August 31, 2024

United States Department of the Interior
National Park Service
Denver Service Center
12795 W. Alameda Parkway
P.O. Box 25287
Denver, CO 80225-0287

ATTENTION: Susan Lehmann

Dear Susan,

REFERENCE: NPS Arc Flash Evaluation - WRST
Trip Report

On 06/17/24 through 06/21/24 Davin Blubaugh and Aidan Blessing with RSA Engineering travelled to Wrangell-St. Elias National Park & Preserve (WRST) to investigate the electrical distribution systems. The intent of the site visits was to gather enough information on the equipment to provide an accurate arc flash calculation, provide warning labels for the equipment, and observe/record any obvious code deficiencies.

One-line diagrams have been generated for each facility based upon our site investigation. These one-line diagrams show the details of the power distribution system at each site/building, and those details are not replicated within the below report.

Arc-flash calculations were performed for all 3-phase distribution systems/equipment. The equipment operating at 120/240V, single-phase or less, was not included within the arc-flash calculations and were provided with generic arc-flash warning labels only.

In general, the electrical distribution system at all sites was in good to fair condition. Common items such as working space violations, equipment labeling, and missing junction box covers were noted throughout, but overall, the deficiencies observed were minimal. A Flir thermal imaging camera was used on all equipment to look for hot spots occurring from loose connections or damaged breakers, and no such hot spots were observed on any equipment. The following report addresses the code deficiencies and recommendations observed during our site investigation.

Copper Center:
The electrical distribution system for Copper Center begins at the Garage Building in the center of the complex roughly halfway between the Headquarters Building (Admin) and the Visitor Center. The electrical service is fed with 480V, 3-phase underground from a Copper Valley Electric Association (CVEA) pad-mounted utility transformer to a wall-mounted tap box on the exterior of the Garage building which feeds the site fire pump and an exterior mounted Main Distribution Panel 'MDP1'. 'MDP1' feeds all buildings on the site and steps down at various transformers: one located in the mezzanine of the Garage, one on the exterior of the Visitor Center, one under the Marc Building, and one outside of the Headquarters (Admin) Building.

The Visitor Center Main Distribution Panel 'MDP2' is located on the exterior and feeds the Visitor Center, The Exhibit Building, the Comfort Station (Restroom), and the Theater. The distribution panel on the exterior of the Marc Building (labeled 'MBDL' on the one-line) is a 120/240V, single-phase distribution panel which feeds the Marc Building and the Resource Building.

Reference the facility one-line diagram for electrical distribution system details.

An arc-flash analysis has been performed for the three-phase equipment within the electrical distribution system at Copper Center. The results of this analysis are included within the attachments at the end of this report.

Code Deficiencies

1. Garage Building:
    a. Panel 'GA' is partially missing dead front cover over main lugs. Provide new dead front cover to fully enclose main lugs to protect against accidental electrical contact per NEC 110.27.
    b. Neutral wire appears to be abandoned and not properly capped in garage building (Image #1). Either demolish neutral wire back to source, or properly enclose abandoned wire with junction box as required by NEC 300.15.
    c. Panel 'MDP1' schedule is missing a label for the Marc Building feeder. Provide updated circuit directories for panelboard per NEC 408.4.
    d. The neutral and ground were not bonded at Disconnect 'DGA' and we could not verify if the neutral was bonded within the upstream transformer. Confirm neutral and ground bond at secondary side of XFMR 'TGA' (located on mezzanine) and if it does not exist, provide one as required by NEC 250.24(A)(5).
2. Visitor Center:
    a. Panel 'VCO' is partially missing dead front cover over main lugs (Image #2). Provide new dead front cover to fully enclose main lugs to protect against accidental electrical contact per NEC 110.27.
3. Exhibit Building:
    a. Junction box in crawlspace is missing a cover. Tuck in conductors and provide new junction box cover as required per NEC section 314.25.
4. Admin Building:
    a. Panel 'HQ0' has a piece of wire being utilized as a handle-tie to connect circuit breakers #38 and #40 together for a multi-wire branch circuit (Image #3). Remove the wire and provide a listed 2-pole handle-tie device.
5. Generator Shed:
    a. Panel 'HQE1' does not have panel schedule. Trace out circuit in panel and provide clear, evident, and distinguishable typed circuit directories for panelboard per NEC 408.4.
6. Resource Building:
    a. Panel 'RL2' schedule is missing information on circuit breakers 7-10. Provide clear, evident, and distinguishable circuit directory for panelboard per NEC 408.4.

Electrical Recommendations

1. All Buildings - Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

2. Garage Building:
    a. Panel 'GAE' has an abandoned conductor within the panel. Recommend demolishing abandoned conductors and associated conduit and junction boxes completely.
    b. Panels 'GA' and 'GAE' have neutrals that are shared between circuits. Note that this may have not been a code requirement when the equipment was installed and therefore could be "grandfathered" but does not meet the current NEC minimum requirements. Recommend that all circuits with shared neutrals are handle-tied together.
    c. No emergency lighting was observed at garage building. Recommend providing emergency lighting near 'MDP1' and the electrical equipment within the building to allow for troubleshooting during power outages.

3. Visitor Center:
    a. Panel 'VCO' has neutrals that are shared between circuits. Note that this may have not been a code requirement when the equipment was installed and therefore could be "grandfathered" but does not meet the current NEC minimum requirements. Recommend that all circuits with shared neutrals are handle-tied together.

Copper Center Cultural Center:

The Cultural Center building at Copper Center is fed underground from a separate 120/240V, single-phase CVEA pad-mounted transformer located near the main Copper Center site 3-phase transformer. The building power distribution system is limited to the service equipment and a single panel which feeds all loads for the building.

Code Deficiencies

1. Emergency lights are non-functional. Recommend repairing or replacing non-functioning emergency lights to ensure path of egress is illuminated under loss of power.
2. FACP breaker in panel was lockable, but not code required red colored. Recommend providing a new red "FIRE" lockable handle, or at a minimum paint the handle lock red.

Electrical Recommendations

1. No further electrical recommendations for this area.

Copper Center Box Cabins:

The Box Cabin area at Copper Center is fed underground from a 120/240V, single-phase pole-mounted CVEA utility transformer. The site electrical system is limited to the service equipment, a panel in the "Main House", a Cabin distribution panel, Cabin disconnects, and individual enclosed circuit breakers feeding each Cabin (reference the one-line for system details).

Code Deficiencies

1. Conductors from Combination Meterbase/Disconnect (CMD) to panel 'Cabin Distribution' are undersized for the existing 200A upstream overcurrent protection device. Recommend intercepting the circuit at the CMD and adding a 100A breaker within 10-feet of the CMD (per NEC 240.21) or (worst case) replace the #2 AWG conductors with #3/0 AWG copper conductors that are properly sized for 200A 2-Pole breaker per NEC 310.16.
2. CMD does not have a panel schedule. Provide clear, evident, and distinguishable circuit directory for panelboard per NEC 408.4.
3. PVC Conduits is unsupported on all box cabins typical (Image #4), and is not properly seated in the Cabin Distribution Panel. Properly secure/support and fasten PVC in accordance with NEC 352.30.

Electrical Recommendations

1. Panel 'Main House' and Panels 'Cabin 1' through 'Cabin 8' do not have Arc Fault Interrupting Circuits (AFCI) protected breakers. Recommend providing new AFCI breakers for all panels and providing dual AFCI/GFCI breakers for circuits that currently have GFCI breakers per NEC 210.12. This was likely not a code requirement at the time of installation, but has since been added to the NEC.
2. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

Gulkana Hangar:
The Gulkana Hangar is a single-phase service fed underground from a nearby pole-mounted CVEA utility transformer. The building electrical system is limited to the service equipment, two panels, an exterior generator and associated generator transfer switch/panel combination device which feeds standby power to minimal equipment in the building. Reference the one-line for system details.

Code Deficiencies

1. There is conduit separation at the CMD exposing conductors (Image #5). Correct conduit installation to conceal/protect conductors.
2. The #8 AWG copper conductors feeding the ATS/Panel combination device in the Hangar are tapped off of the line side of the main lugs of the Hangar Panel. There is no overcurrent device at the point of termination in the ATS/Panel which is a violation of NEC 240.21 for tapped conductors. Recommend adding a 30A, 2-pole breaker within the Hangar Panel to feed the ATS/Panel. Note, this will require rearranging breakers/circuits within the panel to allow for a new 2-pole breaker.
3. Panel 'SAR' in the southwest corner of the building does not have a panel schedule. Provide clear, evident, and distinguishable circuit directory for panelboard per NEC 408.4.

Electrical Recommendations

4. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

Glenallen Main Shop:
The Main Shop building in Glenallen is fed with a 120/208V, 3-phase service overhead from a bank of three (3) 10kVA pole-mounted CVEA utility transformers. The service equipment and MDP is located on the outside of the Shop building and feeds the Mechanical Shop panels, Carpenter Shop Panels, Shed Building, and Storage Garage. Reference the one-line for system details.

An arc-flash analysis has been performed for the three-phase equipment within the electrical distribution system at the Glenallen Main Shop. The results of this analysis are included within the attachments at the end of this report.

