



# Regulator Components

# Internal Components

- Main Coil
- Main Core
- Reactor
- Potential Transformer (PT)
- On Load Tap Changer (OLTC)
- Internal Series Arrester (Zenox)
- Current Transformer (CT)
- Main Clamp Assembly
- Internal Assembly



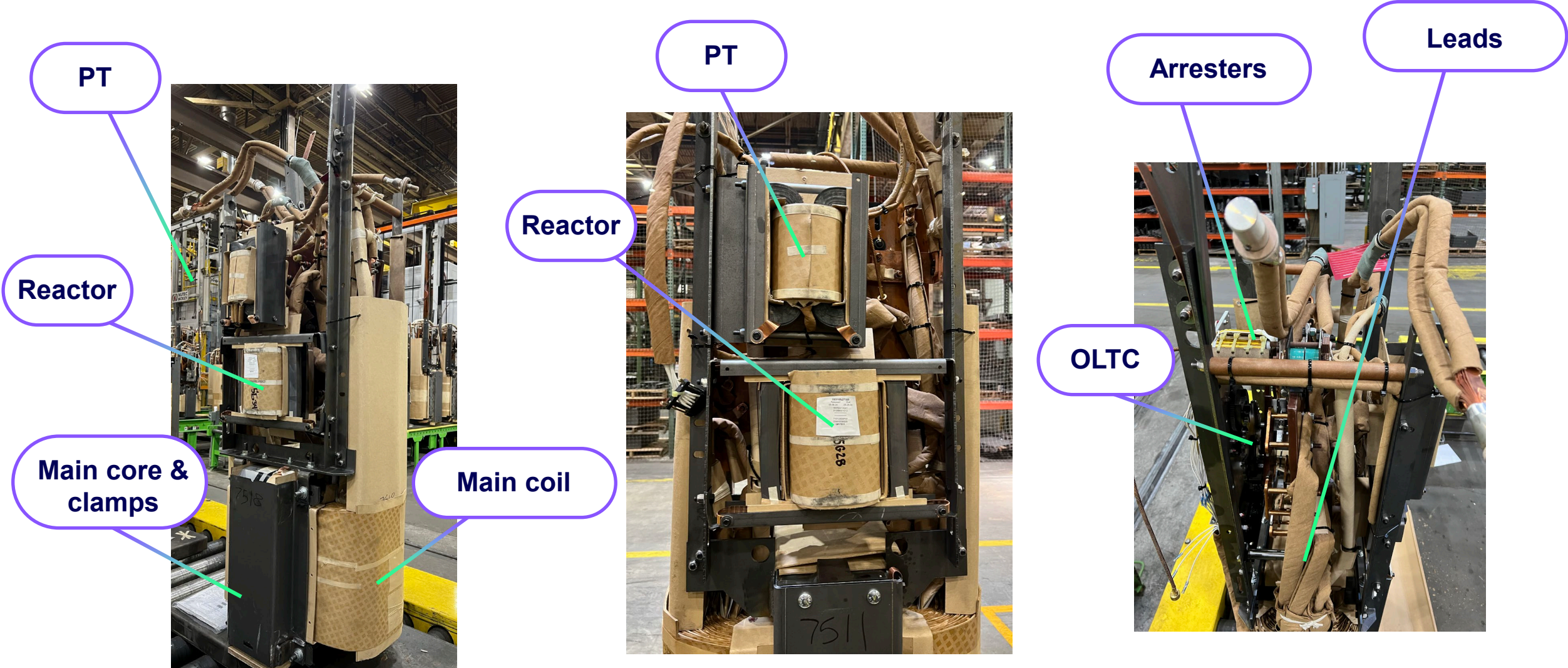
# Regulator Components

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- Current Transformer (CT)
- Main Clamp Assembly
- Internal Assembly

# Internal Components Overview





## Regulator Components

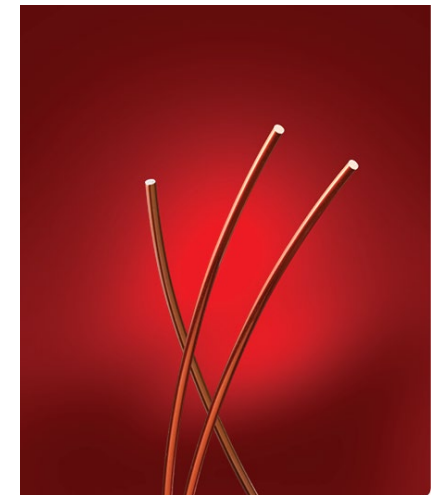
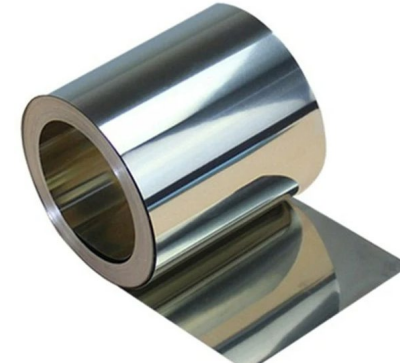
- Internal Components
- Main Coil

**Rectangular shape with layered windings, and contains:**

- **Exciting winding**, normally made by wire.
- **Series winding**, normally made by strip/foil.
- **Equalizer**, normally made by strip/foil.
- **Utility winding** (potential winding), made by wire.
- **Coil leads.**
- **Cooling ducts** and **insulation** (TUK DPP, pressboard, crepe tubes).
- **Aluminum** or **copper** are used for the conductive elements.
- The arrangement of the windings can be done in different ways:
  - Primary-Secondary (**PS**).
  - Primary-Secondary-Primary (**PSP**).



# Main Coil – Conductor Types



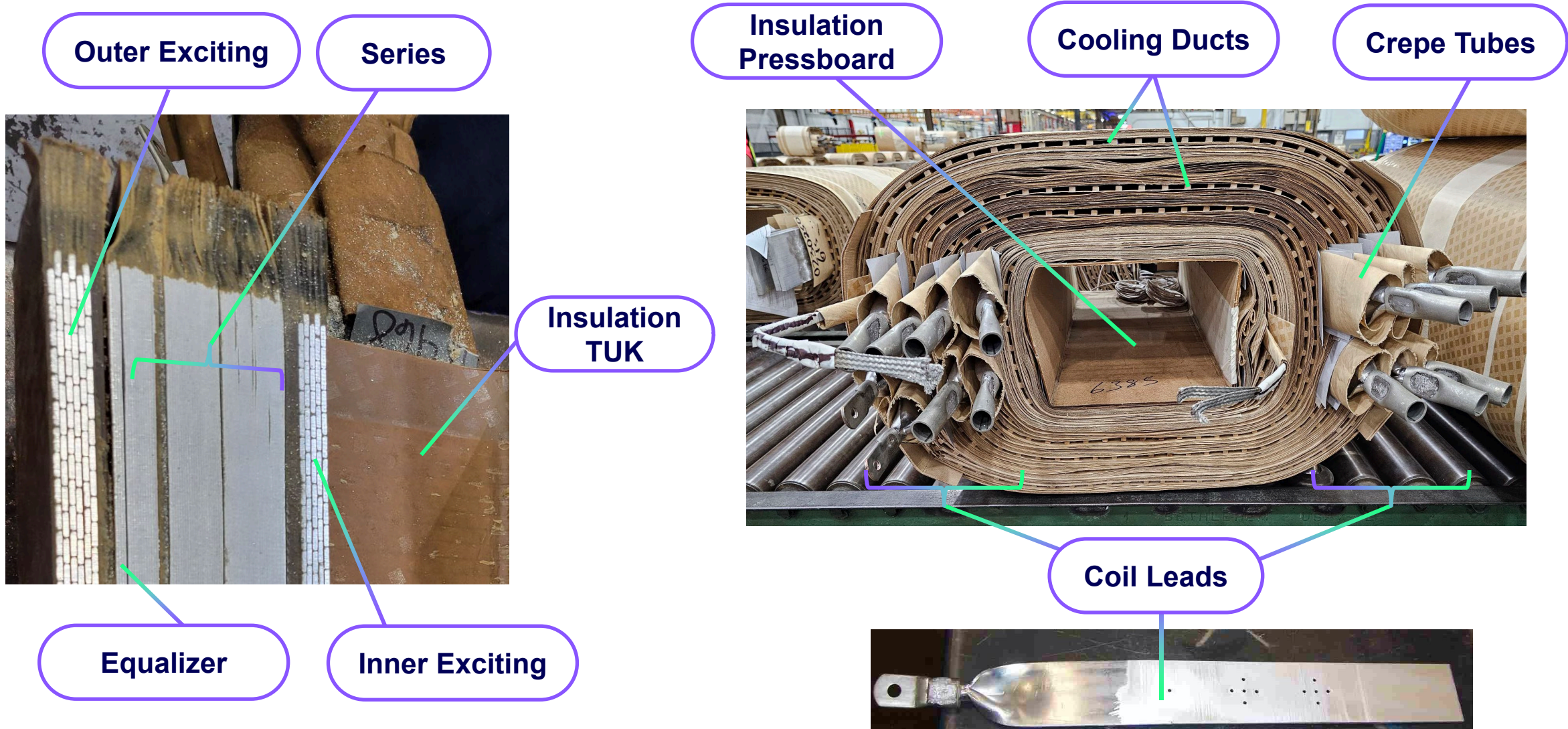
Type	Shaped/Rectangular Wire	Shaped/Rectangular Wire	Strip	Strip	Round
Metal	Copper	Aluminum	Copper	Aluminum	Copper
Insulation	Polyvinyl Formal / Formvar	Poly Phenyl Sulfone	Bare	Bare	Polyvinyl Formal / Formvar
Used in	High voltage winding (NET) Exiting winding (VR)		Low voltage winding (NET) Series winding (VR)		Potential Transformer (PT)





Name	Diamond Dotted Paper	Pressboard	Ducts	Crepe tube
Description	Thermally-Upgraded Paper covered with diamonds of epoxy	High density board	Composition of sticks of pressboard glued to DDP	Insulation tubes made by corrugated paper
Characteristics	- Thickness (5, 10 & 15 mils) - Width/Length	-Thickness (0.062", 0.094", 0.125", etc.)	-Thickness of the stick (0.125", 0.188", 0.25", etc.)	- Internal diameters (0.25", 0.5", 0.75", etc.)
Used as	-Interlayer insulation, lead protection and pad	-Form, end strip, shield, and filler	-Cooling ducts and insulation	- Lead insulation

