DC Traction Power Substation Design

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Presentation Objectives

- Provide helpful knowledge when it comes to DC Traction Power equipment and substation designs
- Introduce typical North American standards used in the industry to help designers and specifiers develop project requirements
- Share common industry practices

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Agenda

- Most Common North American DC Rail Systems and Categories
- LRT DC Traction Power Distribution Network Overview
- Introduction to a DC Traction Power Substation
- DC Traction Substation Grounding Practices
- Medium Voltage Switchgear
- Transformer Rectifier Units
- DC Switchgear
- DC Disconnect Switches
- Negative Grounding Devices
- Substation Automation System
- Power Control Rooms/Prefabricated Buildings
- Q & A

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Most Common North American DC Rail Systems and Categories

Heavy Rail Systems

- >6 train cars
- 2-8min headways
- Underground/Above ground systems
- Mostly 3rd rail systems
- Traction Power Substations >4MW
- Brick & Mortar Buildings

Examples

New York Subway
Chicago Subway
WMATA
BART
TTC Subway

Light Rail Systems

- <6 Train Cars
- 5-15min headways
- Mainly Above Ground
- Dedicated right of way
- OCS systems
- Traction Power Substations 1MW-3MW
- Prefab Buildings

Examples

Montreal REM
Toronto: Finch, Eglinton
Calgary Transit
Edmonton Valley Line

Streetcar Systems

- <6 Train cars
- 5-15min headways
- Above Ground
- Operates with circulating cars
- OCS systems
- Traction Power Substations 0.5-1.5MW
- Prefab Buildings

Examples

TTC Streetcar
Portland
Kansas City
Oklahoma City

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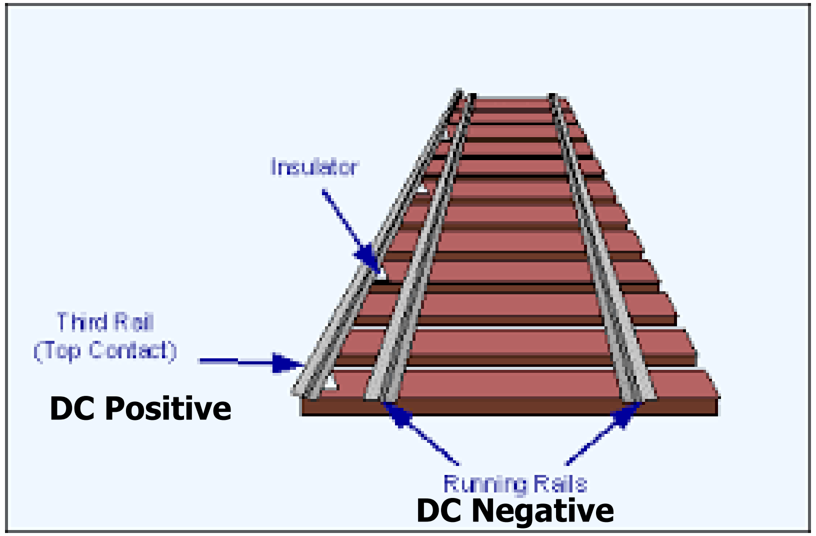
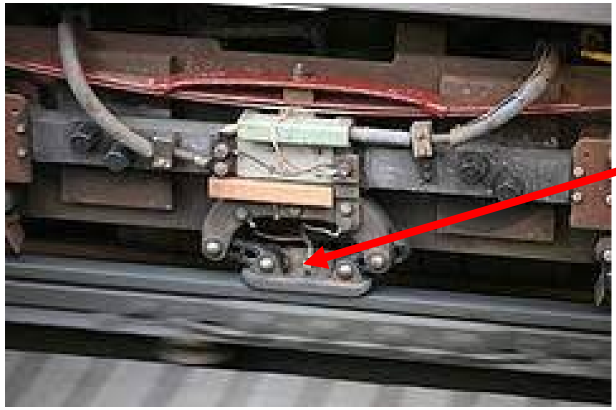
Most Common North American DC Rail Systems and Categories

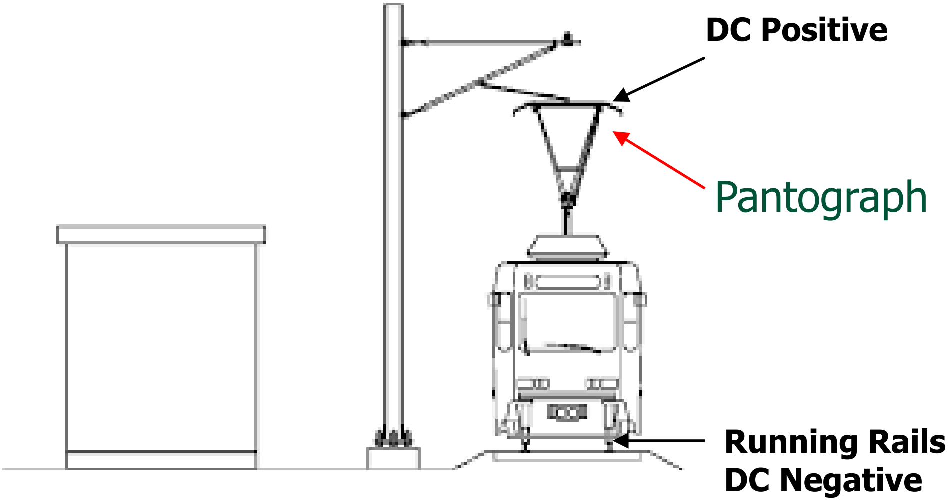
3RD Rail System





Train Collector Shoe "rubbing" 3rd rail

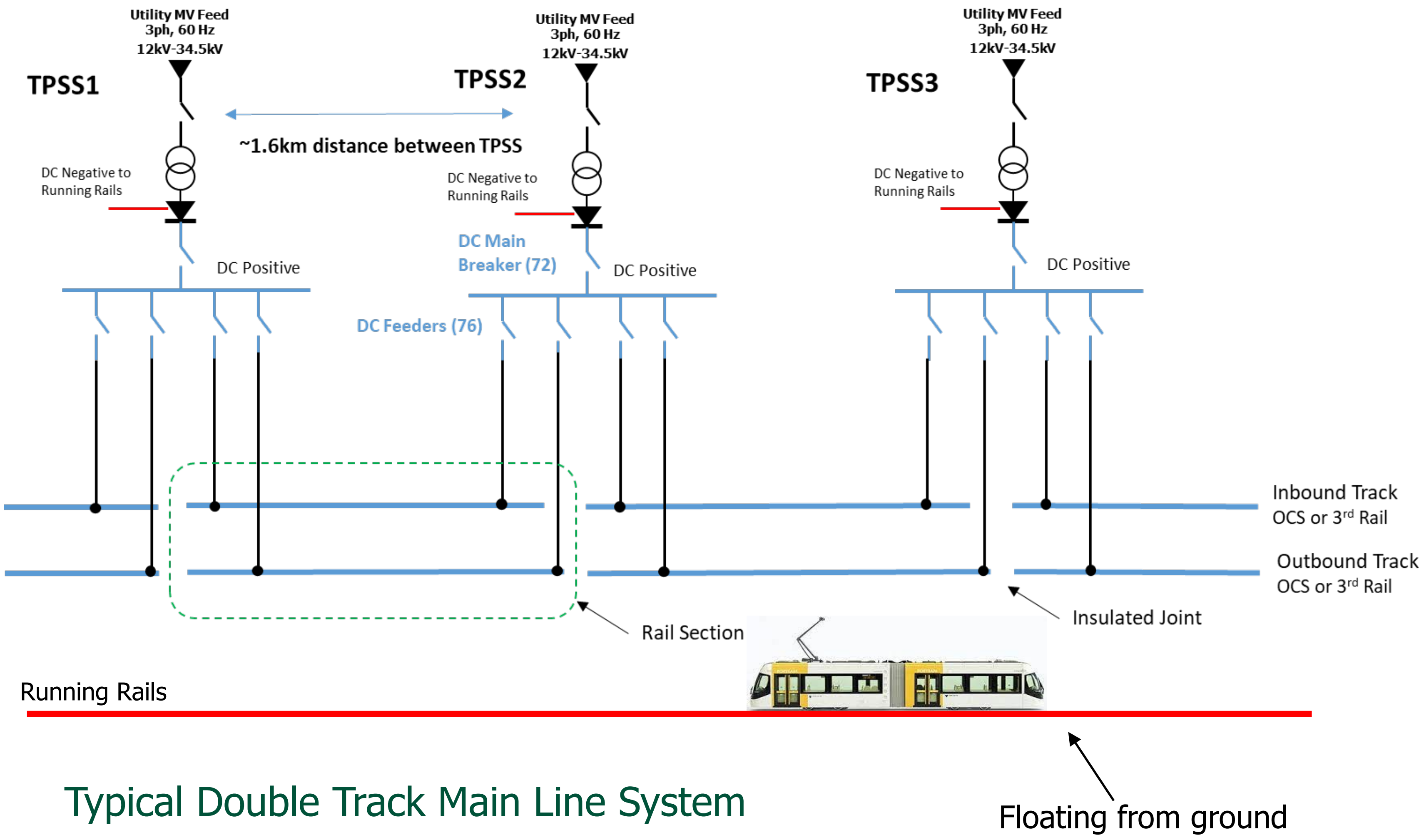
Overhead Catenary System (OCS)