Code Deficiencies

1. The CMD and MDP mounted on the exterior of the shop are installed too high off of the ground for adequate access per NEC 240.24 and the enclosure below the CMD violates the required working clearances per NEC 110.26 (Image #6). A platform could be built to access the equipment, but the enclosure below the CMD would need to be relocated. Alternatively, the CMD and MDP could be lowered and shifted over, however, that would require additional work relocating conduit and wire.
2. The MDP is missing blank space fillers exposing the interior of the panel. Provide additional blank space filler plates.
3. The Carpenter shop main panel (labeled as 'CSL1' on the one-line) is missing blank space fillers exposing the interior of the panel. Provide additional blank space filler plates.
4. The Shed Panel (labeled as 'SBL1' on the one-line) is inaccessible due to the amount of stored materials in front (Image #7). Remove stored items to allow for adequate NEC 110.26 working space.
5. The Storage Garage panel (labeled as 'SGL1' on the one-line) is missing blank space fillers exposing the interior of the panel. Provide additional blank space filler plates

Electrical Recommendations

1. The Mechanical Shop main panel (labeled as 'MSL1' on the one-line diagram) and several breakers within the panel are manufactured by Zinsco. All of Zinsco's electrical equipment was recalled years ago due to fire hazards and failures. Recommend replacing this panel and all breakers with a new panel.
2. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

Glenallen Pumphouse:

The Pumphouse building in Glenallen is fed with a 120/240V, 1-phase service underground from a 10kVA pad-mounted CVEA utility transformer. The service equipment is a CMD on the exterior of the building which feeds the Pumphouse interior panel and also feeds the adjacent Trail Maintenance Building. Reference the one-line for system details.

Code Deficiencies

1. No code deficiencies were noted for the Pumphouse or Trail Maintenance Buildings.

Electrical Recommendations

1. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

Glenallen Housing:

The Glenallen Housing area is comprised of two main multi-family dwelling buildings, Building A (4-housing unit and a shared Boiler Room) and Building B (2-housing unit and a shared Boiler Room). Each building is fed underground from the same pad-mounted CVEA utility transformer located on the west end of the site. Each building has a multi-meter pack for service equipment to individually meter each unit and respective Boiler Room. Reference the one-line for system details.

Code Deficiencies

1. Panel 'DA' within the Garage of Unit A2 has a NEC 110.26 working space violation with the HRV ductwork (Image #8). Recommend relocating the ductwork out of the panel working space.

Electrical Recommendations

1. No further recommendations for the Glenallen Housing area.

Slana Visitor Center:

The Slana Visitor Center is fed overhead from a 120/240V, single-phase, pole-mounted CVEA utility transformer to a CMD mounted to the exterior of the Garage Building. The CMD feeds to the Garage Panel which feeds out to the Sleeping Cabins, Bunkhouse and Visitor Center Buildings. The CMD also has a separate feeder to the Fish Weir Office. Reference the one-line for system details.

Code Deficiencies

1. The Garage Building panel has missing knockouts exposing the interior of the panel to dirt/dust/debris. Provide knockout fillers to seal panel.

2. The #12 AWG copper feeder conductors from the Garage Building Panel to Sleeping Cabin #1 and #2 are undersized for the 30A breaker in the Panel. Recommend replacing the 30A, 2-pole breaker with a new 20A, 2-pole breaker.
3. The feeders from the Garage Panel to the exterior mounted Bunkhouse ECB and from the Bunkhouse ECB to the exterior mounted Visitor Center ECB do not contain an Equipment Grounding Conductor (EGC) and at least a portion of the conduits are non-metallic PVC, meaning that the conduit cannot serve as a ground path for the feeders. Provide an EGC within the feeder conduit per NEC 250.122 requirements.
4. There are several locations onsite where the neutral wire and ground wire are bonded within enclosures. The neutral and ground should only be bonded in one location at the service CMD. Remove all neutral to ground bonds downstream of the service equipment. This was noted at the Enclosed Circuit Breaker (ECB) on the exterior of the bunkhouse, the ECB on the exterior of the Visitor Center, Sleeping Cabin #1 panel, and the Sleeping Cabin #2 panel, although a thorough investigation of all equipment should take place to ensure all grounds and neutrals are properly isolated.
5. The Bunkhouse Panel has a NEC 110.26 working space clearance violation with the water heater installed in front of the Panel. Recommend relocating the water heater to provide adequate NEC clearances (Image 9).
6. The disconnect on the exterior of the Fish Weir Office is not properly grounded, the EGC needs to be identified with green tape (currently white conductor), and the conduit feeding the equipment is separated from the enclosure (Image #10). Recommend connecting the incoming EGC to the enclosure, provide green tape on EGC, and correct the conduit installation.

Electrical Recommendations

1. Recommend demolishing the Old Generator Breaker and associated feeder between the breaker and the Manual Transfer Switch (MTS) as the generator is no longer present and the equipment is not needed.
2. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

<u>Slana Ranger Residence:</u>

The Slana Ranger Residence is fed overhead from a 120/240V, single-phase, pole-mounted CVEA utility transformer to a CMD mounted to the exterior of the Garage Building. The CMD feeds to the Garage Panel which feeds out to the Residence. Reference the one-line for system details.

Code Deficiencies

1. The Garage Panel has duct tape covering several open spaces in the panel (Image #11). Provide approved blank spaces fillers in-lieu of duct tape.
2. The Garage Panel schedule does not appear to be accurate as there is an unlabeled circuit breaker in spaces 21 & 23. Provide clear, evident, and distinguishable circuit directory for panelboard per NEC 408.4.
3. The feeders from the Garage Panel to the exterior mounted Residence Panelboard do not contain an Equipment Grounding Conductor (EGC) and at least a portion of the conduit is non-metallic PVC, meaning that the conduit cannot serve as a ground path for the feeders. Provide an EGC within the feeder conduit per NEC 250.122 requirements.

4. The Panel inside of the Ranger Residence (Labeled Panel 'B' on the one-line) has numerous flexible conduits that require adequate supporting per NEC 348.30 (Image #12).

Electrical Recommendations

1. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

Slana Freed Property:

The Slana Freed Property is fed overhead from a 120/240V, single-phase, pole-mounted CVEA utility transformer to a CMD mounted to the exterior of the main House. The CMD feeds to the interior House Panel which feeds the Cabins on site. The CMD also feeds an abandoned Waste Water Treatment Building behind the House. Reference the one-line for system details.

Code Deficiencies

1. The House Panel is located in the kitchen and does not have adequate working clearances per NEC 110.26. The only way to provide adequate clearances would be to remove some of the counter and cabinets or relocate the panel (Image #13).

Electrical Recommendations

1. Recommend removing the feeder and electrical equipment associated with the abandoned Waste Water Treatment Building.
2. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

McCarthy West Side Complex:

The McCarthy West Side Complex consists of an Electrical Building, Support Building, Communication Cabin, and Well House. The site is powered via a propane generator and solar/battery system housed within the Electrical Building and all loads are distributed out from there to the other buildings at 120/240V, single-phase. Reference the one-line for system details.

Code Deficiencies

1. Support Building Panel is missing blank space filler. Provide blank space filler for panel.

Electrical Recommendations

1. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

McCarthy Airport:

The McCarthy Airport building consists primarily of an Electrical/Boiler Room and a Ranger Station Office area. The site is powered via a propane cogeneration unit and a solar/battery system housed within the Electrical/Boiler Room. All building loads are powered from a panel in the Electrical/Boiler Room and another smaller panel in the Ranger Station office at 120/240V, single-phase. Reference the one-line for system details.

Code Deficiencies

1. No code deficiencies noted for the McCarthy Airport.

Electrical Recommendations

1. The wiring interface between the cogeneration unit and the solar/battery system was not very well documented. Recommend displaying a single schematic diagram within the building showing the major system components (cogen unit, solar panels, batteries, inverters, panels, etc) for ease of maintenance and troubleshooting.
2. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

Kennecott:

The power distribution system for the main historic site at Kennecott begins at the Electrical connexes (labeled as Power Plant or 'NP' on the one-line) located on the south end of the site. The Power Plant was recently upgraded back in 2021/2022 with four (4) new solar arrays, charge controllers, 74kWh battery bank, inverters, power distribution panels, and a new 25kW diesel generator. The project was designed by Design Alaska with Construction Drawings dated 3/11/2021 and the equipment was supplied and installed by RMC engineering out of Juneau, AK. This new Power Plant provides power to all of the NPS buildings at Kennecott, with the exception of Silk Stocking Row and the National Creek Water Treatment Shed, which both have their own onsite microgrids (reference next sections).

The AC side of the site distribution begins at Panel 'A' within the new power plant and steps up the site voltage to 480V, 3-phase for distribution. From the new Power Plant the site distribution routes underground to the north to hit various distribution panels and step-down transformers throughout the site. The one-line diagram provided documents the entire electrical distribution system and references the buildings each piece of equipment is located within. Reference the one-line for system details.

An arc-flash analysis has been performed for the three-phase equipment within the electrical distribution system at Kennecott. The results of this analysis are included within the attachments at the end of this report.

Code Deficiencies

1. The Wash House Panel (labeled as Panel 'WHL1' on the one-line) does not have adequate NEC 110.26 working clearances due to the stacked washer/dryer in front of the Panel (Image #14).
2. The 120/208V Distribution Panel in the Transformer (Old Gen Shed) Building (labeled as Panel 'TBDL' on the one-line diagram and labeled 'MDP1' in the field) is downstream of a step-down transformer and requires a Main Circuit Breaker (MCB) per NEC 408.36 (Image #15). Recommend providing an additional 225A, 3-pole breaker in an available space within the panel and moving the line side terminations from the main lugs to the new circuit breaker.
3. The Panel in the General Manager's Office is located in a closet under the stairs and does not have adequate NEC 110.26 working space headroom (Image #16).

Electrical Recommendations

1. Recommend placing a system one-line diagram at major electrical distribution panel locations and denoting a "You are here" location identifier to assist with maintenance and troubleshooting of the electrical system. Suggested locations would be the New Power Plant, Rec Center electrical shed, Transformer Building (Old Gen Shed), Leaching Plant, and the Old Power Plant.

2. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

Kennecott Silk Stocking Row:

Silk Stocking Row consists of a Garage Building that houses the main electrical equipment, an adjacent Generator Shed, the North House and the South House. The site is powered via a small diesel generator and a battery/inverter system. The battery inverter system is within the Garage Building and feeds a Garage Panel that feeds the Garage loads as well as panels in the North and South Houses at 120/240V, single-phase. Reference the one-line for system details.

