

Case Study

Arc Flash and Coordination Study in a Critical Operation Facility

This Hospital's Main Data Center supports 24 Clinical Locations in 4 states plus their Telemedicine Division storing vital infrastructure and medical information as well as the business and accounting functions for the operation. Losses in this Data Center effect far more than revenue losses, losses here effect lives.

This type of facility cannot shut down; circuit breakers cannot trip out of sequence; panels cannot be de-energized. To assist in determining the criteria for sequenced electrical protection and personnel protection in energized electrical equipment, the facilities manager called on Hunt Engineers, Inc. to perform Arc Flash and Coordination Studies.

Following are excerpts from the actual study performed.

ARC FLASH STUDY Normal Power On, Generator Off, ATS's on Normal

Arc Flash Evaluation Arc Flash Evaluation IEEE 1584 - 2002/2004a Edition Bus + Line Side Report (Include Line Side + Load Side Contributions)

Hunt Engineering, Inc. performs Arc Flash studies showing the expected energy of the flash, the safe boundary to be maintained at the Switchgear and the severity of the protective clothing required to safely work in the energized gear.

| | Bus Name | Protective Device Name | Bus kV | Bus Bolted Fault (kA) | Bus Arcing Fault (kA) | Prot Dev Bolted Fault (kA) | Prot Dev Arcing Fault (kA) | Trip/Delay Time (sec.) | Breaker Opening Time (sec.) | Equip Type | Gap (mm) | Arc Flash Boundary (in) | Working Distance (in) | | | |
|----|---|---------------------------|--------|-----------------------|-----------------------|----------------------------|----------------------------|------------------------|-----------------------------|------------|----------|-------------------------|-----------------------|------------|-------------------------------------|--------|
| 1 | MSWB1 (Main Switchboard) | | 0.48 | 57.85 | 27.17 | 57.85 | 27.17 | | 0.000 | SWG | 32 | 0 | 24 | | | |
| 2 | MSWB1 (Main Switchboard) (MSWB MAIN CB LineSide) | MaxTripTime @2.0s | 0.48 | 57.85 | 27.17 | 57.85 | 27.17 | 2 | 0.000 | SWG | 32 | 561 | 24 | | | |
| 3 | MSWB1 (Main Switchboard) (ATS1-N CB LineSide) | ATS1-N CB | 0.48 | 57.85 | 27.17 | 57.85 | 27.17 | 0.04 | 0.000 | SWG | 32 | 39 | 24 | 2.5 | Category 1 | # 0003 |
| 4 | MSWB1 (Main Switchboard) (ATS2-N CB LineSide) | ATS2-N CB | 0.48 | 57.85 | 23.09 | 57.85 | 23.09 | 0.06 | 0.000 | SWG | 32 | 46 | 24 | 3.1 | Category 1 (*N3) | # 0004 |
| 5 | | | | | | | | | | | | | | | | |
| 6 | PNL E41S3 | | 0.48 | 32.75 | 18.07 | 32.75 | 18.07 | | 0.000 | PNL | 25 | 0 | 18 | 0 | Category (*N6) | # 0008 |
| 7 | PNL E41S3 (T-E21S1 CB LineSide) | PNL E41S3 CB (T-E21S1 CB) | 0.48 | 32.75 | 18.07 | 32.75 | 18.07 | 0.01 | 0.000 | PNL | 25 | 12 | 18 | 0.63 | Category 0 (*N5) | # 0006 |
| 8 | | | | | | | | | | | | | | | | |
| 9 | PNL LS41S | ATSLS-N CB | 0.48 | 37.64 | 20.35 | 37.64 | 20.35 | 0.017 | 0.000 | PNL | 25 | 18 | 18 | 1.2 | Category 0 | # 0012 |
| 10 | | | | | | | | | | | | | | | | |
| 11 | PNL. E21S1 | | 0.208 | 1.74 | 1.28 | 1.74 | 1.28 | | 0.000 | PNL | 25 | 0 | 18 | 0 | Category (*N6) | # 0011 |
| 12 | PNL. E21S1 (E21S1 MAIN CB LineSide) | T-E21S1 CB | 0.208 | 1.74 | 1.08 | 1.74 | 1.08 | 1.144 | 0.000 | PNL | 25 | 34 | 18 | 3.4 | Category 1 (*N3) | # 0009 |
| 13 | | | | | | | | | | | | | | | | |
| 14 | PNL. E41S1 | | 0.48 | 43.02 | 22.81 | 43.02 | 22.81 | | 0.000 | PNL | 25 | 0 | 18 | 0 | Category (*N6) | # 0013 |
| 15 | PNL. E41S1 (PNL E41S3 CB LineSide) | PNL E41S3 CB | 0.48 | 43.02 | 22.81 | 43.02 | 22.81 | 0.01 | 0.000 | PNL | 25 | 14 | 18 | 0.81 | Category 0 | # 0011 |
| 16 | | | | | | | | | | | | | | | | |
| 17 | PNL. E41S2 | | 0.48 | 46.93 | 24.56 | 46.93 | 24.56 | | 0.000 | PNL | 25 | 0 | 18 | 0 | Category (*N6) | # 0015 |
| 18 | PNL. E41S2 (UPS2 CB LineSide) | UPS2 CB | 0.48 | 46.93 | 24.56 | 46.93 | 24.56 | 0.06 | 0.000 | PNL | 25 | 44 | 18 | 5.3 | Category 2 | # 0013 |
| 19 | Category 0: Nonmelting, Flammable Materials with Weight >= 4.5 oz/sq yd | 0.0 - 1.2 cal/cm^2 | | | | | | | | | | | | #Cat 0 = 3 | (*N2) < 80% Cleared Fault Threshold | |