IMPORTANT

The mainline DC Negative (Running Rails) are always isolated from ground to avoid stray currents from damaging underground piping infrastructure

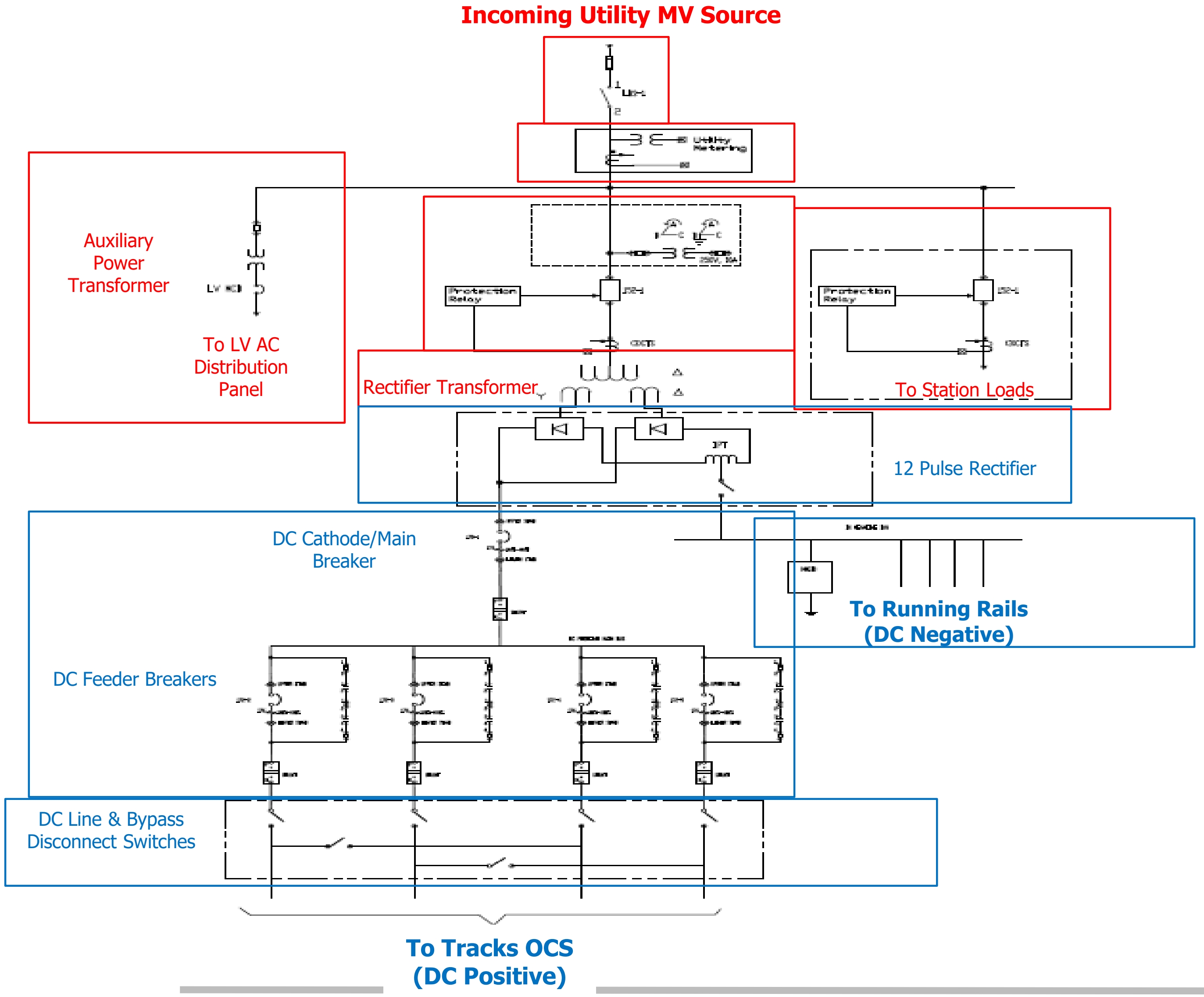
LRT DC Traction Power Distribution Network Overview



Typical Double Track Main Line System

- TPSS Incoming source is always a 3ph MV source
- The MV network distribution can be radial, parallel or ring type
- DC network distribution is radial
- DC Output 570-1500Vdc
- DC Rail systems are sectionalized
- TPSS Power and Equipment ratings and Quantities are determined by load flows studies
- DC Rail systems are always designed with N-1 or N-2 substation redundancy

Introduction to a DC Traction Power Substation



Main Incoming Disconnecting Device

Primary Utility Metering Section

Substation Auxilairy Power Source

Rectifier Transformer Feeder Breaker

Other MV Feeders

Transformer Rectifier Unit (TRU)

- Rectifier Transformer
- Rectifier

DC Negative Switchgear

DC Positive Breaker Switchgear

DC Line& Bypass Switches

Introduction to a DC Traction Power Substation

Typical Prefabricated Traction Power Substation Layout

** Incoming and outgoing cables are always bottom entry

DC Circuits

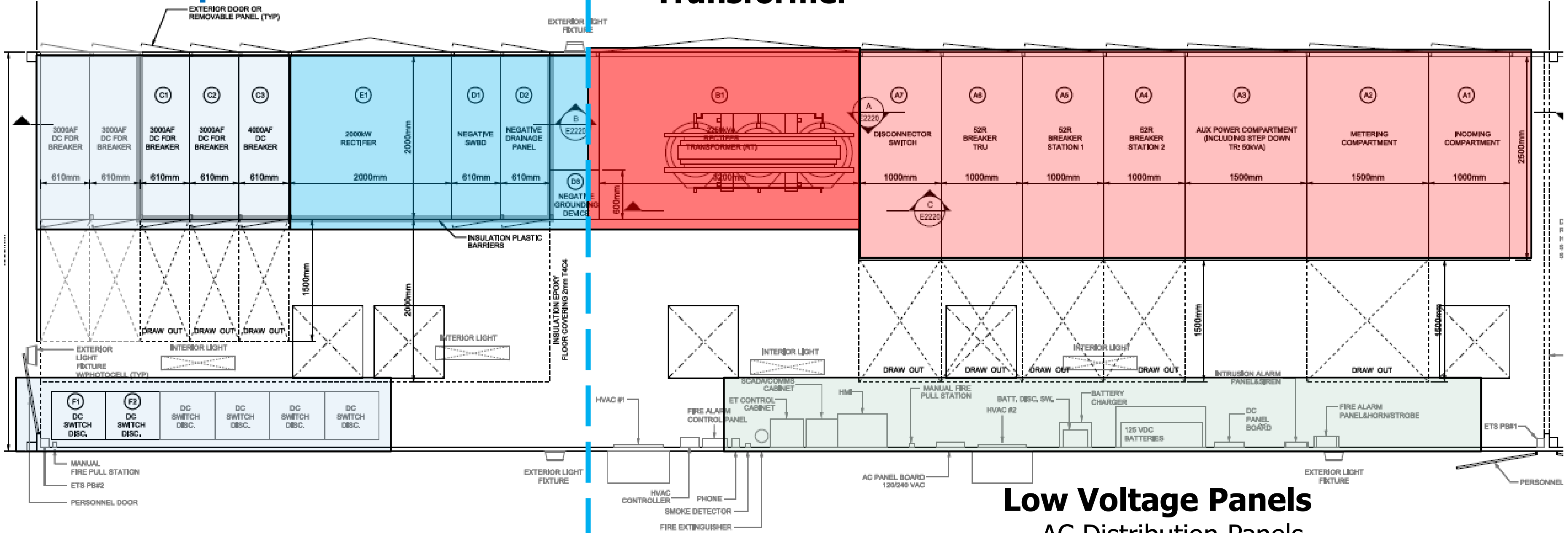
DC Switchgear Line Up

Rectifier & Negative Bus

MV AC Circuits

Rectifier Transformer

MV Switchgear Line Up



DC Disconnect Line and Bypass Switches

Low Voltage Panels

- AC Distribution Panels
- DC Distribution Panels
- Battery Charger/Batteries
- Substation Automation
- Communication Racks

