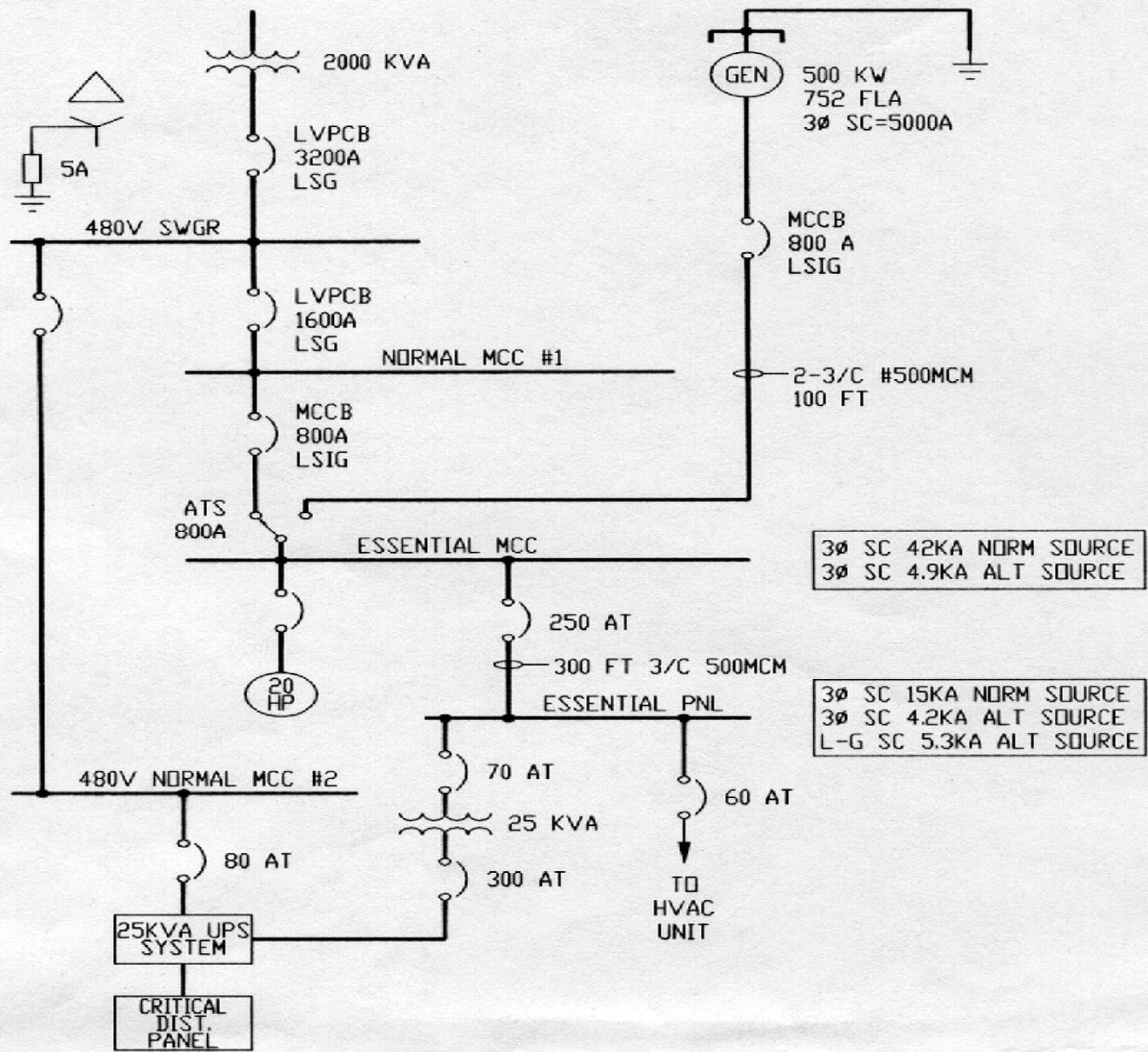


# Is Selectivity Achieved in Critical Low-Voltage UPS and Standby Generator Power Circuits?

Presented by: Jim Bowen  
Roy Cossé

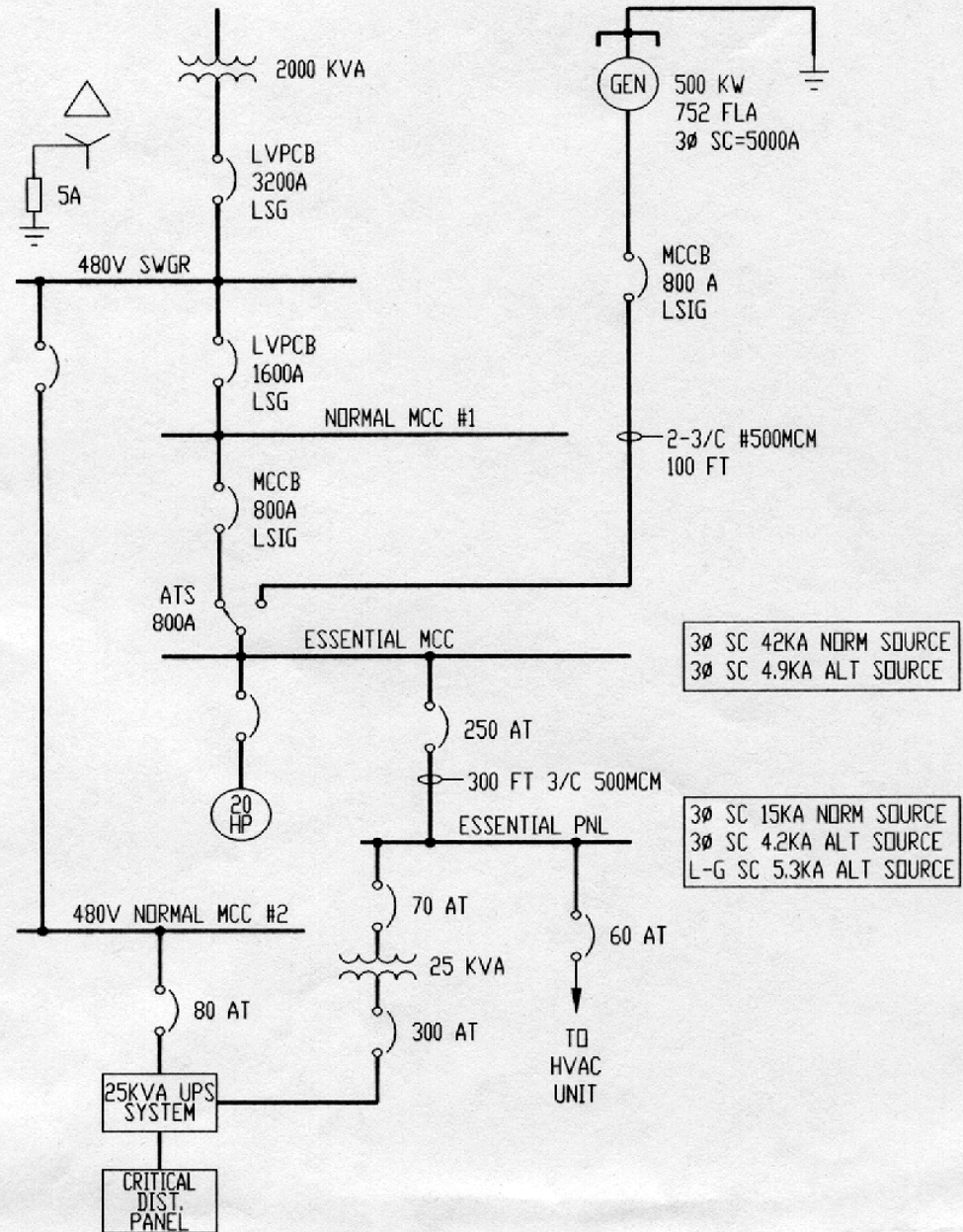
1999 PCIC





# Typical One Line

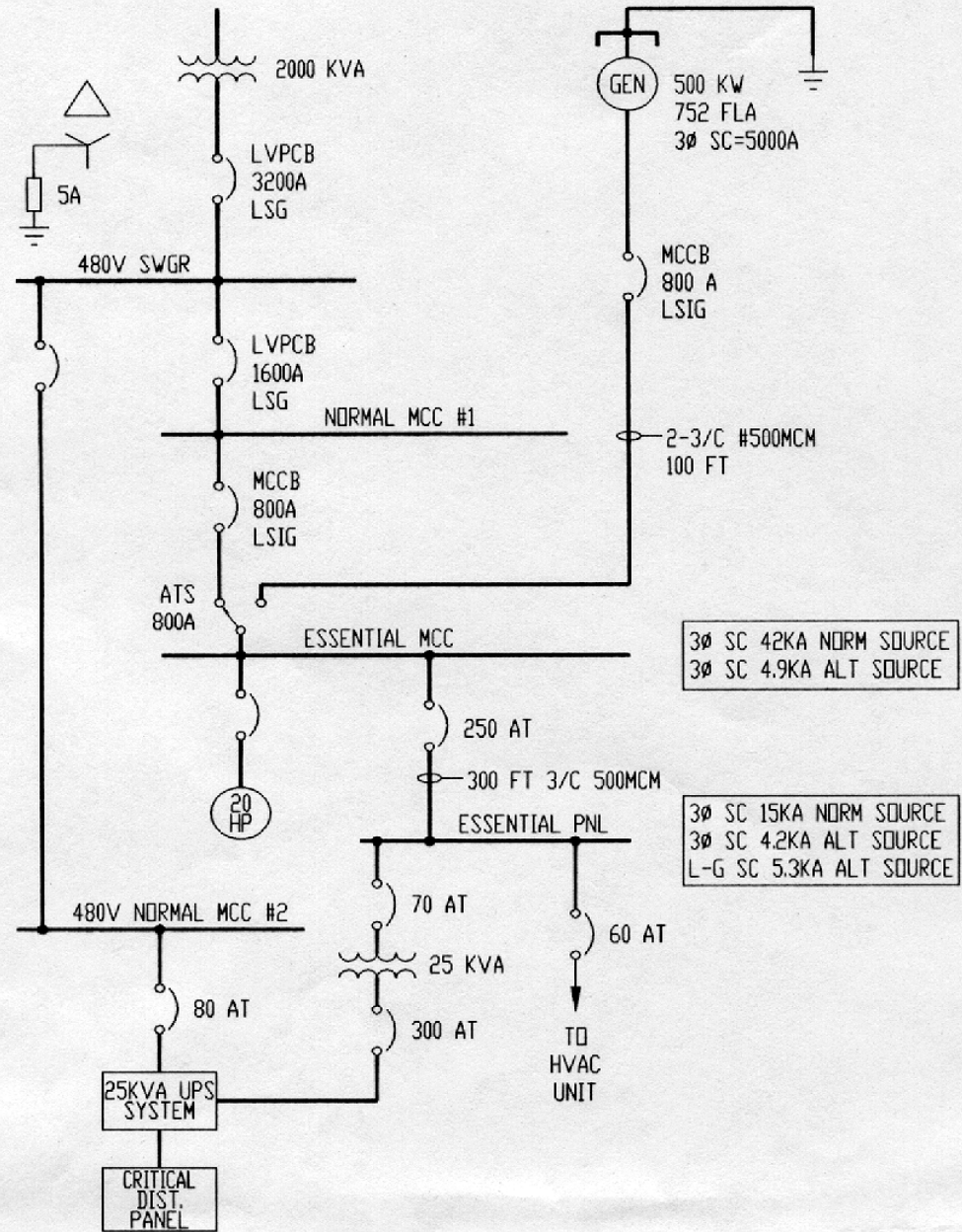
- 500 kW generator
- 2000 kW normal source
- 800 amp ATS
- 25 KVA UPS
- Essential MCC