Code Deficiencies

1. The North House Panel is installed within a cabinet thus violating adequate NEC 110.26 working space requirements (Image #17). Suggest removing the cabinet to allow for proper clearances.

Electrical Recommendations

1. Recommend providing unique equipment id's and clearly labeling all electrical equipment with phenolic labels denoting equipment name, amperage, voltage, and source.

Kennecott National Creek Water Treatment Shed:

The Water Treatment Shed has a small solar/battery system that feeds a sine-wave inverter and a single 20A, 120V circuit breaker for the shed loads. Reference the one-line for system details.

Code Deficiencies

1. The Water Treatment Shed Panel does not have a panel schedule, though the single receptacle it feeds is fairly apparent (Image #18). Provide clear, evident, and distinguishable circuit directory for panelboard per NEC 408.4.
2. Given the nature of the small shed, there is not sufficient NEC 110.26 working clearance for the Panel.

Electrical Recommendations

1. No further recommendations for the Water Treatment Shed.

(REFERENCED IMAGES LOCATED ON THE FOLLOWING PAGES)

Image #1 – *Garage Building abandoned conductor*

Image #2 – *Visitor Center Panel 'VC0' missing main lug cover*

Image #3 – *Admin Building Panel 'HQ0' unlisted handle-tie*

Image #4 – *Box Cabin PVC conduit needing supports*

Image #5 – *Gulkana Hangar conduit separation*

Image #6 – *Glenallen Shop CMD and MDP NEC 110.26 & 240.24 violation*

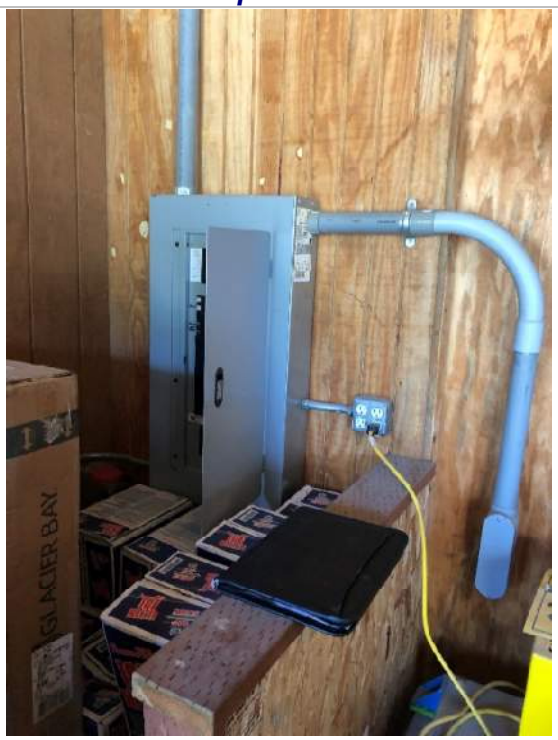


Image #7 – *Shed Building panel NEC 110.26 clearance issues*

Image #8 – *Glenallen Housing Unit A2 Panel 'DA' NEC 110.26 violation*

Image #9 – *Bunkhouse Panel NEC 110.26 working space violation*

Image #10 – *Slana VC Fish Weir Office Disconnect issues (reference report)*

Image #11 – *Slana Ranger Residence Garage Panel duct tape*

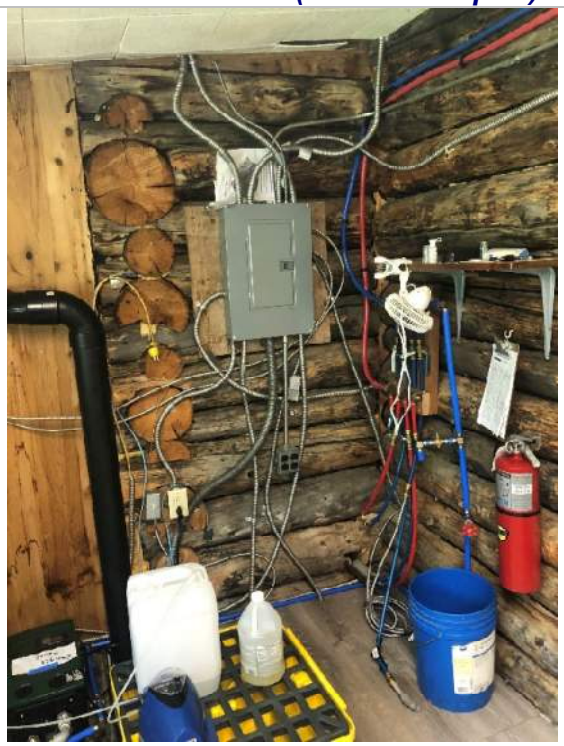


Image #12 – *Slana Ranger Residence Interior Panel flex conduit*

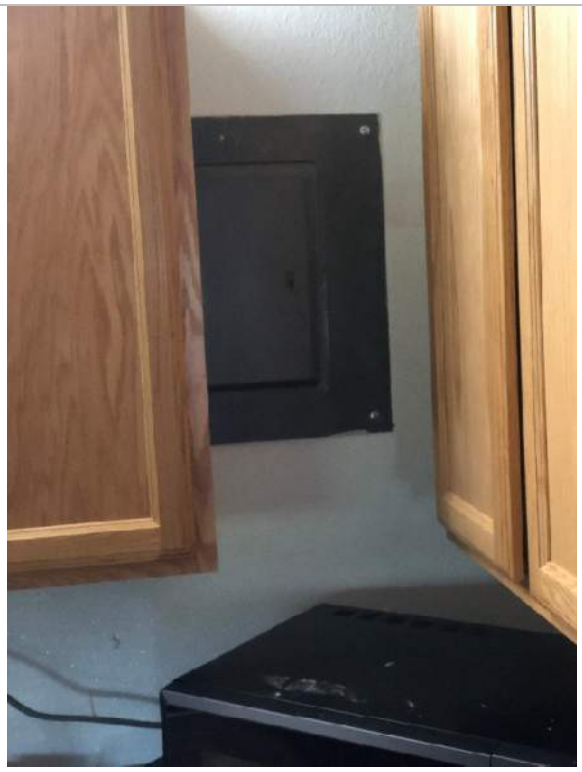


Image #13 – *Slana Freed House Panel NEC 110.26 violation*

Image #14 – *Kennecott Wash House Panel NEC 110.26 working space violation*

Image #15 – *Kennecott Transformer Bldg Distribution Panel needing MCB*

Image #16 – *Kennecott GMO Panel NEC 110.26 working space violation*

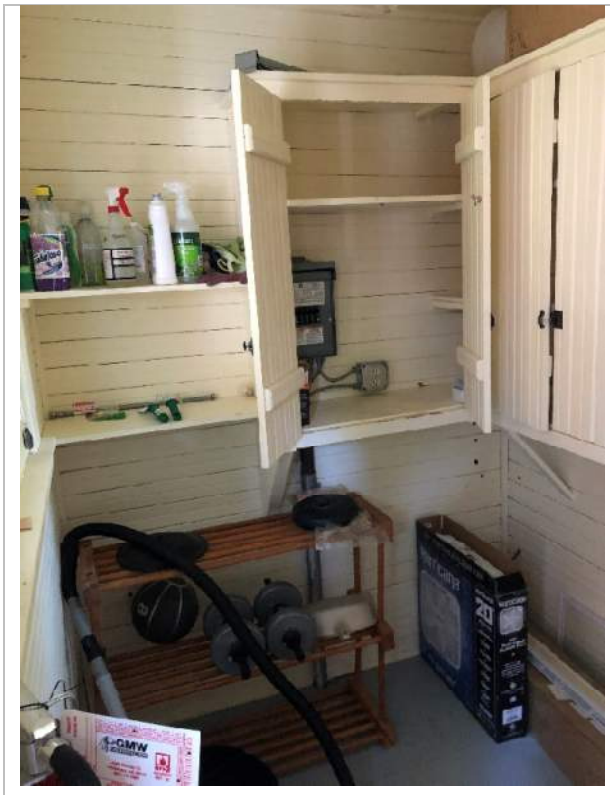


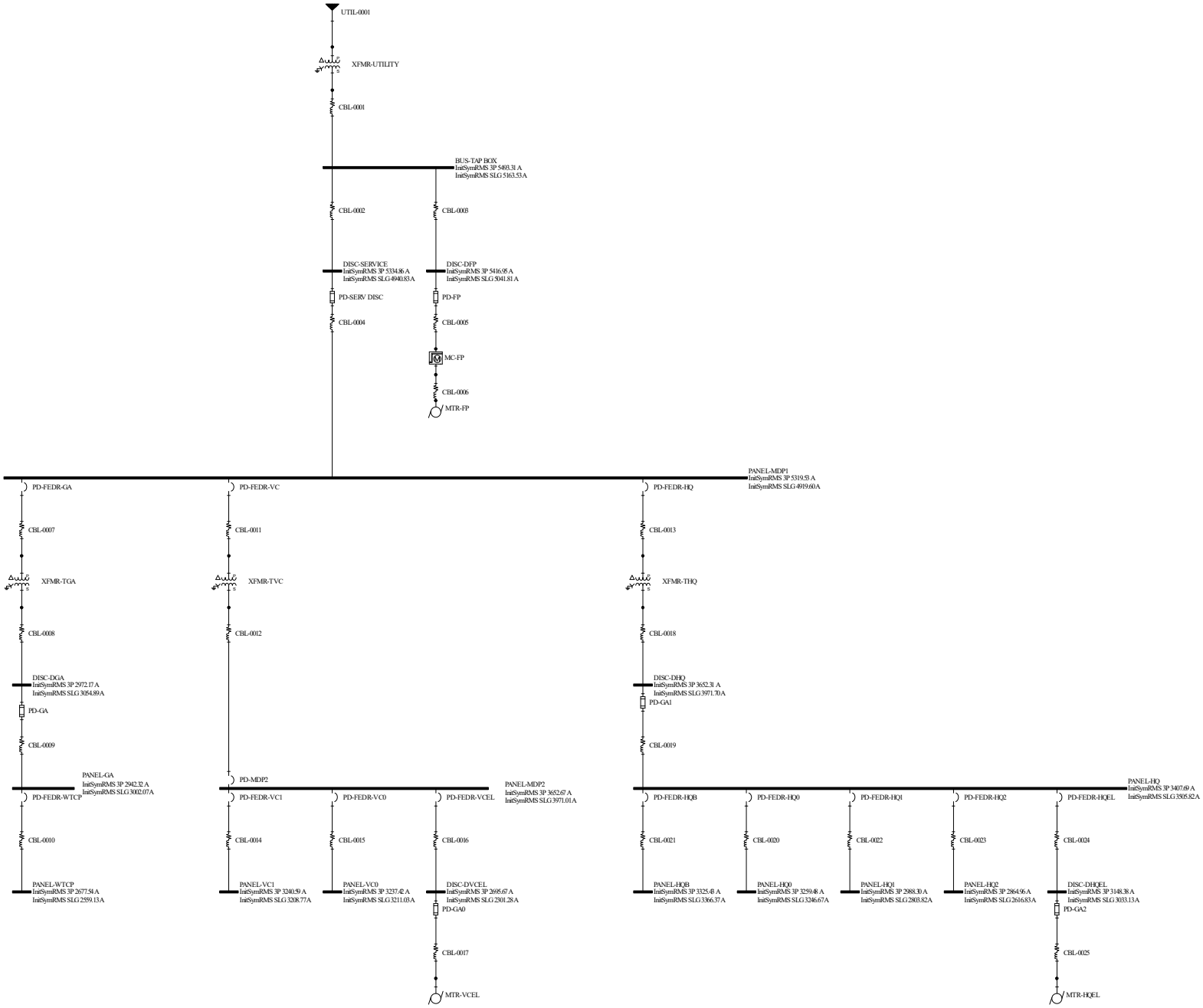
Image #17 – *Kennecott Silk Stocking North House NEC 110.26 violation*	**Image #18 – *Kennecott National Creek Shed Panel missing schedule and NEC 110.26 violation***

If you have any questions concerning the above, please do not hesitate to call.

Sincerely,

Davin Blubaugh
Senior Electrical Engineer

db/ab
24-0347/M3144
Attachments



WRST - ARC FLASH ANALYSIS - COPPER CENTER
FACILITY ONE-LINE DIAGRAM
AUGUST 31, 2024

Project: Copper Center
Base Project

DAPPER Fault Analysis Input Report (English)

Utilities

Contribution From Name	Bus Name	In/Out Service	Nominal Voltage		-------- Contribution Data -------- Duty	Units	X/R		PU (100 MVA Base) R PU	X PU
UTIL-0001	BUS-0001	In	12,470	3P:	1,000,000	MVA	9,999.00	Pos:	0.0000	0.0001
				SLG:	333,333	MVA	9,999.00	Zero:	0.0000	0.0001

Motors

Contribution From Name	# of Motors	Bus Name	In/Out Service	Nominal Voltage	--------- Contribution Data -------- Base kVA	Xd"	X/R	PU (100 MVA Base) R PU	X PU
MTR-FP	1	BUS-0007	In	480	40.11	0.1507	4.90	76.717	375.834
MTR-HQEL	1	BUS-0027	In	208	15.04	0.1507	4.90	204.577	1,002.225
MTR-VCEL	1	BUS-0026	In	208	15.04	0.1507	4.90	204.577	1,002.225

Cables

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------ Size	Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base) R pu	jX pu

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	------ Cable Description ------ Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
CBL-0001	BUS-0002	In	1	50	500	Copper	Magnetic	PVC	Pos:	0.6380	1.0113
									Zero:	2.0095	2.4891
	BUS-TAP BOX										