ARC FLASH STUDY Generator On, Normal Power Off, Ats's on Emergency

Arc Flash Evaluation Arc Flash Evaluation IEEE 1584 - 2002/2004a Edition Bus + Line Side Report (Include Line Side + Load Side Contributions)

Titles in the Study advise of the electrical conditions present for the particular Arc Flash study. Hunt Engineering uses these titles to clearly define design conditions, on this page informing that flash calculations were performed with the generator running, normal power off and the ATS transferred to emergency.

| | Bus Name | Protective Device Name | Bus kV | Bus Bolted Fault (kA) | Bus Arcing Fault (kA) | Prot Dev Bolted Fault (kA) | Prot Dev Arcing Fault (kA) | Trip/ Delay Time (sec.) | Breaker Opening Time (sec.) | Equip Type | Gap (mm) | Arc Flash Boundary (in) | Working Distance (in) | | | |
|----|--|---------------------------|--------|-----------------------|-----------------------|----------------------------|----------------------------|-------------------------|-----------------------------|------------|----------|-------------------------|-----------------------|------|------------------|--------|
| 1 | GENERATOR BUS | | 0.48 | 10.00 | 6.56 | 10.00 | 6.56 | | 0.000 | PNL | 25 | 0 | 18 | | | |
| 2 | GENERATOR BUS (41GDP1 CB LineSide) | 41GDP1 CB | 0.48 | 10.00 | 6.56 | 10.00 | 6.56 | 2 | 0.000 | PNL | 25 | 158 | 18 | | | |
| 3 | GENERATOR BUS (ATS-LS CB LineSide) | ATS-LS CB | 0.48 | 10.00 | 6.56 | 10.00 | 6.56 | 0.017 | 0.000 | PNL | 25 | 9 | 18 | | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | GENERATOR DIST PNL 41GDP1 | 41GDP1 CB | 0.48 | 9.87 | 6.48 | 9.87 | 6.48 | 2 | 0.000 | PNL | 25 | 156 | 18 | 42 | Dangerous! (*N9) | # 0006 |
| 6 | GENERATOR DIST PNL 41GDP1 (GEN ATS1 CB LineSide) | GEN ATS1 CB | 0.48 | 9.87 | 5.51 | 9.87 | 5.51 | 0.31 | 0.000 | PNL | 25 | 45 | 18 | 5.4 | Category 2 (*N3) | # 0005 |
| 7 | GENERATOR DIST PNL 41GDP1 (GEN ATS2 CB LineSide) | GEN ATS2 CB | 0.48 | 9.87 | 5.51 | 9.87 | 5.51 | 0.192 | 0.000 | PNL | 25 | 34 | 18 | 3.3 | Category 1 (*N3) | # 0006 |
| 8 | | | | | | | | | | | | | | | | |
| 9 | PNL E41S3 | | 0.48 | 9.01 | 6.00 | 9.01 | 6.00 | | 0.000 | PNL | 25 | 0 | 18 | 0 | Category (*N6) | # 0012 |