LRT- DC Traction Substation Grounding

DC Equipment

Ungrounded with Ground Fault Monitoring

IEEE std 1653.6

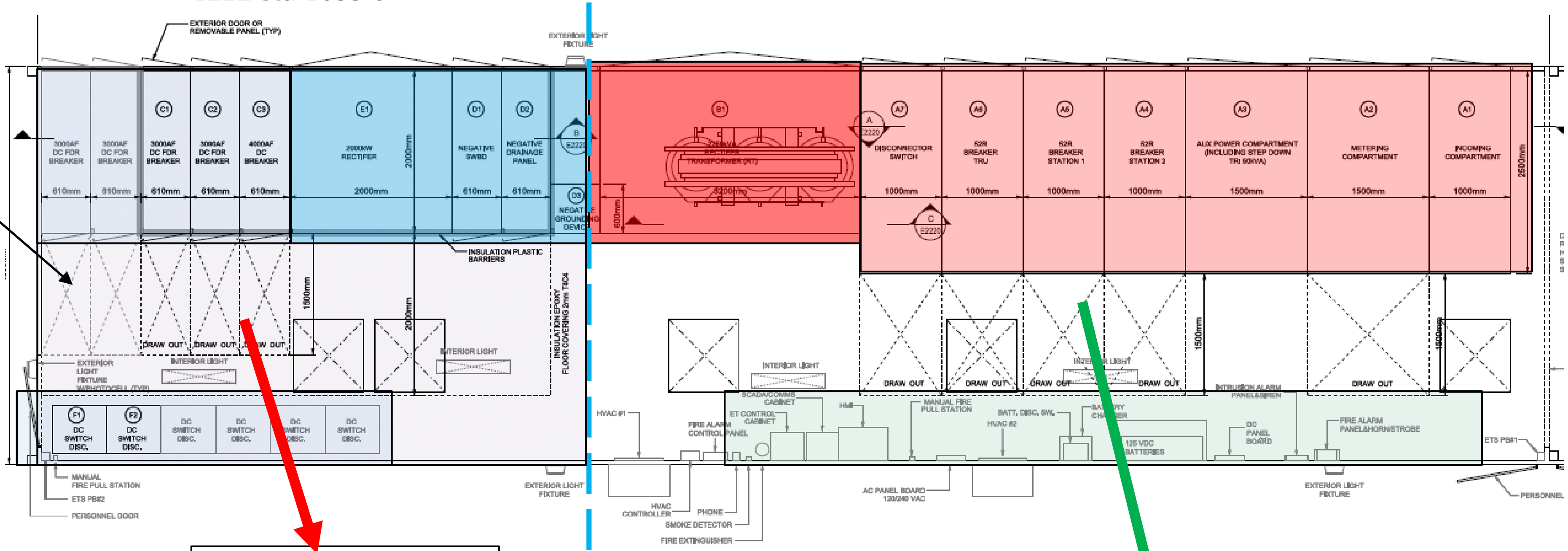
AC Equipment

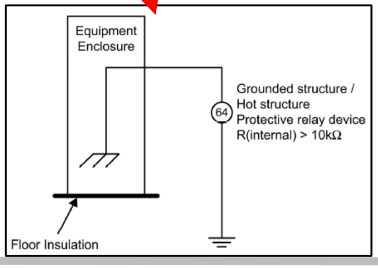
Grounded

IEEE std 142 & 80

Applicable Electrical Codes

DC Equipment enclosures are mounted on insulated epoxy based floors or other insulating materials





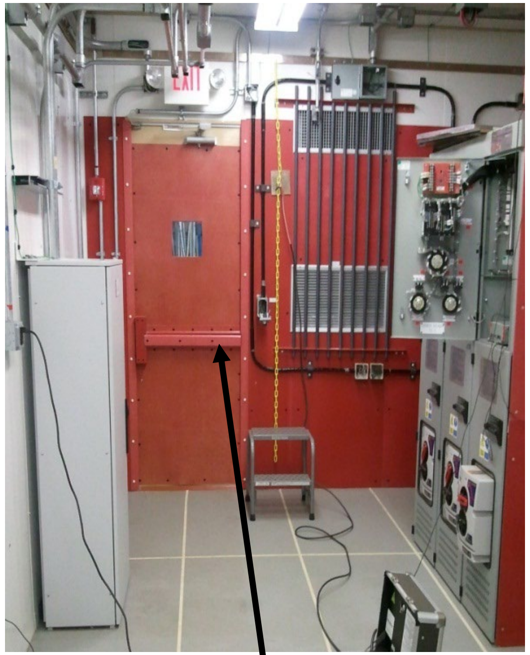
Substation Ground

**High Impedance Ground Fault topology is the preferred

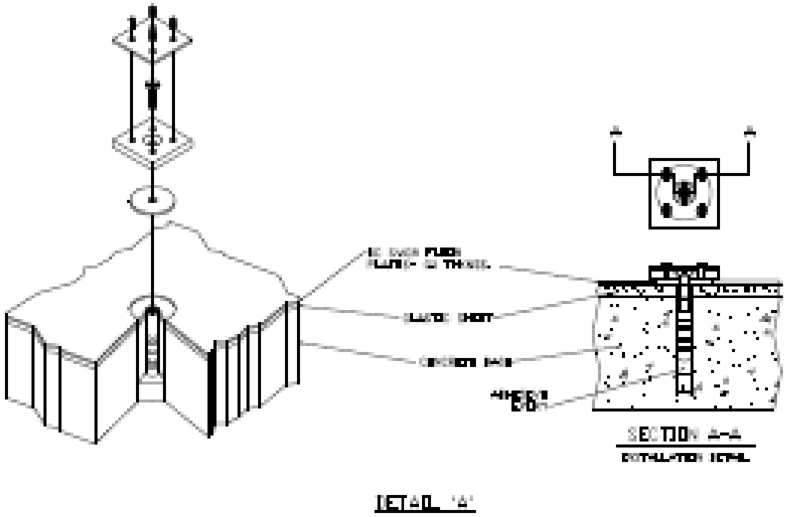
LRT- DC Traction Substation Grounding

Typical Industry Practices

Isolating board (GPO3) between the rectifier (ungrounded) and rectifier transformer (grounded)



If desired clearances can't be achieved isolating boards can be applied to walls, doors etc



Insulated DC Equipment Anchoring System

POWELL Air Insulated MV Switchgear –Most Common Solution

Metalclad Switchgear (IEEE C37.20.2)

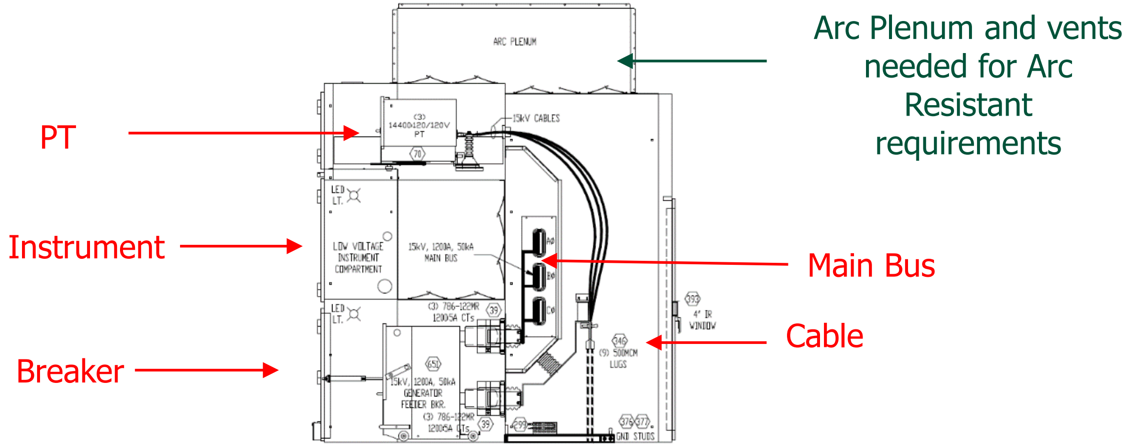
- Applicable to MV Circuit Breaker Sections

Metal Enclosed Switchgear (IEEE C37.20.3)

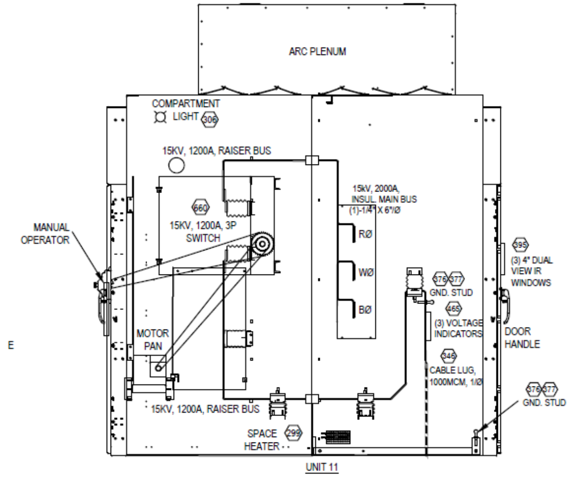
- Applicable to Load Break Switch and Utility Metering sections
  - Enclosure construction: no compartmentalization

Arc Resistant Switchgear Rating (IEEE C37.20.7)

- Type 2: Arc resistant around the entire perimeter (Metal Enclosed and Metalclad)
- Type 2B: Arc resistant around the entire perimeter with instrument door open (Metalclad only)
- Type 2C: : Arc resistant around the entire perimeter and between compartments (Metalclad Only)



Typical AR Metalclad Switchgear Section Side View



Typical AR Metal Enclosed LBS Section Side View

Specifying MV Switchgear

MV Switchgear Rating/Design Drivers

- <u>Voltage Class and BIL Ratings:</u>
  - ➢ *Utility Service Nominal Voltage*
    - ▪ IEEE & CSA C22.2 No. 31-10 standard
    - ▪ IEEE Std ratings: 15kV/95kV-27kV/125kV-38kV/150kV
- <u>Continuous Current Rating</u>
  - ➢ *Typical TPSS Incoming current is ~25-300A*
    - ▪ Main Bus 1200A Typical (min. IEEE std)
    - ▪ Circuit Breaker 1200A Typical (min IEEE std)
    - ▪ 600A typical for Load Break Switches
- <u>Short circuit withstand rating</u>
  - ➢ *Utility Service available fault current*
  - ➢ *Utility specified rating*
  - ➢ *System studies*
    - ▪ Standard Values: <u>16kA, 25kA, 31.5kA</u>, 40kA, 50kA, 63kA

Table 6
Impulse and corona-extinction test voltages for high-voltage switchgear assemblies
(See Clauses 8.2.1.8, 8.2.2.3, 8.5.1.3, 8.5.2, and 8.5.3.)

