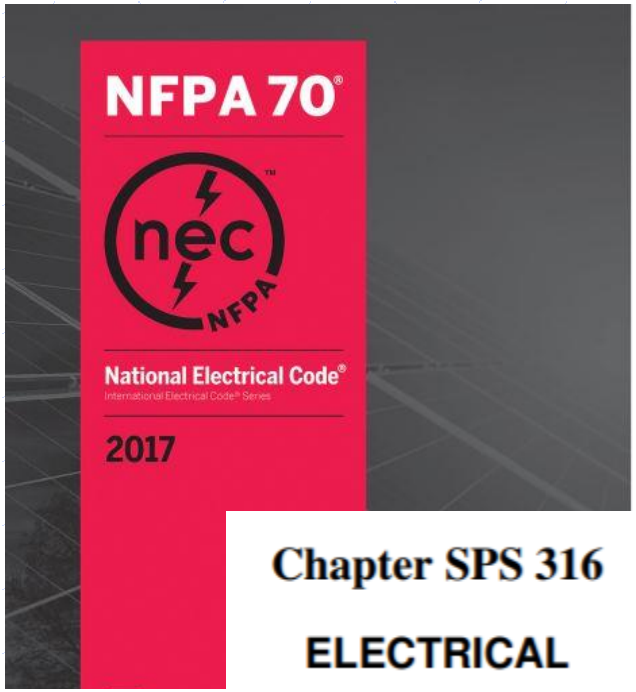
RING & DUCHATEAU
CONSULTING ENGINEERS



- MEPT team of 90+
- 60% of work in healthcare
- Healthcare is what we do best
- Locations in Milwaukee, Madison

GOVERNING CODES

NEC, What We Use For Buildings



Chapter SPS 316

ELECTRICAL

Published under s. 35.93, Wis. Stats., by the Legislative Reference Bureau.

SAFETY AND PROFESSIONAL SERVICES

Utilities Have Their Own Rules

Menu » Administrative Rules Related » Administrative Code » Public Service Commission (PSC) » Chapter PSC 113

Chapter PSC 113

SERVICE RULES FOR ELECTRICAL UTILITIES

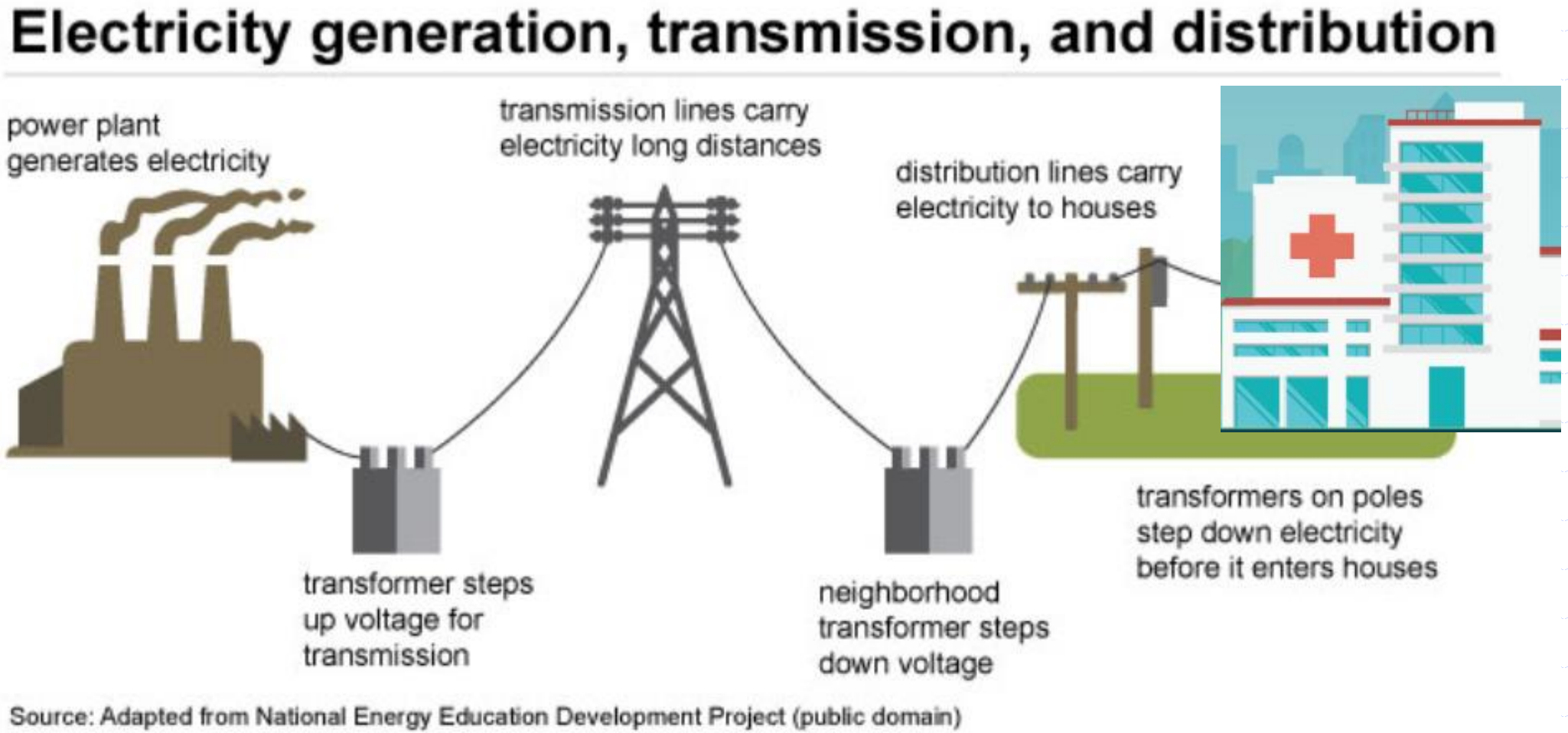
Subchapter I — General

PSC 113.01 Application of rules.
PSC 113.012 Definitions.

Subchapter II — Miscellaneous Service Requirements

PSC 113.0201 General requirement.
PSC 113.0202 Relocation of poles.