# Main Coil Components



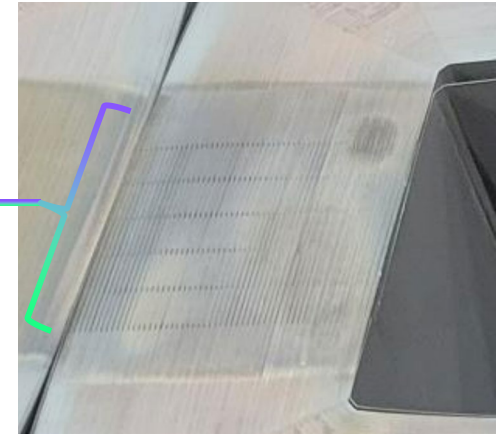


Main Core

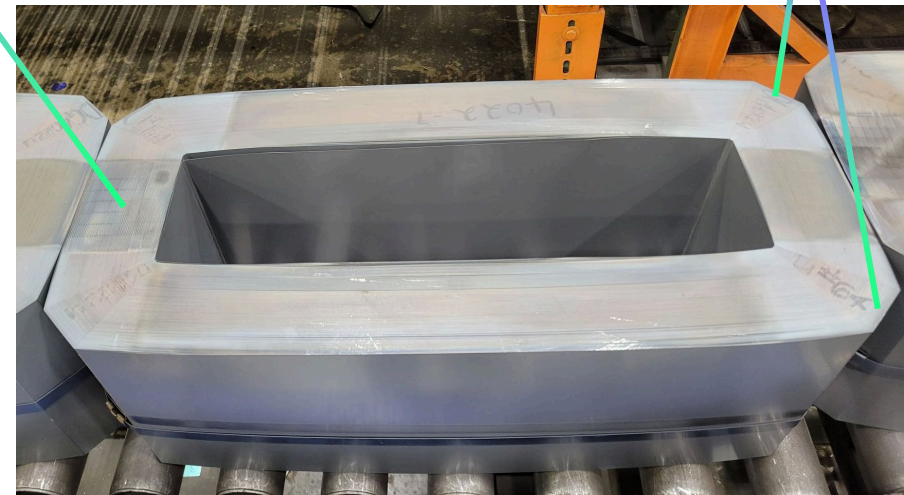
- Wound type
- Laminated material
- Distributed gaps
- Unicore core type
- Made by high efficiency silicon steel
- Two loops are use in a shell type arrangement



**Distributed Gaps**



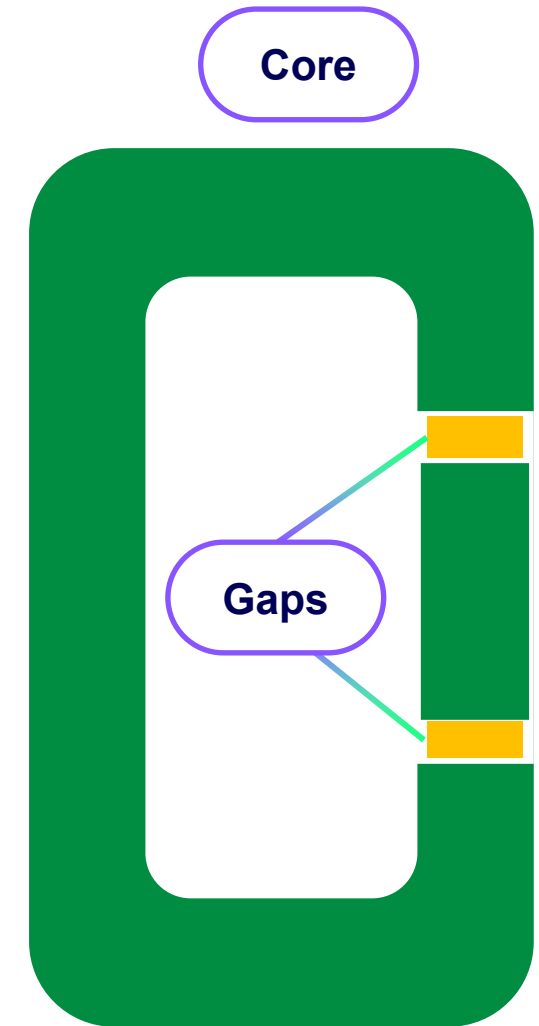
**Unicore Type**



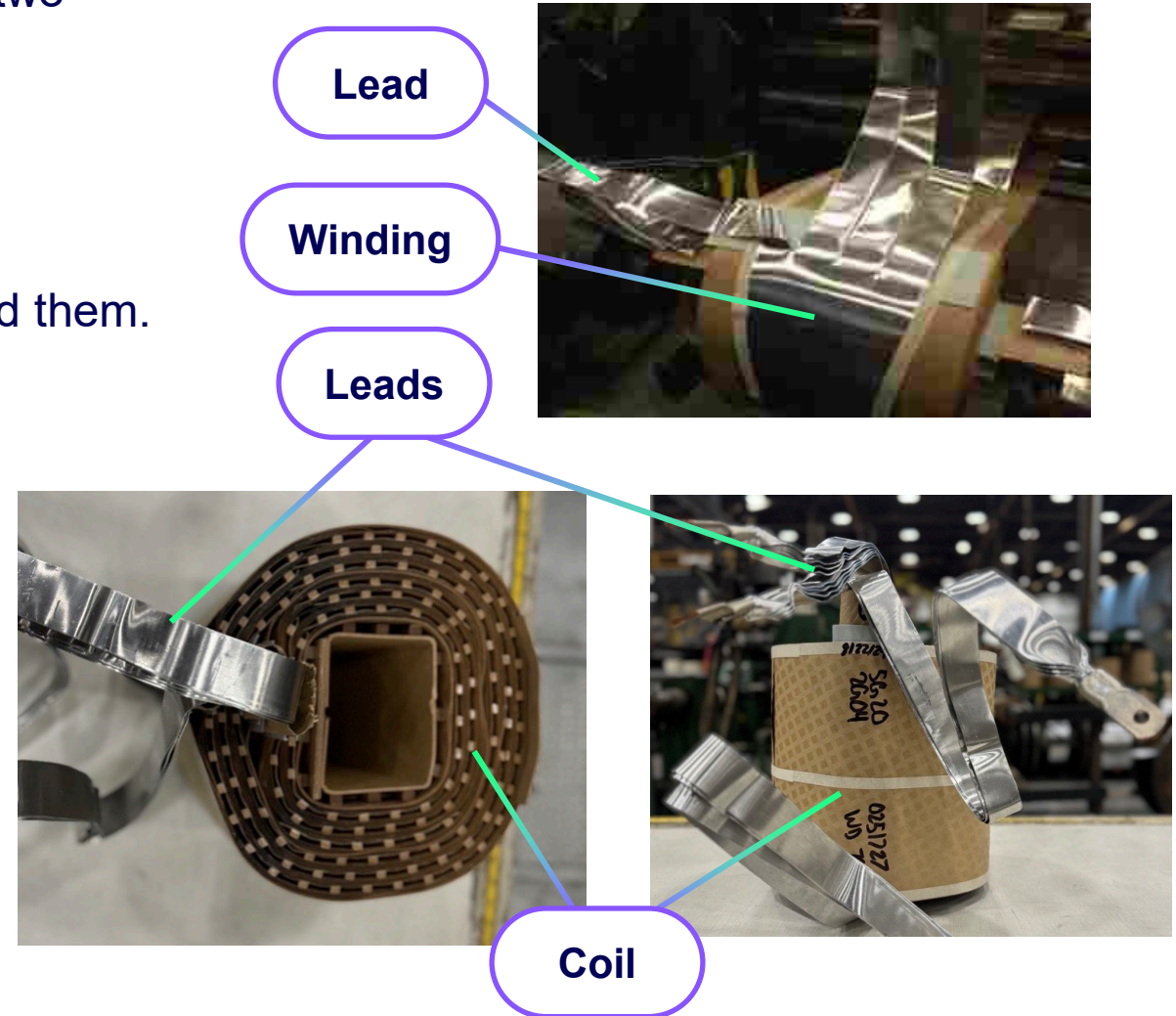
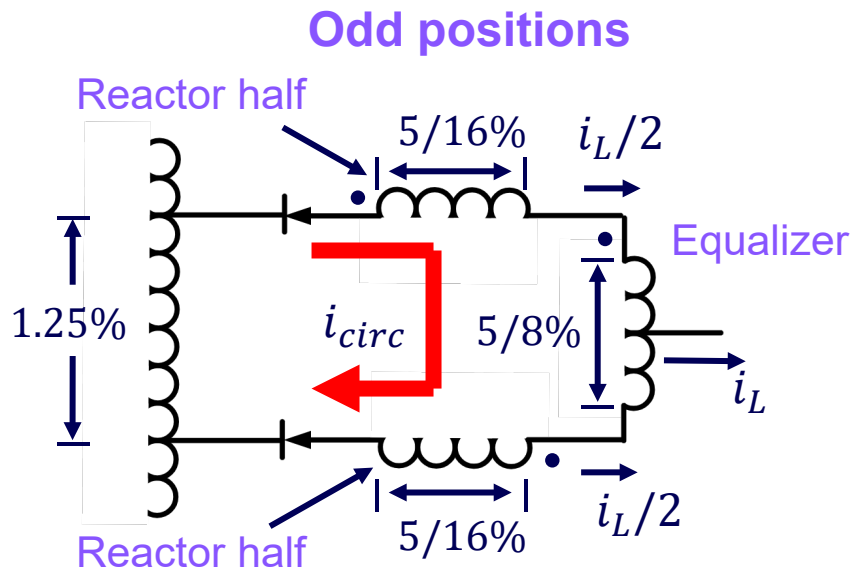