Voltage rating, kV			
Nominal	Maximum	Impulse test voltage, kV*	Corona-extinction test voltage,kV†‡
1.2	1.3	30	0.9
2.4	2.6	45	1.8
4.16	4.76	60	3.5
7.2	8.25	75	5.5
13.8	15.0	95	10.5
14.4	15.5	110	10.75
18.0	20.0	110	14.0
27.6	29.8	125	19
34.5	38.0	150	26.5

Table 8—Preferred ratings for class S1 circuit breakers for cable systems below 100 kV [a, b]

Line no.	Rated maximum voltage (1) U_r	Rated continuous current (6)	Rated short-circuit and short-time current (I_{sc})	Rated interrupting time (2)	Maximum permissible tripping time delay	Rated closing and latching current (3) (4)
	kV, rms	A, rms	kA, rms	ms	Y, sec	kA, peak
	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
1	4.76	1200, 2000	31.5	50 or 83	2	82
2	4.76	1200, 2000	40	50 or 83	2	104
3	4.76	1200, 2000, 3000, 4000	50	50 or 83	2	130
4	4.76	1200, 2000, 3000, 4000	63	50 or 83	2	164
5	8.25	1200, 2000, 3000	40	50 or 83	2	104
6	15	1200, 2000	20	50 or 83	2	52
7	15	1200, 2000	25	50 or 83	2	65
8	15	1200, 2000	31.5	50 or 83	2	82
9	15	1200, 2000, 3000	40	50 or 83	2	104
10	15	1200, 2000, 3000	50	50 or 83	2	130
11	15	1200, 2000, 3000, 4000	63	50 or 83	2	164

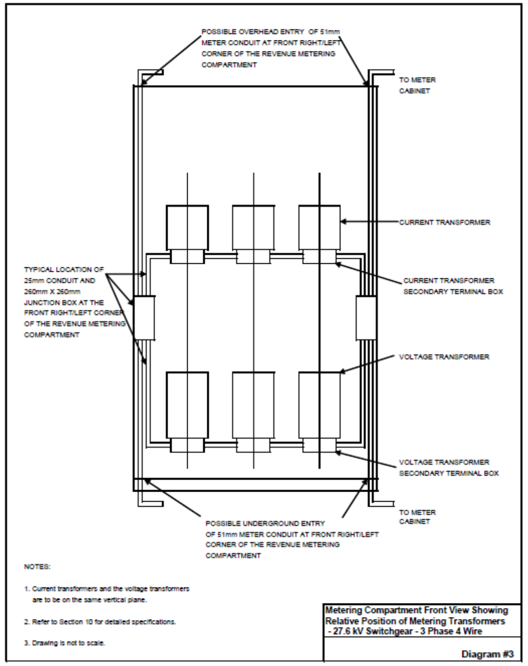
Specifying MV Switchgear

MV Switchgear Rating/Design Drivers

- Non-Arc Resistant or Arc Resistant Switchgear
  - *Transit Authority/Designer Decision*
    - Current trend in Canada is to specify Type 2C Arc Resistant Switchgear
  - *Arc resistant switchgear requires a plenum system to exhaust the gases*
    - Into the substation or outside the substation?
- Incoming Device Selection (Load Break Switch vs Circuit Breaker)
  - *Utility company may have a preference*
  - *Continuous/Fault Current Levels*
  - *Operation and performance preference*
    - Circuit Breaker provides the most operational flexibility and easier to coordinate
- Primary Utility Metering Section
  - *Utility specification is the main driver*
    - Some require a LBS downstream the metering section
  - *Utility supply CTs and PTs*
    - The specs of CTs and PTs drive the design as well

Arc Resistant Switchgear

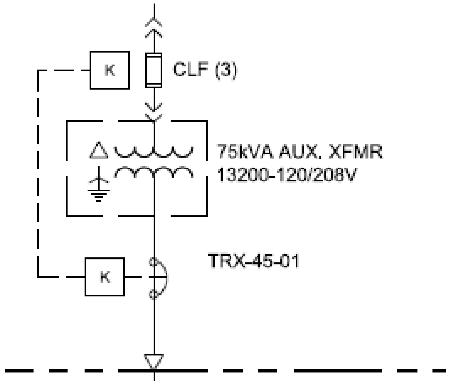
Toronto Hydro 27.6kV Metering Section Diagram



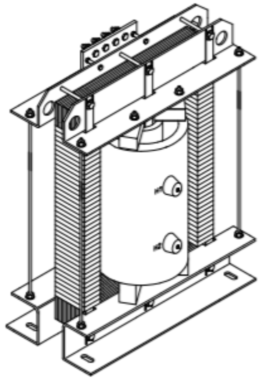
Specifying MV Switchgear- Substation Auxiliary Power

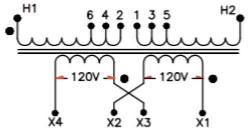
MV Switchgear Rating/Design Drivers

- Auxiliary Power Transformer Sizing is based on substation auxiliary loads
  - HVAC systems, Battery Charger, Lighting, 120Vac outlets, Equipment heaters
  - Typical Auxiliary Transformer sizing ~30-75kVA
- Typical Switchgear solutions
  - Withdrawable fuses + transformer in the same enclosure
  - Fused Load Break Switch + transformer in the same enclosure
  - Separate transformer and Circuit Breaker/Load Break Switch
- Auxiliary Transformers inside the switchgear
  - Dry type (VPI), without enclosure
  - Primary Voltage same as system voltage and BIL rating same as switchgear
  - Low Voltage is dependant of auxiliary loads



Auxiliary Power using withdrawable fuse solution





PRIMARY VOLTS	CONNECT
105%	1 – 2
102.5%	2 – 3
100%	3 – 4
97.5%	4 – 5
92.5%	5 – 6

2 ±2-1/2% PRIMARY TAPS
SUFFIX "B"

Auxiliary Power/CPT Example

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Specifying MV Switchgear- Protection Scheme

MV Switchgear Rating/Design Drivers

- In general, the typical current and voltage protection functions when it comes to circuit breaker sections

- **Special Notes**

  - Differential protection (87) is typically not specified
  - Careful when specifying CT accuracy rating: C100 is typically good enough
    - >C200 CTs get quite large and may require deeper MV section cabinets which leads to more costs and space issues
  - When performing coordination studies, the protection scheme needs to consider for TRU Overload load conditions (Extra Heavy Duty Traction Service)
    - 100% continuous
    - 150% for 2 hours
    - 300% for 1 min
    - 450% for 15 sec

  - Needs to be coordinated with the DC side protection scheme

  - Protection scheme needs to consider Utility system characteristics and upstream protection
    - This information needs to be provided by the Utility for each location

Transformer Rectifier Units (TRU)

- **The TRU is the "heart" of the substation**
  - The rectifier transformer steps down the incoming MV to a low secondary voltage and the rectifier converts it into a usable DC voltage
  - Load flow studies determine the nominal power rating and required overload class as per IEEE1653.2 (ex. Extra Heavy Traction or Heavy Traction)
- **Typical TRU Characteristics**
  - Main Standard: IEEE1653.2
  - TRU Topology: 12 pulse parallel with IPT (ANSI Ckt 31)
  - DC Output Voltage: 750Vdc or 1500Vdc
  - DC output voltage regulation: 4%-6% from 1% to 100% Load
  - Power Factor: ~0.94-0.96 lagging at 100% load (12 pulse)
  - Total TRU efficiency: 98%-98.5%
  - Meets IEEE 519 AC current harmonic limits without filtering