ELECTRICAL UTILITY SOURCE



SYSTEM VOLTAGES

NEC Low Voltage Systems

Low Voltage < 120 Volts

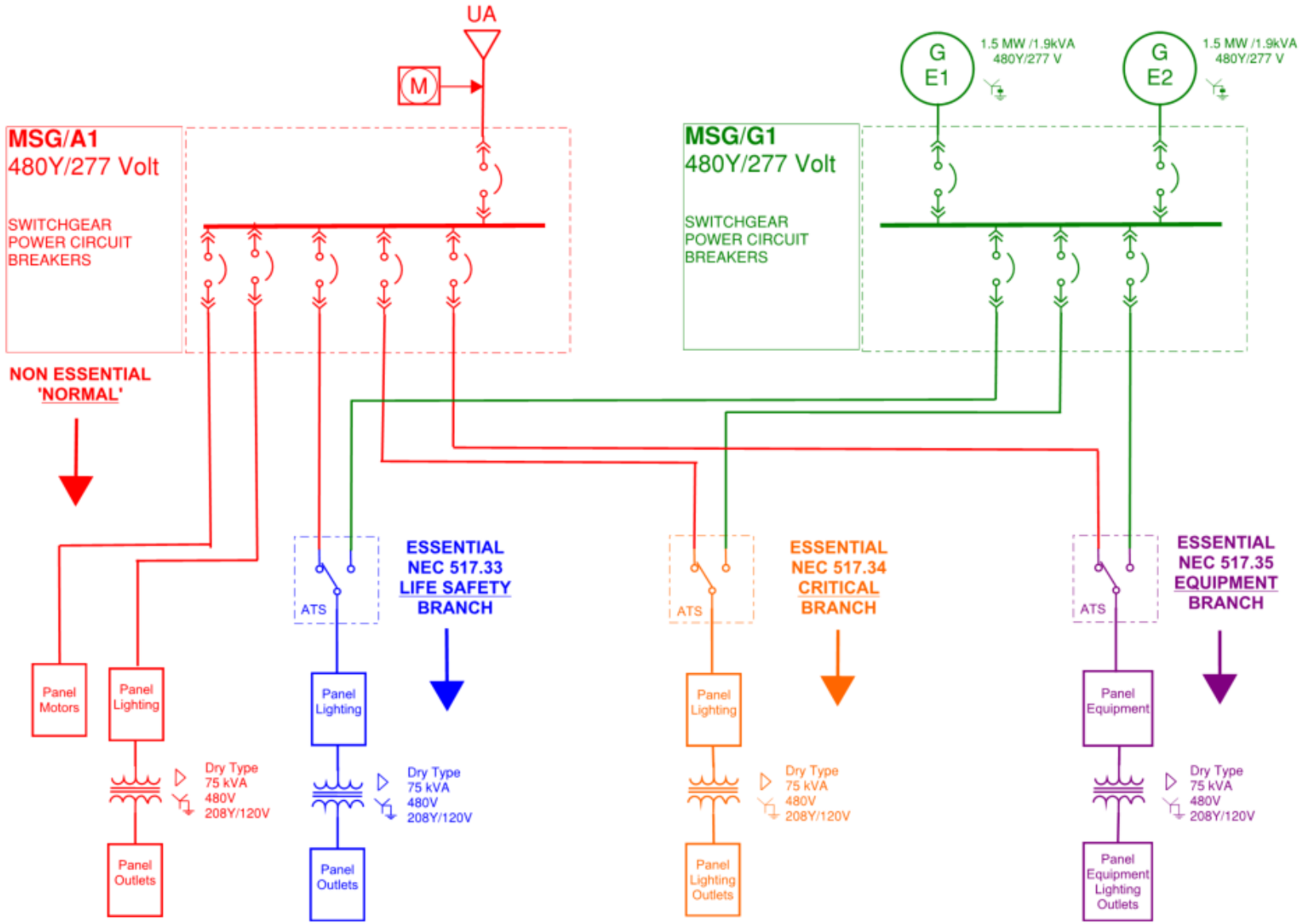
- Data
- Fire Alarm
- Nurse Call

NEC Power Systems

Low Voltage < 600 Volts

- 480Y/277 Volts
- 208Y/120 Volts
- 240/120 Volts
- System Voltages

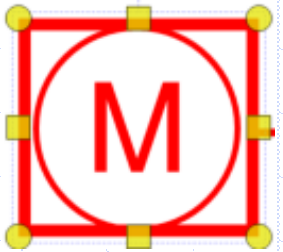
TYPICAL NEC 517 ELECTRICAL DISTRIBUTION SYSTEM



METERING


GE Watthour Meter
KILOWATTHOURS
CL 200 240 V 3 W FM 2S TA 30
CAT NO 721X007030
Kh 7.2

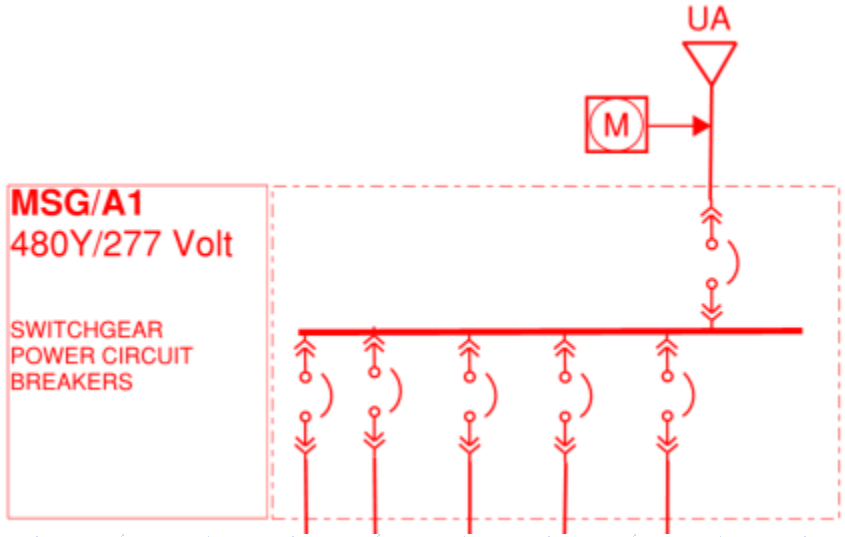

WARNING


M

MAIN SWITCH GEAR MSG – LOW VOLTAGE SWITCH GEAR

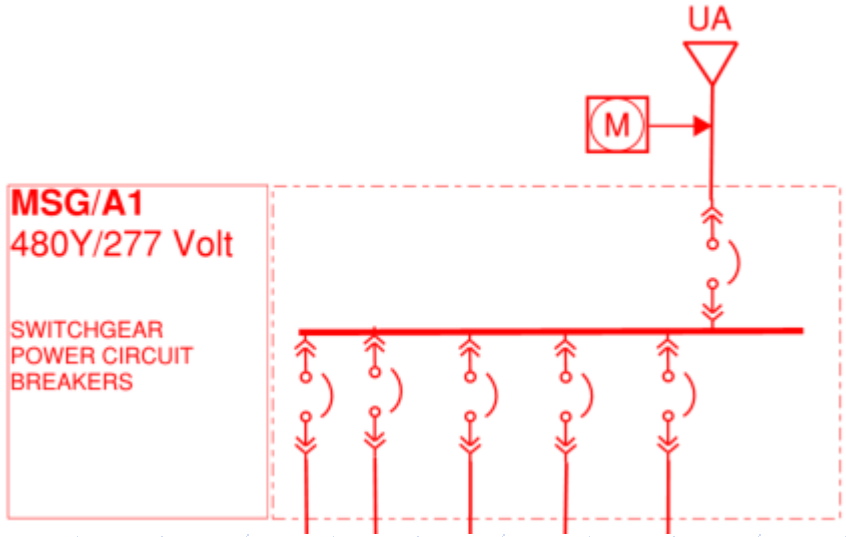
Switch Gear

- 2,000 Amp through 6,000 Amp
- High quality product
- Circuit breakers in front
- Circuit Breakers removable for service
- Bussing in the middle
- Cable access in the rear
- Clearance front and back



Masterpact NW Circuit Breaker on Its Rails

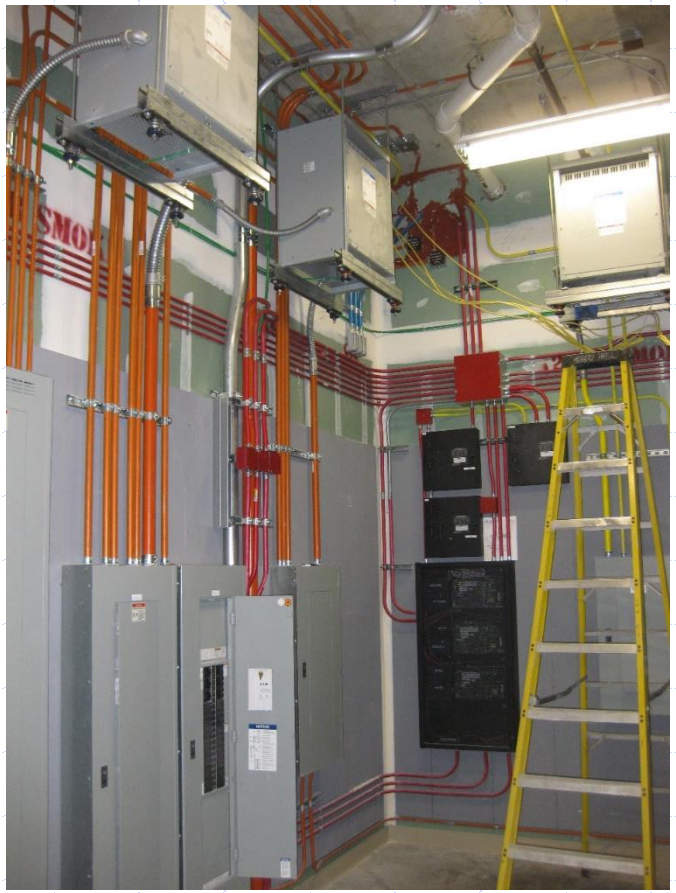
MAIN SWITCH BOARD MSB – Low Voltage Switch Board

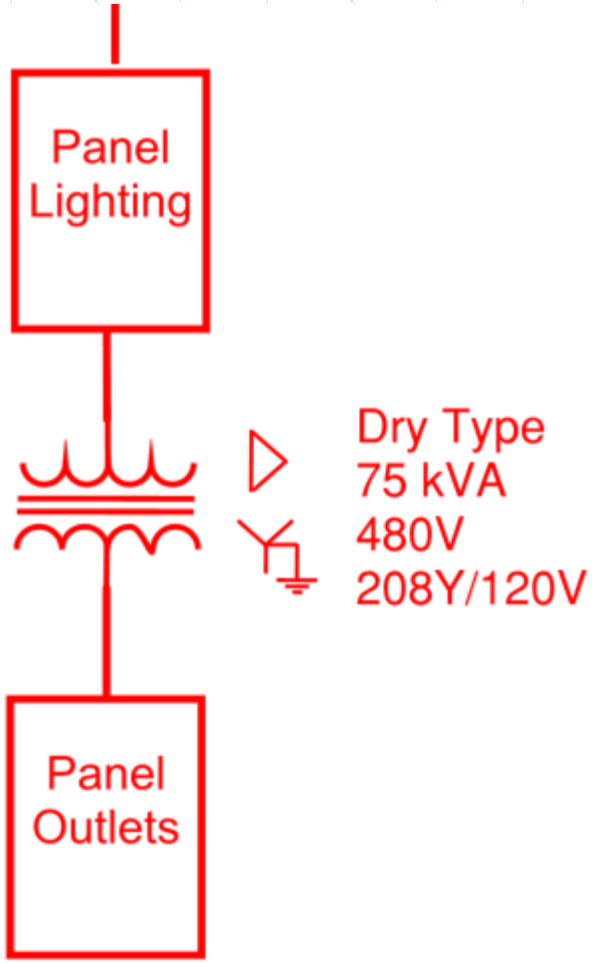


Switch Board

- 2,000 Amp through 4,000 Amp
- Good quality product, less cost
- Circuit breakers in front, bolted to bus
- Circuit breakers NOT easily removed
- Bussing in the back
- Cable access top/bottom
- Clearance front only