# Reactor Assembly

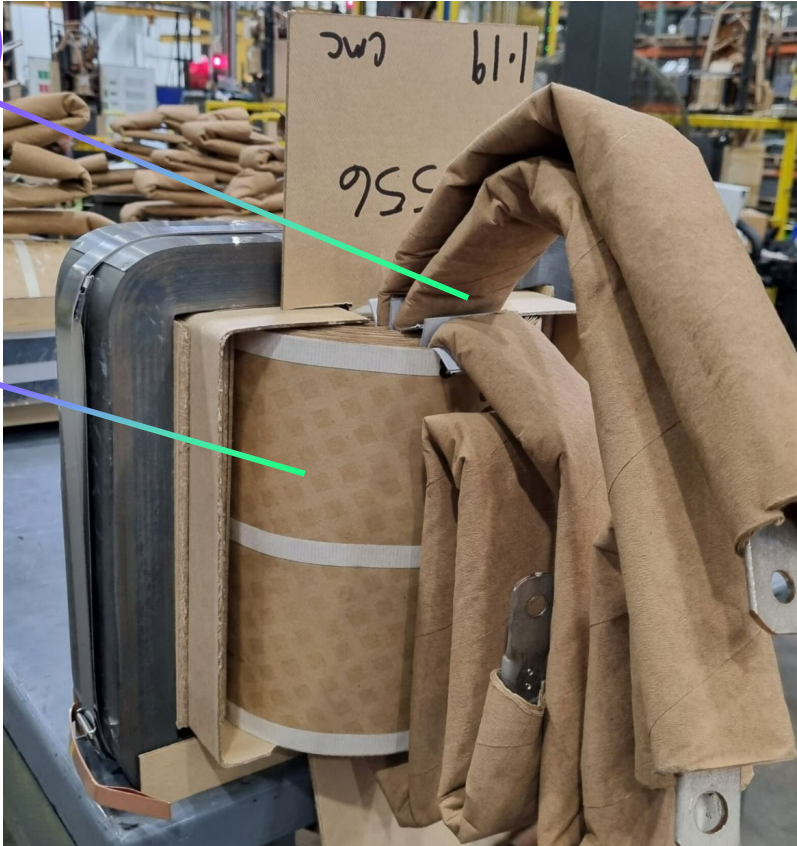
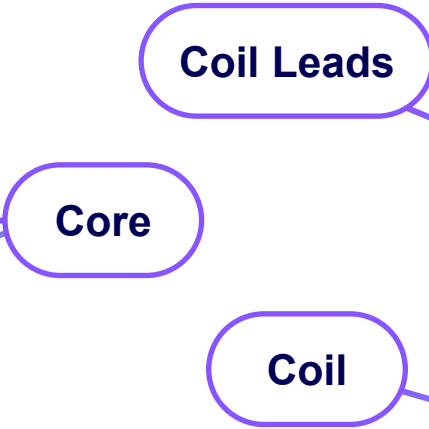
- Wound tranco core type
- 2 pieces with 2 air-gaps
- Gaps in the core generate a **reactive impedance**
- The reactive impedance will **limit the circulating current** that is generated when the OLTC is at bridging positions
- Two loops are used in a shell type arrangement.



- The reactor coil is made by a winding that is split into two sections.
- Each section will carry the half of the load current.
- The windings are made of strip/foil.
- Leads are made by cutting the strip in pieces and bend them.



# Core & Coil Assembly





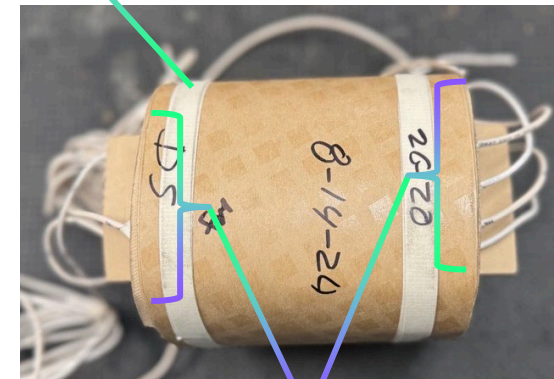
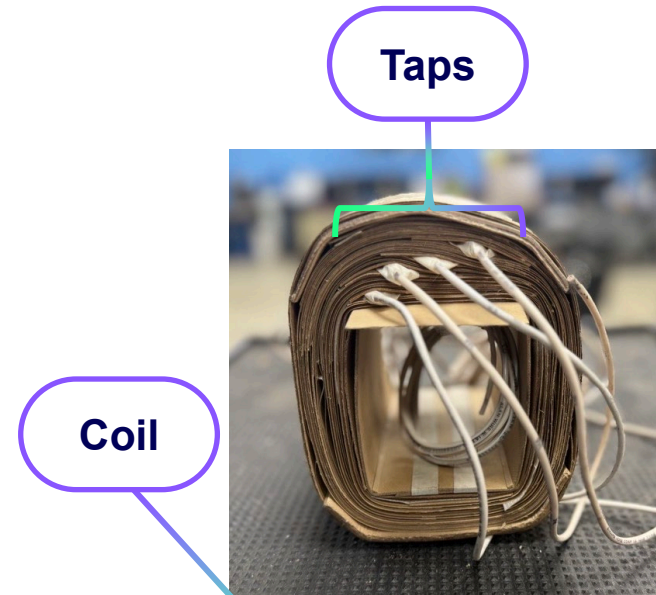


# Potential Transformer (PT)

# Instrument Transformer – PT Coil

- Contains two windings: primary (HV) and secondary (LV).
- HV measures the line voltage at the load side (source side) between L and SL terminals.
- LV designed with the proper turns to obtain the desirable ratio between both windings; this reduces the line voltage (normally to 120 V) to provide to the control.
- Both windings can have multiple taps to change the ratios - making it capable of operating at different system voltages.
- Both windings are constructed of wire.

**PT core:** Wound tranco core type/two (2) loops are used in a shell type arrangement.



# PT Assembly - Core, Coil & Clamps



Low Voltage Taps



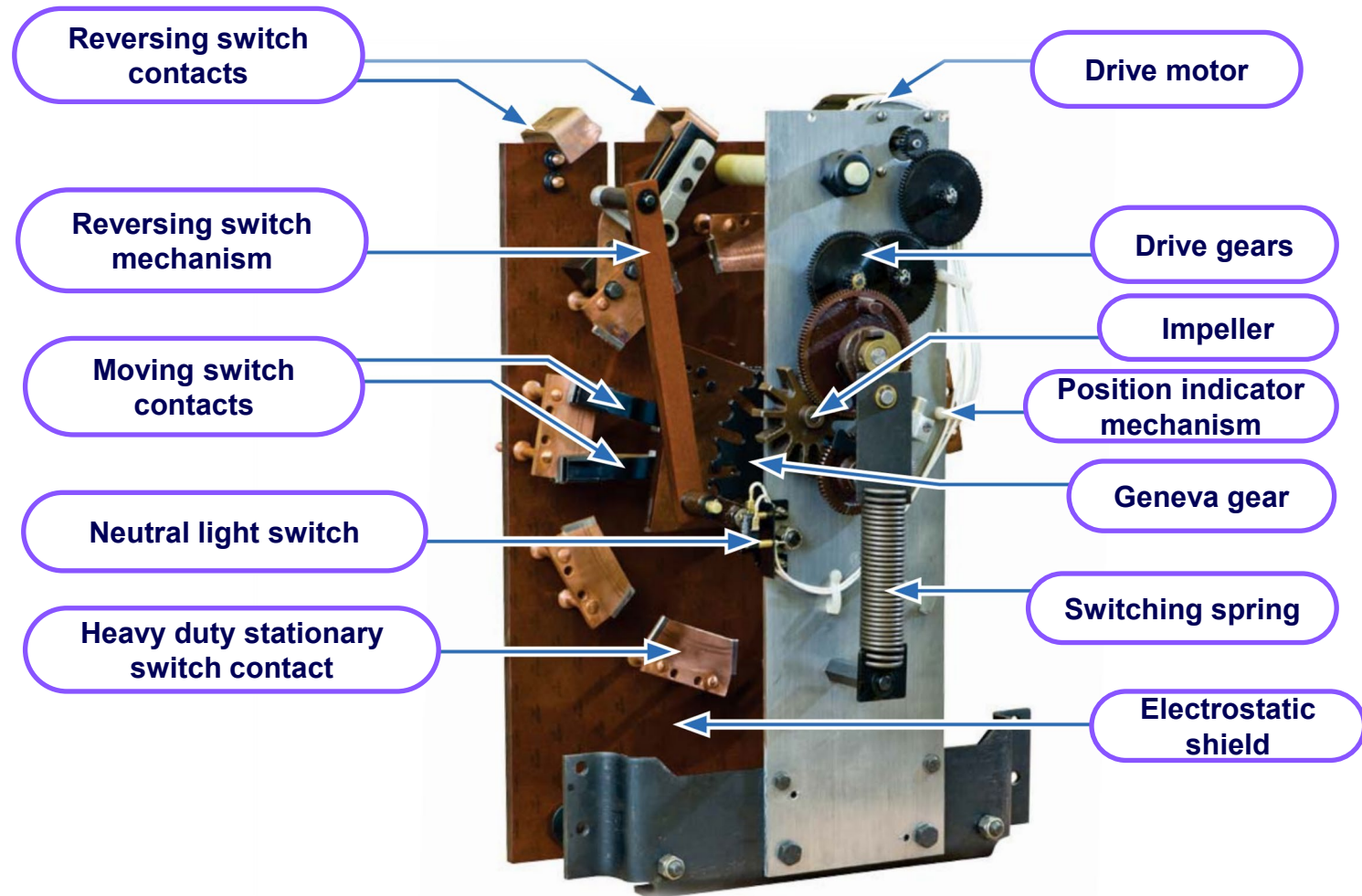
High Voltage Taps



# On Load Tap Changer (OLTC)

## Prolec GE On Load Tap Changer (OLTC) mechanism:

- Three ratings available:
  - 300 A, 13,800 V
  - 668 A, 13,800 V
  - 668 A, 22,000 V
- Moving times from -16L to +16R in 180 seconds.
- Moving contacts and tips of stationary contacts are made of **Elkonite copper alloy** which is an arc-resistant material that provide high mechanical properties and excellent resistance to erosion.

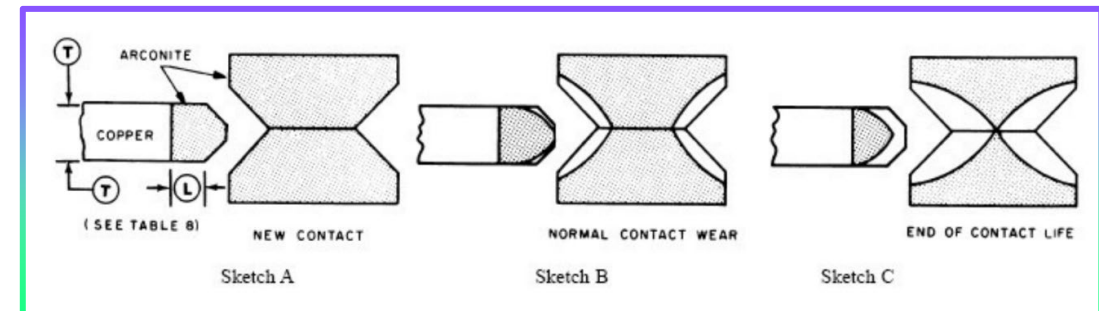
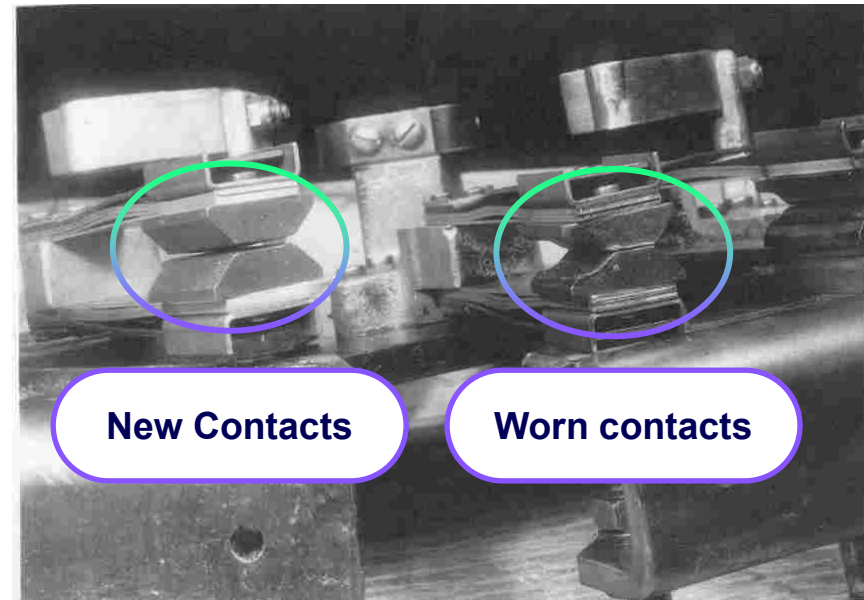