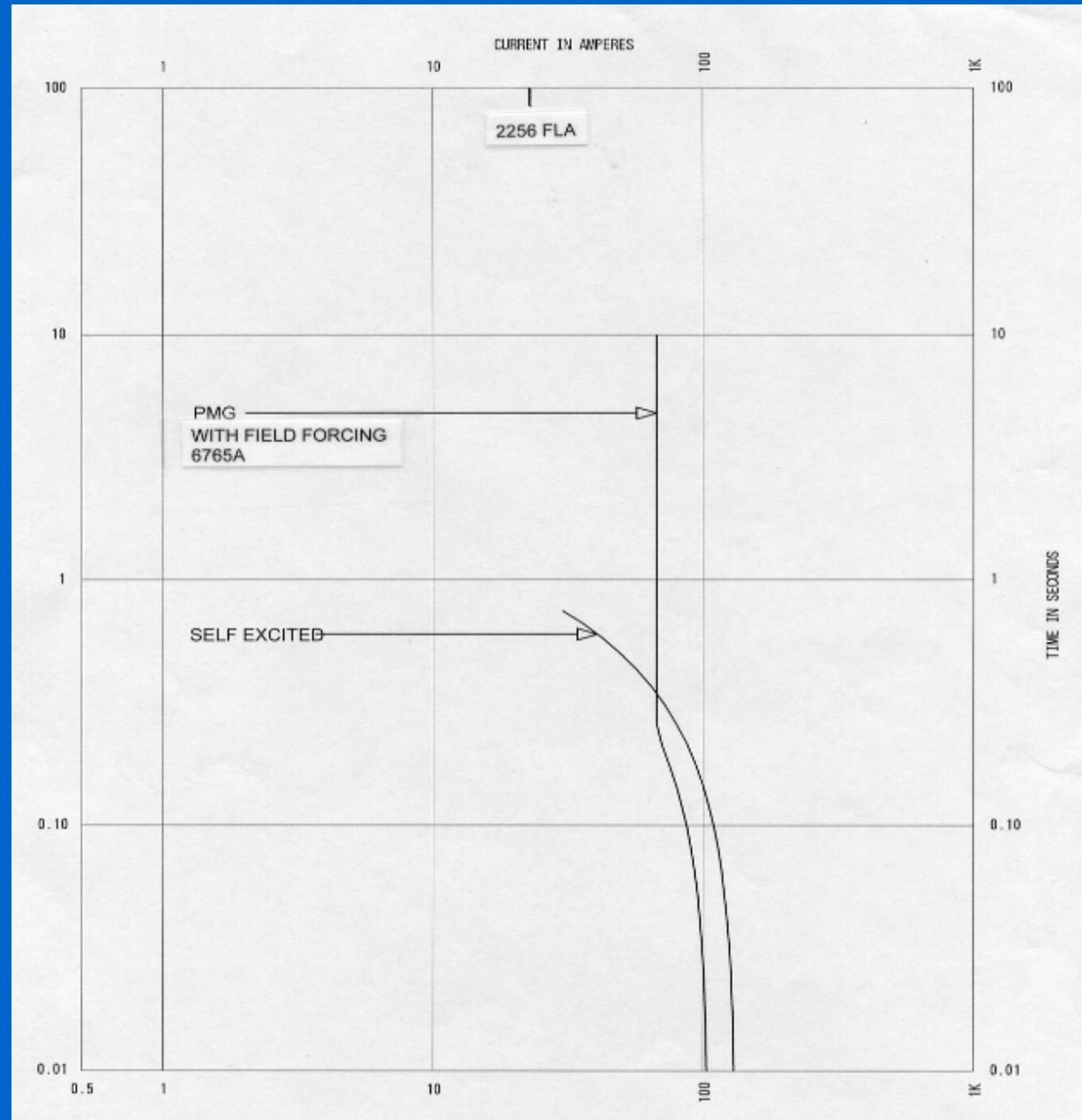
# AVR w/ Excitation Support System

- AVR senses bus voltage
- AVR increases excitation as voltage decreases
- Sustained fault current decrement with boost 3 p.u. for 10 sec.



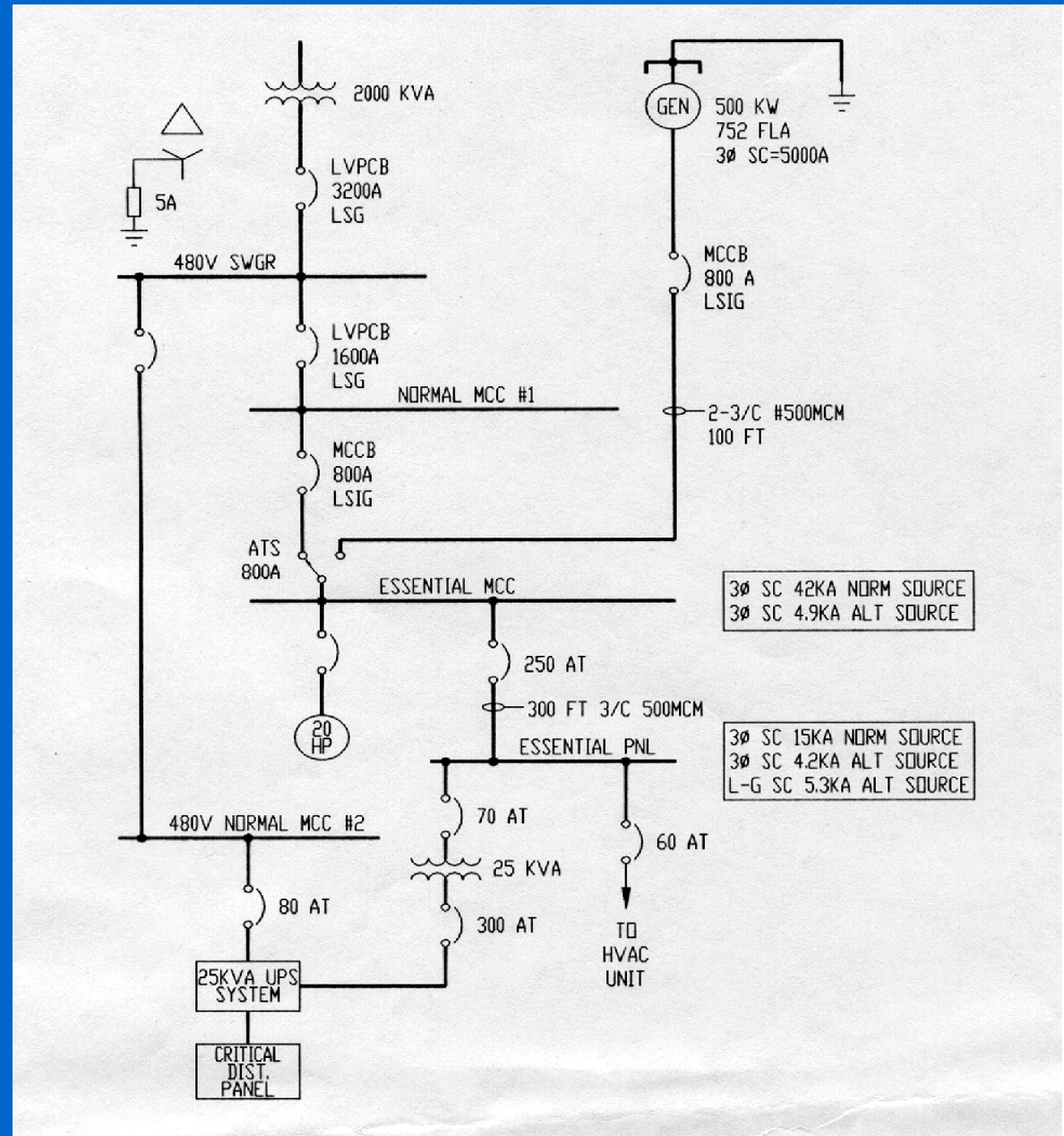
# Generator Decrement

- Fault Support
  - Standard excitation
  - PMG with field forcing
- Decrement approximation



# Remote Faults

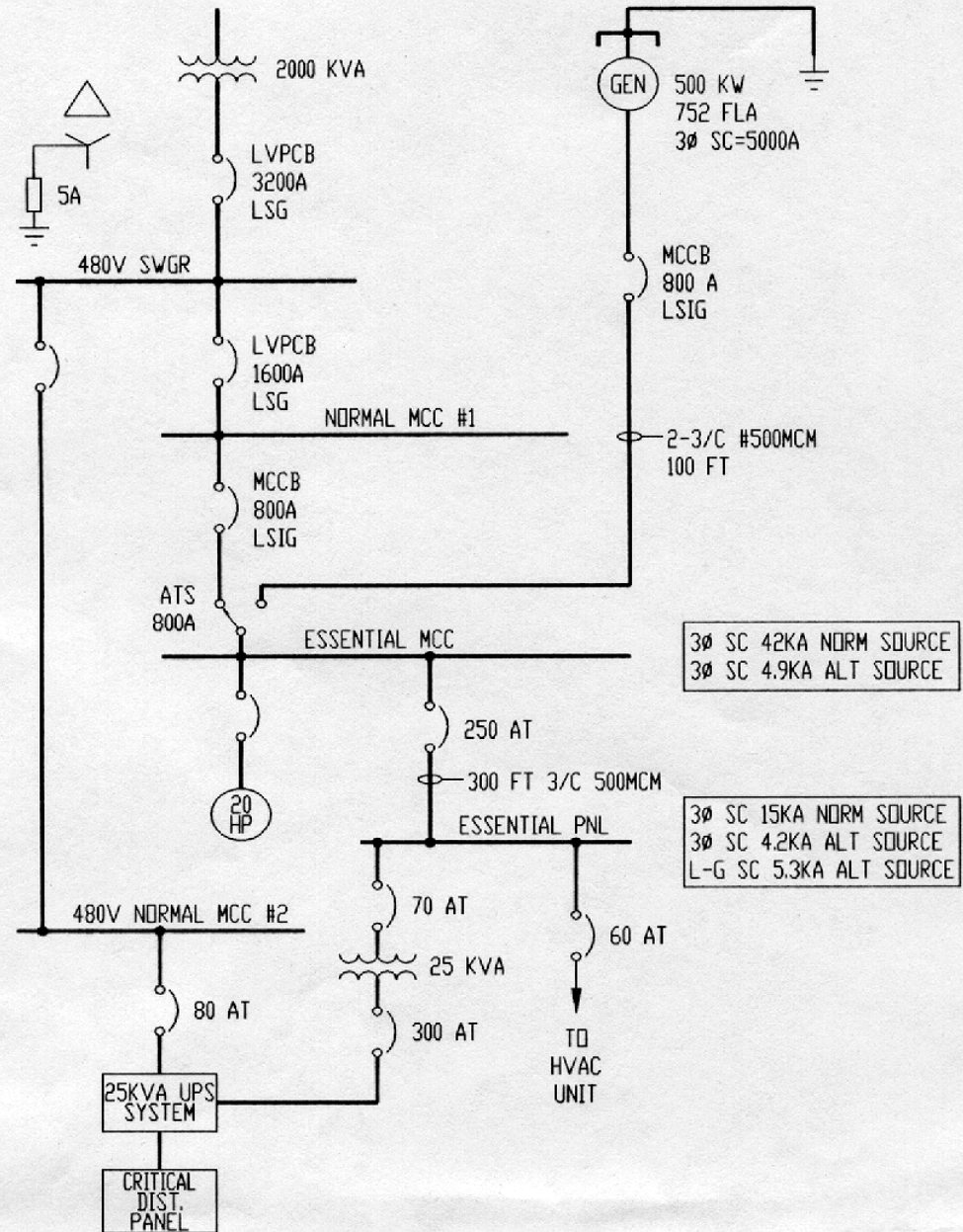
- Normal Supply (42kA)
  - 300FT/500MCM  $\Rightarrow$  15kA
  - 300FT/#10AWG  $\Rightarrow$  711A
- Generator Supply (5kA)
  - 300FT/500MCM  $\Rightarrow$  4.2kA
  - 300FT/#10AWG  $\Rightarrow$  425A