BRANCH PANELBOARD AND SMALL TRANSFORMER





Branch Panelboard

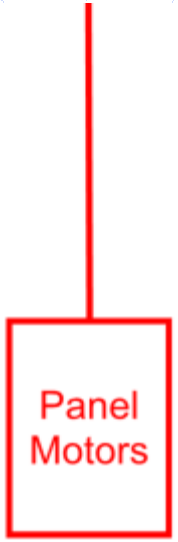
- Typically 125Amp, 225Amp, or 400Amp
- A branch Panelboard is for distribution of small sized loads
  - Receptacles/Outlets
  - Lighting
- Size of Panelboard calculated from combined downstream loads
- Circuit breakers can typically be up to 50% of the main bus size
- Majority of the breakers will be 20A/1PA branch Panelboard is for distribution of small sized loads

LOAD CENTER

Load Center

- Typically 60amp, 100Amp
- Residential Grade
- Available at
  - Home Depot
  - Lowe's
  - Fleet Farm

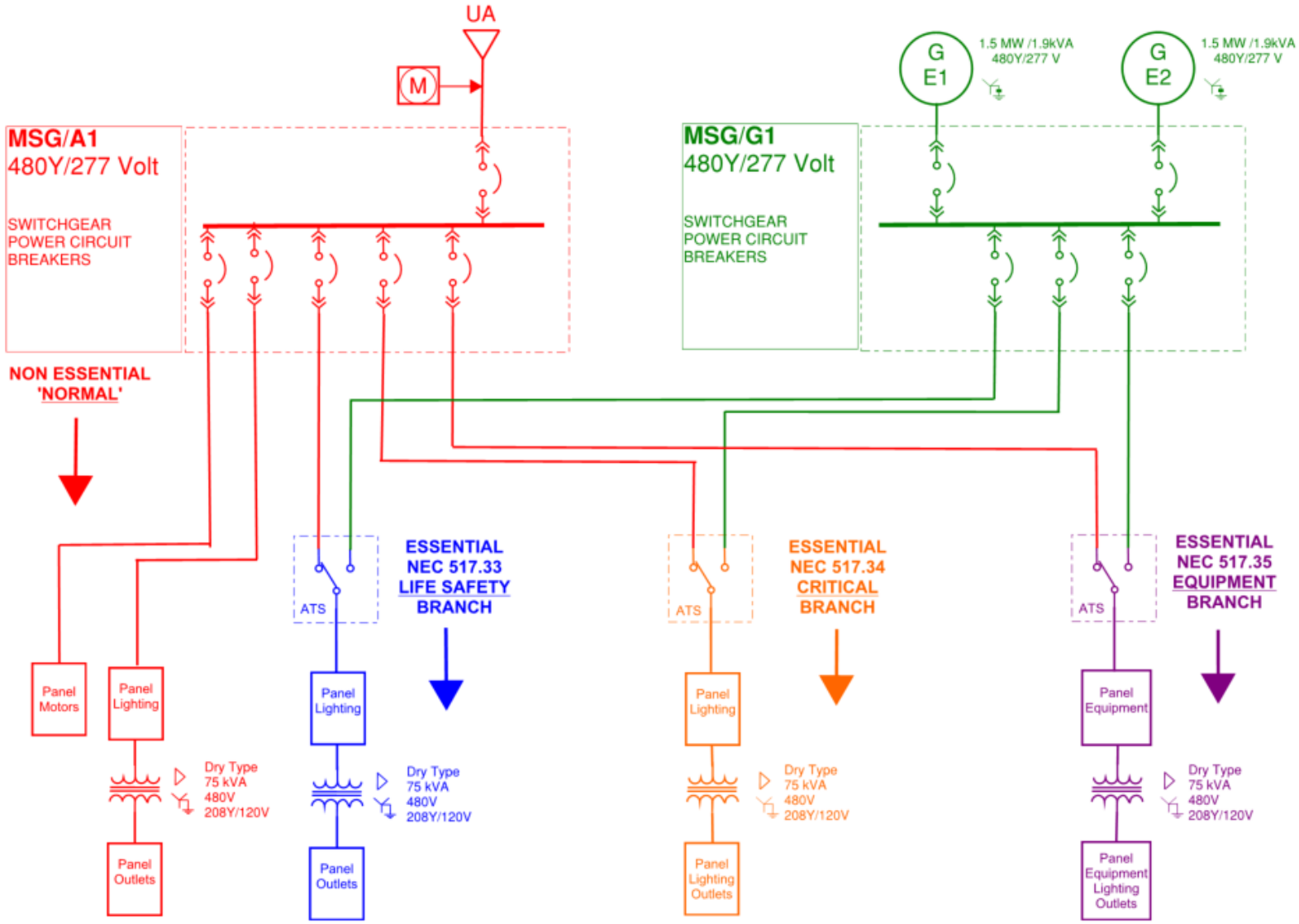
POWER PANELBOARD



Power Panelboard

- Typically 400Amp, 800Amp, or 1,200Amp
- A power Panelboard is for distribution of medium sized loads
  - Small motors
  - Branch Panelboards
- Size of Panelboard calculated from combined downstream loads
- Circuit breakers are typically up to 50% of the main bus size