## Expected minimum number of operations and contact wear:

KVA	VOLTS	AMP	LIFE	INSPECT	SWITCH SIZE
100	2500	400	1950000	1450000	HC
100	5000	200	2000000	1500000	MC
100	19920	50	2000000	1500000	HV
114.3	7620	150	600000	450000	LC
125	2500	500	1100000	840000	HC
125	5000	250	2000000	1500000	MC
138	13800	100	1250000	960000	LC
144	14400	100	2000000	1500000	HV
167	2500	668	620000	460000	HC
167	5000	334	1300000	1000000	HC
167	7620	219	1100000	830000	MC
200	19920	100	2000000	1500000	HV
207	13800	150	2000000	1500000	HC
250	5000	500	560000	420000	HC
250	7620	328	930000	700000	HC
276	13800	200	1350000	1000000	HC
288	14400	200	1100000	830000	HV
333	5000	668	310000	230000	HC
333	7620	437	550000	410000	HC
333	14400	230	740000	560000	HV
333	19920	167	1150000	870000	HV
400	19920	200	850000	640000	HV
414	138000	300	660000	490000	HC
416	7620	546	310000	230000	HC
416	14400	289	540000	410000	HV
432	14400	300	510000	380000	HV
500	14400	347	230000	170000	HV
509	7620	668	180000	130000	HC
576	14400	400	230000	170000	HV

The above table is compiled with reference to actual contact life tests of several selected ratings.

LC = Low Current Switch  
MC = Mid Current Switch  
HC = High Current Switch  
HV = High Voltage Switch





## Regulator Components

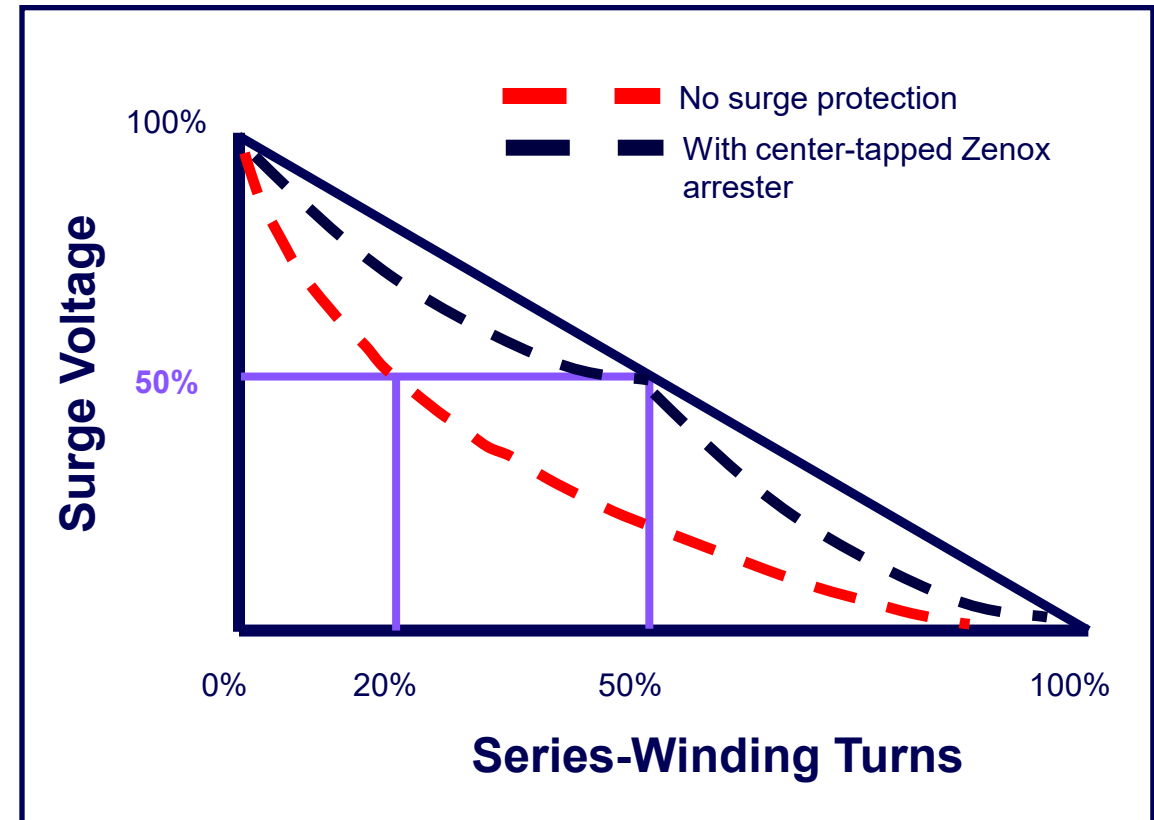
- Internal Components
  - Internal Series Arrester (Zenox)

# Internal Series Bypass Arrester (Zenox)

- Installed inside the tank.
- Counts with a center tap.
- This arrangement helps on distribute surge voltage more evenly on the series winding, thus reducing turn to turn stresses.

Chart shows a representative case:

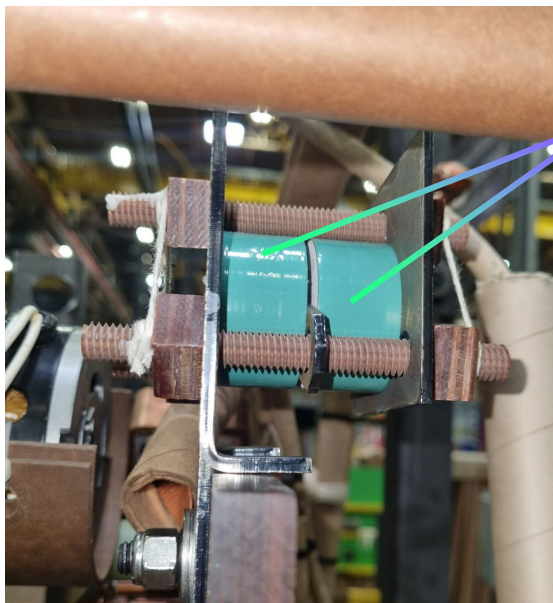
- **No surge protection:**
  - 20% of the winding takes 50% of the voltage.
- **Center-tapped Zenox arrester:**
  - 50% of the voltage appears across 50% of the winding.
  - Further reducing turn-to-turn stresses.





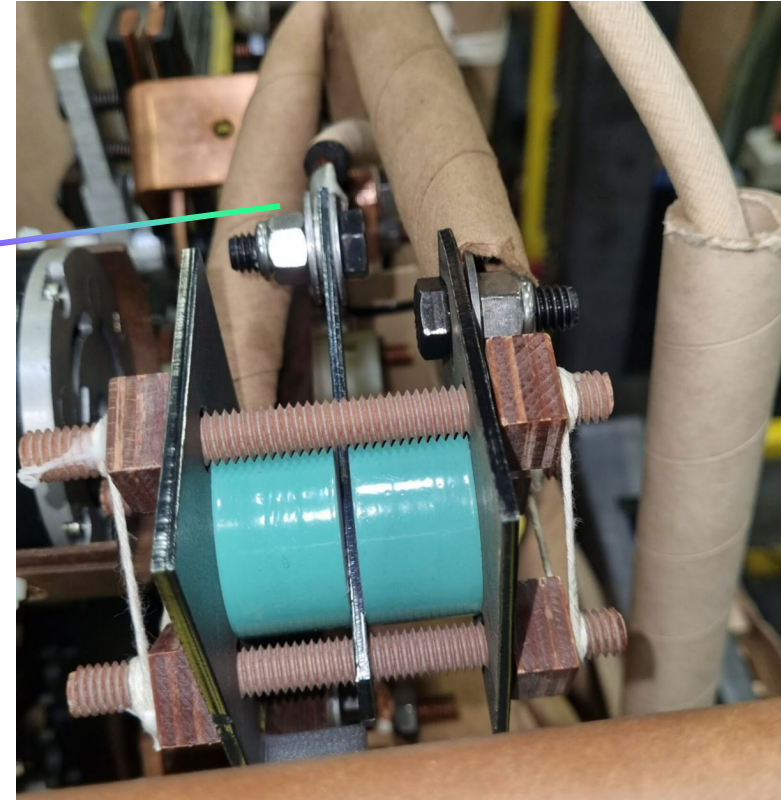
# Internal Series Arrester (Zenox) - Advantage

- Safest shipping and installation
- Avoid wildlife causing short circuit across source and load bushings
- No Maintenance required



**Zenox disks**

**Center Tap**



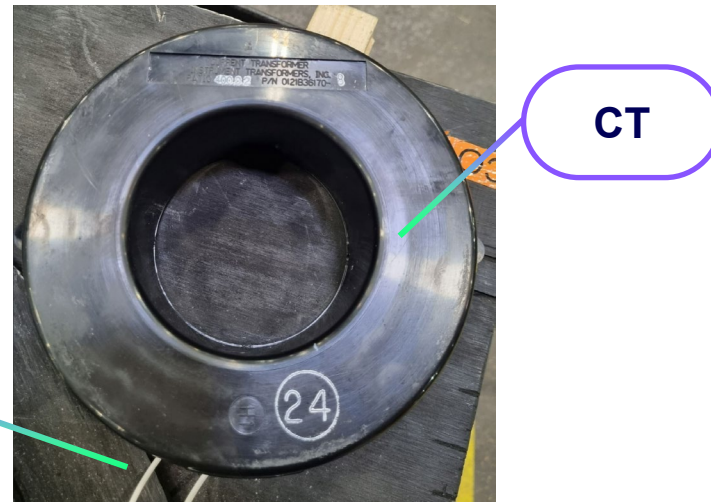


## Regulator Components

- Internal Components
  - Current Transformer (CT)

# Current Transformers (CT)

- Installed in load bushing.
- Measures output load current
- Provides a proportional current for the control - Normally 0.2 A secondary current at rated primary load.
- Used by controller for metering purposes as well as control features **line drop compensation (LDC)**.