CBL-0002	BUS-TAP BOX	In	1	30	500	Copper	Magnetic	PVC	Pos:	0.3828	0.6068
									Zero:	1.2057	1.4935
	DISC-SERVICE										
CBL-0003	BUS-TAP BOX	In	1	3	6	Copper	Magnetic	PVC	Pos:	0.6641	0.0892
									Zero:	2.0927	0.2197
	DISC-DFP										
CBL-0004	DISC-SERVICE	In	1	3	500	Copper	Magnetic	PVC	Pos:	0.0383	0.0607
									Zero:	0.1206	0.1493
	PANEL-MDP1										
CBL-0005	DISC-DFP	In	1	40	6	Copper	Magnetic	PVC	Pos:	8.8542	1.1892
									Zero:	27.9028	2.9288
	BUS-0006										
CBL-0006	BUS-0008	In	1	10	6	Copper	Magnetic	PVC	Pos:	2.2135	0.2973
									Zero:	6.9757	0.7322
	BUS-0007										
CBL-0007	PANEL-MDP1	In	1	60	2	Copper	Magnetic	PVC	Pos:	5.2604	1.5234
									Zero:	16.5781	3.7500
	BUS-0022										

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------ Size	Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
CBL-0008	BUS-0023	In	1	25	1/0	Copper	Magnetic	PVC	Pos:	7.3965	3.1204
									Zero:	23.3104	7.6796
	DISC-DGA										
CBL-0009	DISC-DGA	In	1	3	1/0	Copper	Magnetic	PVC	Pos:	0.8876	0.3744
									Zero:	2.7972	0.9216
	PANEL-GA										
CBL-0010	PANEL-GA	In	1	20	2	Copper	Magnetic	PVC	Pos:	9.3380	2.7043
									Zero:	29.4286	6.6568
	PANEL-WTCP										
CBL-0011	PANEL-MDP1	In	1	150	1/0	Copper	Magnetic	PVC	Pos:	8.3333	3.5156
									Zero:	26.2630	8.6523
	BUS-0024										
CBL-0012	BUS-0025	In	1	30	500	Copper	Magnetic	PVC	Pos:	2.0386	3.2313
									Zero:	6.4210	7.9535
	PANEL-MDP2										
CBL-0013	PANEL-MDP1	In	1	200	3/0	Copper	Magnetic	PVC	Pos:	6.9878	4.5052
									Zero:	22.0226	11.0938
	BUS-0032										
CBL-0014	PANEL-MDP2	In	1	25	2	Copper	Magnetic	PVC	Pos:	11.6725	3.3804
									Zero:	36.7858	8.3210
	PANEL-VC1										

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	------ Cable Description ------ Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
CBL-0015	PANEL-MDP2	In	1	30	1	Copper	Magnetic	PVC	Pos:	11.0947	3.9525
									Zero:	34.9621	9.7286
	PANEL-VC0										
CBL-0016	PANEL-MDP2	In	1	75	2	Copper	Magnetic	PVC	Pos:	35.0176	10.1412
									Zero:	10.3573	24.9630
	DISC-DVCEL										
CBL-0017	DISC-DVCEL	In	1	20	2	Copper	Magnetic	PVC	Pos:	9.3380	2.7043
									Zero:	29.4286	6.6568
	BUS-0026										
CBL-0018	BUS-0033	In	1	30	500	Copper	Magnetic	PVC	Pos:	2.0386	3.2313
									Zero:	6.4210	7.9535
	DISC-DHQ										
CBL-0019	DISC-DHQ	In	1	50	500	Copper	Magnetic	PVC	Pos:	3.3977	5.3855
									Zero:	10.7017	13.2558
	PANEL-HQ										
CBL-0020	PANEL-HQ	In	1	10	2	Copper	Magnetic	PVC	Pos:	4.6690	1.3522
									Zero:	14.7143	3.3284
	PANEL-HQ0										
CBL-0021	PANEL-HQ	In	1	10	3/0	Copper	Magnetic	PVC	Pos:	1.8607	1.1996
									Zero:	5.8640	2.9540
	PANEL-HQB										

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------ Size	Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
CBL-0022	PANEL-HQ	In	1	30	2	Copper	Magnetic	PVC	Pos:	14.0070	4.0565
									Zero:	44.1429	9.9852
	PANEL-HQ1										
CBL-0023	PANEL-HQ	In	1	40	2	Copper	Magnetic	PVC	Pos:	18.6760	5.4087
									Zero:	58.8573	13.3136
	PANEL-HQ2										
CBL-0024	PANEL-HQ	In	1	20	2	Copper	Magnetic	PVC	Pos:	9.3380	2.7043
									Zero:	29.4286	6.6568
	DISC-DHQEL										
CBL-0025	DISC-DHQEL	In	1	20	2	Copper	Magnetic	PVC	Pos:	9.3380	2.7043
									Zero:	29.4286	6.6568
	BUS-0027										

2-Winding Transformers

Xformer Name	In/Out Service	----------Primary & Secondary---------- Bus	Conn.	Volts	FLA	Nominal kVA	Z PU (100 MVA Base)	R pu	jX pu
XFMR-TGA	In	BUS-0022	D	480	90	75.0	Pos:	56.8067	25.8213
			WG	208	208		Zero:	56.8067	25.8213
		BUS-0023							
XFMR-THQ	In	BUS-0032	D	480	135	112.5	Pos:	28.0818	38.3787
			WG	208	312		Zero:	28.0818	38.3787
		BUS-0033							

Xformer Name	In/Out Service	----------Primary & Secondary---------- Bus	Conn.	Volts	FLA	Nominal kVA	Z PU (100 MVA Base)	R pu	jX pu
XFMR-TVC	In	BUS-0024	D	480	135	112.5	Pos:	28.0818	38.3787
			WG	208	312		Zero:	28.0818	38.3787
		BUS-0025							
XFMR-UTILITY	In	BUS-0001	D	12,470	12	225.0	Pos:	8.6667	21.3333
			WG	480	311		Zero:	8.6667	21.3333
		BUS-0002							