TYPICAL NEC 517 ELECTRICAL DISTRIBUTION SYSTEM



DIESEL GENERATORS

Indoor

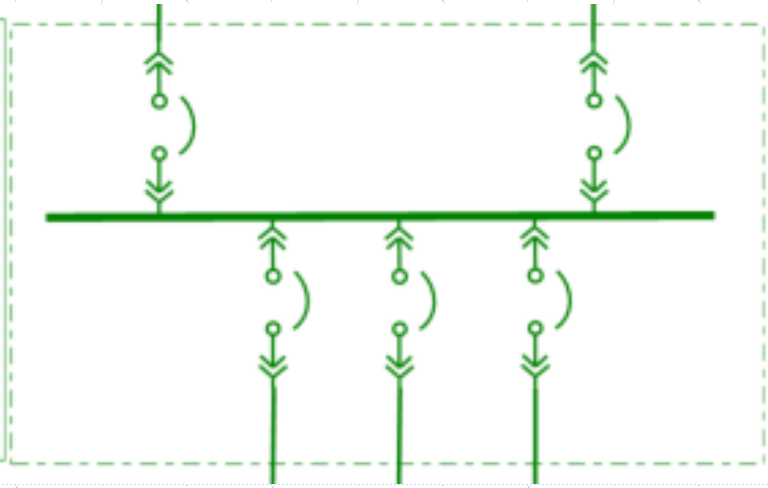
Outdoor, Walk-in Enclosure

Outdoor, Level 3
Sound Enclosure

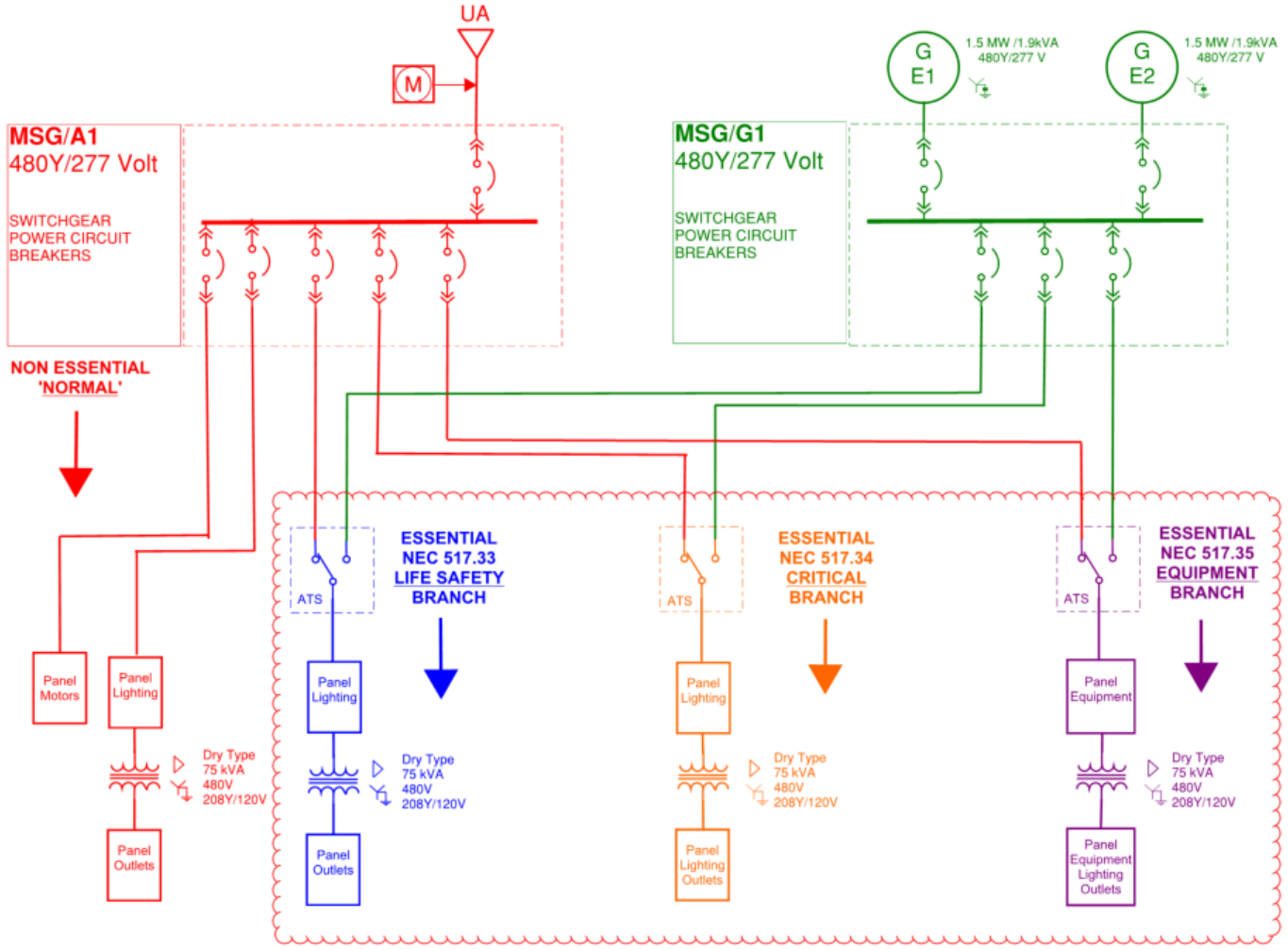
GENERATOR PARALLELING SWITCH GEAR

MSG/G1
480Y/277 Volt

SWITCHGEAR
POWER CIRCUIT
BREAKERS

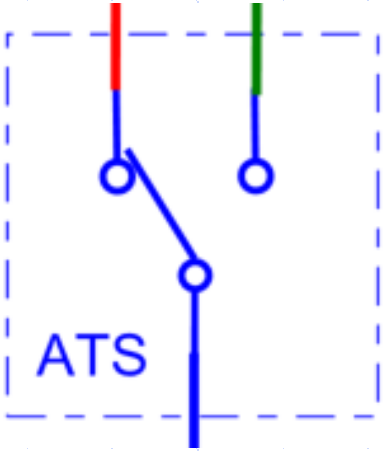


NEC 517 ESSENTIAL ELECTRICAL SYSTEM

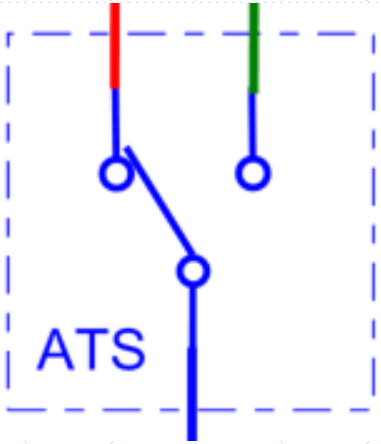


AUTOMATIC TRANSFER SWITCHES OPEN TRANSITION

- A ‘break-before-make’ transition
- When the normal source goes down, power will be interrupted while the loads are being transferred
- When the normal source is once again restored, the power will be interrupted and the loads will be transferred back to the normal source



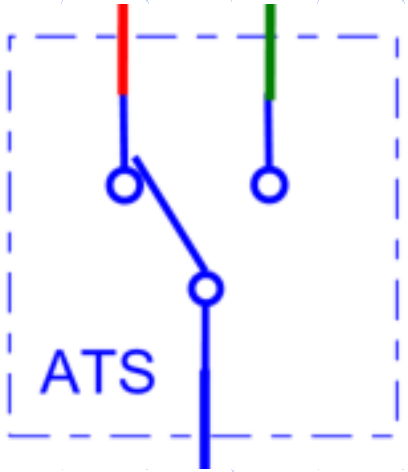
AUTOMATIC TRANSFER SWITCHES CLOSED TRANSITION



- A ‘make-before-break’ transition
- Main contacts overlap to permit transfer of loads with out interruption
- Phase monitoring of the circuit to verify both sources are in phase
- Control logic will continuously monitor the sources condition and the status of whether the load needs to be transferred

AUTOMATIC TRANSFER SWITCHES BYPASS ISOLATION

- Bypass/Isolation component allows transfer switches to be maintained, tested, and inspected with out power interruptions
- Flexibility to bypass to any available source with the transfer switch removed by a second switching mechanism
- Bypass switch contacts are closed only during the bypass isolation operation



LIFE SAFETY NEC 517.33

(A) Illumination means of egress

(B) Exit Signs

(C) Alarm & Alerting Systems

- Smoke control
- Kitchen hood supply/exhaust
- Supply Exhaust for important loads listed in NEC

(D) Communication Systems

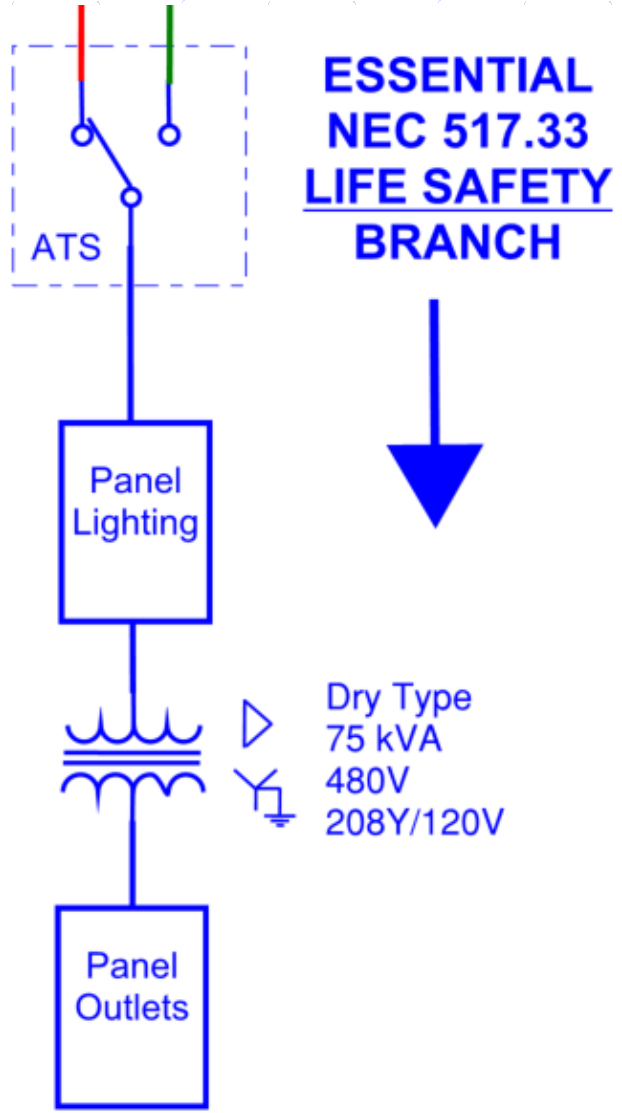
- Where used for issuing instructions during emergency situations.

(E) Generator Set Locations

- Task Illumination, Batt Packs, outlets at Generator and ATS

(F) Generator Set Accessories

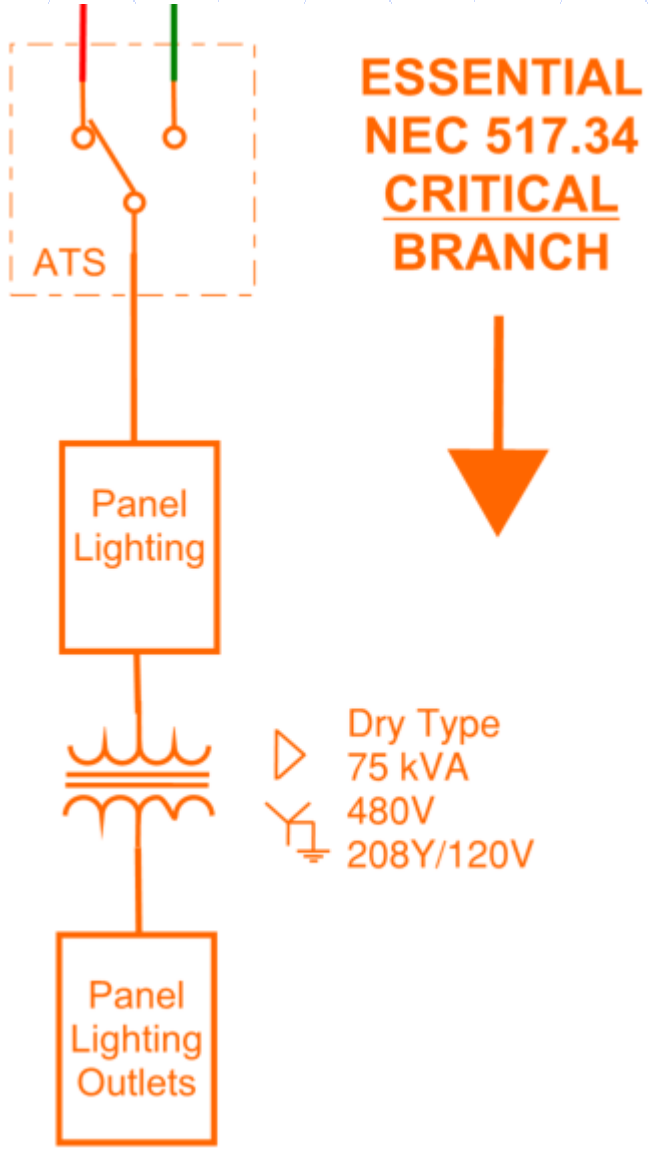
- Fuel Pumps, Fans, louvers, controls…….