| 10 | PNL E41S3 (T-E21S1 CB LineSide) | PNL E41S3 CB (T-E21S1 CB) | 0.48 | 9.01 | 6.00 | 9.01 | 6.00 | 0.016 | 0.000 | PNL | 25 | 8 | 18 | 0.31 | Category 0 (*N5) | # 0008 |
| 11 | | | | | | | | | | | | | | | | |
| 12 | PNL LS41S | ATS-LS CB | 0.48 | 9.22 | 6.12 | 9.22 | 6.12 | 0.017 | 0.000 | PNL | 25 | 8 | 18 | 0.33 | Category 0 | # 0012 |
| 13 | | | | | | | | | | | | | | | | |
| 14 | PNL. E21S1 | | 0.208 | 1.66 | 1.23 | 1.66 | 1.23 | | 0.000 | PNL | 25 | 0 | 18 | 0 | Category (*N6) | # 0015 |
| 15 | PNL. E21S1 (E21S1 MAIN CB LineSide) | T-E21S1 CB | 0.208 | 1.66 | 1.05 | 1.66 | 1.05 | 1.235 | 0.000 | PNL | 25 | 35 | 18 | 3.6 | Category 1 (*N3) | # 0011 |
| 16 | | | | | | | | | | | | | | | | |
| 17 | PNL. E41S1 | | 0.48 | 9.58 | 6.32 | 9.58 | 6.32 | | 0.000 | PNL | 25 | 0 | 18 | 0 | Category (*N6) | # 0017 |
| 18 | PNL. E41S1 (PNL E41S3 CB LineSide) | PNL E41S3 CB | 0.48 | 9.58 | 6.32 | 9.58 | 6.32 | 0.016 | 0.000 | PNL | 25 | 8 | 18 | 0.32 | Category 0 | # 0013 |
| 19 | | | | | | | | | | | | | | | | |
| 20 | PNL. E41S2 | | 0.48 | 9.32 | 6.18 | 9.32 | 6.18 | | 0.000 | PNL | 25 | 0 | 18 | 0 | Category (*N6) | # 0019 |
| 21 | PNL. E41S2 (UPS2 CB LineSide) | UPS2 CB | 0.48 | 9.32 | 6.18 | 9.32 | 6.18 | 0.06 | 0.000 | PNL | 25 | 18 | 18 | 1.2 | Category 0 | # 0015 |



WARNING - Arc Flash Hazard

HUNT Engineering, Inc. generated Arc Flash Hazard Stickers showing panel information and hazard information for posting on panels.

| | | | |
|-----------------|---------------------------|-------------|------------|
| Client | Hospital | | |
| Location | | | |
| Job # | 11-136-010-00 | Date | 12/14/2012 |
| Engineer | Hunt Engineering Services | | |

| | | | | | |
|--------------------|---------------|-------------------|------------------------|-------------------|-----------------------------------|
| Bus | PNL E41S1 | | Category | LV Panelboard | |
| Rated Volts | 480 | Rated Amps | 800 | Mf/Ty/Desc | SQUARE D, I-LINE CLASS 2110, 800A |
| Main Device | PNL E41S3 CB | | Device Settings | | |
| SQUARE D, LC | | Phase | Thermal Curve | INST | |
| 300-600A | | | | LO (2000A) | |
| Frame | Sensor | Plug | | | |
| 400 | 400 | | | | |