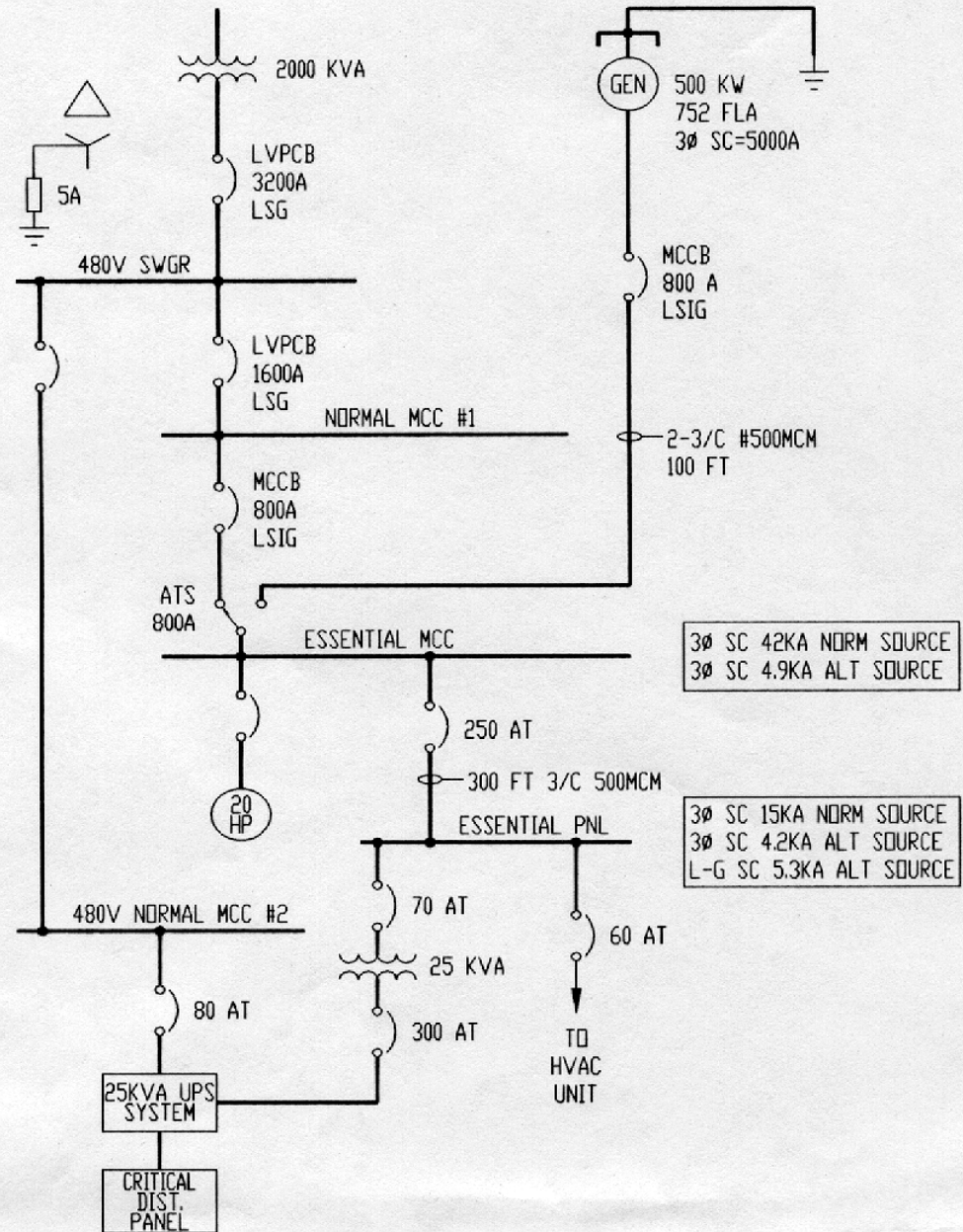
# Remote Faults

- Confirm instantaneous clearing during downstream reduce faults
- High impedance faults often not cleared



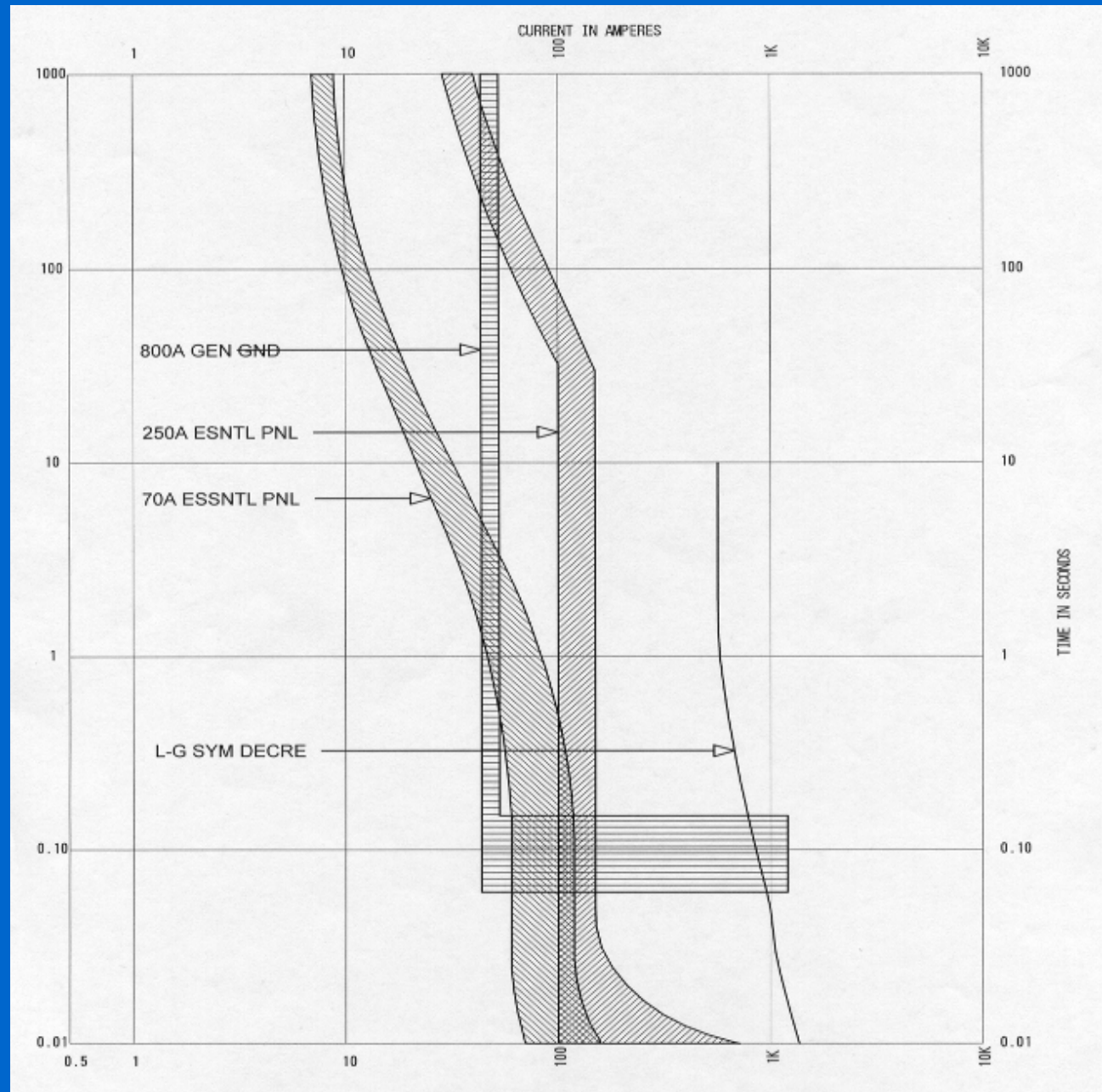
# Solid Ground Generator

- L-G fault > Line fault
- Low magnitude GF not detected by instantaneous MCCB's
- Uncleared GF results in voltage collapse to instrument loads



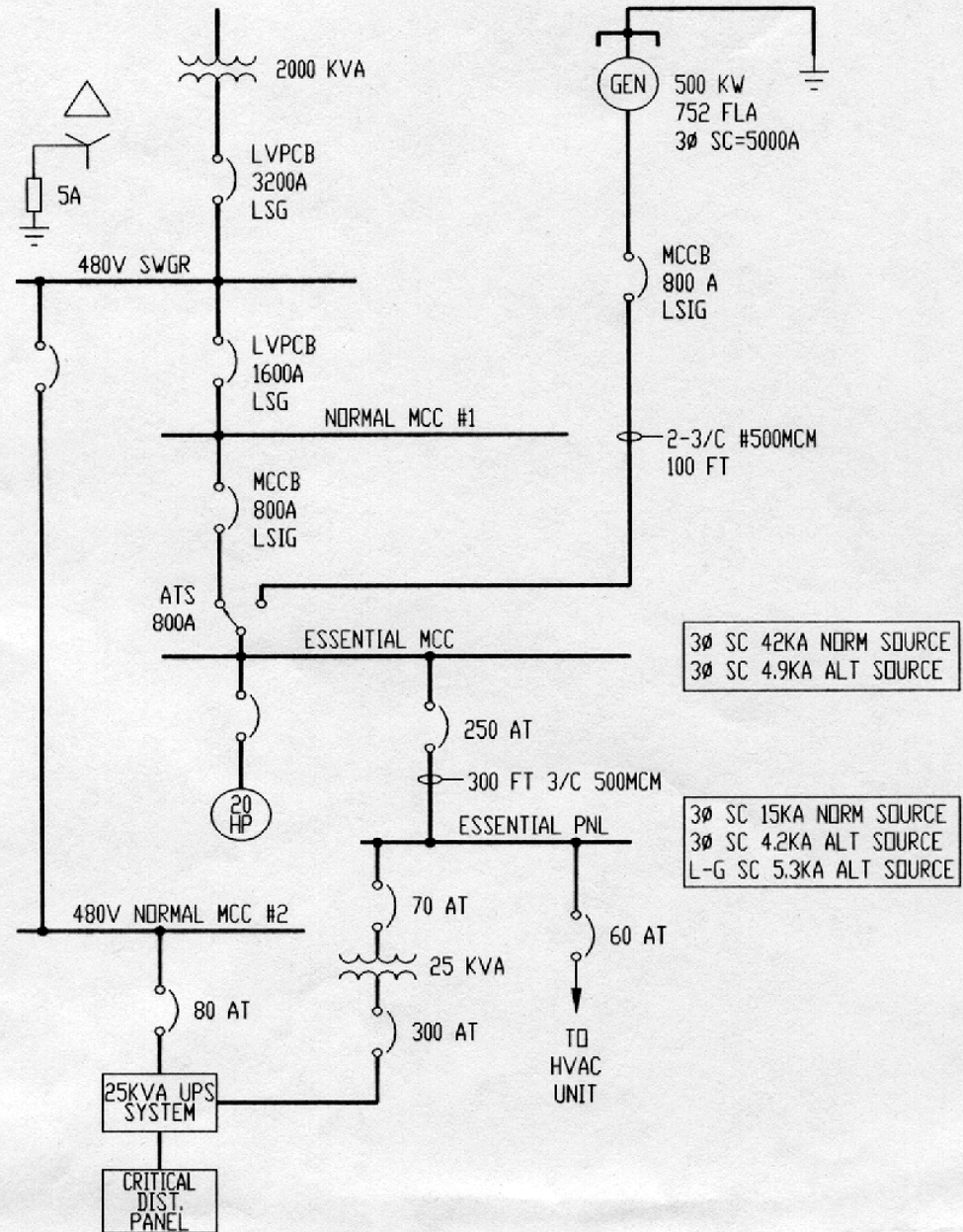
# Ground Protection

- Higher fault level
- Only high level faults protected
- Non-selectivity of 70A bkr and 250A in magnitude
- 800A bkr GF setting not selective in magnitude