Extra Heavy Traction Overload Class

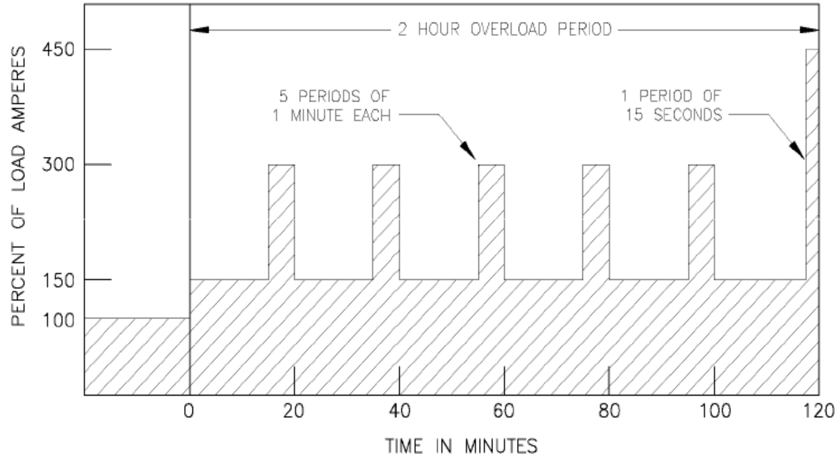
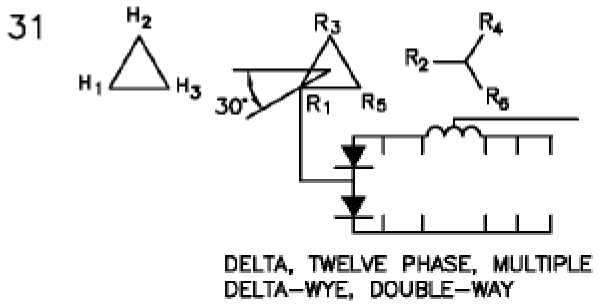


Figure 2—Extra heavy traction service

TRU ANSI Circuit 31



LRT- Rectifier Transformers

- **Dry Type Transformer Families**
  - VPI (Vacuum Pressure Impregnated)- Encapsulated Resin
    - Insulation class up to 220C
    - Typically lower weight and lower cost than Cast Coil
  - Solid Cast (Cast Coil)
    - Insulation class up to 180/185C
    - Cast windings have a higher environmental protection
    - Can withstand higher mechanical forces due to short circuits
    - Primary winding cast coil and secondaries are VPI is a common solution

Cast Coil

VPI

LRT- Rectifier Transformers Standards

➢ Dry Type Transformers Design standards

- IEEE C57.12.01 – Dry Type Transformer General Requirements
- IEEE C57.18.10 – Transformers for Rectifier applications
- IEEE C57.12.91 – Dry Type Transformer Test Code
- IEEE 1653.1 - Traction power application
- CSA -C88-M90 applicable sections to rectifier applications

Cast Coil

Notes:

➢ Typically traction power rectifier transformers are not required to meet energy/efficiency transformer standards.

➢ If CSA approvals are required, expect field inspection test reports

VPI

Rectifier Transformers Specifications

- **Dry Type Class- Cast Coil and/or VPI**
  - It is the specifier's choice or it could be open to all dry types
- **kVA Rating**
  - Usually, determined by TPSS integrator/Rectifier vendor
  - For a 12 pulse system: ~5% more than nominal TRU kW rating
- **Cooling**
  - Natural Convection (AA class) is the preferred rating
  - Natural Convection with Future Forced cooling (AA/FFA) is also common
    - Force cooling can increase kVA rating by ~30%
- **Primary Voltage Rating**
  - Nominal voltage same as incoming voltage
  - BIL rating should be the same as the MV switchgear rating
- **Transformer impedances and secondary voltages**
  - Determined by TPSS Integrator/Rectifier vendor
  - Typical impedance values: 8%-13%
  - Typical secondary voltages: ~583Vrms for 750Vdc and ~1167Vrms for 1500Vdc

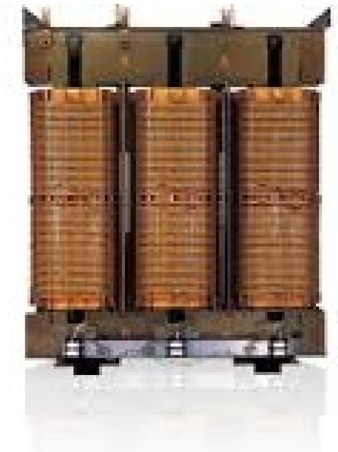
Cast Coil

VPI

Rectifier Transformers Specifications

- **Winding Material/Conductor**
  - Copper or Aluminum are available
  - Copper is the preferred conductor in the US
  - Aluminum is often used in Canada and it can present ~20% cost savings
  - If copper is the desired material, clearly specify it with mention that Aluminum windings are not acceptable.
- **Audible Noise Rating**
  - IEEE standards specifies the standard audible noise levels based on power ratings (~65dB-68dB at 1m)
  - If lower audible noise levels are required, be aware that it will increase transformer weight, dimensions and costs
- **Temperature Rise Ratings- ~30 years life expectancy**
  - For Cast Coil transformer with 180C insulation class
    - 115C after overloads
  - For VPI Transformers with 220C insulation class
    - 150C after overloads

Cast Coil



VPI

Rectifier Transformers Specifications

➢ Efficiency and Losses
- Typical efficiency is ~99% at 100% Load (No Load + Winding/load losses)

➢ Other Transformer Items to Consider
- 2-stage Temperature monitor (49A and 49T)
- Electrostatic shield (in between primary and secondaries) to reduce common mode "noise"
- Door switches
- Differential protection 87T (very rare but available)

➢ Testing
- IEEE standards define the routine standards and type design tests
- Typical Type Tests are performed on one unit of each design:
  - Temperature test
  - Audible noise (done at full voltage/ No load as per IEEE test code)
  - BIL
  - Short Circuit Testing needs to be clearly specified


Cast Coil

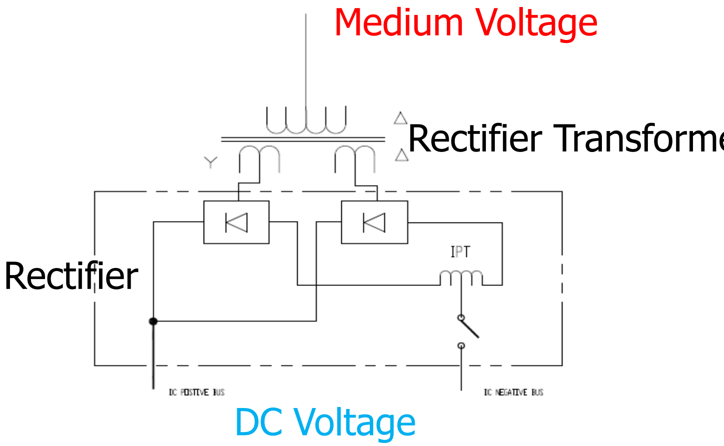

VPI

LRT- Traction Diode Rectifiers

- **Traction Diode Rectifiers Design Standard**
  - IEEE 1653.2 standard for Uncontrolled Traction Power Rectifiers up to 1500V
- **Diode based Rectifiers is the preferred technology**
  - Most reliable, very robust, very efficient and low cost
- **Traction Diode Rectifiers General Characteristics**
  - 12 Pulse Parallel Rectifiers with IPT (ANSI Ckt 31) preferred
    - Constructed using two 3 phase diode bridges operating in parallel
    - Diode legs usually consists of multiple diodes operating in parallel to meet the required nominal and overload currents
  - Indoor rated
  - Cooling is always natural convection
  - Bus bars are always copper with tin or silver plating

LRT- Traction Diode Rectifiers- Specification

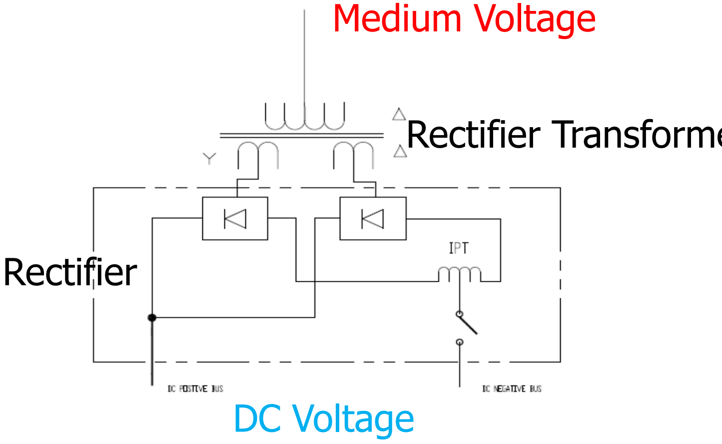
- **Rectifier Output Voltage**
  - The same as the desired System DC output Voltage
- **Rectifier Nominal Power and Overload Rating**
  - Same as TRU requirements
- **DC Short Circuit Value and Withstand Duration**
  - Rectifiers are required to operate during DC short circuit conditions without any damage to allow protections to operate
  - Short circuit withstand duration should be less <200ms
    - 200ms is enough time to trip protections
    - More than 200ms, rectifier designers will need to increase fuse sizing and costs for no real useful reason.
- **Efficiency**
  - Typical Diode Rectifier efficiencies >99.3%
- **Diode Peak Inverse Voltage Rating**
  - 2.5 times the peak/crest of the secondary AC voltage
    - Margin allowing rectifier to withstand surges/spikes that occur in the system