CT Terminals

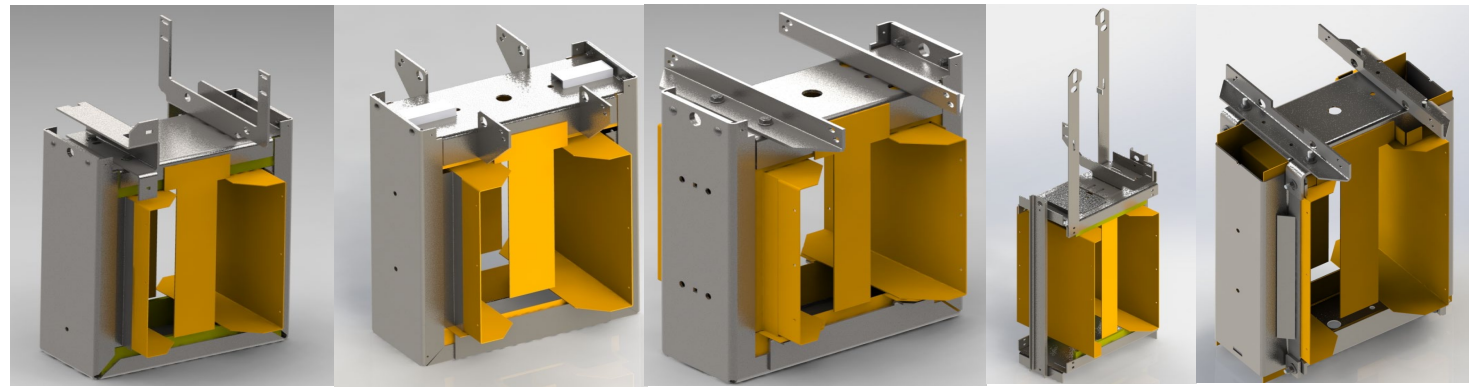


## Regulator Components

- Internal Components
  - Main Clamp Assembly

## CC Clamp Assembly:

- Holds the main cores and coil in place; capable of withstanding the axial and radial forces generated by the regulator operation
- Provides space to add the required insulations of the live part and provide the required points of connection to assembly it to the rest of the internal assembly.



**Clamp Assembly types:** Changes depending on the design type.

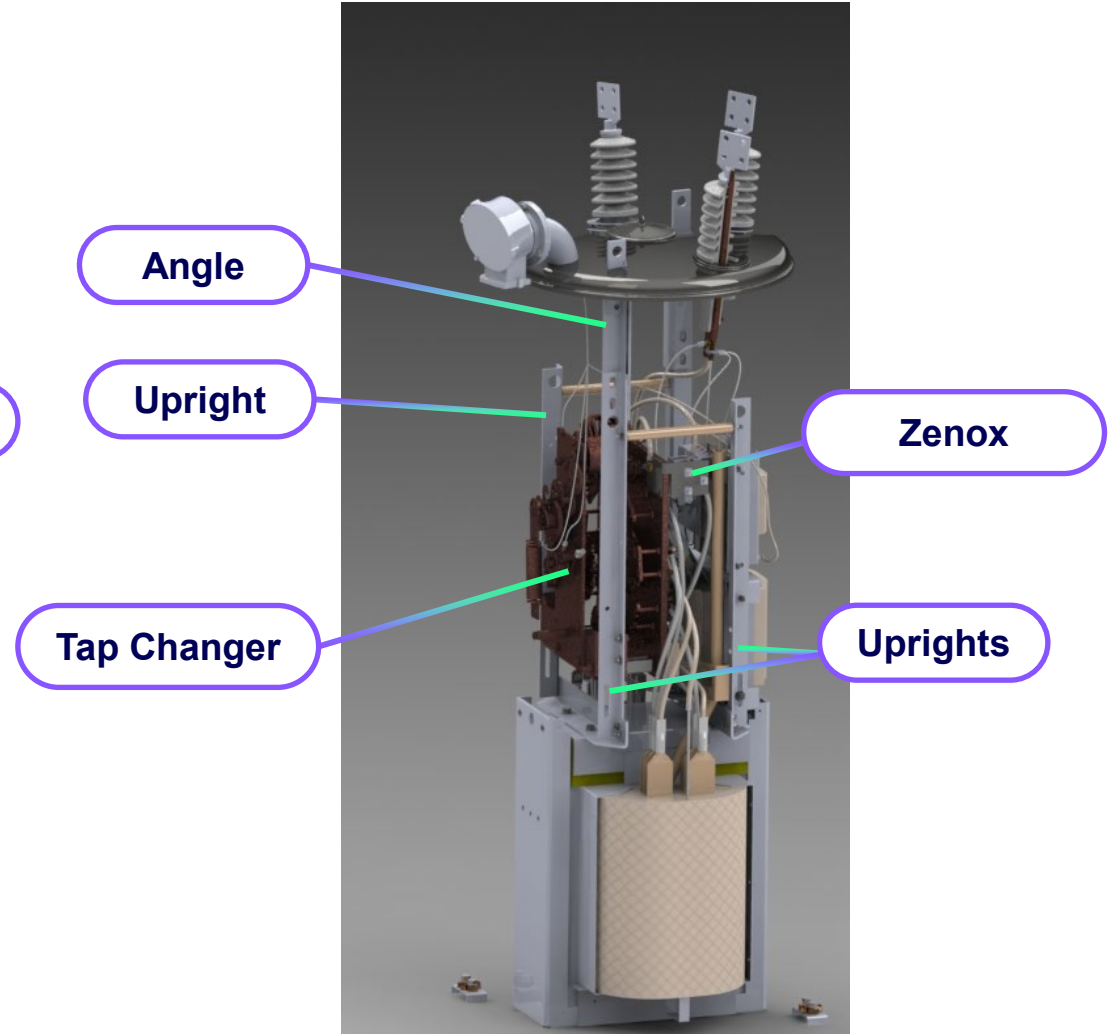
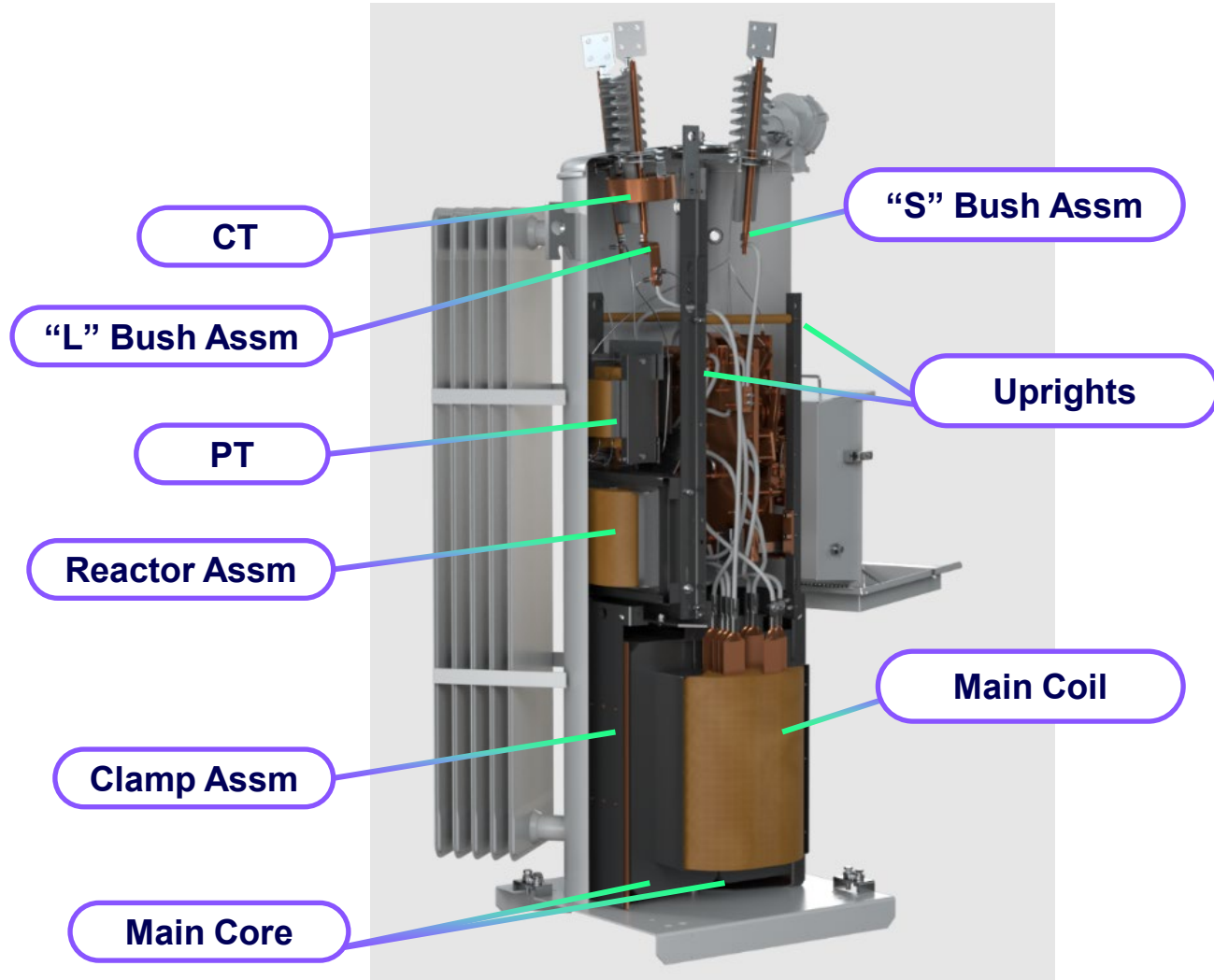
- 2 Pieces Type
- 2 Pieces (Ear Type)
- 2 Pieces (Cross Bar Type)
- Channel Type
- 4 Pieces Type