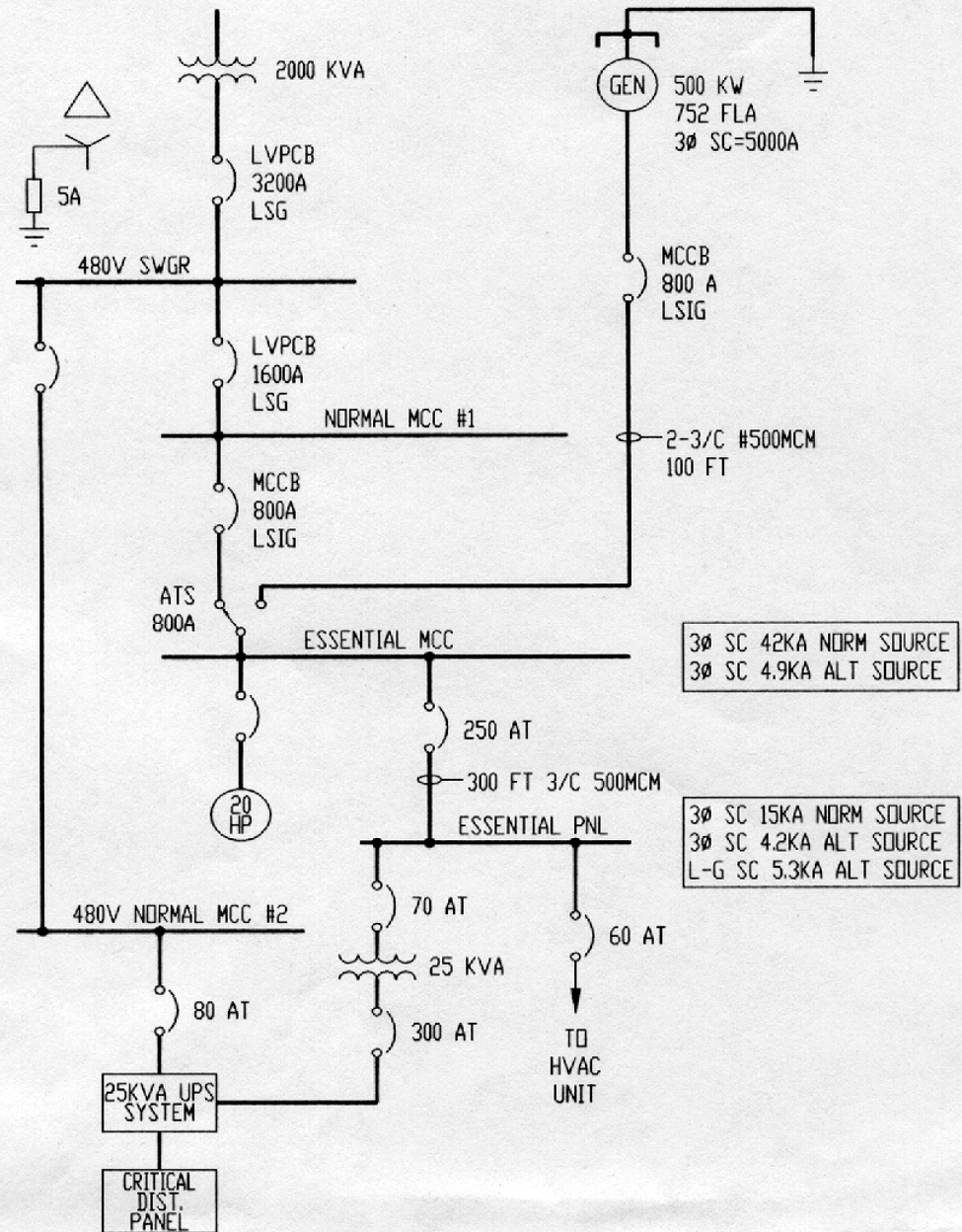
# Achieving GF Selectivity

- Add GF protection and shunt trip to all downstream bkr.
- Add 51G and neutral CT to generator
- GF's are promptly cleared and system voltage maintained



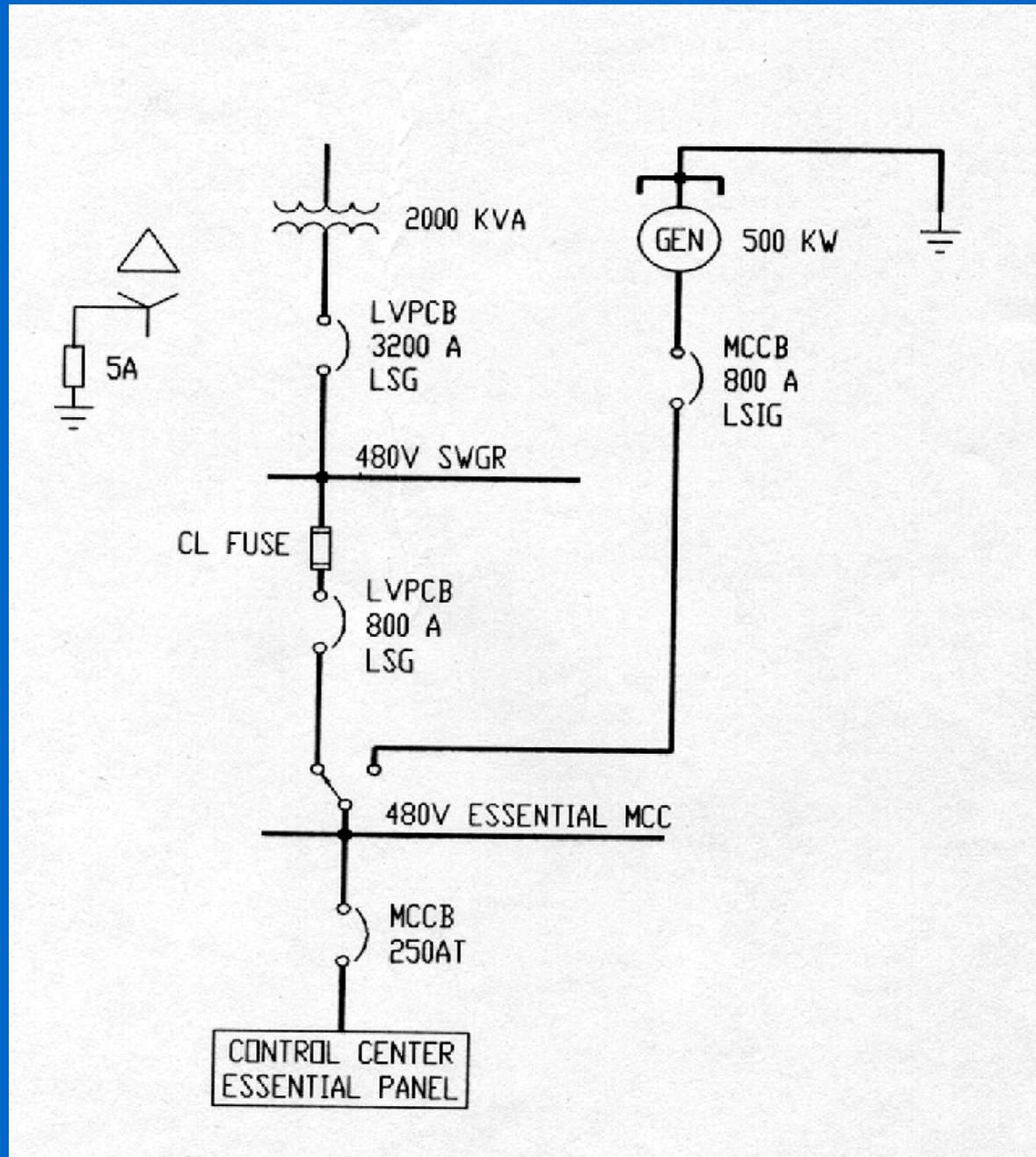
# Hi-Resistance Grounded Generator

- Selectivity during GF not an issue
- No bus voltage impact during GF
- Single phase load isolation xfmr means less available GF current to interrupt



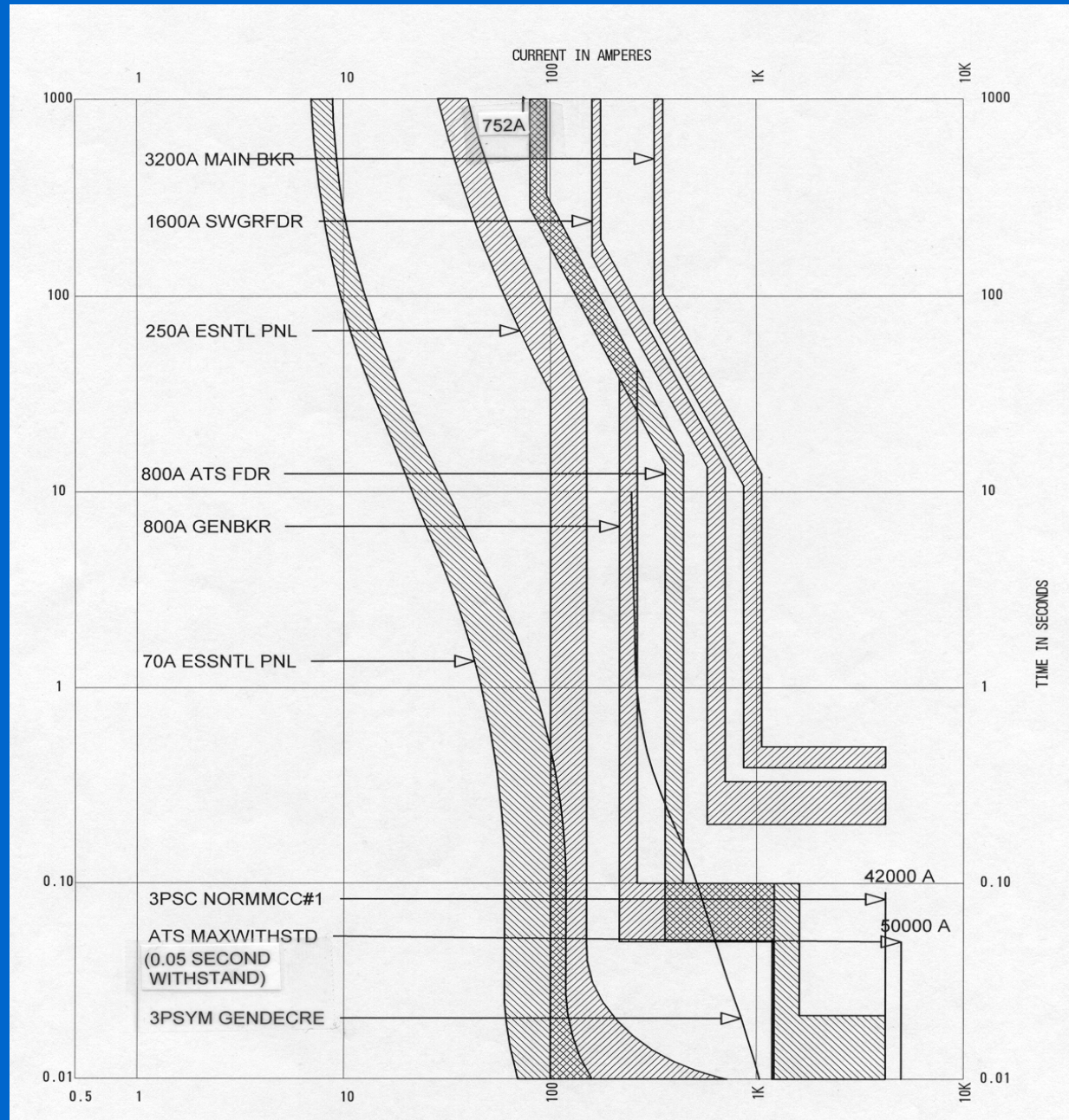
# ATS Sizing

- ATS sized for 750A generator
- 3 cycle short circuit withstand
- No close and latch rating
- Some 30 cycle withstand units are available