CRITICAL NEC 517.34

(A) Task illumination, fixed equipment, selected receptacles, and special power circuits serving following:

1. Critical Care (Category 1) spaces that utilize anesthetizing gases…..
2. Isolated power systems in special environments
3. Patient care spaces:
   a. Infant Nurseries
   b. Medication preparation areas
   c. Pharmacy Dispensing areas
   d. Selected acute nursing areas
   e. Psychiatric bed areas (omit receptacles)
   f. Ward treatment rooms
   g. Nurse stations
4. Additional specialized task illumination and receptacles…..
5. Nurse Call systems
6. Blood, bone, and tissue banks
7. Telephone and data equipment rooms and closets
8. Task Illumination and receptacles for ….Many Departments…..
9. Additional task illumination, receptacles, and selected power circuits needed for effective hospital operations……..



ISOLATED POWER SYSTEMS

- NFPA 99 operating rooms = wet procedure rooms
- Isolated power systems
- Ungrounded system
- Alarms to notify medical staff of fault >0.005 amps or 5 miliamps
- Line isolation monitor ‘LIM’
- Grounding
- Monthly and annual testing
- Xhhw insulation on wires
- DON’T FORGET THE LASER/X-ray !

UPS

A unit consisting of the following components:

- AC to DC Converter (rectifier)
- DC bus with backup battery system
- DC to AC Converter (inverter)
- Solid-state bypass switch
- Maintenance bypass switch

Battery:

- Chemical energy storage devices
- Designed to provide back up power when the normal source is lost

Flywheel:

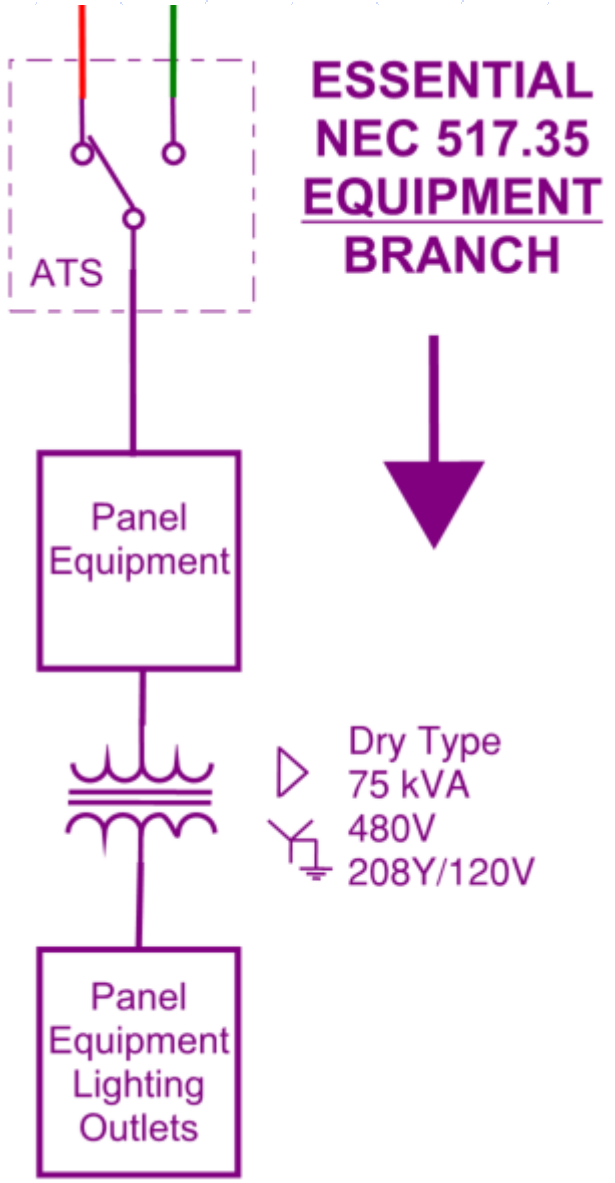
- A mass rotating around an axis (the motor generator rotor) by the use of magnets in a vacuum
- Designed to provide back up power when the normal source is lost

EQUIPMENT NEC 517.34

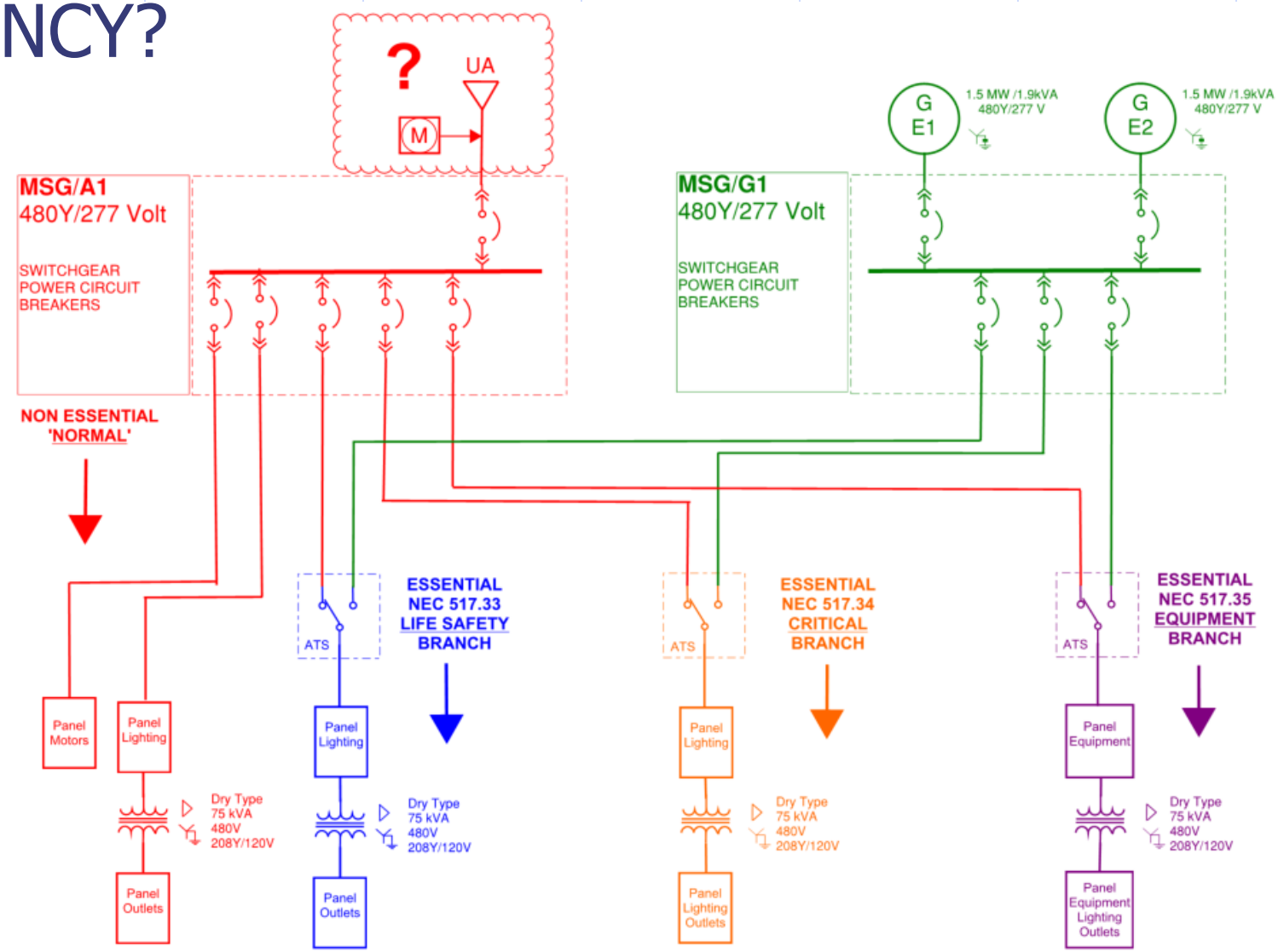
(A) Equipment for Delayed Automatic Connection
- Central Suction
- Sump Pumps
- Medical Air
- Smoke control
- Kitchen hood supply/exhaust
- Supply Exhaust for important loads listed in NEC

(B) Equipment for Delayed Automatic or Manual Connection
- Heating equipment for OR, labor, recover, ICU, coronary care
- Important loads listed in NEC