Project: Copper Center

DAPPER Fault Contribution Complete Report

Comprehensive Short Circuit Study Settings

Three Phase Fault	Yes	**Faulted Bus**	All Buses
Single Line to Ground	Yes	**Bus Voltages**	First Bus From Fault
Line to Line Fault	No	**Branch Currents**	First Branch From Fault
Line to Line to Ground	No	**Phase or Sequence**	Report phase quantities
Motor Contribution	Yes	**Fault Current Calculation**	Asymmetrical RMS (with DC offset and Decay)
Transformer Tap	Yes	**Asym Fault Current at Time**	0.50 **Cycles**
Xformer Phase Shift	Yes		

				----------Initial Symmetrical Amps----------				----------Asymmetrical Amps----------				---Init Sym Neutral Amps---	
Bus Name	---------Contributions---------			**3 Phase**	**SLG**	**LLG**	**LL**	**3 Phase**	**SLG**	**LLG**	**LL**	**SLG**	**LLG**
DISC-DFP				**5,417**	**5,042**	**0**	**0**	**5,777**	**5,306**	**0**	**0**		
	CBL-0005	CABLE	In	310	193	0	0	331	203	0	0		
	CBL-0003	CABLE	In	5,111	4,852	0	0	5,451	5,107	0	0	5,042	
DISC-DGA				**2,972**	**3,055**	**0**	**0**	**2,972**	**3,055**	**0**	**0**		
	CBL-0009	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0008	CABLE	In	2,972	3,055	0	0	2,972	3,055	0	0	3,055	
DISC-DHQ				**3,652**	**3,972**	**0**	**0**	**3,717**	**4,031**	**0**	**0**		
	CBL-0019	CABLE	In	267	194	0	0	272	197	0	0		
	CBL-0018	CABLE	In	3,402	3,790	0	0	3,463	3,847	0	0	3,972	
DISC-DHQEL				**3,148**	**3,033**	**0**	**0**	**3,183**	**3,048**	**0**	**0**		
	CBL-0025	CABLE	In	270	174	0	0	273	174	0	0		
	CBL-0024	CABLE	In	2,903	2,875	0	0	2,935	2,889	0	0	3,033	
DISC-DVCEL				**2,696**	**2,301**	**0**	**0**	**2,702**	**2,302**	**0**	**0**		
	CBL-0017	CABLE	In	270	154	0	0	271	154	0	0		

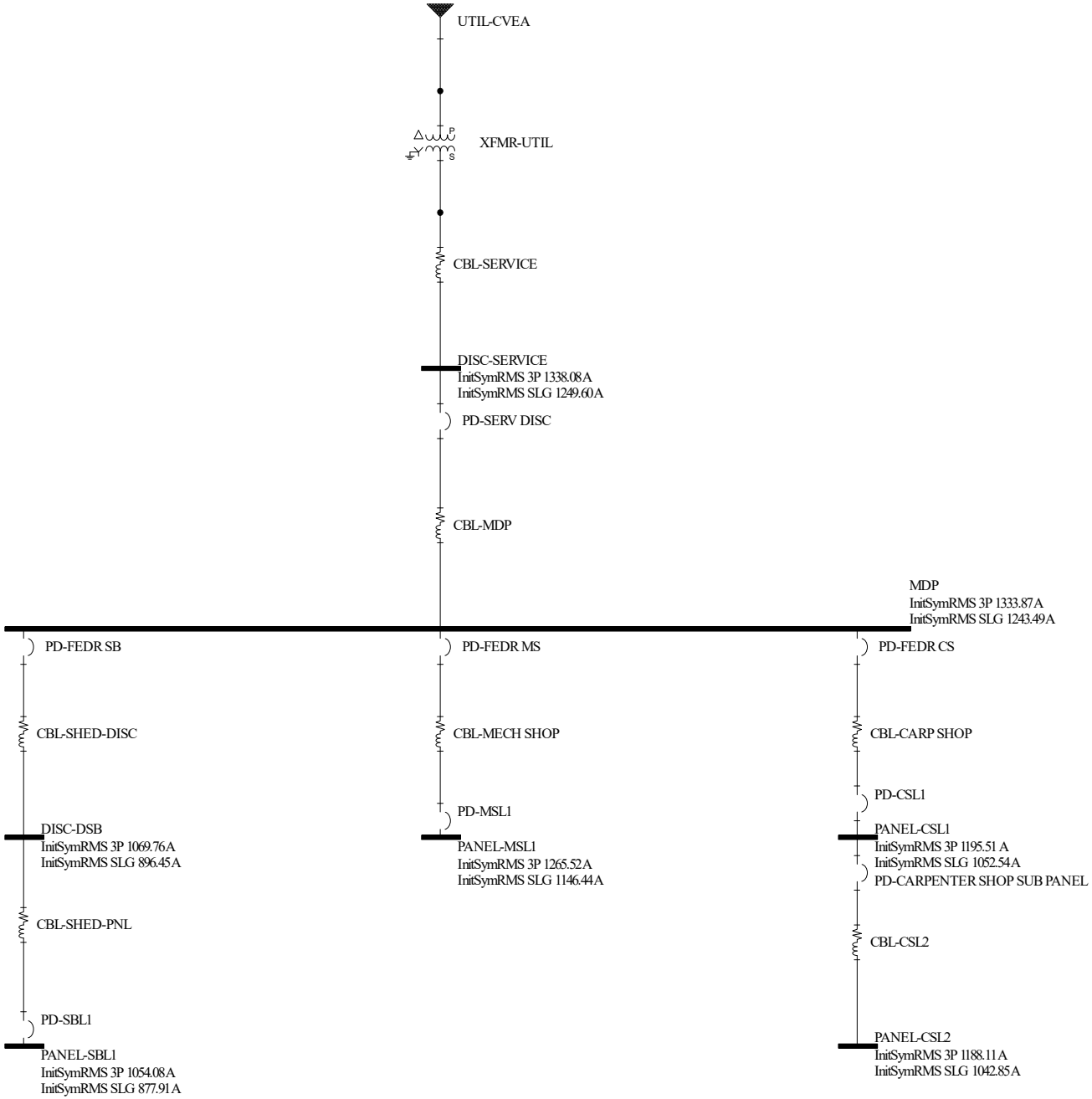
Bus Name	---------Contributions---------			----------Initial Symmetrical Amps---------- 3 Phase	SLG	LLG	LL	----------Asymmetrical Amps---------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
	CBL-0016	CABLE	In	2,470	2,172	0	0	2,476	2,173	0	0	2,301	
DISC-SERVICE				**5,335**	**4,941**	**0**	**0**	**5,738**	**5,263**	**0**	**0**		
	CBL-0004	CABLE	In	220	136	0	0	236	144	0	0		
	CBL-0002	CABLE	In	5,117	4,806	0	0	5,504	5,120	0	0	4,941	
PANEL-GA				**2,942**	**3,002**	**0**	**0**	**2,943**	**3,002**	**0**	**0**		
	CBL-0010	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0009	CABLE	In	2,942	3,002	0	0	2,943	3,002	0	0	3,002	
PANEL-HQ				**3,408**	**3,506**	**0**	**0**	**3,470**	**3,557**	**0**	**0**		
	CBL-0022	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0021	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0023	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0020	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0024	CABLE	In	269	184	0	0	274	187	0	0		
	CBL-0019	CABLE	In	3,156	3,333	0	0	3,214	3,382	0	0	3,506	
PANEL-HQ0				**3,259**	**3,247**	**0**	**0**	**3,302**	**3,272**	**0**	**0**		
	CBL-0020	CABLE	In	3,259	3,247	0	0	3,302	3,272	0	0	3,247	
PANEL-HQ1				**2,988**	**2,804**	**0**	**0**	**3,009**	**2,811**	**0**	**0**		
	CBL-0022	CABLE	In	2,988	2,804	0	0	3,009	2,811	0	0	2,804	
PANEL-HQ2				**2,865**	**2,617**	**0**	**0**	**2,880**	**2,621**	**0**	**0**		
	CBL-0023	CABLE	In	2,865	2,617	0	0	2,880	2,621	0	0	2,617	
PANEL-HQB				**3,325**	**3,366**	**0**	**0**	**3,381**	**3,407**	**0**	**0**		
	CBL-0021	CABLE	In	3,325	3,366	0	0	3,381	3,407	0	0	3,366	
PANEL-MDP2				**3,653**	**3,971**	**0**	**0**	**3,706**	**4,023**	**0**	**0**		
	CBL-0014	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0015	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0016	CABLE	In	266	192	0	0	269	195	0	0		
	CBL-0012	CABLE	In	3,404	3,791	0	0	3,455	3,840	0	0	3,971	
PANEL-VC0				**3,237**	**3,211**	**0**	**0**	**3,259**	**3,221**	**0**	**0**		
	CBL-0015	CABLE	In	3,237	3,211	0	0	3,259	3,221	0	0	3,211	
PANEL-VC1				**3,241**	**3,209**	**0**	**0**	**3,260**	**3,217**	**0**	**0**		
	CBL-0014	CABLE	In	3,241	3,209	0	0	3,260	3,217	0	0	3,209	
PANEL-WTCP				**2,678**	**2,559**	**0**	**0**	**2,678**	**2,559**	**0**	**0**		
	CBL-0010	CABLE	In	2,678	2,559	0	0	2,678	2,559	0	0	2,559	

Arc Flash Evaluation Report

Bus Name	Bus kV	Protective Device Name	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Bolted Fault (kA)	Prot Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Arc Duration	Arc Type	ArcFlash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm2)	PPE
DISC-DFP	0.480	MaxTripTime @2.0s	5.42	4.03	4.90	3.64	2.000	0.000	2.000	In Box	89.87	18.00	15.67	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
DISC-DGA	0.208	PD-FEDR-GA	2.97	1.22	2.97	1.22	2.000	0.000	2.000	In Box	44.50	18.00	5.10	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
DISC-DHQ	0.208	PD-FEDR-HQ	3.65	1.53	3.40	1.42	2.000	0.000	2.000	In Box	49.13	18.00	5.97	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
DISC-DHQEL	0.208	PD-FEDR-HQEL	3.15	1.30	2.90	1.20	1.957	0.000	1.957	In Box	43.37	18.00	4.89	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
DISC-DVCEL	0.208	PD-FEDR-VCEL	2.70	1.10	2.47	1.00	2.000	0.000	2.000	In Box	39.27	18.00	4.17	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit

Bus Name	Bus kV	Protective Device Name	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Bolted Fault (kA)	Prot Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Arc Duration	Arc Type	ArcFlash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm2)	PPE
DISC-SERVICE	0.480	MaxTripTime @2.0s	5.33	3.96	4.82	3.58	2.000	0.000	2.000	In Box	88.81	18.00	15.38	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-GA	0.208	PD-GA	2.94	1.21	2.94	1.21	2.000	0.000	2.000	In Box	44.19	18.00	5.04	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-HQ	0.208	PD-GA1	3.41	1.42	3.16	1.31	2.000	0.000	2.000	In Box	46.62	18.00	5.49	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-HQ0	0.208	PD-FEDR-HQ0	3.26	1.16	3.26	1.16	2.000	0.000	2.000	In Box	41.39	18.00	4.54	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-HQ1	0.208	PD-FEDR-HQ1	2.99	1.06	2.99	1.06	2.000	0.000	2.000	In Box	39.07	18.00	4.14	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-HQ2	0.208	PD-FEDR-HQ2	2.86	1.17	2.86	1.17	2.000	0.000	2.000	In Box	41.54	18.00	4.57	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-HQB	0.208	PD-FEDR-HQB	3.33	1.38	3.33	1.38	2.000	0.000	2.000	In Box	45.87	18.00	5.35	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-MDP2	0.208	PD-MDP2	3.65	1.53	3.40	1.42	0.024	0.000	0.024	In Box	3.26	18.00	0.08	No Arc-rated PPE Required

Bus Name	Bus kV	Protective Device Name	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Bolted Fault (kA)	Prot Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Arc Duration	Arc Type	ArcFlash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm2)	PPE
PANEL-VC0	0.208	PD-FEDR-VC0	3.24	1.15	3.24	1.15	2.000	0.000	2.000	In Box	41.48	18.00	4.56	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-VC1	0.208	PD-FEDR-VC1	3.24	1.15	3.24	1.15	2.000	0.000	2.000	In Box	41.50	18.00	4.56	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-WTCP	0.208	PD-FEDR-WTCP	2.68	1.09	2.68	1.09	2.000	0.000	2.000	In Box	41.37	18.00	4.54	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit



WRST - ARC FLASH ANALYSIS - GLENALLEN
FACILITY ONE-LINE DIAGRAM
AUGUST 31, 2024

Project: Glennallen Main Shop
Base Project

DAPPER Fault Analysis Input Report (English)

Utilities

Contribution From Name	Bus Name	In/Out Service	Nominal Voltage	-------- Contribution Data --------					PU (100 MVA Base)		
					Duty	Units	X/R			R PU	X PU
UTIL-CVEA	BUS-0001	In	12,470	3P:	1,000,000	MVA	9,999.00		Pos:	0.0000	0.0001
				SLG:	333,333	MVA	9,999.00		Zero:	0.0000	0.0001

Cables

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------				Per Unit (100 MVA Base)		
					Size	Cond. Type	Duct Type	Insul		R pu	jX pu
CBL-CARP SHOP	MDP	In	1	75	1/0	Copper	Magnetic	PVC	Pos:	22.1894	9.3611
									Zero:	69.9311	23.0388
	PANEL-CSL1										
CBL-CSL2	PANEL-CSL1	In	1	3	2	Copper	Magnetic	PVC	Pos:	1.4007	0.4056
									Zero:	4.4143	0.9985
	PANEL-CSL2										

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	Cond. Type	Duct Type	Insul		R pu	jX pu
					------ Cable Description ------				Per Unit (100 MVA Base)		
CBL-MDP	DISC-SERVICE	In	1	3	3/0	Copper	Magnetic	PVC	Pos:	0.5582	0.3599
									Zero:	1.7592	0.8862
	MDP										
CBL-MECH SHOP	MDP	In	1	35	1/0	Copper	Magnetic	PVC	Pos:	10.3550	4.3685
									Zero:	32.6345	10.7514
	PANEL-MSL1										
CBL-SERVICE	BUS-0002	In	1	135	1/0	Aluminum	Non-Magnetic	XLP	Pos:	65.5279	14.0417
									Zero:	04.1582	35.6971
	DISC-SERVICE										
CBL-SHED-DISC	MDP	In	1	160	1/0	Copper	Magnetic	PVC	Pos:	47.3373	19.9704
									Zero:	49.1864	49.1494
	DISC-DSB										
CBL-SHED-PNL	DISC-DSB	In	1	8	2	Copper	Magnetic	PVC	Pos:	3.7352	1.0817
									Zero:	11.7715	2.6627
	PANEL-SBL1										

2-Winding Transformers

Xformer Name	In/Out Service	----------Primary & Secondary---------- Bus	Conn.	Volts	FLA	Nominal kVA		Z PU (100 MVA Base) R pu	jX pu
XFMR-UTIL	In	BUS-0001	D	12,470	2	30.0	Pos:	125.0000	68.0000
			WG	208	96		Zero:	125.0000	68.0000
		BUS-0002							

Project: Glennallen Main Shop

DAPPER Fault Contribution Complete Report

Comprehensive Short Circuit Study Settings

Three Phase Fault	Yes	**Faulted Bus**	All Buses
Single Line to Ground	Yes	**Bus Voltages**	First Bus From Fault
Line to Line Fault	No	**Branch Currents**	First Branch From Fault
Line to Line to Ground	No	**Phase or Sequence**	Report phase quantities
Motor Contribution	Yes	**Fault Current Calculation**	Asymmetrical RMS (with DC offset and Decay)
Transformer Tap	Yes	**Asym Fault Current at Time**	0.50 **Cycles**
Xformer Phase Shift	Yes		

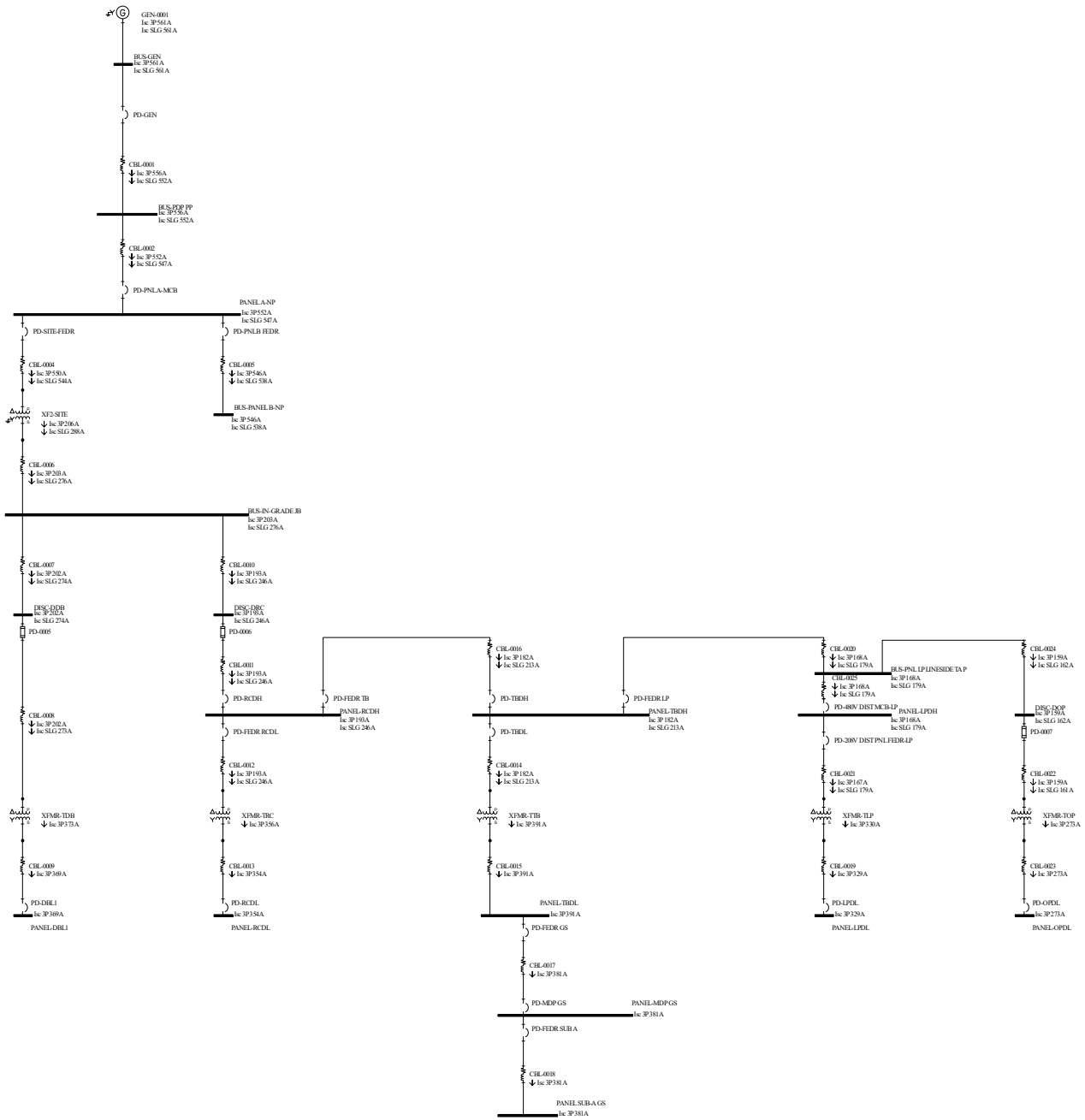
				----------Initial Symmetrical Amps----------				----------Asymmetrical Amps----------				---Init Sym Neutral Amps---	
Bus Name	**---------Contributions---------**			**3 Phase**	**SLG**	**LLG**	**LL**	**3 Phase**	**SLG**	**LLG**	**LL**	**SLG**	**LLG**
DISC-DSB				**1,070**	**896**	**0**	**0**	**1,070**	**896**	**0**	**0**		
	CBL-SHED-PNL	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-SHED-DISC	CABLE	In	1,070	896	0	0	1,070	896	0	0	896	
DISC-SERVICE				**1,338**	**1,250**	**0**	**0**	**1,338**	**1,250**	**0**	**0**		
	CBL-MDP	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-SERVICE	CABLE	In	1,338	1,250	0	0	1,338	1,250	0	0	1,250	
MDP				**1,334**	**1,243**	**0**	**0**	**1,334**	**1,243**	**0**	**0**		
	CBL-SHED-DISC	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-MECH SHOP	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-CARP SHOP	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-MDP	CABLE	In	1,334	1,243	0	0	1,334	1,243	0	0	1,243	
PANEL-CSL1				**1,196**	**1,053**	**0**	**0**	**1,196**	**1,053**	**0**	**0**		
	CBL-CSL2	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-CARP SHOP	CABLE	In	1,196	1,053	0	0	1,196	1,053	0	0	1,053	