Typical TRU ANSI Ckt 31

LRT- Traction Diode Rectifiers- Specification

- **Full performance with one blown diode per leg (N-1 Redundancy)**
  - 12 pulse rectifiers require a minimum of 24 diodes to meet this criteria
  - Each diode requires a fuse in series to “knock out” the blown diode
  - Rectifier must be able to monitor for 2 stage diode failures (98A and 98T)
- **Current balancing between paralleled diodes**
  - This requirement is to reduce the risk of a diode thermal issues
  - Not more than 120% of its proportionate share
- **2- Stage Diode Temperature Monitoring (26R1 and 26R2)**
  - Typically the top diode assemblies are monitored using thermal switches
  - If all diodes need to be monitored, it needs to be clearly specified
- **Surge Protection (99)**
  - Diode leg surge protection either RC snubbers or MOVs
  - Phase and DC Output surge protection usually with MOVs but some vendors use RC filtering as well
  - Surge protection circuits are monitored by having fuses in series with surge protection devices



Typical TRU ANSI Ckt 31

LRT- Traction Diode Rectifiers- Specification

Ground Fault Relay (64)

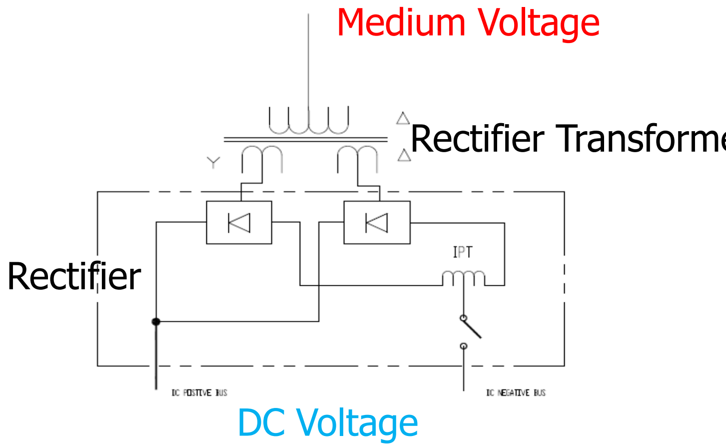
- Rectifier enclosures are always isolated from substation ground and therefore a ground fault relay is used to detect
  - Hot structure/Enclosure is energized (64)
    - This condition causes a substation trip
  - Grounded structure (64G) meaning rectifier enclosure is grounded
    - This condition typically causes an alarm

Negative Disconnect Switch (89N)

- Typically located in the rectifiers and also provides running rail cable connection point
- The rating of the Negative Disconnect Switch should be the same as the DC Main Cathode Breaker
- The switch can be manually operated or motorized for remote operation (designer's choice)
- The switch comes with auxiliary contacts to monitor the state of the switch (open/close)

<u>Note</u>

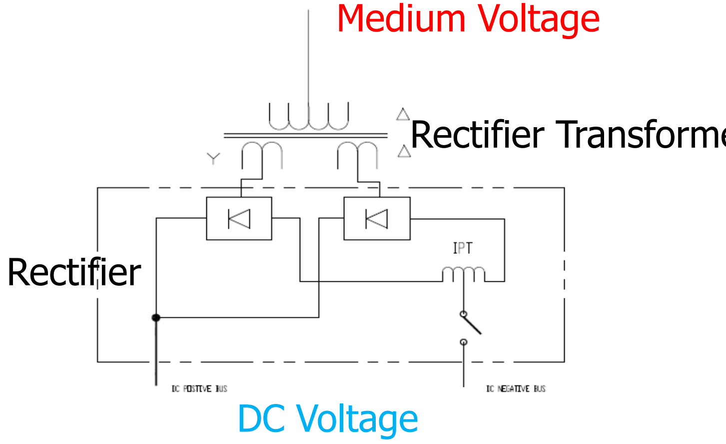
- If needed, the Negative Disconnect Switch and/or Negative Bus can be located in a separate cabinet



Typical TRU ANSI Ckt 31

LRT- Traction Diode Rectifiers- Specification

- **Testing**
  - IEEE 1653.2 defines the routine and design tests
  - Typically the combined TRU 3rd party lab tests covers all the required rectifier design tests
    - Often required because TRUs are typically custom designed for the project and it's the only way to test the overall TRU performance (regulation, harmonics, efficiencies etc)
    - To avoid potential issues:
      - Make the testing mandatory OR
      - Accept previous tests only if exact same design AND same manufacturers



Typical TRU ANSI Ckt 31

- **CSA approval**
  - **CSA approval is always obtained through special field inspection either at vendors factory or at site.**

POWELL LRT- Traction DC Switchgear

- **DC Switchgear and Breaker Design Standards**
  - IEEE C37.20.1 relates to the DC Switchgear
  - IEEE C37.14 and IEEE C37.16 relates to the DC Breakers
- **DC Switchgear and Breakers for Traction Application**
  - Single pole – bi-directional current flow and interruption capablities
  - Breakers are withdrawable and roll out directly on the floor
  - Breakers require arc chutes to extinguish the arc generated when opening the breaker under current (due to inductive load and DC current)
  - Typical LRT current ratings are 2kA, 4kA, 6kA
  - The breakers are high speed breaker class
    - Higher short circuit current interruption capabilities
    - 120kA/200kApk@800Vdc & 60kA/100kApk@1600Vdc
  - Breakers have an adjustable direct acting trip function
    - Breakers can trip themselves on high currents extremely fast without any external devices
  - DC Traction Protection relays have specialized protection functions
  - The switchgear itself is similar to a metalclad switchgear
    - Always air insulated
    - Control compartment, breaker compartment, main bus/cable compartment
    - Exhaust vent to allow exhausting of arcing "gases" from the arc chute
    - Breakers can be in Connected, Test and Disconnected positions
    - Shutters

DC Switchgear Line Up

DC Breaker

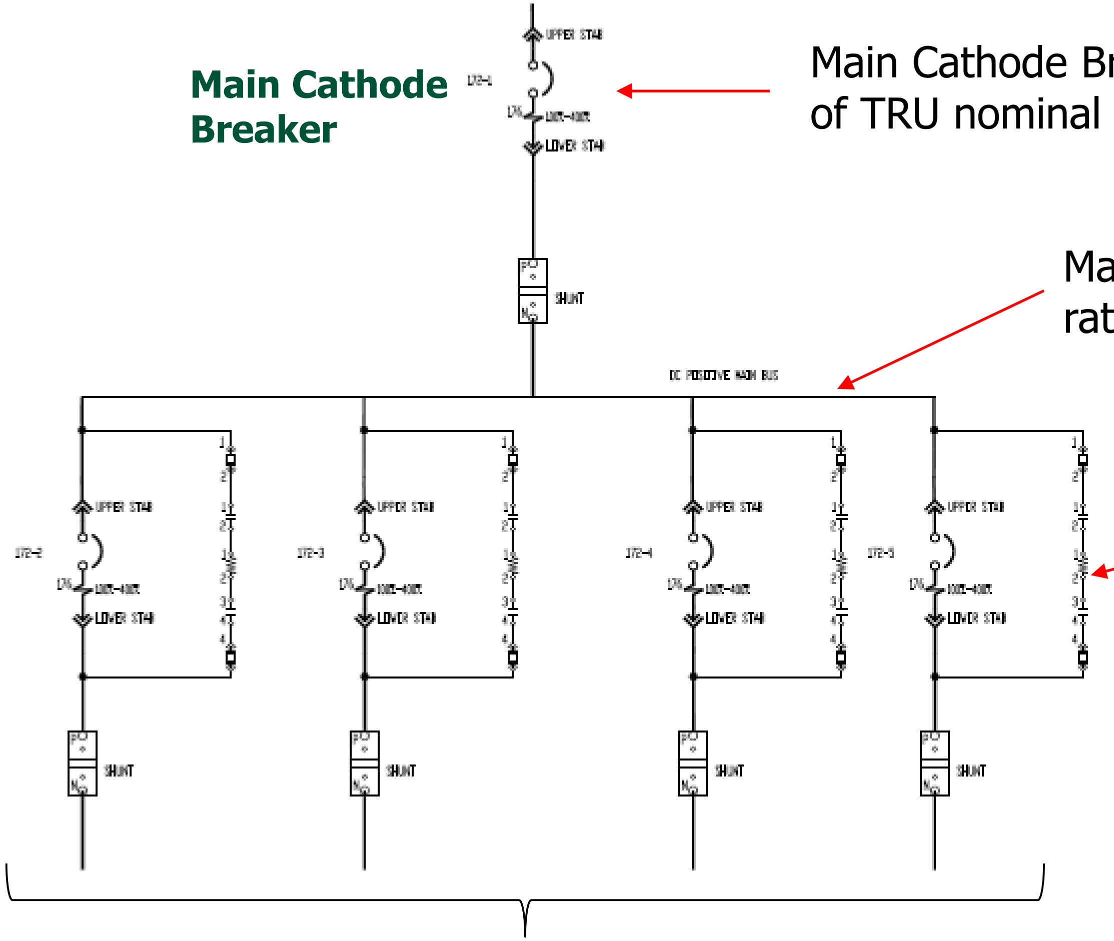
LRT- DC Switchgear Current Ratings/Sizing

From Rectifier (+)

Main Cathode Breaker

Main Cathode Breaker Continuous current rating is typically 150% of TRU nominal DC current (= 2hr @ 150% load requirement)

Main Bus Continuous Current rating typically same current rating as Main Cathode Breaker