**Note:** When customer request 40X Short circuit designs, the clamp assembly requires additional reinforcements.

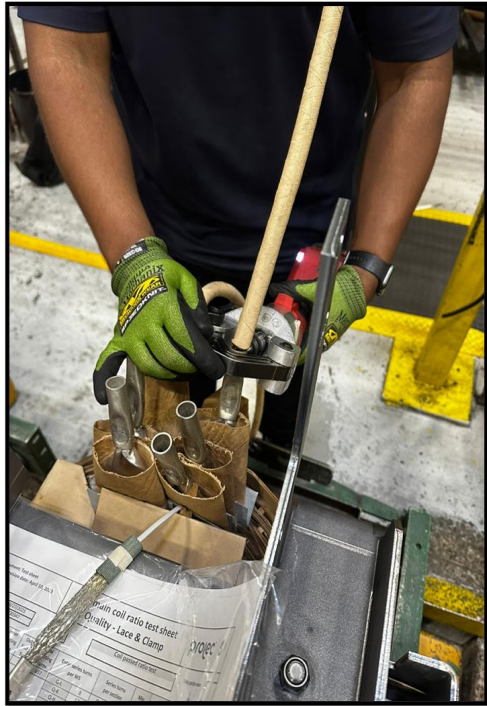


## Regulator Components

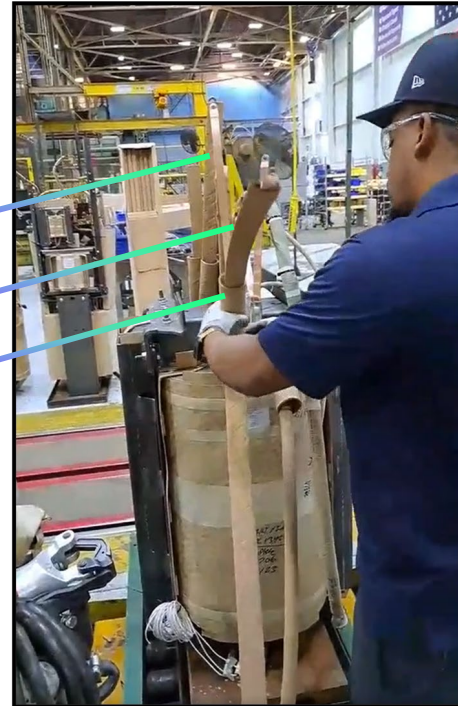
- Internal Components
  - Internal Assembly



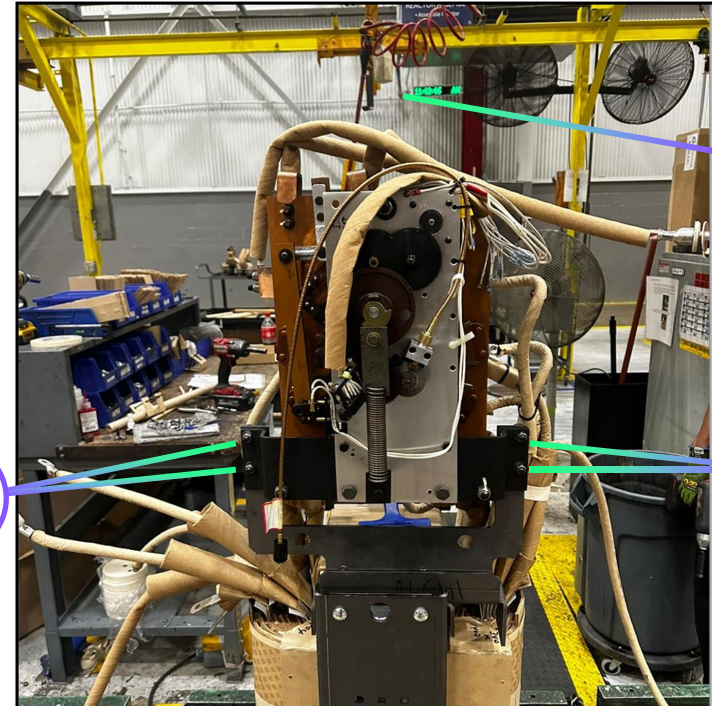
# Crimp Leads & Mount Switch



- Lead
- Insulation
- Tube



- Bolts

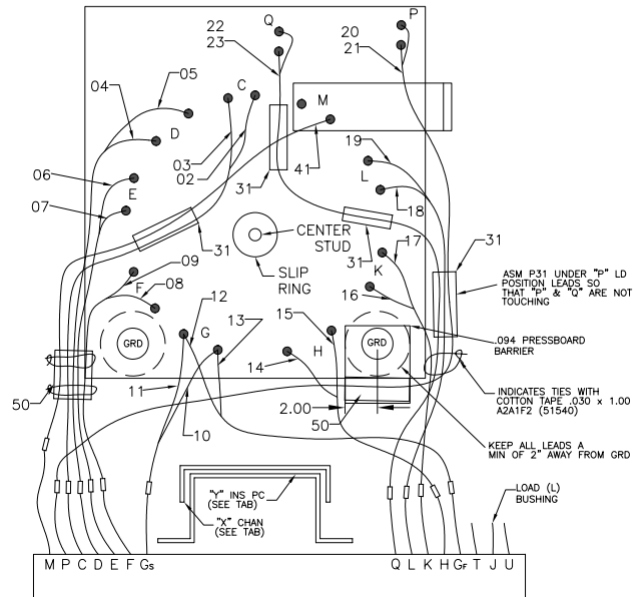


- Crane
- Bolts

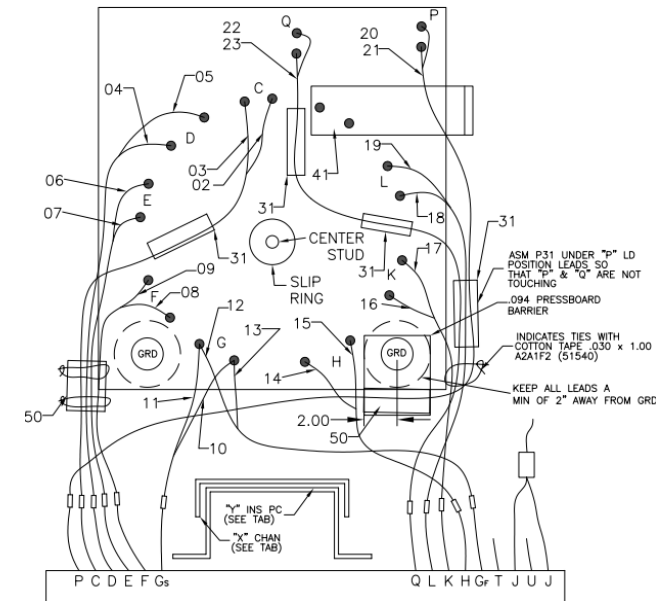


## Tap Changer Lead Connections

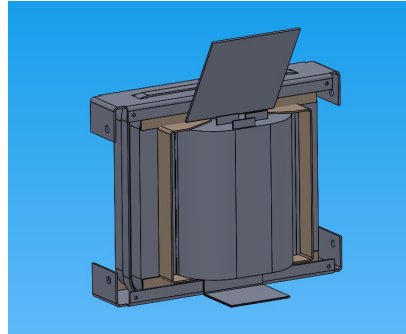
Type A (With M shelf connection)



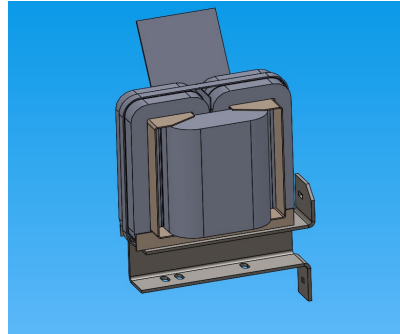
Type B (Without M shelf connection)



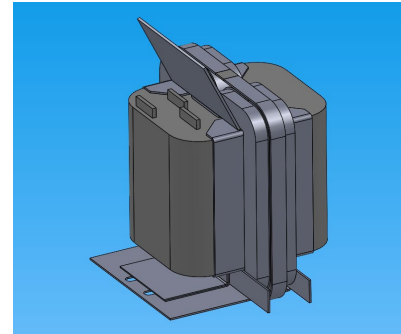
# Reactor Assembly Types



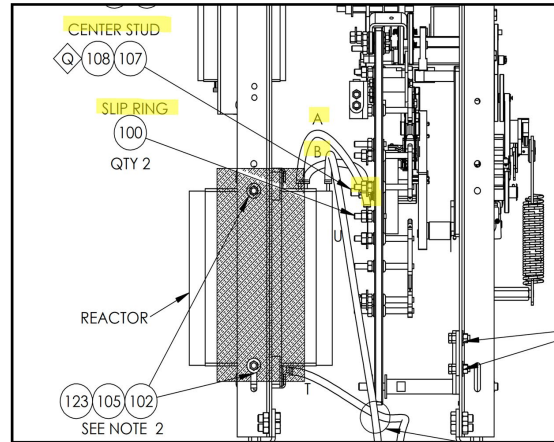
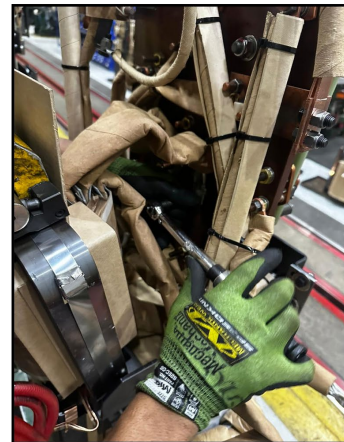
- Type: Standard/Double PT
- Between Uprights



- Type: Redesign
- On Top Clamp
- With Bracket



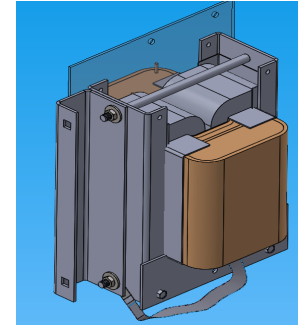
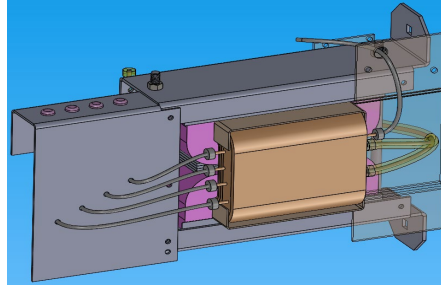
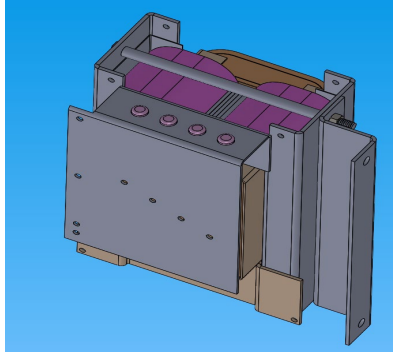
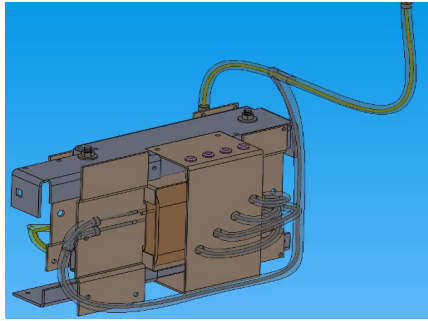
- Type: Fast-Cycle
- On Top Clamp
- With Bottom Clamp only