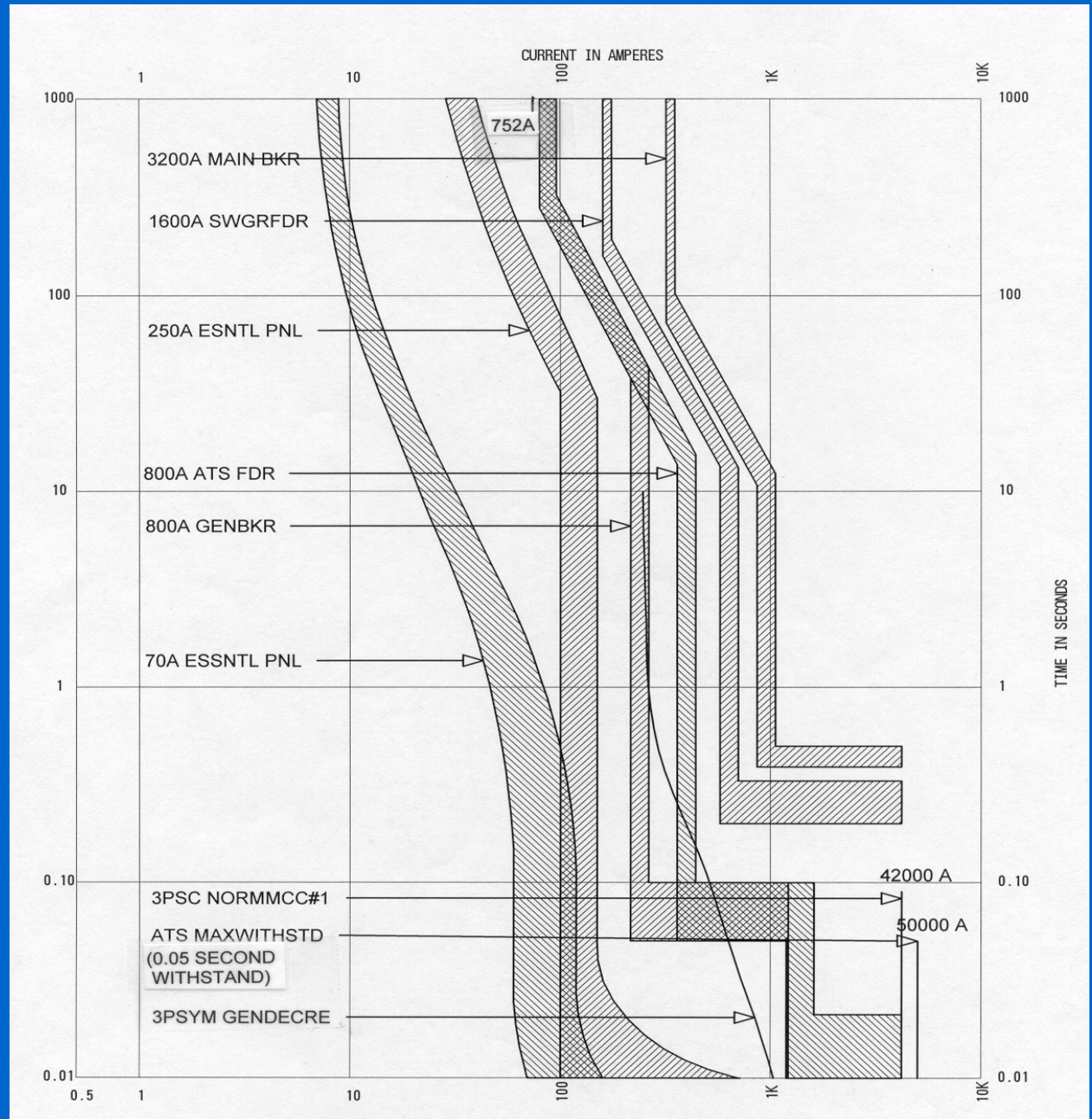
# Normal Source Short Circuit

- 42KA available
- 3200A, 1600A FDR breaker selectivity
- Assure selectivity W/ 800A FDR bkr
- Definite time required for selectivity, does not protect ATS



# Gen. Source Short Circuit

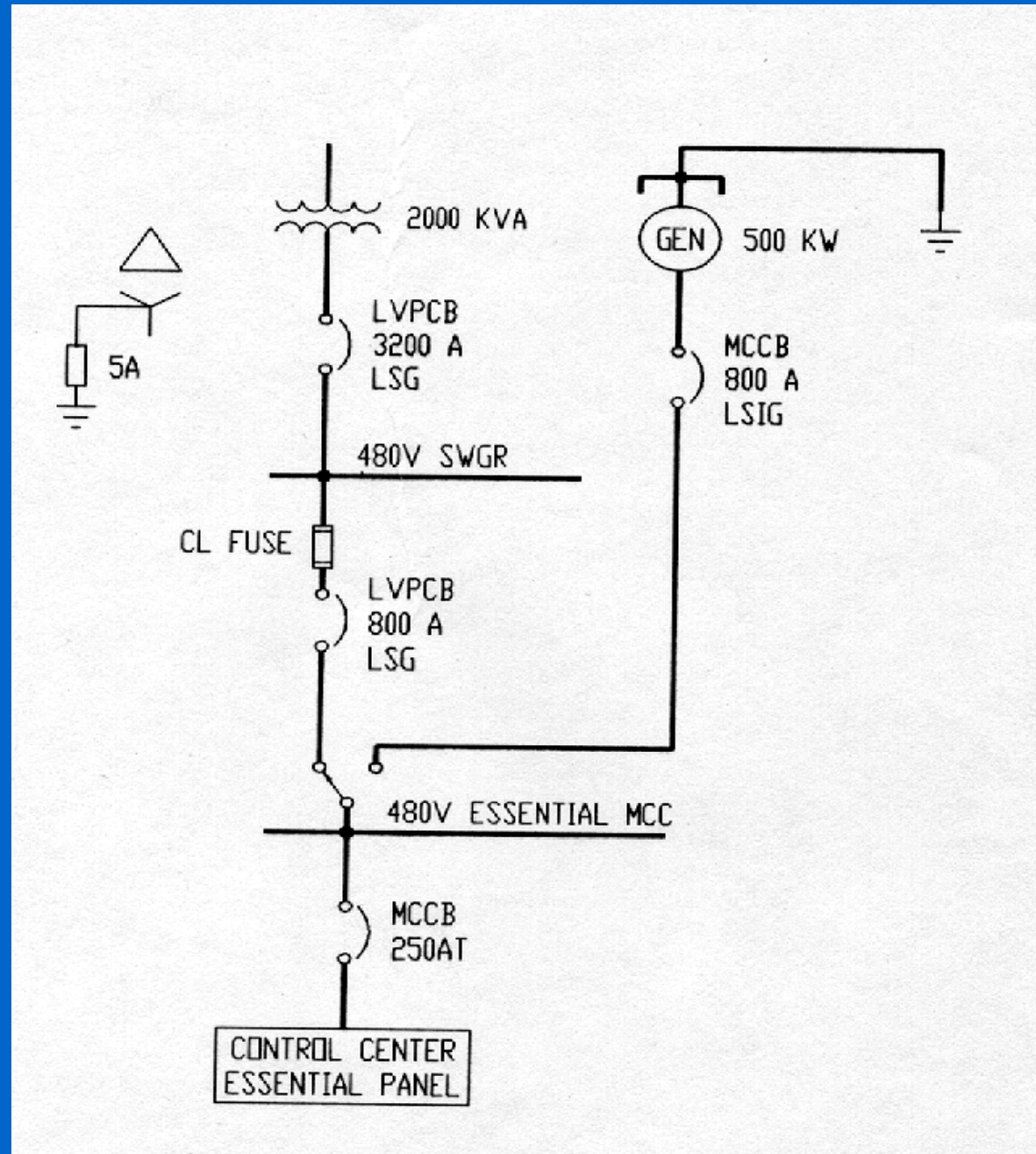
- 8KA w/ “Boost”
- 250A FDR bkr clears bolted faults
- Hi-impedance faults require thermal protection of 250A FDR bkr
- Prolonged clearing time depresses voltage to critical process loads





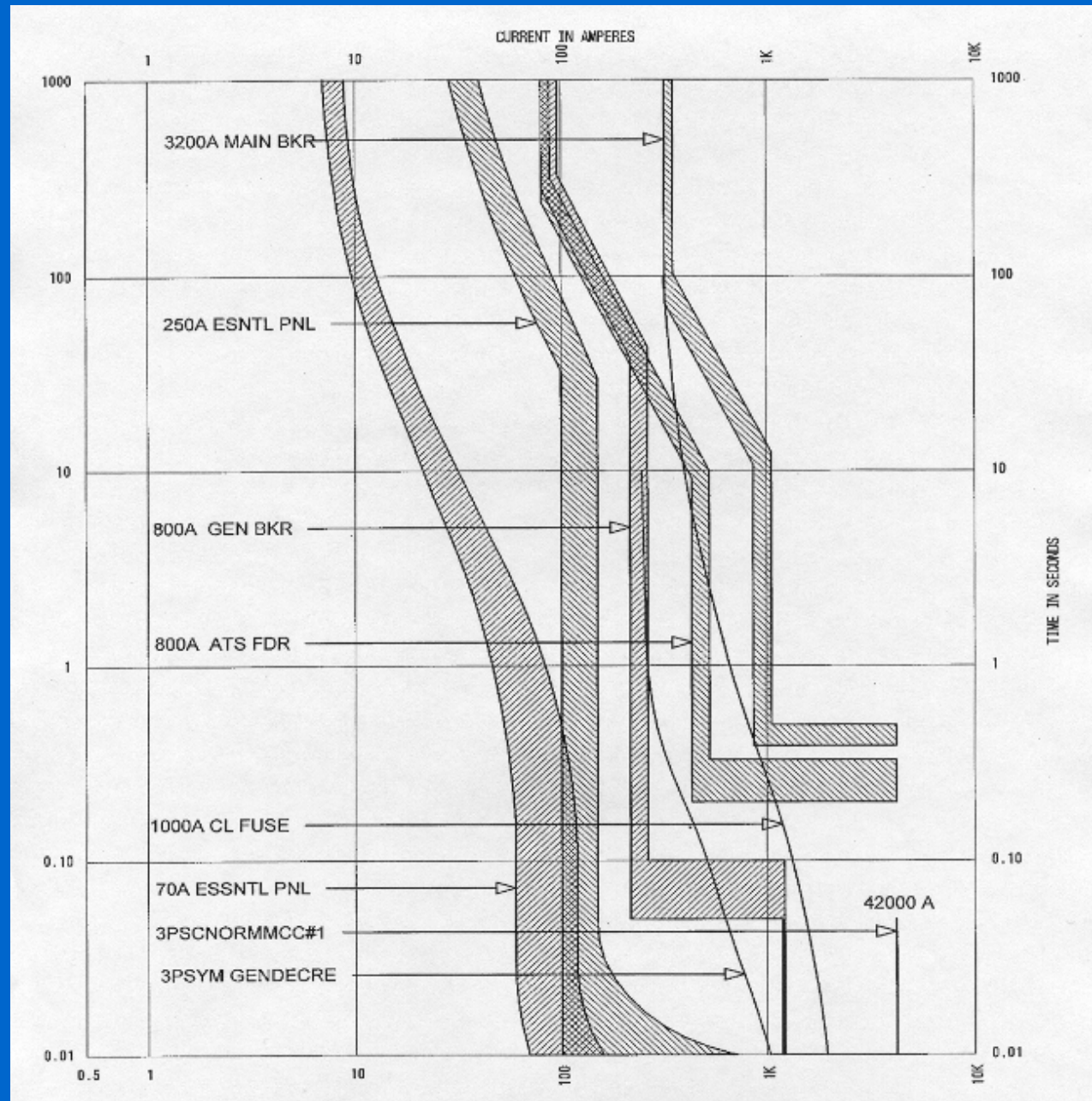
# ATS w/ Current Limiting Fuse

- Fuse protects ATS for 0 - 3 cycles range
- Eliminate the 1600A feeder bkr
- Optimize the 70A Essential Pnl main breaker