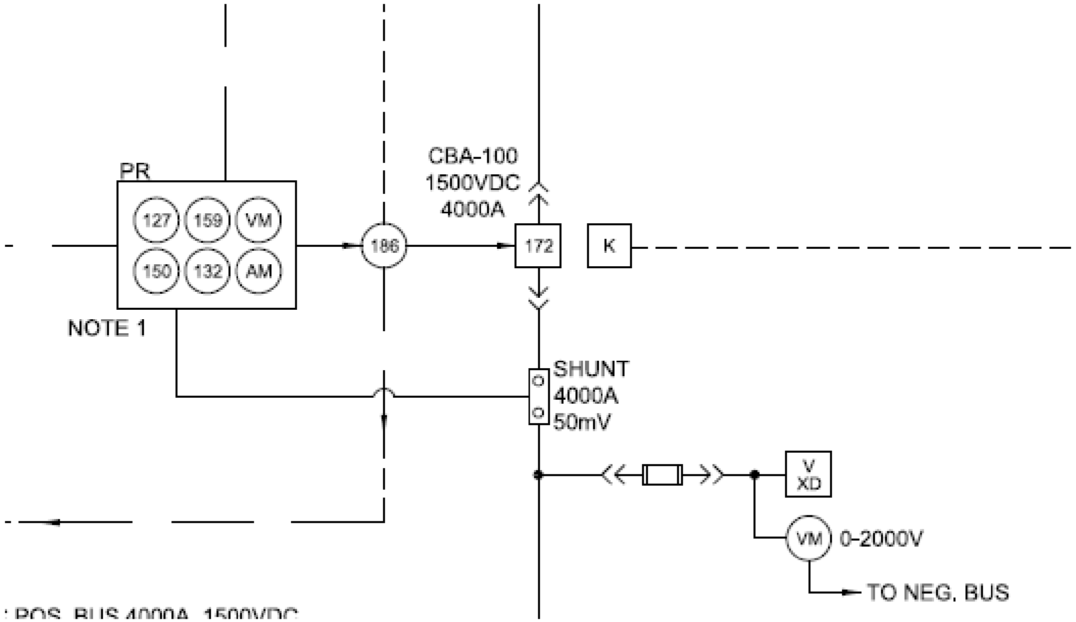
Feeder Breakers

Feeder Breaker Current rating determined by load flows but typically it's one rating below Main Breaker

To OCS

LRT- DC Switchgear Protection Functions

Main Cathode Breaker

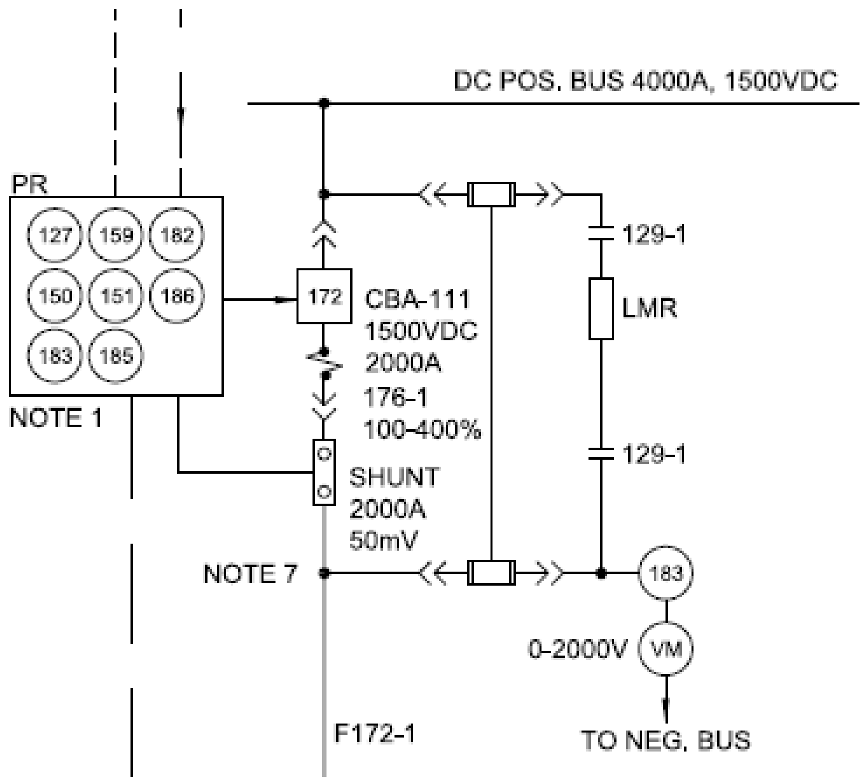


Protection Functions

- Under/Over Voltage (27,59)
- **Reverse Current (32)**
- Overcurrent protection (50/51)
- Lockout (86)
- DC Switchgear Ground Fault (64)
- Direct Tripping (at breaker)
- Interlocking with negative disconnect switch (mechanical and/or electrical) and Rectifier Transformer breaker

LRT- DC Switchgear Protection Functions

Feeder Breaker



Protection Functions

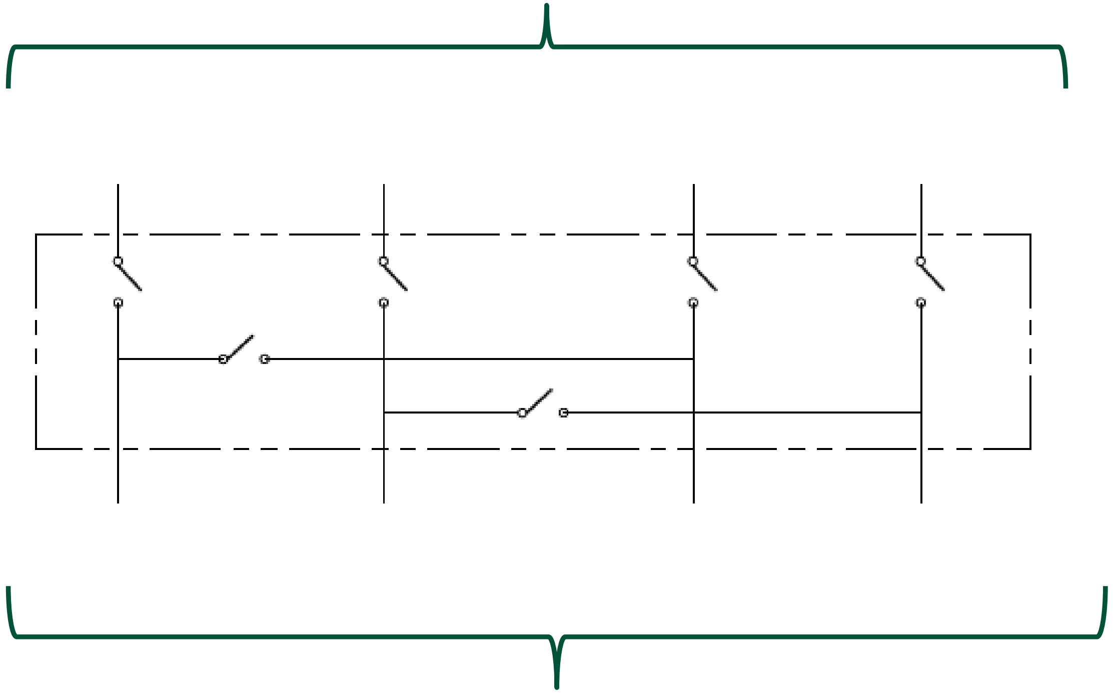
- Under/Over Voltage (27,59)
- Auto Reclose (82/83)
- Overcurrent protection (50/51)
    - **Cable/OCS Thermal Overcurrent**
- Lockout (86)
- **Line Test/Load Measuring**
- **Rate of Rise (dI/dt)**
- **Transfer Tripping of adjacent substations (85)**
- Direct Tripping (at breaker)

LRT- DC Switchgear Testing

- **Testing**
  - Routine testing program is driven by the standards
  - Design Testing
    - IEEE standards clearly define the required design test program
    - Most manufacturers have existing IEEE design test reports/certificates for the breakers and the switchgear.
- **CSA Approval**
  - Currently there are no CSA certified traction power DC breakers and/or DC switchgear
  - The solution applied is a CSA special field inspection

LRT- DC Disconnect Switches

From DC Feeder Breakers

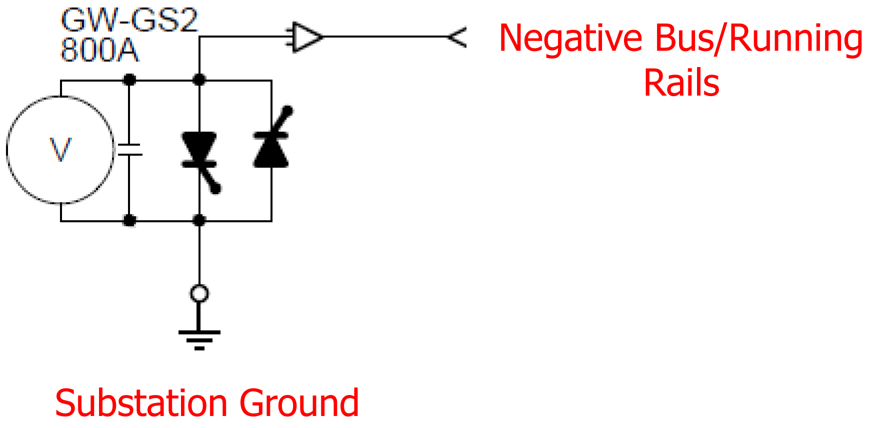


To OCS

- DC Disconnect switches are typically single pole/single throw No Load switches
  - Interlocking with feeder breakers is required to avoid opening the switches under load
- Motorized or manually operated
- Short circuit withstand typically >50kA@100ms
- The continuous current rating is normally equal to feeder breaker current rating
- Can be located outdoor or inside the substation
- Available in metallic and non-metallic enclosures