Arc Flash Calculation - IEEE 1584 - 2002/2004a Edition

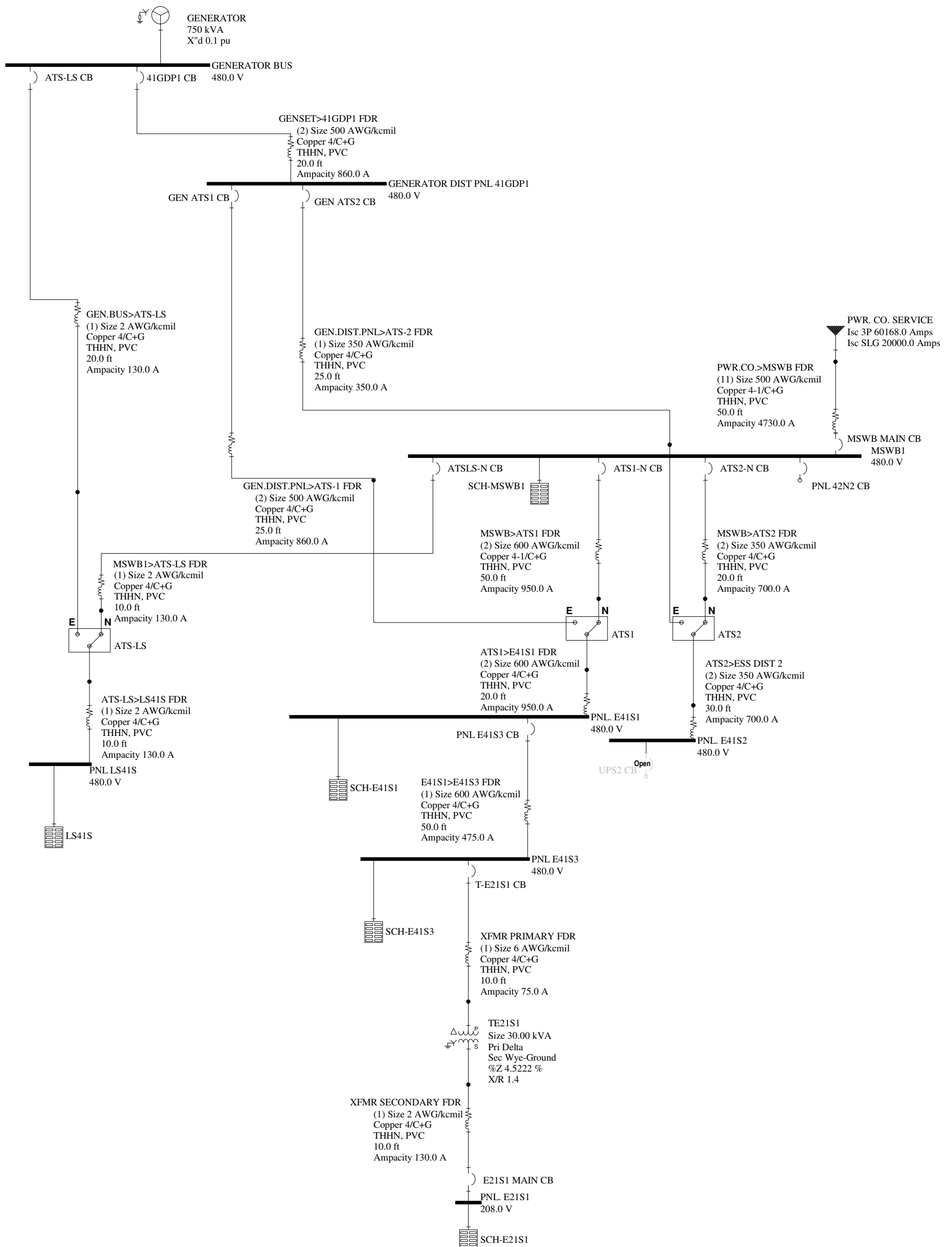
| | | | | | |
|--|--|---|---------------------|------------------------|-----------|
| Bolted Short Circuit Fault | 43.0 kA 3Phase | Trip/Delay | Breaker Open | Arcing Duration | |
| Arcing Fault in Protective Device | 22.8 kA 3Phase | 0.010 s | 0.000 s | 0.010 s | |
| Arc/Equipment Type | Panel | Gap: 25 | Grounded | | |
| Arc Flash Boundary | 14" | @ 1.2 cal/cm² - 2nd Degree Burn Boundary of Bare Skin | | | |
| Working Distance | 18 inches | | 21 | 24 | 30 48 |
| Incident Energy | 0.81 cal/cm ² | | 0.63 | 0.50 | 0.35 0.16 |
| PPE Clothing Category | Category 0 - Nonmelting, Flammable Materials with Weight >= 4.5 oz/sq yd | | | | |