Bus Name	---------Contributions---------			----------Initial Symmetrical Amps---------- 3 Phase	SLG	LLG	LL	----------Asymmetrical Amps---------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
PANEL-CSL2				**1,188**	**1,043**	**0**	**0**	**1,188**	**1,043**	**0**	**0**		
	CBL-CSL2	CABLE	In	1,188	1,043	0	0	1,188	1,043	0	0	1,043	
PANEL-MSL1				**1,266**	**1,146**	**0**	**0**	**1,266**	**1,146**	**0**	**0**		
	CBL-MECH SHOP	CABLE	In	1,266	1,146	0	0	1,266	1,146	0	0	1,146	
PANEL-SBL1				**1,054**	**878**	**0**	**0**	**1,054**	**878**	**0**	**0**		
	CBL-SHED-PNL	CABLE	In	1,054	878	0	0	1,054	878	0	0	878	

Arc Flash Evaluation Report

Bus Name	Bus kV	Protective Device Name	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Bolted Fault (kA)	Prot Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Arc Duration	Arc Type	ArcFlash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm2)	PPE
DISC-DSB	0.208	PD-FEDR SB	1.07	0.40	1.07	0.40	2.000	0.000	2.000	In Box	21.86	18.00	1.64	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
DISC-SERVICE	0.208	MaxTripTime @2.0s	1.34	0.51	0.00	0.00	2.000	0.000	2.000	In Box	25.61	18.00	2.11	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
MDP	0.208	PD-SERV DISC	1.33	0.51	1.33	0.51	2.000	0.000	2.000	In Box	25.55	18.00	2.10	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-CSL1	0.208	PD-FEDR CS	1.20	0.45	1.20	0.45	2.000	0.000	2.000	In Box	23.65	18.00	1.86	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-CSL2	0.208	PD-CARPENTER SHOP SUB PANEL	1.19	0.45	1.19	0.45	2.000	0.000	2.000	In Box	23.54	18.00	1.84	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit

Bus Name	Bus kV	Protective Device Name	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Bolted Fault (kA)	Prot Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Arc Duration	Arc Type	ArcFlash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm2)	PPE
PANEL-MSL1	0.208	PD-MSL1	1.27	0.48	1.27	0.48	2.000	0.000	2.000	In Box	24.62	18.00	1.98	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit
PANEL-SBL1	0.208	PD-SBL1	1.05	0.40	1.05	0.40	2.000	0.000	2.000	In Box	21.64	18.00	1.61	Arc-rated shirt & pants or arc-rated coverall or arc-rated arc flash suit



WRST - ARC FLASH ANALYSIS - KENNECOTT
FACILITY ONE-LINE DIAGRAM
AUGUST 31, 2024

Project: Kennecott
Base Project

DAPPER Fault Analysis Input Report (English)

Generators

Contribution From Name	Bus Name	In/Out Service	Nominal Voltage	-------- Contribution Data -------- Base kVA	X"	X/R		PU (100 MVA Base) R PU	X PU
GEN-0001	BUS-GEN	In	208	31.25	0.15	4.01	Pos:	119.6202	480.0000
					0.15	4.01	Neg:	119.6202	480.0000
					0.15	4.01	Zero:	119.62	480.00

Cables

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------ Size	Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
CBL-0001	BUS-GEN	In	1	20	2	Copper	Magnetic	PVC	Pos:	9.3380	2.7043
									Zero:	29.4286	6.6568
	BUS-PDP PP										
CBL-0002	BUS-PDP PP	In	1	20	1/0	Copper	Magnetic	EDPM/C	Pos:	6.0558	2.0340
									Zero:	9.6293	5.1729
	PANEL A-NP										

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	------ Cable Description ------ Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
CBL-0004	PANEL A-NP	In	1	6	2	Copper	Magnetic	PVC	Pos:	2.8014	0.8113
									Zero:	8.8286	1.9970
	BUS-0019										
CBL-0005	PANEL A-NP	In	1	20	2	Copper	Magnetic	PVC	Pos:	9.3380	2.7043
									Zero:	29.4286	6.6568
	BUS-PANEL B-NP										
CBL-0006	BUS-0018	In	1	180	2	Copper	Magnetic	PVC	Pos:	15.7813	4.5703
									Zero:	49.7344	11.2500
	BUS-IN-GRADE JB										
CBL-0007	BUS-IN-GRADE JB	In	1	20	2	Copper	Magnetic	PVC	Pos:	1.7535	0.5078
									Zero:	5.5260	1.2500
	DISC-DDB										
CBL-0008	DISC-DDB	In	1	20	2	Copper	Magnetic	PVC	Pos:	1.7535	0.5078
									Zero:	5.5260	1.2500
	BUS-0016										
CBL-0009	BUS-0017	In	1	20	2	Copper	Magnetic	PVC	Pos:	9.3380	2.7043
									Zero:	29.4286	6.6568
	PANEL-DBL1										
CBL-0010	BUS-IN-GRADE JB	In	1	450	2	Copper	Magnetic	PVC	Pos:	39.4531	11.4258
									Zero:	24.3359	28.1250
	DISC-DRC										

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	------ Cable Description ------ Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
CBL-0011	DISC-DRC	In	1	5	2	Copper	Magnetic	PVC	Pos:	0.4384	0.1270
									Zero:	1.3815	0.3125
	PANEL-RCDH										
CBL-0012	PANEL-RCDH	In	1	10	2	Copper	Magnetic	PVC	Pos:	0.8767	0.2539
									Zero:	2.7630	0.6250
	BUS-0022										
CBL-0013	BUS-0023	In	1	10	2	Copper	Magnetic	PVC	Pos:	4.6690	1.3522
									Zero:	14.7143	3.3284
	PANEL-RCDL										
CBL-0014	PANEL-TBDH	In	1	10	2	Copper	Magnetic	PVC	Pos:	0.8767	0.2539
									Zero:	2.7630	0.6250
	BUS-0024										
CBL-0015	BUS-0025	In	1	5	4/0	Copper	Magnetic	PVC	Pos:	0.7396	0.5744
									Zero:	2.3310	1.4146
	PANEL-TBDL										
CBL-0016	PANEL-RCDH	In	1	600	2	Copper	Magnetic	PVC	Pos:	52.6042	15.2344
									Zero:	65.7813	37.5000
	PANEL-TBDH										
CBL-0017	PANEL-TBDL	In	1	100	4/0	Copper	Magnetic	PVC	Pos:	14.7929	11.4876
									Zero:	46.6208	28.2914
	PANEL-MDP GS										

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	Cond. Type	Duct Type	Insul		R pu	jX pu
					------ Cable Description ------				Per Unit (100 MVA Base)		
CBL-0018	PANEL-MDP GS	In	1	3	2	Copper	Magnetic	PVC	Pos:	1.4007	0.4056
									Zero:	4.4143	0.9985
	PANEL SUB-A GS										
CBL-0019	BUS-0026	In	1	10	2	Copper	Magnetic	PVC	Pos:	4.6690	1.3522
									Zero:	14.7143	3.3284
	PANEL-LPDL										
CBL-0020	PANEL-TBDH	In	1	800	2	Copper	Magnetic	PVC	Pos:	70.1389	20.3125
									Zero:	21.0417	50.0000
	BUS-PNL LP LINESIDE TAP										
CBL-0021	PANEL-LPDH	In	1	6	2	Copper	Magnetic	PVC	Pos:	0.5260	0.1523
									Zero:	1.6578	0.3750
	BUS-0034										
CBL-0022	DISC-DOP	In	1	50	2	Copper	Magnetic	PVC	Pos:	4.3837	1.2695
									Zero:	13.8151	3.1250
	BUS-0039										
CBL-0023	BUS-0040	In	1	6	2	Copper	Magnetic	PVC	Pos:	2.8014	0.8113
									Zero:	8.8286	1.9970
	PANEL-OPDL										
CBL-0024	BUS-PNL LP LINESIDE TAP	In	1	500	2	Copper	Magnetic	PVC	Pos:	43.8368	12.6953
									Zero:	38.1510	31.2500
	DISC-DOP										

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------ Size	Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
CBL-0025	BUS-PNL LP LINESIDE TAP	In	1	1	2	Copper	Magnetic	PVC	Pos:	0.0877	0.0254
									Zero:	0.2763	0.0625
	PANEL-LPDH										