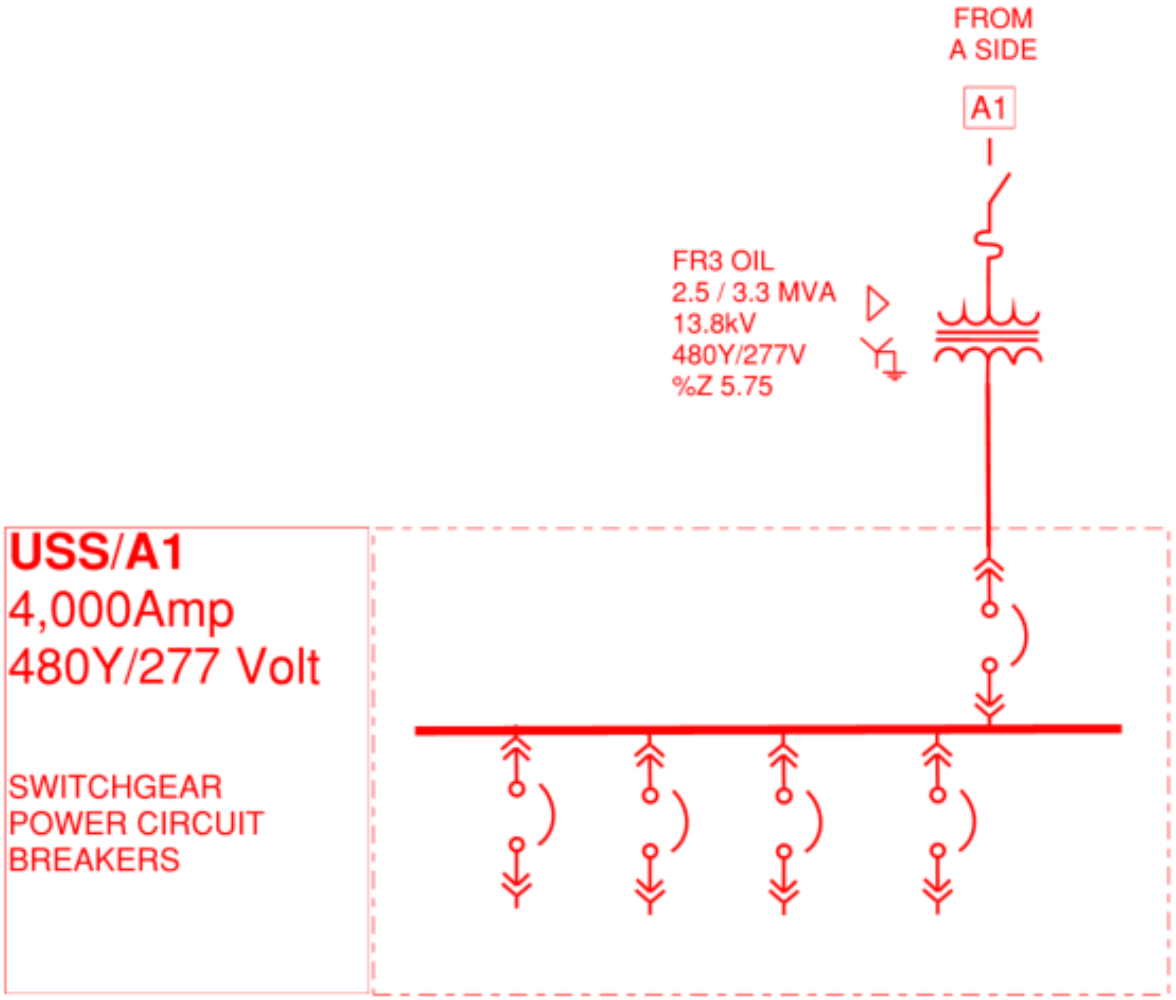
(C) AC Equipment for Nondelayed Automatic Connection
- Generator Accessories



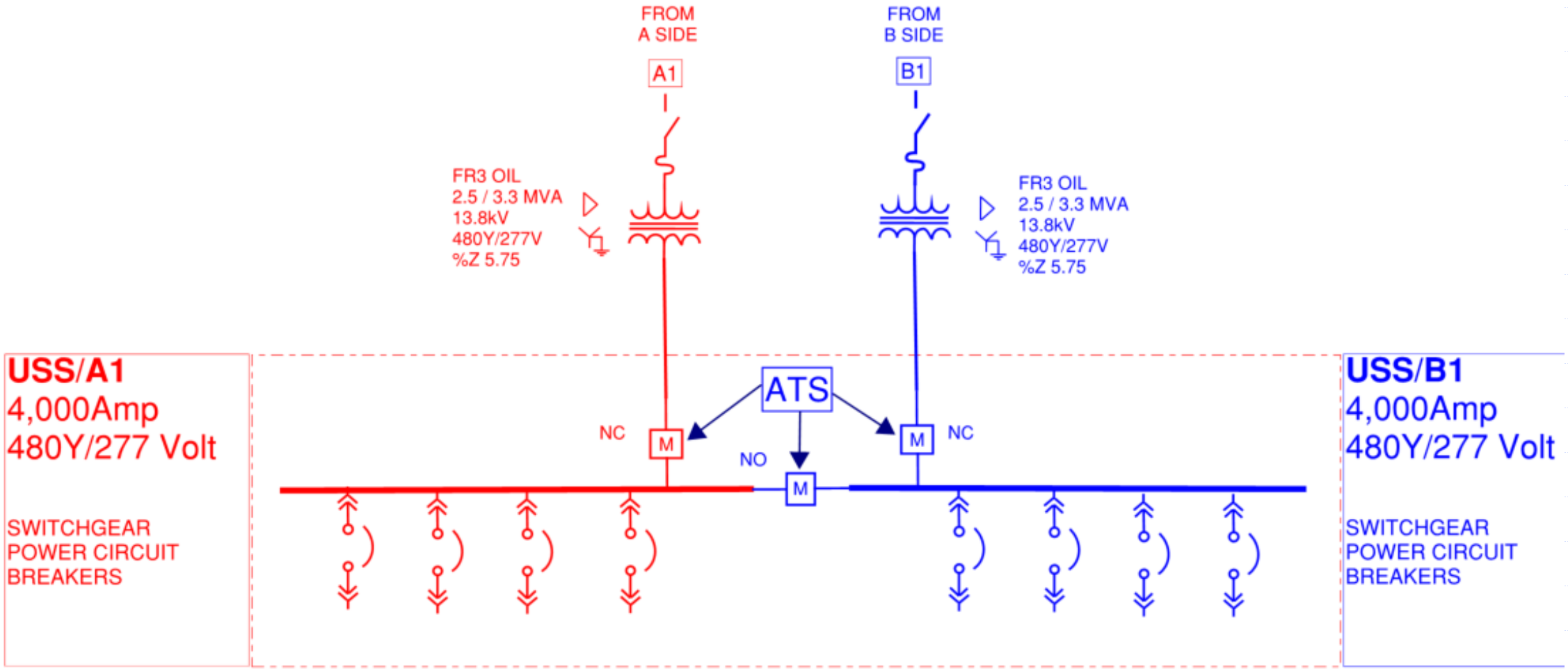
PRIMARY (Medium Voltage) DISTRIBUTION SYSTEMS? REDUNDANCY?