Personnel Protection Equipment Table

| Clothing Description | Hazard Category | Clothing Layers | Arc Rating (cal/cm ²) | Notes |
|---|-----------------|----------------------|-----------------------------------|----------------------|
| Nonmelting, Flammable Materials with Weight >= 4.5 oz/sq yd | 0 | 1 | N/A | |
| Arc-rated FR Shirt & Pants | 1 | 1 | 4 | |
| Arc-rated FR Shirt & Pants | 2 | 1 or 2 | 8 | |
| Arc-rated FR Shirt & Pants & Arc Flash Suit | 3 | 2 or 3 | 25 | |
| Arc-rated FR Shirt & Pants & Arc Flash Suit | 4 | 3 or more | 40 | |
| No FR Category Found | Dangerous! | Do not work on live! | N/A | Do not work on live! |

Proper Protective Equipment Required

Hunt Engineering, Inc.
 System electrical one-line
 diagram for reference.
 Also shows voltage drop
 information for feeders.



PARTIAL ELECTRICAL RISER DIAGRAM

ARC FLASH STUDY - PANELS E41S1, E41S3, E21S1
December 14, 2012

Hunt Engineering, Inc.
 Sequenced Electrical
 overcurrent protection
 showing adjustable
 circuit breaker settings.

ADJUSTABLE LOW VOLTAGE CIRCUIT BREAKER SETTINGS

| DESIGNATION | | | | | | TRIP UNIT | | | | | | | | | |
|--------------------------------|----------|------------|--------|--------------|------------|------------------|----------------------------|------------------------------------|-----------|-----------|-----------|-----------|-----|-------------|--|
| Location/Name | Function | Frame Amps | AIC kA | MFR | TYPE MODEL | Amps Sensor/Plug | Description | TYPE/MODEL | SETTINGS | | | | | | |
| | | | | | | | | | L.T. P.U. | L.D. TIME | S.D. P.U. | S.D. TIME | I2T | INST P.U. | |
| MSWB1, MSWB MAIN CB | Phase | 4,000 | 150 | SQUARE D | NW40L | 4,000 0 | LSI, 400-6000AS, UL | Masterpact NW, 5.0 & 6.0 A/P/H | 0.4 | | 1.5 | 0.1 | Out | 2 | |
| MSWB1, MSWB MAIN CB | Ground F | 4,000 | 150 | SQUARE D | NW40L | 4,000 0 | GF, 1600-6000A Sensors, UL | Masterpact NW, 6.0A/P/H | J | 0.3 | | | In | | |
| MSWB1, ATS1-N CB | Phase | 800 | 65 | SQUARE D | MX | 800 800 | LSI, 100-800A | MX, Micrologic | 1.0 | 2 | 2.0 | .1 | In | 12.0 | |
| MSWB1, ATS1-N CB | Ground F | 800 | 65 | SQUARE D | MX | 800 800 | LSI, 100-800A | MX, Micrologic | 1.0 | 2 | 2.0 | .1 | In | 12.0 | |
| MSWB1, ATS2-N CB | Phase | 1,200 | 65 | SQUARE D | PJ | 600 0 | LSI, 250-1200A | Powerpact P-Frame, 5.0 & 6.0 A/P/H | 1 | | 2 | 0.1 | In | 12 | |
| MSWB1, PNL 42N2 CB | Phase | 400 | 65 | SQUARE D | LX | 400 400 | LSI, 100-600A | LX & LXI, Micrologic (1993) | 1.0 | 14 | 7 | 0.2 | | 8 | |
| MSWB1, PNL 42N2 CB | Ground F | 400 | 65 | SQUARE D | LX | 400 400 | GF, 250-600A | LX & LXI, Micrologic | 0.55 | 0.2 | | | | | |
| PNL E41S2, UPS2 CB | Phase | 1,200 | 50 | SQUARE D | PK | 600 0 | LSI, 100-1200A, UL | Powerpact P-Frame, 6.0A/P/H | 1 | | 1.5 | 0 | Out | 2 | |
| GENERATOR BUS, 41GDPI CB | Phase | 1,200 | 50 | MERLIN GERIN | CK 1200N | 1,200 800 | I, 200-1200A | Compact CK, STR 25DP | | | | | | 8 | |
| GENERATOR DIST PNL 41GDPI, GEN | Phase | 1,200 | 65 | SQUARE D | PJ | 600 0 | LSI, 250-1200A | Powerpact P-Frame, 5.0 & 6.0 A/P/H | 1 | | 2 | 0.1 | In | Fixed 12 | |
| GENERATOR DIST PNL 41GDPI, GEN | Phase | 800 | 65 | SQUARE D | MX | 800 800 | LSI, 100-800A | MX, Micrologic | 1.0 | 2 | 2.0 | .1 | In | 12.0 | |