2-Winding Transformers

Xformer Name	In/Out Service	----------Primary & Secondary---------- Bus	Conn.	Volts	FLA	Nominal kVA	Z PU (100 MVA Base)	R pu	jX pu
XF2-SITE	In	BUS-0019	D	208	83	30.0	Pos:	102.1367	45.9600
			WG	480	36		Zero:	102.1367	45.9600
		BUS-0018							
XFMR-TDB	In	BUS-0016	D	480	36	30.0	Pos:	123.5100	101.7133
			W	208	83		Zero:	,300.0000	,300.0000
		BUS-0017							
XFMR-TLP	In	BUS-0034	D	480	36	30.0	Pos:	97.5200	80.3100
			W	208	83		Zero:	,300.0000	,300.0000
		BUS-0026							
XFMR-TOP	In	BUS-0039	D	480	18	15.0	Pos:	202.2467	166.5533
			W	208	42		Zero:	,600.0000	,600.0000
		BUS-0040							
XFMR-TRC	In	BUS-0022	D	480	36	30.0	Pos:	128.6567	105.9500
			W	208	83		Zero:	,300.0000	,300.0000
		BUS-0023							

Xformer Name	In/Out Service	----------Primary & Secondary---------- Bus	Conn.	Volts	FLA	Nominal kVA	Z PU (100 MVA Base)	R pu	jX pu
XFMR-TTB	In	BUS-0024	D	480	90	75.0	Pos:	38.0827	31.3613
			W	208	208		Zero:	,320.0000	,320.0000
		BUS-0025							

Project: Kennecott

DAPPER Fault Contribution Complete Report

Comprehensive Short Circuit Study Settings

Three Phase Fault	Yes	**Faulted Bus**	All Buses
Single Line to Ground	Yes	**Bus Voltages**	First Bus From Fault
Line to Line Fault	No	**Branch Currents**	First Branch From Fault
Line to Line to Ground	No	**Phase or Sequence**	Report phase quantities
Motor Contribution	Yes	**Fault Current Calculation**	Asymmetrical RMS (with DC offset and Decay)
Transformer Tap	Yes	**Asym Fault Current at Time**	0.50 **Cycles**
Xformer Phase Shift	Yes		

				----------Initial Symmetrical Amps----------				----------Asymmetrical Amps----------				---Init Sym Neutral Amps---	
Bus Name	**---------Contributions---------**			**3 Phase**	**SLG**	**LLG**	**LL**	**3 Phase**	**SLG**	**LLG**	**LL**	**SLG**	**LLG**
BUS-GEN				**561**	**561**	**0**	**0**	**668**	**668**	**0**	**0**		
	CBL-0001	CABLE	In	0	0	0	0	0	0	0	0		
	GEN-0001	GEN	In	561	561	0	0	668	668	0	0	561	
BUS-PANEL B-NP				**546**	**538**	**0**	**0**	**625**	**604**	**0**	**0**		
	CBL-0005	CABLE	In	546	538	0	0	625	604	0	0	538	
BUS-PDP PP				**556**	**552**	**0**	**0**	**651**	**640**	**0**	**0**		
	CBL-0002	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0001	CABLE	In	556	552	0	0	651	640	0	0	552	
DISC-DDB				**202**	**274**	**0**	**0**	**212**	**281**	**0**	**0**		
	CBL-0008	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0007	CABLE	In	202	274	0	0	212	281	0	0	274	
DISC-DOP				**159**	**162**	**0**	**0**	**161**	**163**	**0**	**0**		
	CBL-0022	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0024	CABLE	In	159	162	0	0	161	163	0	0	162	

Bus Name	---------Contributions---------			----------Initial Symmetrical Amps---------- 3 Phase	SLG	LLG	LL	----------Asymmetrical Amps---------- 3 Phase	SLG	LLG	LL	---Init Sym Neutral Amps--- SLG	LLG
DISC-DRC				**193**	**246**	**0**	**0**	**200**	**249**	**0**	**0**		
	CBL-0011	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0010	CABLE	In	193	246	0	0	200	249	0	0	246	
PANEL A-NP				**552**	**547**	**0**	**0**	**640**	**627**	**0**	**0**		
	CBL-0005	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0004	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0002	CABLE	In	552	547	0	0	640	627	0	0	547	
PANEL SUB-A GS				**381**	**0**	**0**	**0**	**386**	**0**	**0**	**0**		
	CBL-0018	CABLE	In	381	0	0	0	386	0	0	0		
PANEL-DBL1				**369**	**0**	**0**	**0**	**377**	**0**	**0**	**0**		
	CBL-0009	CABLE	In	369	0	0	0	377	0	0	0		
PANEL-LPDH				**168**	**179**	**0**	**0**	**169**	**179**	**0**	**0**		
	CBL-0021	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0025	CABLE	In	168	179	0	0	169	179	0	0	179	
PANEL-LPDL				**329**	**0**	**0**	**0**	**331**	**0**	**0**	**0**		
	CBL-0019	CABLE	In	329	0	0	0	331	0	0	0		
PANEL-MDP GS				**381**	**0**	**0**	**0**	**387**	**0**	**0**	**0**		
	CBL-0018	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0017	CABLE	In	381	0	0	0	387	0	0	0		
PANEL-OPDL				**273**	**0**	**0**	**0**	**274**	**0**	**0**	**0**		
	CBL-0023	CABLE	In	273	0	0	0	274	0	0	0		
PANEL-RCDH				**193**	**246**	**0**	**0**	**200**	**249**	**0**	**0**		
	CBL-0016	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0012	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0011	CABLE	In	193	246	0	0	200	249	0	0	246	
PANEL-RCDL				**354**	**0**	**0**	**0**	**360**	**0**	**0**	**0**		
	CBL-0013	CABLE	In	354	0	0	0	360	0	0	0		
PANEL-TBDH				**182**	**213**	**0**	**0**	**185**	**214**	**0**	**0**		
	CBL-0014	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0020	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0016	CABLE	In	182	213	0	0	185	214	0	0	213	
PANEL-TBDL				**391**	**0**	**0**	**0**	**397**	**0**	**0**	**0**		
	CBL-0017	CABLE	In	0	0	0	0	0	0	0	0		
	CBL-0015	CABLE	In	391	0	0	0	397	0	0	0		

Arc Flash Evaluation Report

Bus Name	Bus kV	Protective Device Name	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Bolted Fault (kA)	Prot Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Arc Duration	Arc Type	ArcFlash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm2)	PPE
BUS-GEN	0.208	MaxTripTime @2.0s	0.56	0.20	0.00	0.00	2.000	0.000	2.000	In Box	13.88	18.00	0.79	No Arc-rated PPE Required
BUS-PANEL B-NP	0.208	PD-PNL B FEDR	0.55	0.20	0.55	0.20	2.000	0.000	2.000	In Box	13.62	18.00	0.77	No Arc-rated PPE Required
BUS-PDP PP	0.208	PD-GEN	0.56	0.20	0.56	0.20	2.000	0.000	2.000	In Box	13.79	18.00	0.78	No Arc-rated PPE Required
DISC-DDB	0.480	PD-SITE-FEDR	0.20	0.20	0.20	0.20	2.000	0.000	2.000	In Box	11.35	18.00	0.47	No Arc-rated PPE Required
DISC-DOP	0.480	PD-FEDR LP	0.16	0.16	0.16	0.16	2.000	0.000	2.000	In Box	10.08	18.00	0.37	No Arc-rated PPE Required

Bus Name	Bus kV	Protective Device Name	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Bolted Fault (kA)	Prot Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Arc Duration	Arc Type	ArcFlash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm2)	PPE
DISC-DRC	0.480	PD-SITE-FEDR	0.19	0.19	0.19	0.19	2.000	0.000	2.000	In Box	11.10	18.00	0.45	No Arc-rated PPE Required
PANEL A-NP	0.208	PD-PNL A-MCB	0.55	0.20	0.55	0.20	2.000	0.000	2.000	In Box	13.72	18.00	0.78	No Arc-rated PPE Required
PANEL SUB-A GS	0.208	PD-FEDR SUB A	0.38	0.38	0.38	0.38	2.000	0.000	2.000	In Box	10.25	18.00	0.39	No Arc-rated PPE Required
PANEL-DBL1	0.208	PD-DBL1	0.37	0.37	0.37	0.37	2.000	0.000	2.000	In Box	10.10	18.00	0.38	No Arc-rated PPE Required
PANEL-LPDH	0.480	PD-480V DIST MCB-LP	0.17	0.17	0.17	0.17	2.000	0.000	2.000	In Box	10.33	18.00	0.39	No Arc-rated PPE Required
PANEL-LPDL	0.208	PD-LPDL	0.33	0.33	0.33	0.33	2.000	0.000	2.000	In Box	9.52	18.00	0.33	No Arc-rated PPE Required
PANEL-MDP GS	0.208	PD-MDP GS	0.38	0.38	0.38	0.38	2.000	0.000	2.000	In Box	10.26	18.00	0.39	No Arc-rated PPE Required
PANEL-OPDL	0.208	PD-OPDL	0.27	0.27	0.27	0.27	2.000	0.000	2.000	In Box	8.68	18.00	0.28	No Arc-rated PPE Required

Bus Name	Bus kV	Protective Device Name	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Bolted Fault (kA)	Prot Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Arc Duration	Arc Type	ArcFlash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm2)	PPE
PANEL-RCDH	0.480	PD-0006	0.19	0.19	0.19	0.19	2.000	0.000	2.000	In Box	11.10	18.00	0.45	No Arc-rated PPE Required
PANEL-RCDL	0.208	PD-RCDL	0.35	0.35	0.35	0.35	2.000	0.000	2.000	In Box	9.89	18.00	0.36	No Arc-rated PPE Required
PANEL-TBDH	0.480	PD-TBDH	0.18	0.18	0.18	0.18	2.000	0.000	2.000	In Box	10.76	18.00	0.43	No Arc-rated PPE Required
PANEL-TBDL	0.208	PD-TBDL	0.39	0.39	0.39	0.39	2.000	0.000	2.000	In Box	10.39	18.00	0.40	No Arc-rated PPE Required