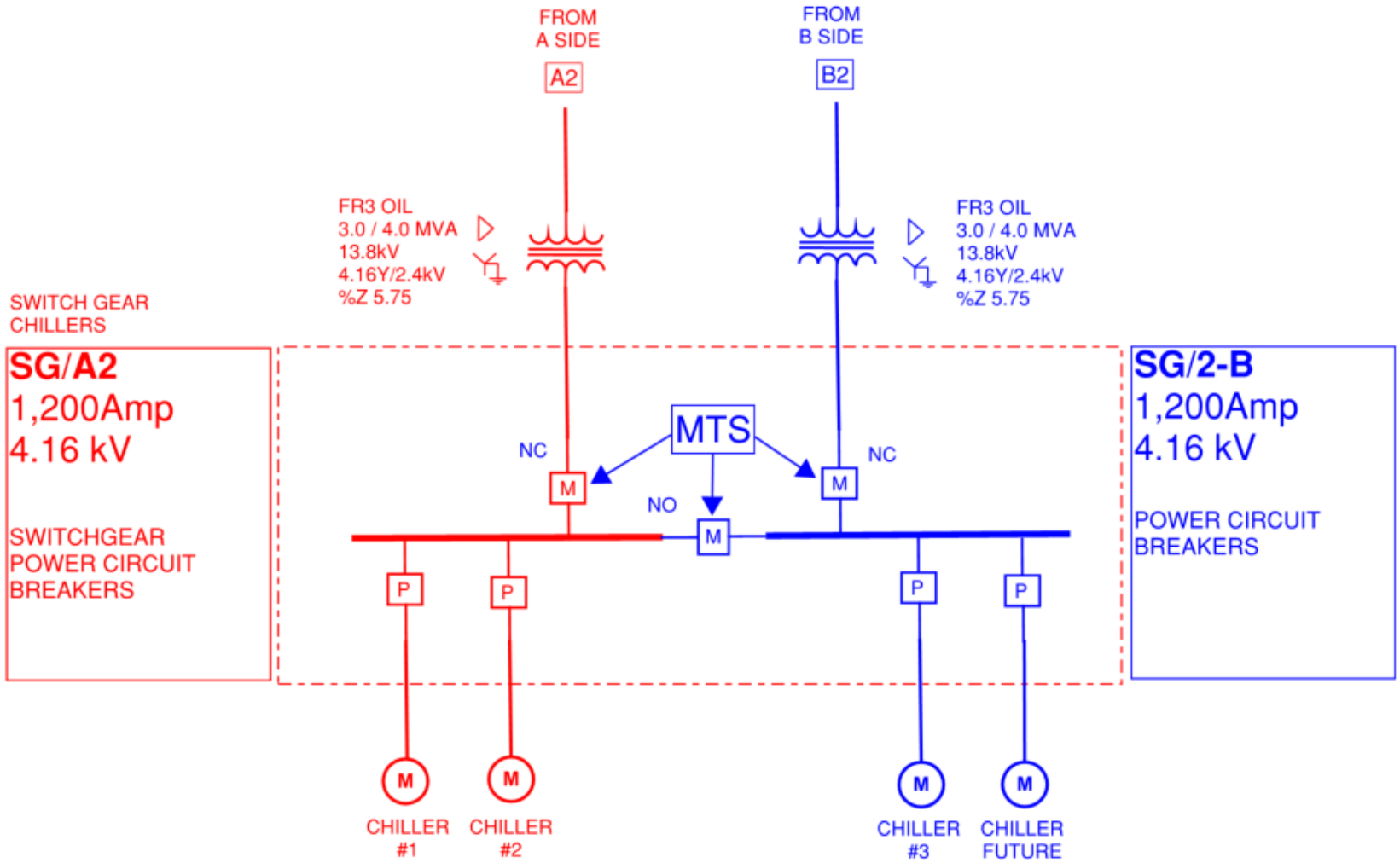
RADIAL FEED


FROM
A SIDE
A1
FR3 OIL
2.5 / 3.3 MVA
13.8kV
480Y/277V
%Z 5.75
USS/A1
4,000Amp
480Y/277 Volt
SWITCHGEAR
POWER CIRCUIT
BREAKERS

SECONDARY SELECTIVE– MAIN TIE MAIN



SECONDARY SELECTIVE – MAIN TIE MAIN, 4.16kV



SYSTEM VOLTAGES

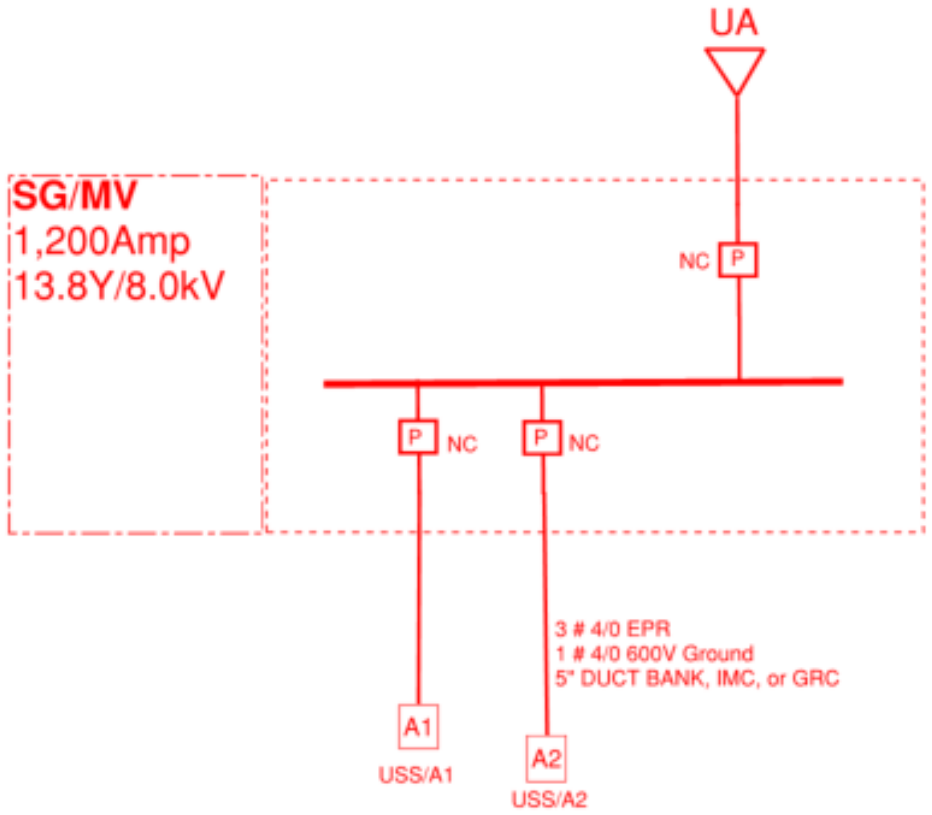
Medium Voltage < 25,000 Volts

- 4,160Y/2,400 Volts
- 13,200Y/7,620 Volts
- 13,800Y/7,970 Volts
- 24,900Y/14,375 Volts
- Distribution Voltages