Reactor Lead to Center Stud (IA)

Reactor Lead to Slip Ring (B)

# Potential Transformer Assembly



- Type 1
- Horizontal Location
- Two UPR Mounted
- Straight Clamp/Bracket

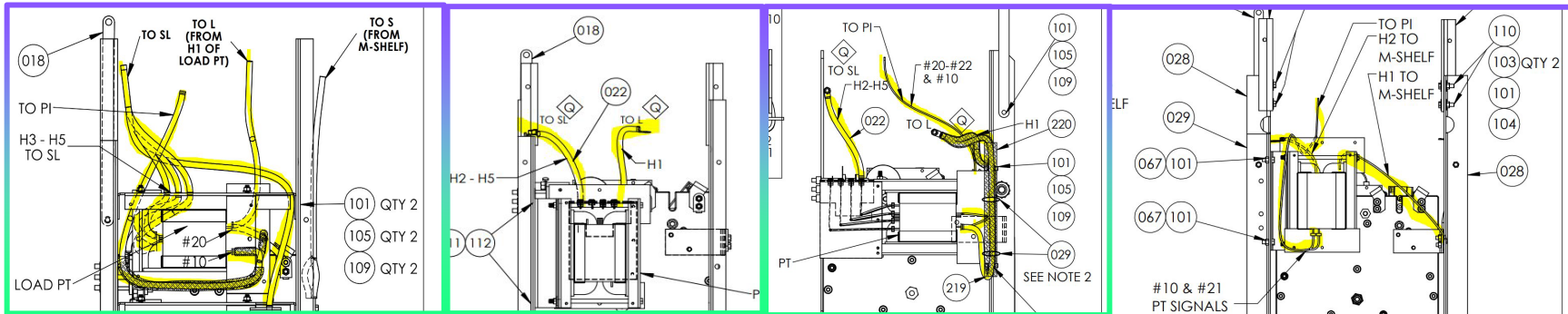
- Type 2
- Vertical Location
- One UPR Mounted
- "Z" Bracket

- Type 3
- Horizontal Location
- One UPR Mounted
- "L" Clamp/Bracket

- Type 4
- Vertical Location
- One UPR Mounted
- "C" Bracket

PT Connections: Every PT will have different connections, depending on the VR Type, the PT Leads (from the PT Winding). Etc.

Potential Transformer



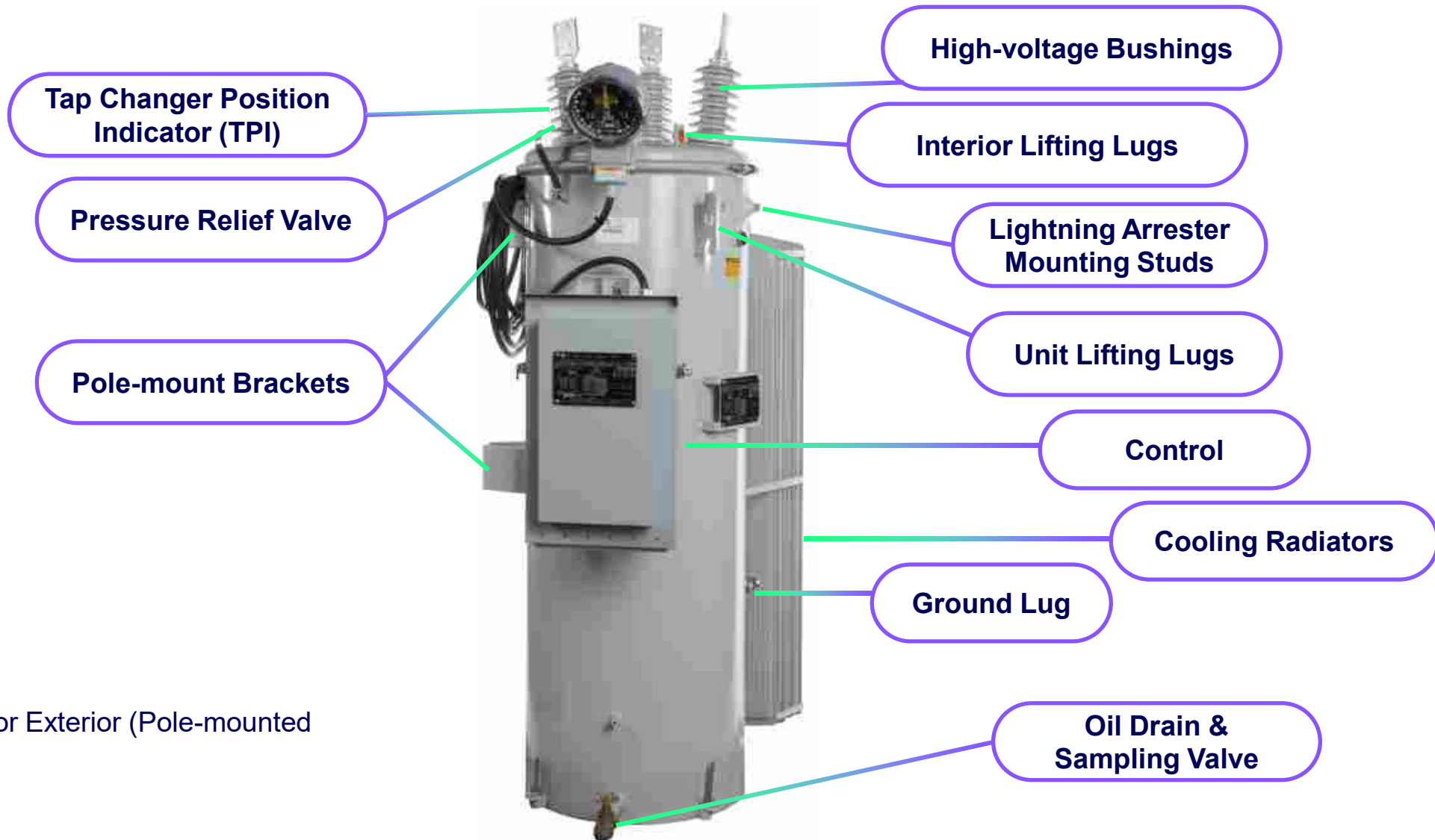


# External Components

# External Components

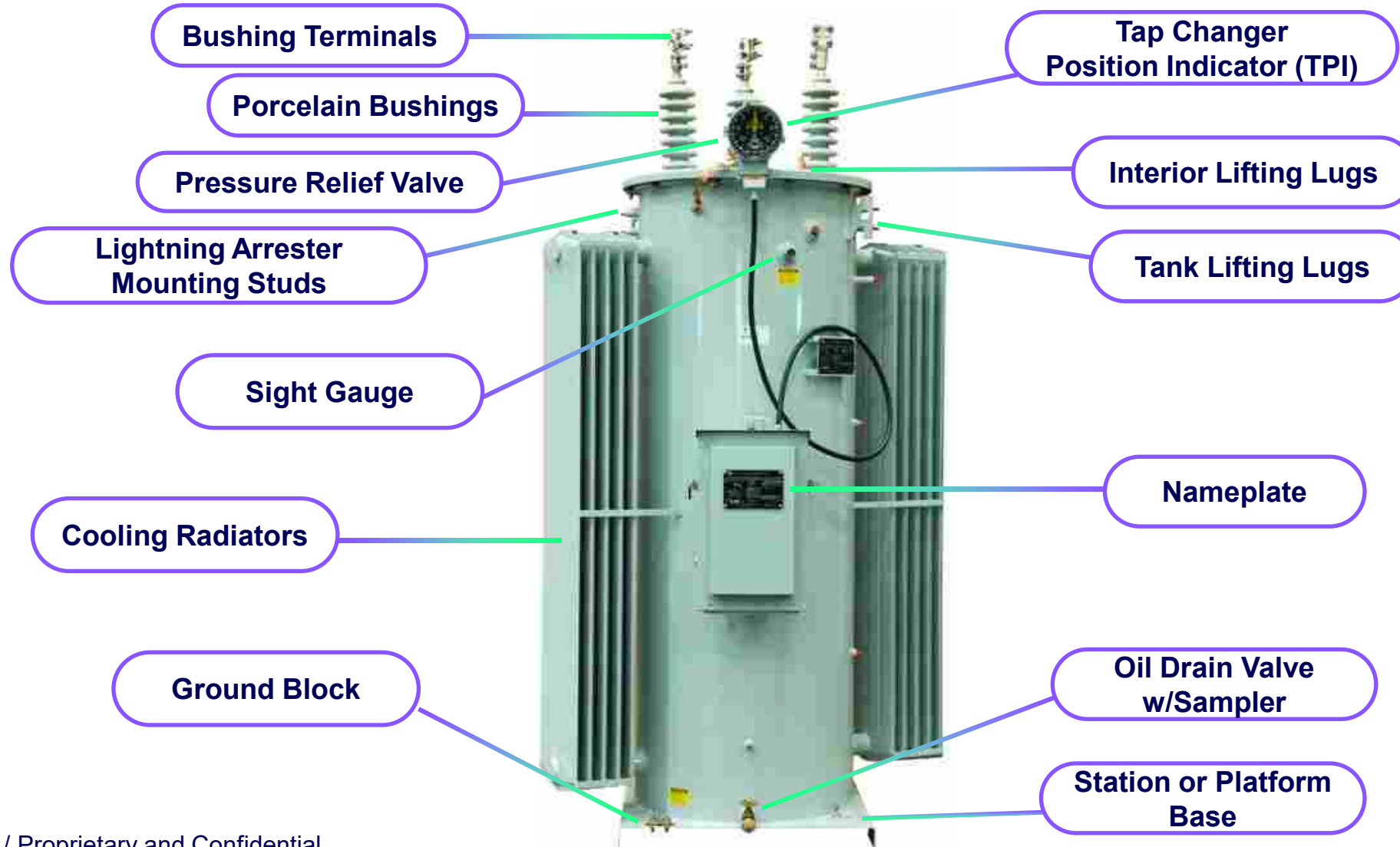
- Tank Assembly
- Cover Assembly
- Porcelains
- Terminals
- Cover Band
- Position Indicator
- Hand Hole
- Pressure Relief Valve
- Sight Gauge
- Pallets
- Other Accessories (Customer request)

# External Components Overview



Voltage Regulator Exterior (Pole-mounted & Substation)