| Bus Name | -----Contributions----- | | -----Initial Symmetrical Amps----- | | | | -----Asymmetrical Amps----- | | | | |
|------------------------|-------------------------|----|------------------------------------|---------------|----------|----------|-----------------------------|---------------|----------|----------|--------|
| | | | 3 Phase | SLG | LLG | LL | 3 Phase | SLG | LLG | LL | |
| BUS-0004 | | | 45,825 | 17,155 | 0 | 0 | 55,750 | 17,202 | 0 | 0 | |
| ATS1>E41S1 FDR | CABLE | In | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| BUS-0006 | | | 53,043 | 18,475 | 0 | 0 | 65,693 | 18,509 | 0 | 0 | |
| ATS2 | | In | 53,042 | 18,474 | 0 | 0 | 65,693 | 18,509 | 0 | 0 | |
| MSWB>ATS2 FDR | CABLE | In | 53,043 | 18,475 | 0 | 0 | 65,693 | 18,509 | 0 | 0 | 18,475 |
| BUS-0007 | | | 53,042 | 18,474 | 0 | 0 | 65,693 | 18,509 | 0 | 0 | |
| ATS2>ESS DIST 2 | CABLE | In | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| BUS-0010 | | | 23,797 | 10,130 | 0 | 0 | 23,861 | 10,131 | 0 | 0 | |
| TE21S1 | 2W-XFMR | In | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| XFMR PRIMARY FDR | CABLE | In | 23,797 | 10,130 | 0 | 0 | 23,861 | 10,131 | 0 | 0 | 10,130 |
| BUS-0011 | | | 1,782 | 1,802 | 0 | 0 | 1,803 | 1,823 | 0 | 0 | |
| XFMR SECONDARY FDR | CABLE | In | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| TE21S1 | 2W-XFMR | In | 1,782 | 1,802 | 0 | 0 | 1,803 | 1,823 | 0 | 0 | 1,802 |
| BUS-0015 | | | 9,523 | 884 | 0 | 0 | 13,504 | 884 | 0 | 0 | |
| ATS2 | | In | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| GEN.DIST.PNL>ATS-2 FDR | CABLE | In | 9,523 | 884 | 0 | 0 | 13,504 | 884 | 0 | 0 | 884 |

Fault Current Calculations by Hunt Engineering, Inc.