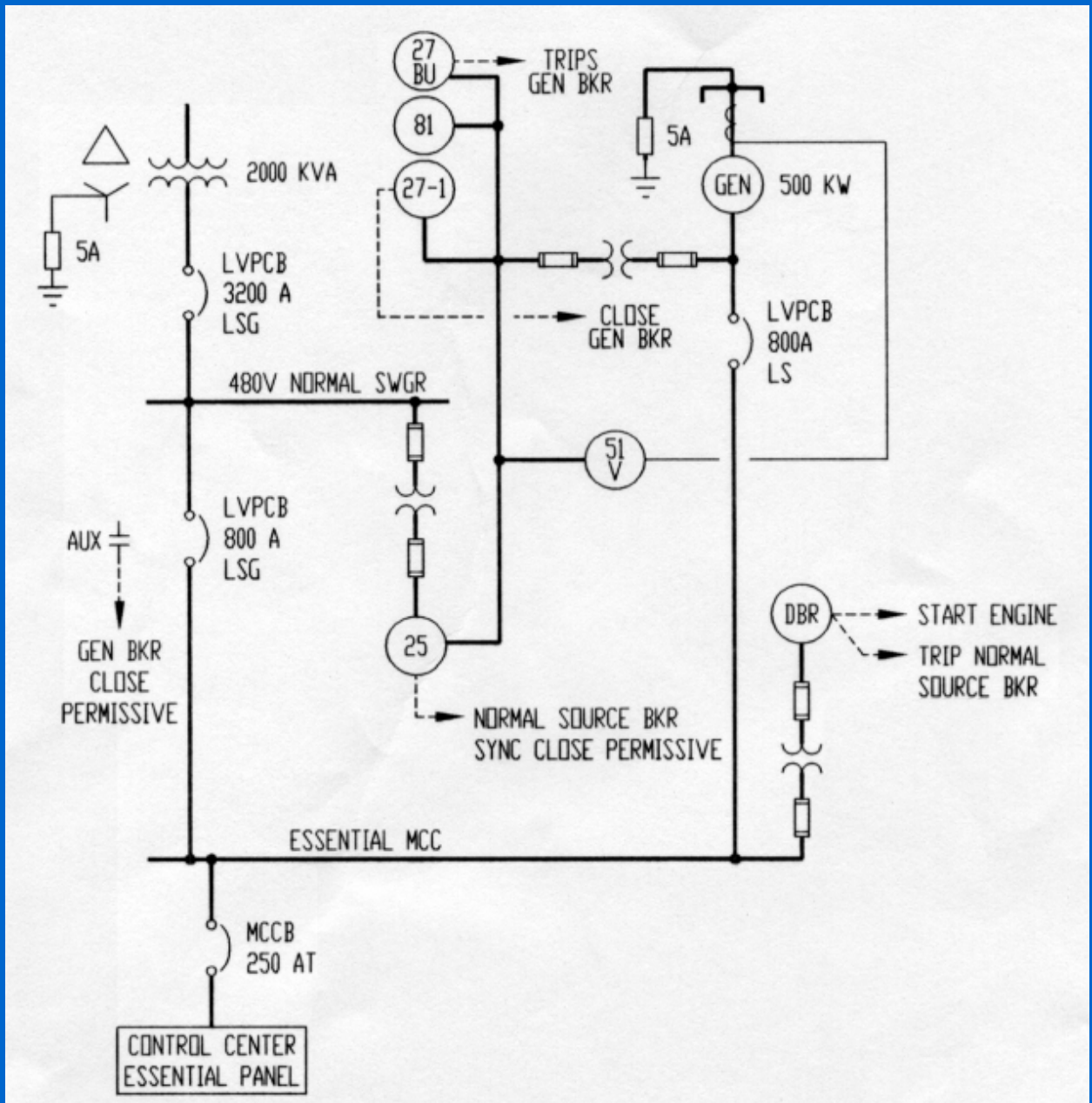
# Current Limiting Fuse

- Beyond 3 cycles LVPCB selective with down stream protection
- CLE limits let-through
- Minimize high impedance fault by additional insulation



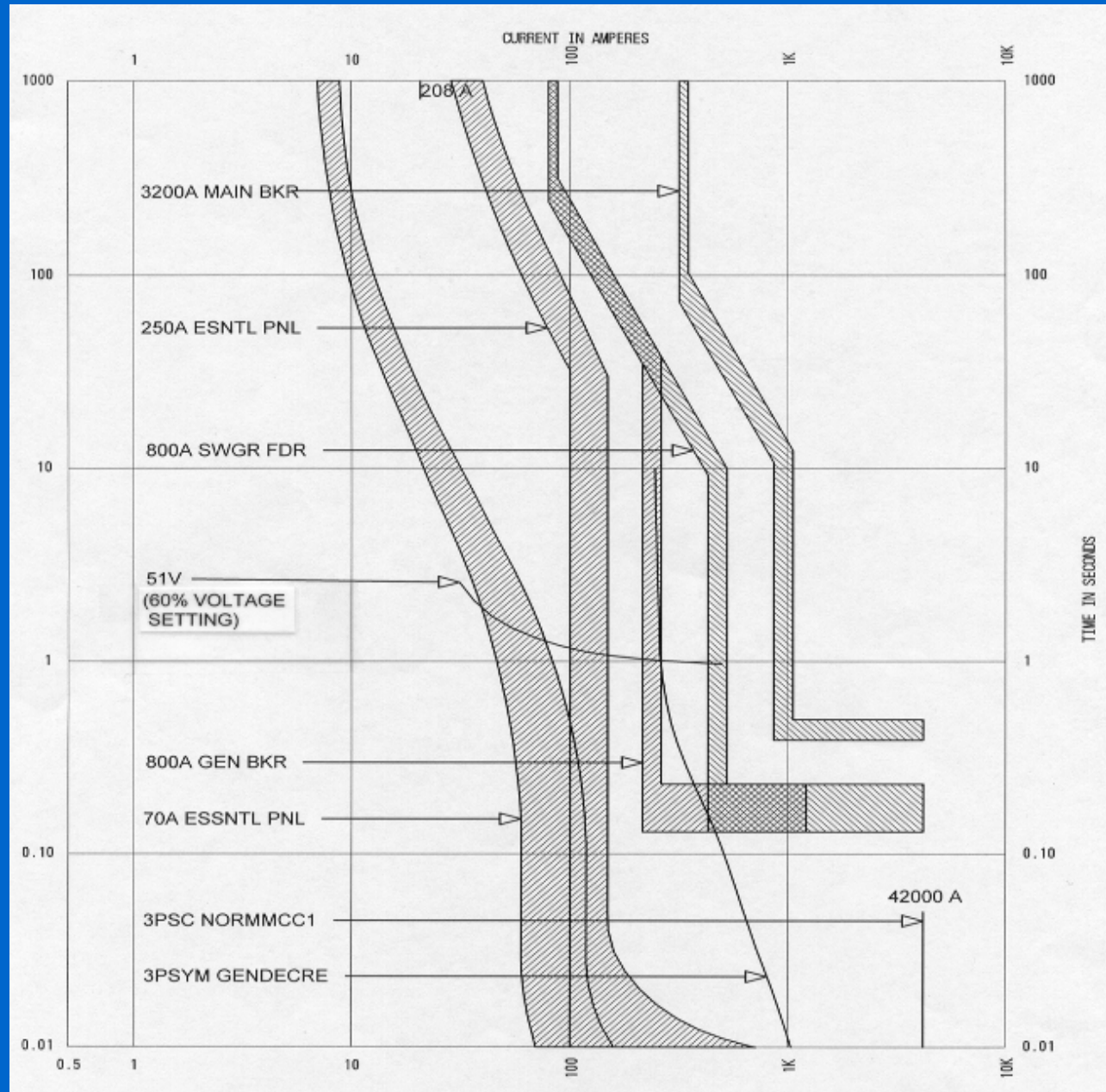
# Non-ATS Configuration

- Eliminates ATS selectivity issues
- Allows generator to achieve rated speed before throw-over
- Allows closed transition return to normal source



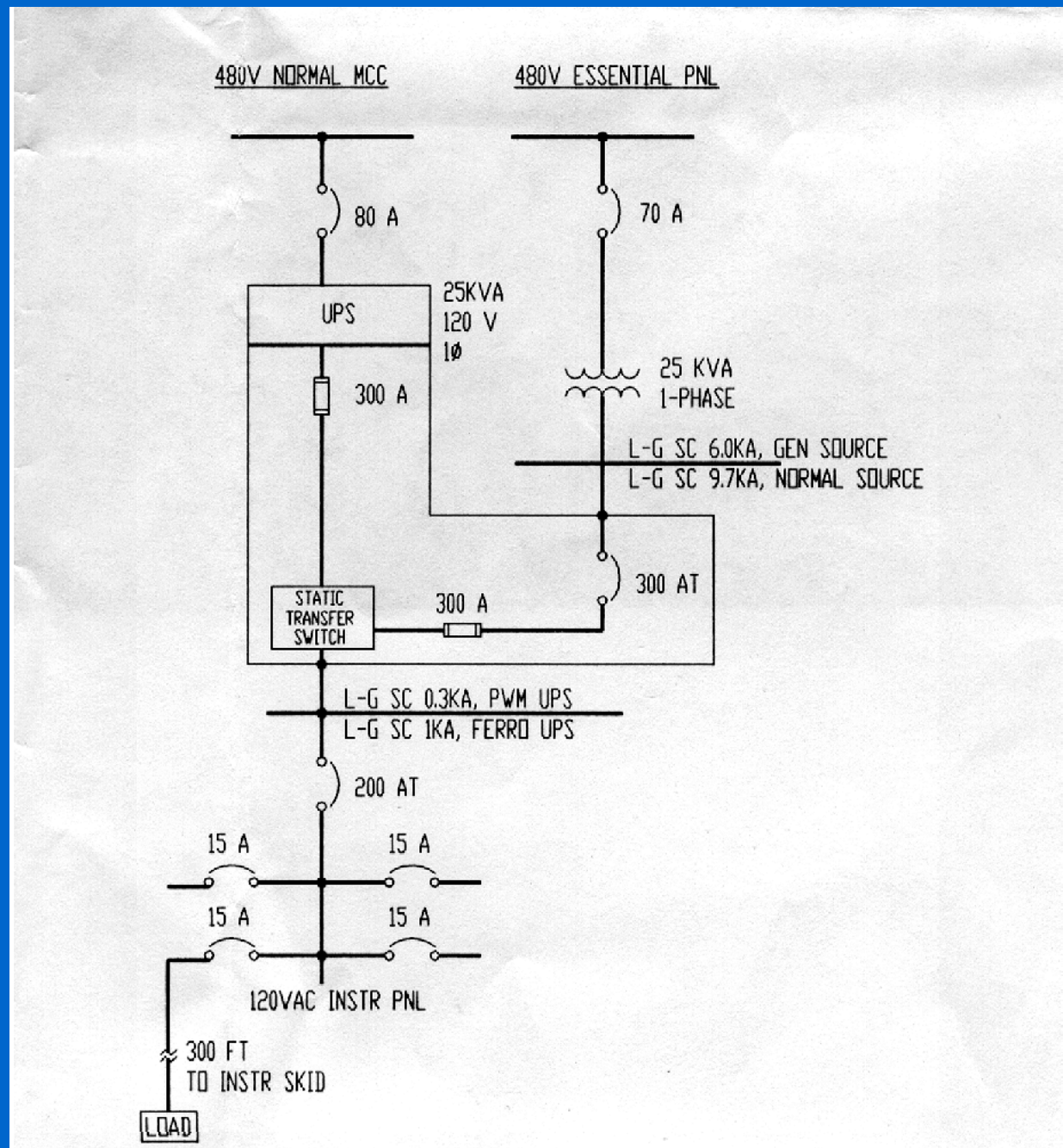
# Non ATS/ 51V Co-ordination

- Definite time 51V only respond for voltage below 70%
- Offer very good back-up protection