LRT- Negative Grounding Devices (NGD/VLD/RGS)

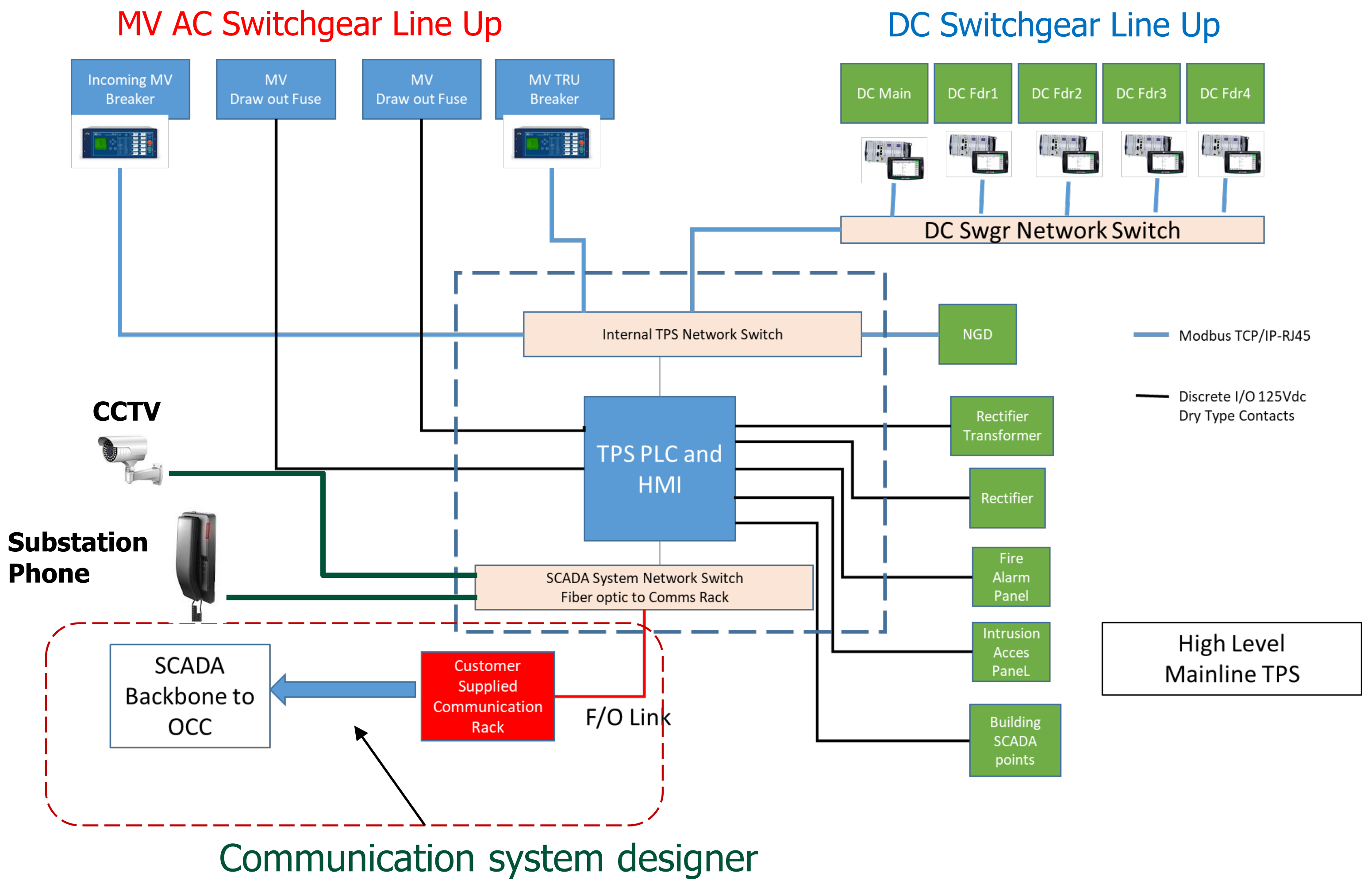
The purpose of the device is to assure that no dangerous potential/voltage occurs between the Negative bus/running rails and ground by temporarily shorting the negative to ground if voltage exceeds thresholds/limits



- Reference standards
  - EN50122-1 safety limits
  - EN50526-2 Functionality and device classes
- Installed in all substations but can also be installed at passenger stations
- Typical ratings 1kA continuous and >35kA short circuit withstand capacity
- Manufacturers have their standard designs and controls that work well
  - Consult the manufacturers and avoid requesting non-standard functionality or ratings

POWELL LRT- TPSS Substation Automation System Overview

Typical TPSS Substation Automation System Architecture



- Collects TPS operational information from all of key substation equipment and transmits it to the Operations Control Center
  - Remote Opening/Closing of breakers
- Automation System typically PLC/HMI solution
- I/Os can be hardwired or via communication "channels"
- AC protection relays have Modbus, DNP3, IEC61850 capabilities BUT not all DC protection relays have IEC61850 and/or DNP3 capabilities but all have Modbus.
- Other Devices sometimes found in substations
  - CCTV Cameras
  - Substation Phone

POWELL LRT- TPSS Substation Automation System Overview

Practical Notes

- Typically SCADA/Comms system inside a TPS prefab building is for **TPS signals only**
  - **If other signal type comm equipment are need to be in the Prefab TPSS**
    - **installed in a dedicated room with a fire rated wall** in between the TPS equipment room and the signals room
  - The equipment required in the room will need to provided by others BUT the TPSS vendor can integrate it or provide the rough ins for field integration.

- TPSS PLC/HMI system manages substation signals only
  - CCTV Cameras and phone(s) can be provided by vendors but typically operate on a separate network and the network devices are provided by the communications designers
  - Same applies if there is a separate network for fire alarm and Access control

- If an RTU needs to be added, the RTU is typically provided by the SCADA/Communications vendors BUT can be integrated by the TPSS vendors or field integrated

LRT- TPSS Substation Automation System Overview

Practical Notes

- The PLC/HMI requirements should be more performance based
  - Provide functional description or logic diagrams
  - If specific equipment is needed, specify the model numbers and manufacturers
  - Provide desired SCADA Point List Table either in specs or in drawings
- When specifying communication protocols specify open protocols and allow for multiple protocol options for the internal TPS network
- Current practice of substation critical interlocking and safety function schemes are hardwired
- Inter substation transfer trip schemes are typically done as a separate system
  - Feeder to Feeder connection scheme
  - Separate Fiber Optic or "pilot wire" connection
  - Main purpose is for speed and reliability

LRT- Prefabricated Buildings/Power Control Rooms

Preferred LRT DC Traction Substation Solution

- Reduces overall project engineering and procurement costs
- Lower installation Costs and Shorter Installation Time
- Packaged construction reduces space requirements
- Fully tested and inspected prior to shipment
  - Reduces field testing time
  - Allows to “iron out” the bugs before going to field
- >30 years life expectancy

POWELL LRT- Prefabricated Buildings/Power Control Rooms

Power Control Rooms Overview

- They are weather proof and "walk in" type enclosures
- Welded Structural Steel Base, Framework and Floor
- Interlocking wall, roof and ceiling panels and includes the thermal insulation
  - Fire Rated walls are available but needs to be specified
- Equipment and Personnel Doors
- Internal ground bus and external ground pads
- Cable trays, wire ways and internal cables/wires
  - Technical floors is not a common practice
- HVAC, Lighting, Fire Alarm, Intrusion Alarm, AC/DC distribution panel etc
- Custom engineered solution to meet the project requirements as well as applicable codes (NBC, Electrical Codes, etc)
- Buildings get CSA approval through special inspection
- Vendors can provide certified structural, seismic and HVAC calculations and can support in obtaining City Permits

POWELL

How Powell can help

- **DC Traction Power Substation Design Services**

- **Provide preliminary designs/solutions as well as budgetary pricing**

  - New substations/projects
  - Replacing existing equipment
  - Complex/challenging projects

- **Support on developing project/equipment specifications**

  - Providing comments on existing specifications
  - Providing equipment design guidelines to help create specifications

- **Product/Solution presentations and demos**
  - General overviews or on a specific subject (ex. Intelligent Sensor solutions, DC breaker etc)

Want to know more?

Any Questions?

Any problems we can help you with?

Fernando Soares, B.Eng

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Powered by Safety

Fernando has been serving the Rail Industry for over 20 years and has exercised different roles such as design engineering, proposals, sales and now as Powell's Traction Power North America Sales Lead

Please feel free to contact Fernando for your Traction Power inquiries