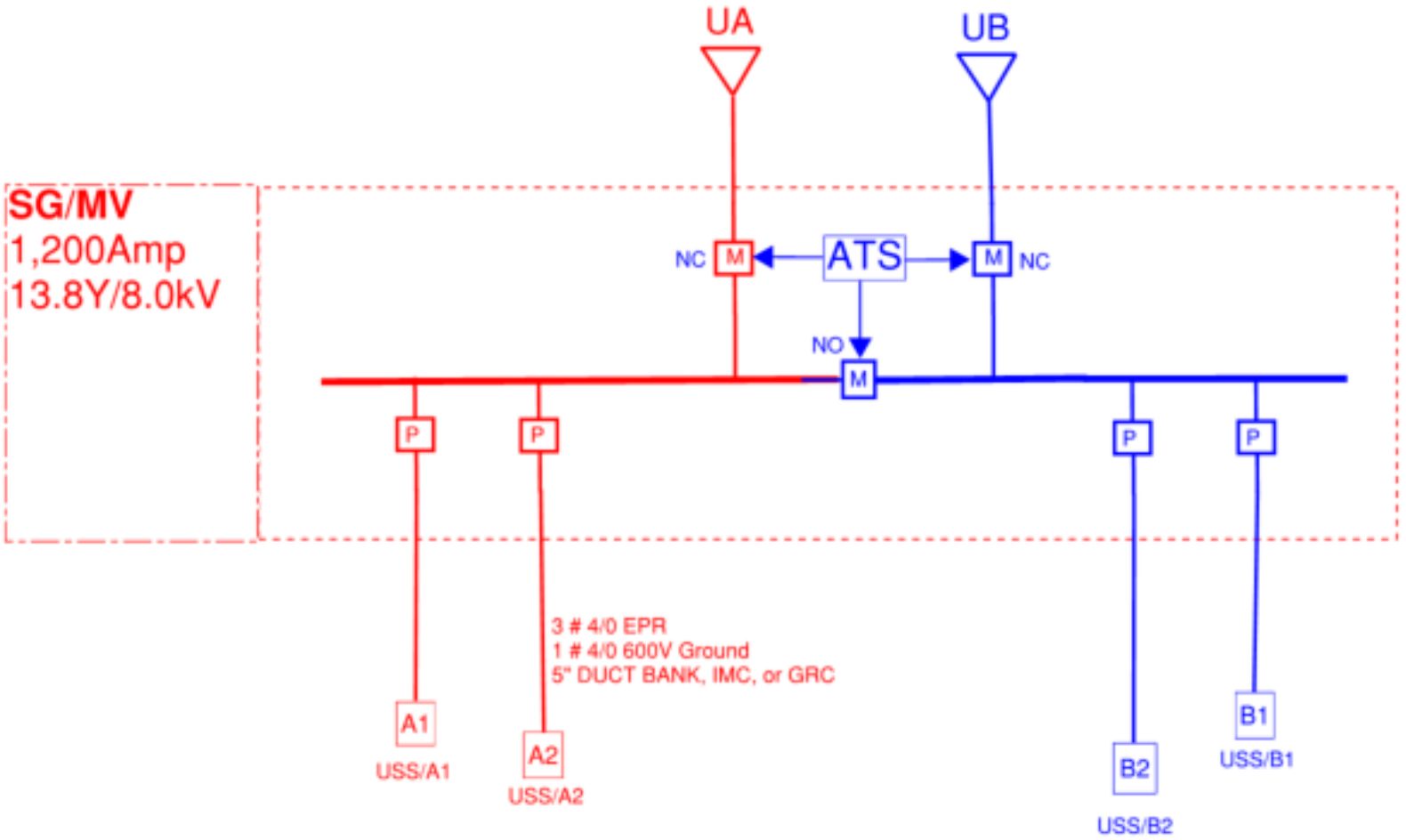
High Voltage > 25,000 Volts

- Utility Transmission (ATC) and sometimes Industrial Distribution

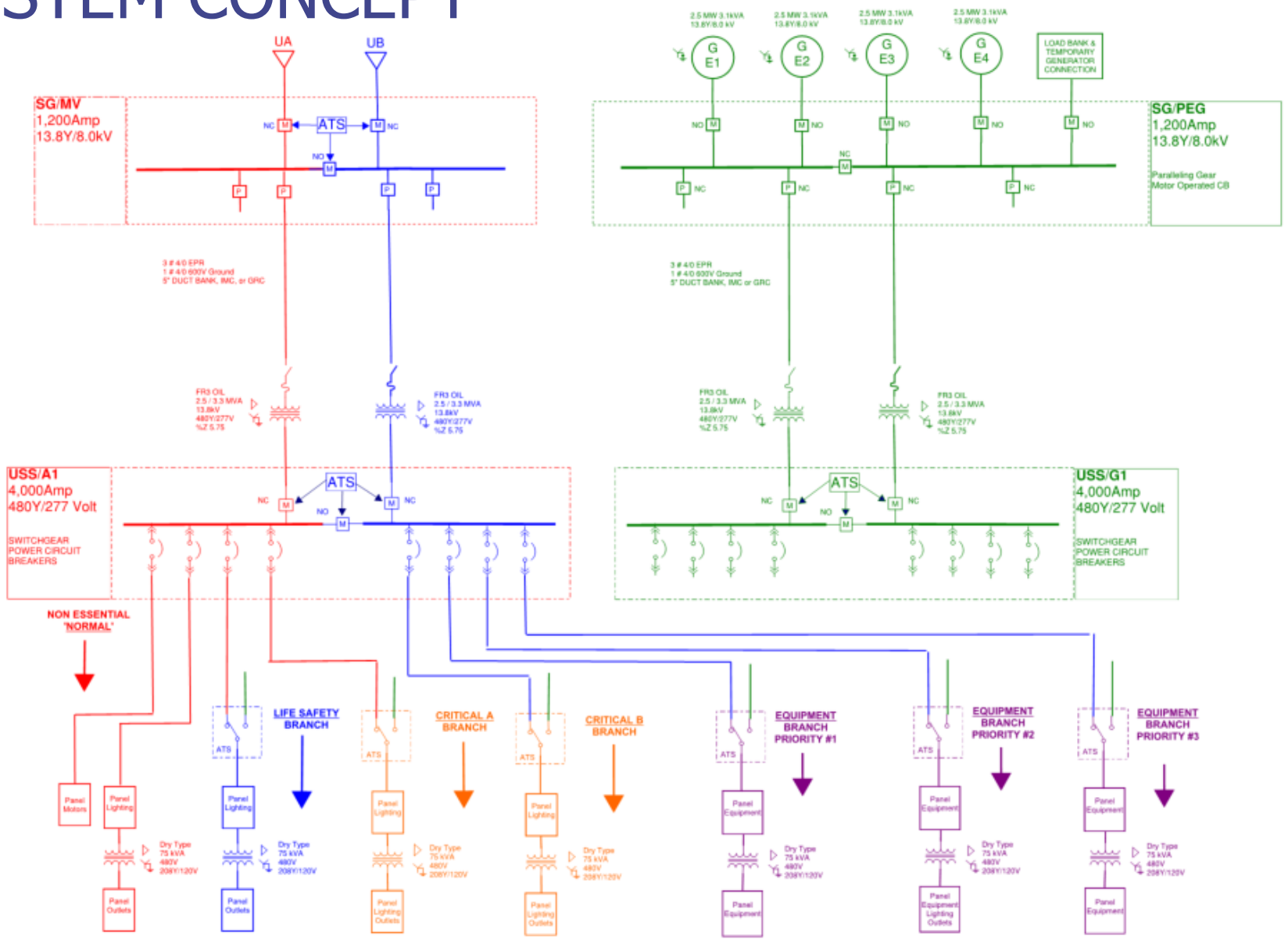
RADIAL FEED


UA
SG/MV
1,200Amp
13.8Y/8.0kV
NC
P
P
NC
P
NC
3 # 4/0 EPR
1 # 4/0 600V Ground
5" DUCT BANK, IMC, or GRC
A1
USS/A1
A2
USS/A2

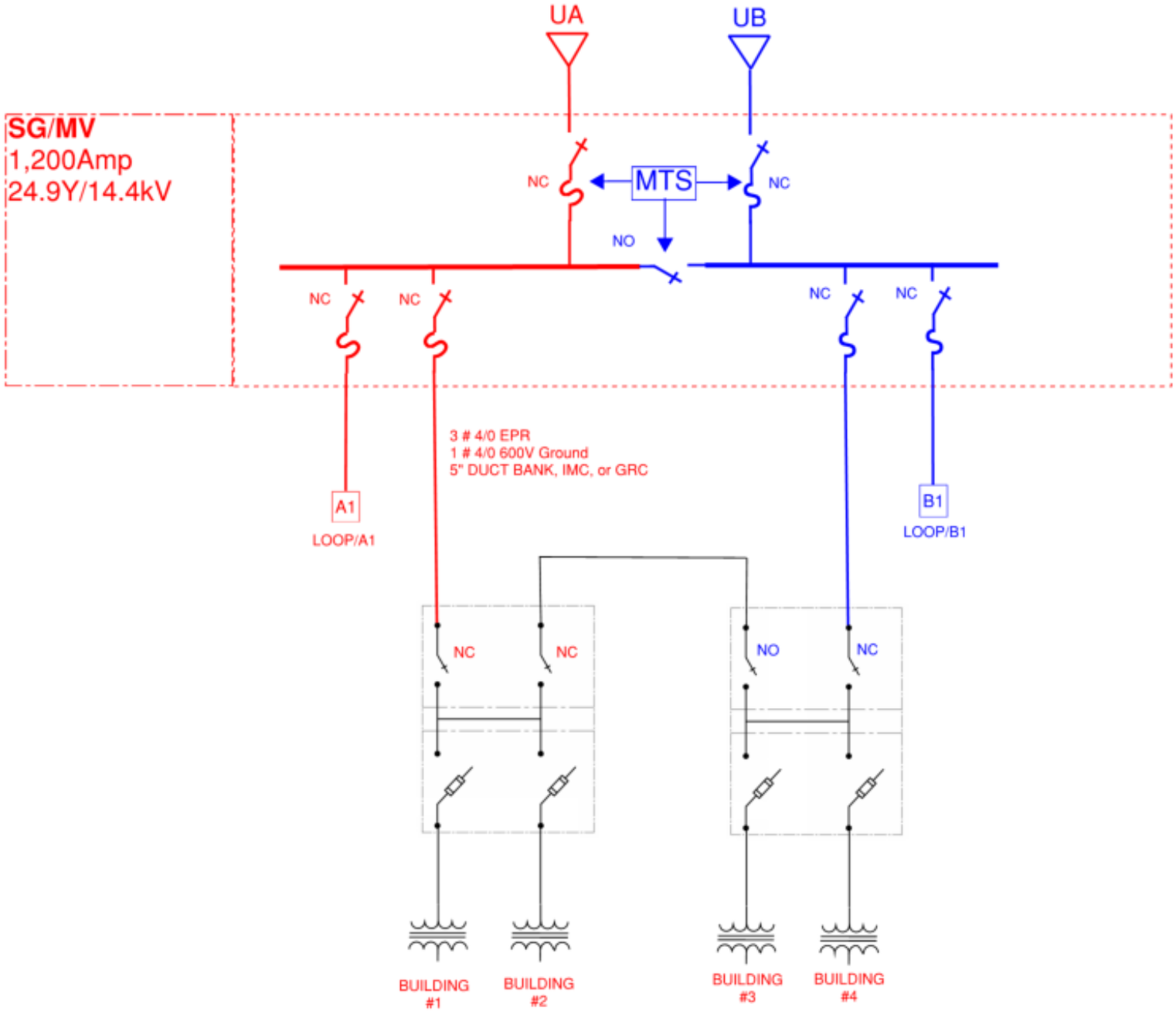
PRIMARY SELECTIVE



ROBUST SYSTEM CONCEPT



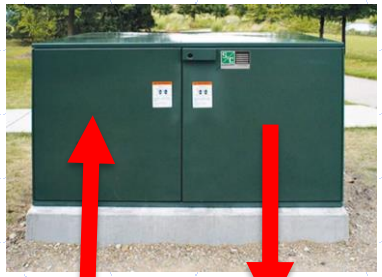
LOOP SYSTEM


SG/MV
1,200Amp
24.9Y/14.4kV
UA
UB
NC
MTS
NC
NO
NC
NC
NC
NC
3 # 4/0 EPR
1 # 4/0 600V Ground
5" DUCT BANK, IMC, or GRC
A1
LOOP/A1
B1
LOOP/B1
NC
NC
NO
NC
BUILDING #1
BUILDING #2
BUILDING #3
BUILDING #4

PRIMARY UTILITY SERVICE / 1 SERVICE

Metal Enclosed Switch Gear
May or may not be automatic switching

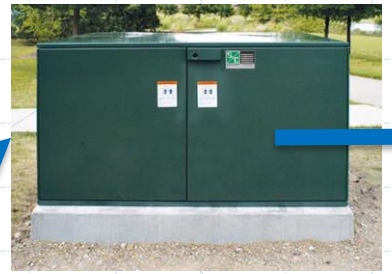
Utility Meter



Utility #A

PRIMARY UTILITY SERVICE / 2 SERVICES

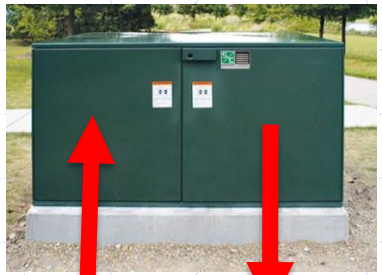
Metal Enclosed
Switch Gear



Utility
Meter

Utility #B

Utility #A



THANK YOU!

Questions?