# UPS

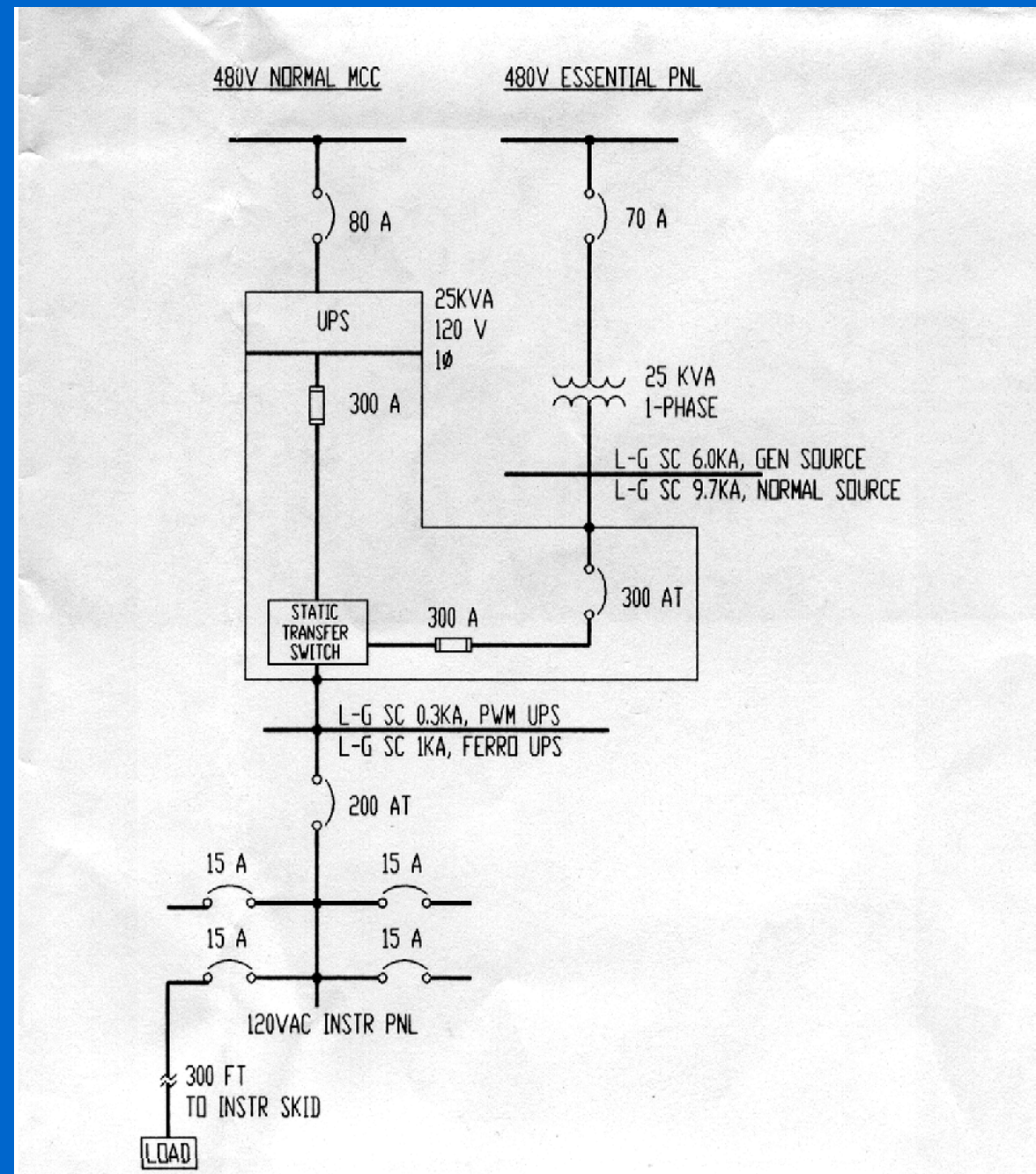
- PWM fault current 150% of FLA
- Ferro-resonant
  - 500% of FLA for 1/4 cycle
  - Decays to the 150% of FLA
- Single phase UPS desirable due to increased short-circuit capability for same watts





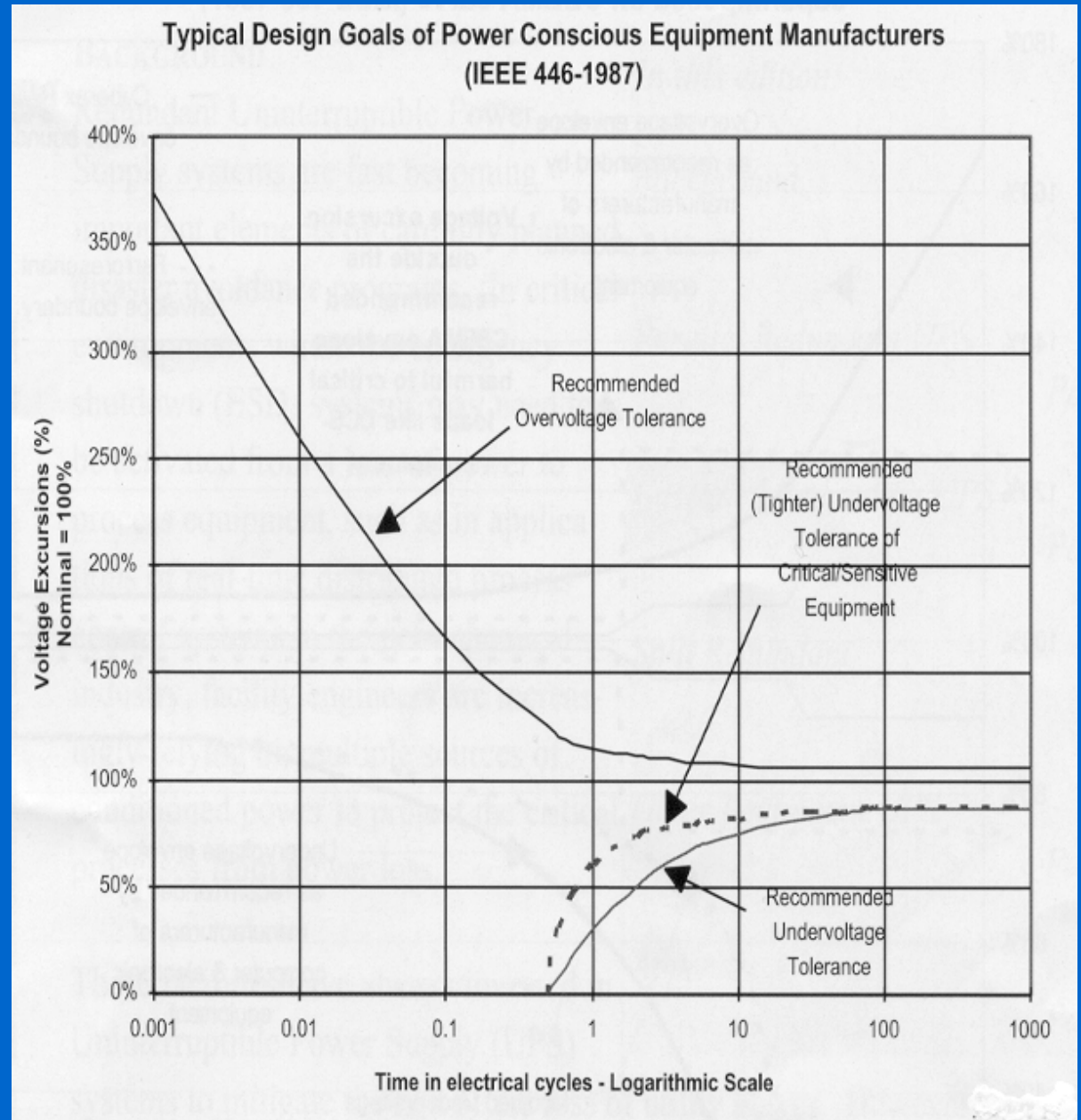
# Typical UPS

- Static Switch typical rating 1000% FLA for 1-5 cycles
- Static switch protected by semiconductor fuses
- Panelboard MCB may require 1-1.5 cycles to interrupt
- 1.5-2 cycle clearing time may require static switch to transfer



# UPS Voltage Support

- UPS manufactures maintain CBEMA
- Dependant on rapid down stream clearing
- Manufactures recommend fast blow fuses
- Voltage collapses and static switch transfers to backup supply by 1/2 cycle



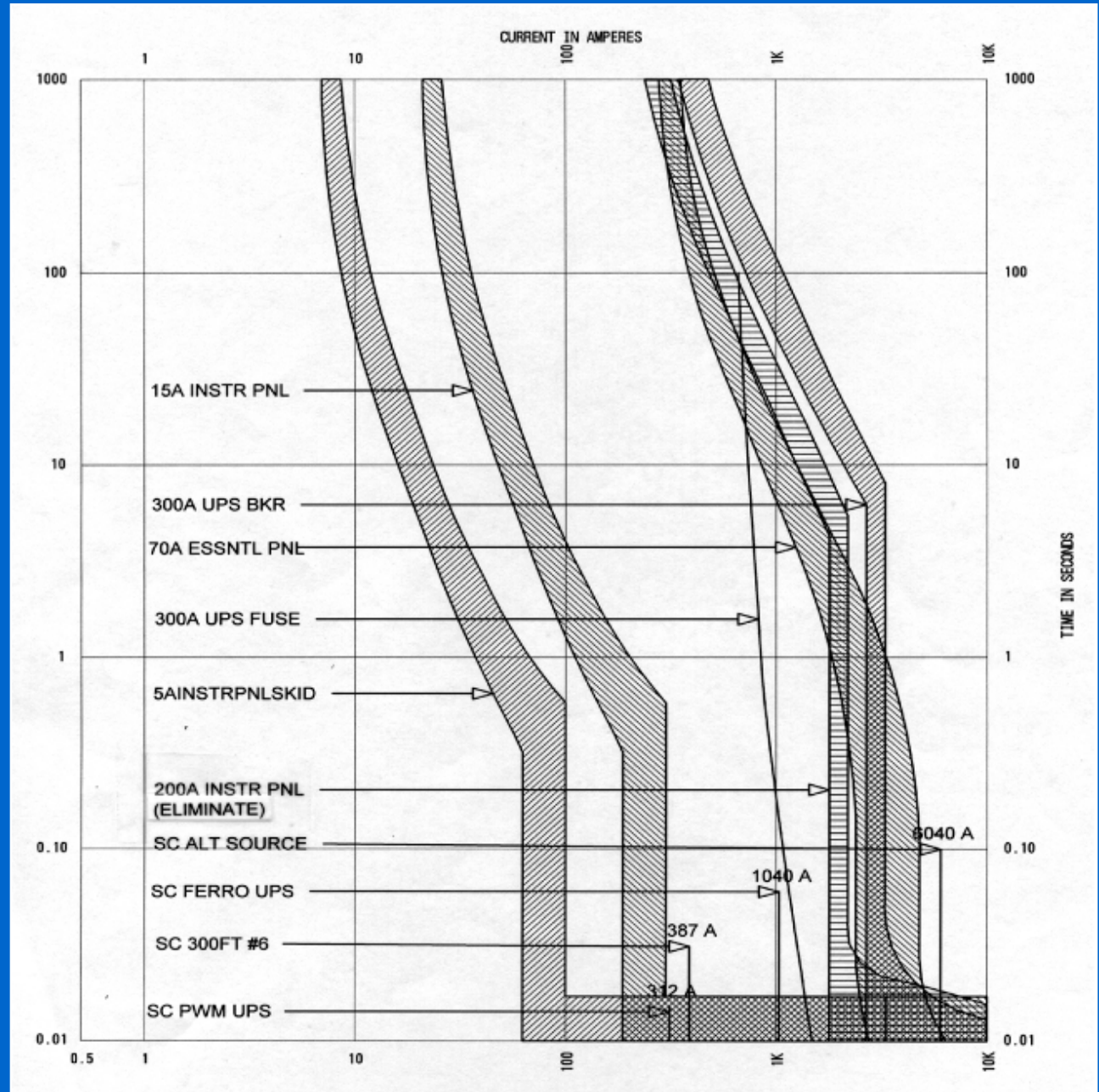


# Variation in Fault Current For Field Located Fault Protection

	<b>Fault current at distribution pnl.</b>	<b>Fault current at load</b>
<b>300ft # 10</b>	<b>1040 amps</b>	<b>154 amps</b>
<b>300ft # 8</b>	<b>1040 amps</b>	<b>246 amps</b>
<b>300ft # 6</b>	<b>1040 amps</b>	<b>387 amps</b>

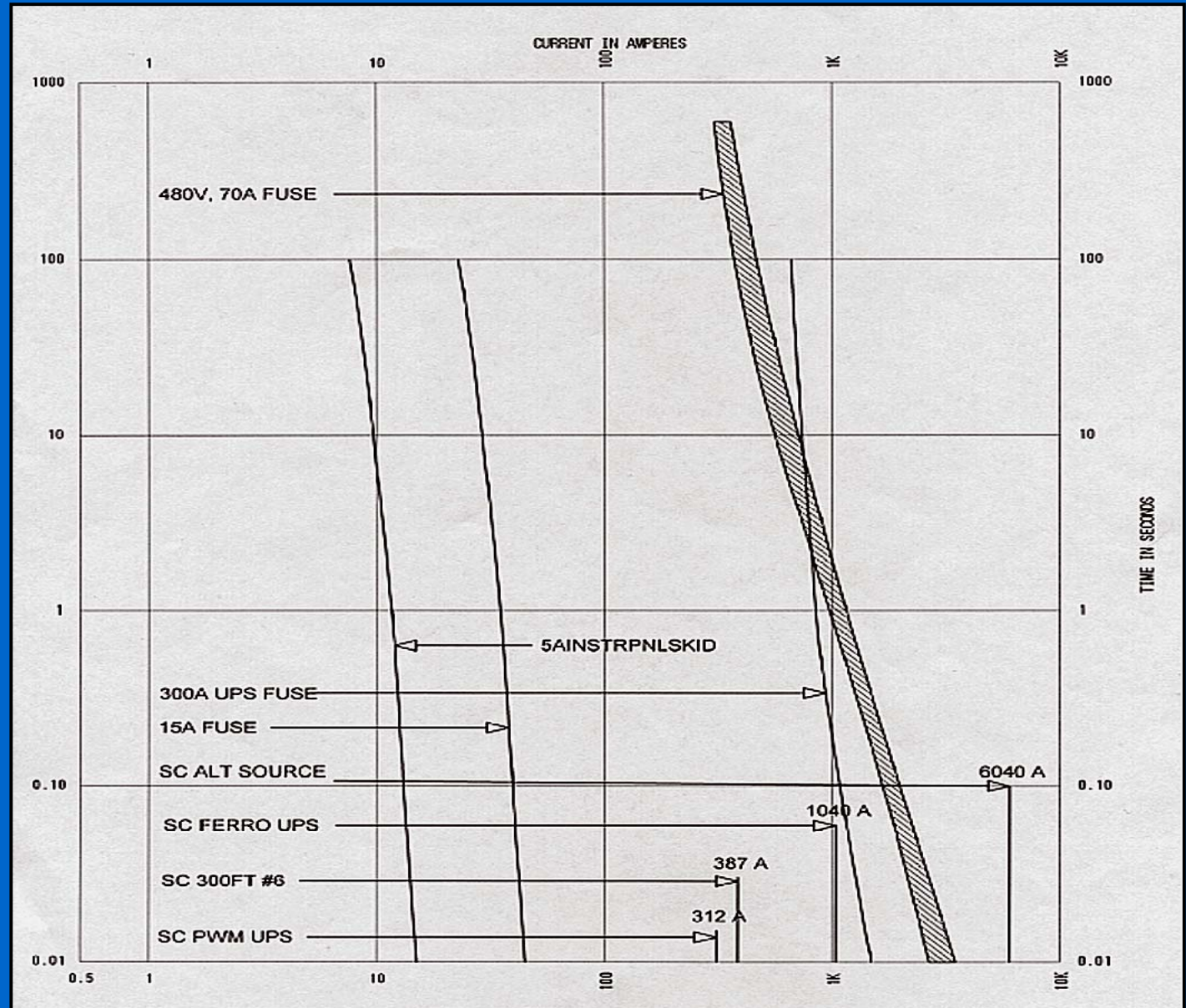
# UPS w/ Breaker

- Downstream protection must be selective with static switch fuses
- With alt source supply, 70A FDR bkr, UPS fuse, panel main bkr clear for a fault on the 15 amp circuit



# UPS w/ Fuses

- Selectivity maintained
- Static transfer to alternate source often not required
- Delete UPS panelboard  
200A Main  
bkr



# Standby Generator Summary

- PMG excitation system with field forcing
- Governor & AVR field testing
- 51V relay on standby generators
- Generator 51V -- definite time characteristic
- Generator bracing for L-G faults
- Solidly grounded generator
  - 51G and CT in generator neutral
  - Ground fault protection on each 480V MCC feeder breaker, include DC shunt trip

# Standby Generator Summary (cont.)

- Generator paralleling requires winding pitch factor evaluation
- Consider high-resistance grounded standby generator benefits
- Low-voltage cable impedance impact on downstream protection
- Additional MCC insulation to prevent faults

# ATS Summary

- Typically, 3 cycle short-circuit withstand capability
- Recently available, 30 cycle withstand for larger sizes
- Current limiting fuses an alternative
- Alternate design with LVPCB's -- no ATS

# UPS System Summary

- Ferro-resonant Units -- Produce higher short circuit output
- Single phase unit offers higher short circuit support
- Mfg's recommend fast acting fuses
- Evaluate reduced fault current at remote protective devices

# MOST IMPORTANTLY

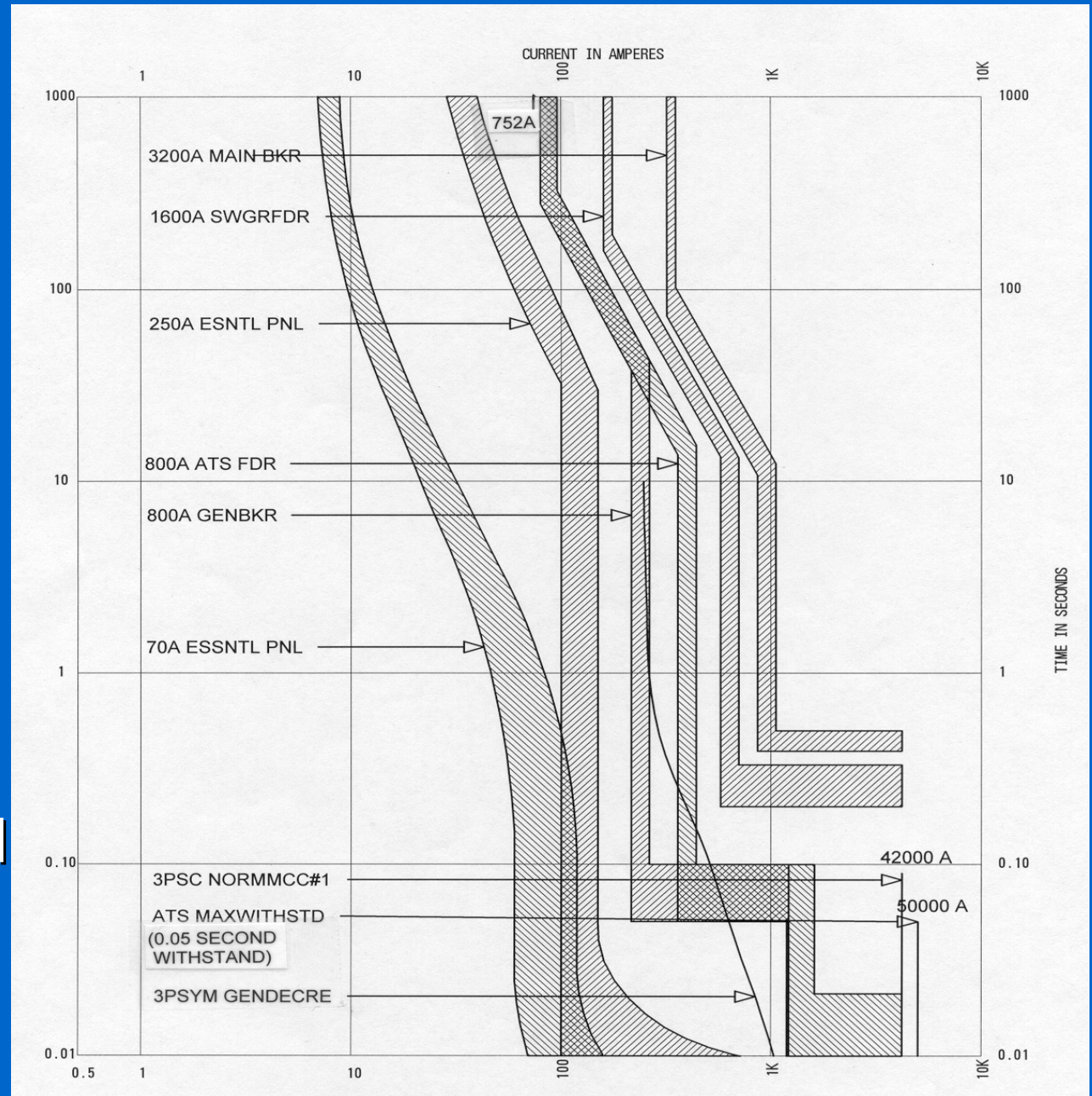
- Co-ordination Studies should be specified for:
  - Normal Source/Standby generator system including short circuit withstand and generator decrement
  - UPS/Instrument Systems including internal UPS system fuses/circuit breakers



The END

# ATS Selectivity

- Line side ATS breaker sized for overload and short circuit withstand
- Instantaneous elements can protect ATS
- Definite time required for selectivity does not protect ATS



# Circuit Selectivity

- 250A FDR bkr not selective with 70A FDR bkr
- Eliminate 70A bkr
- Minimize high impedance fault by additional insulation