# External Components – VR-PM & VR-SS



Voltage Regulator (VR-PM-SS) Exterior, PM (Platform) & SS Substation Mounted



# Tank Assembly

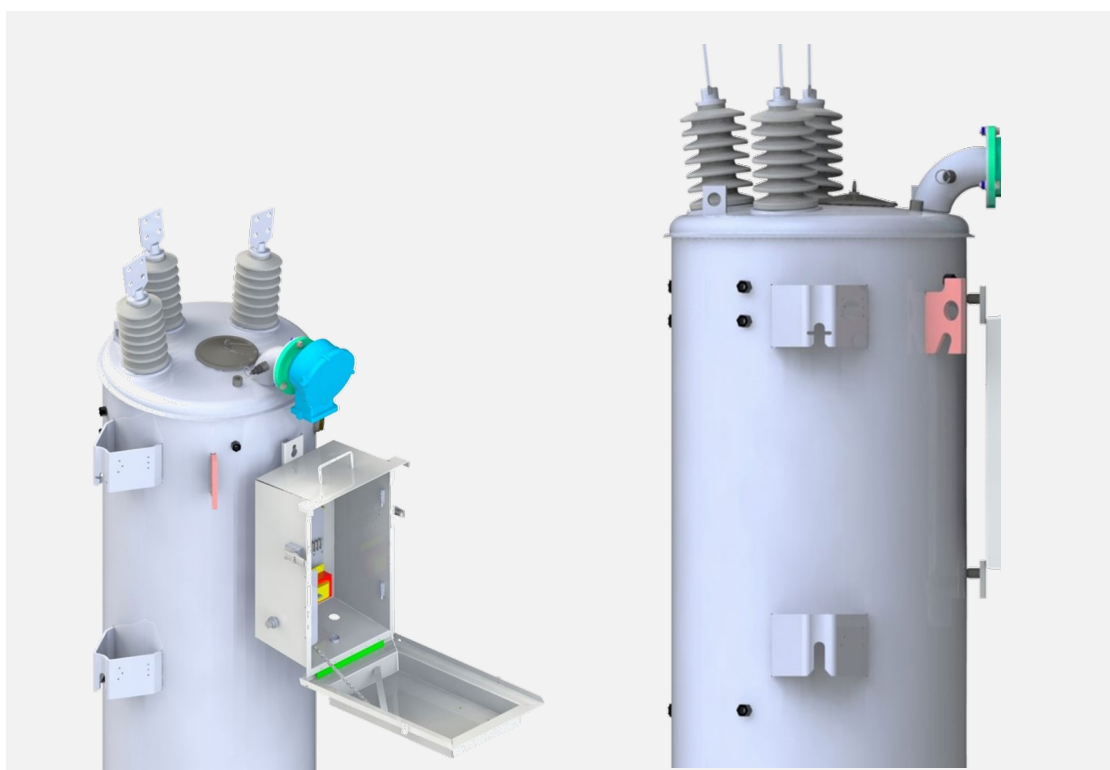


# Tank Assembly

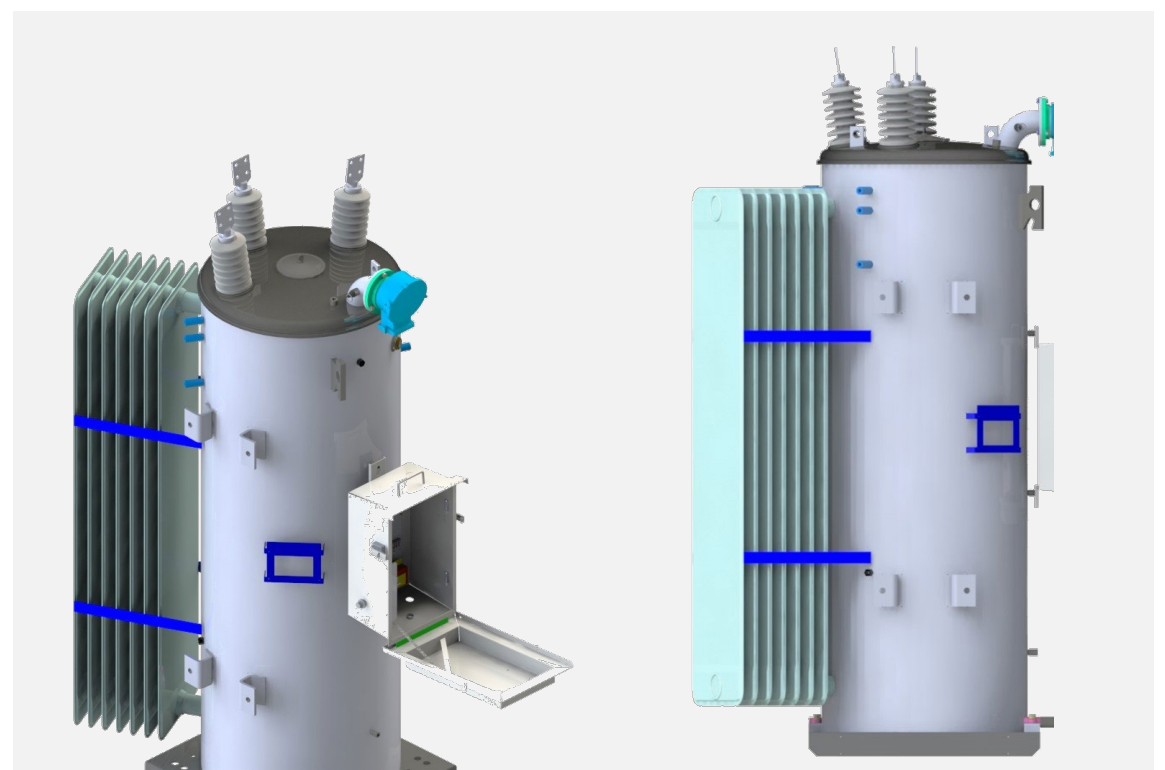
- Round, sealed carbon steel tank with durable weather-resistant powder coat-finish (ANSI No. 70 Gray).
- 3 standard sizes:
  - 21", 25" & 28" diameter.



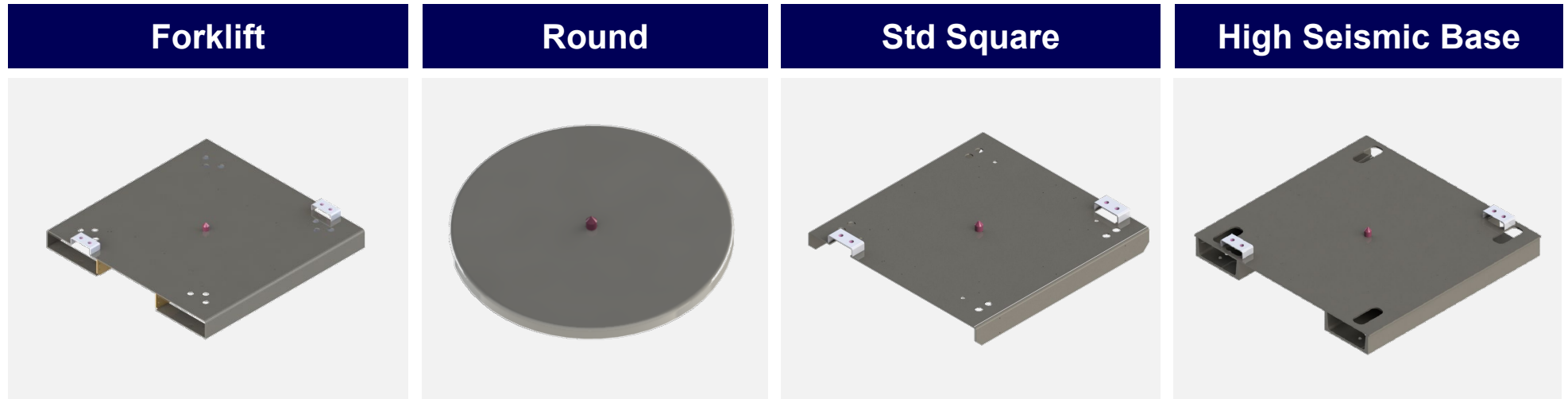
Type B (CS / SS)



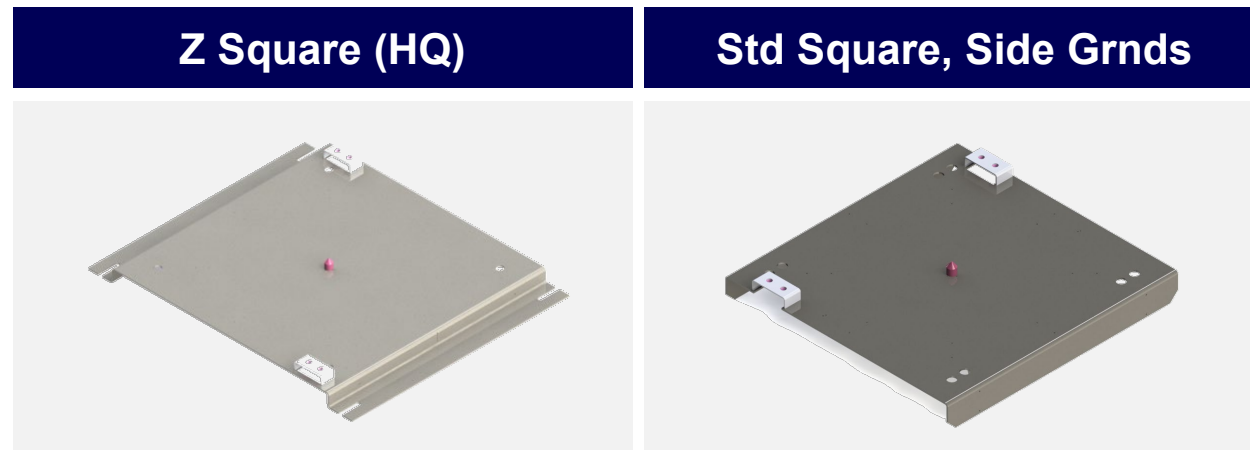
Type C (CS / SS)







- Standard



- Special Customer



Drain Valve	Ground Block	Lifting Lug
	<p>Prolec GE's standard welded tank grounds, 2" x 4.12", one on the front left corner and other on the right rear corner, viewed from the control side. With two 0.5"-13 inch bolts each.</p> 	<p>Standard:</p>  <p>Non-standard:</p> 



## Regulator Components

- External Components
  - Cover Assembly

## Components:

- Cover
- Bar Lift
- Elbow (45° & STD)
- Porcelains
- Bush ASM / B Cap

## < Single-BOM of 6205B002G35 [\[DWG\]](#):

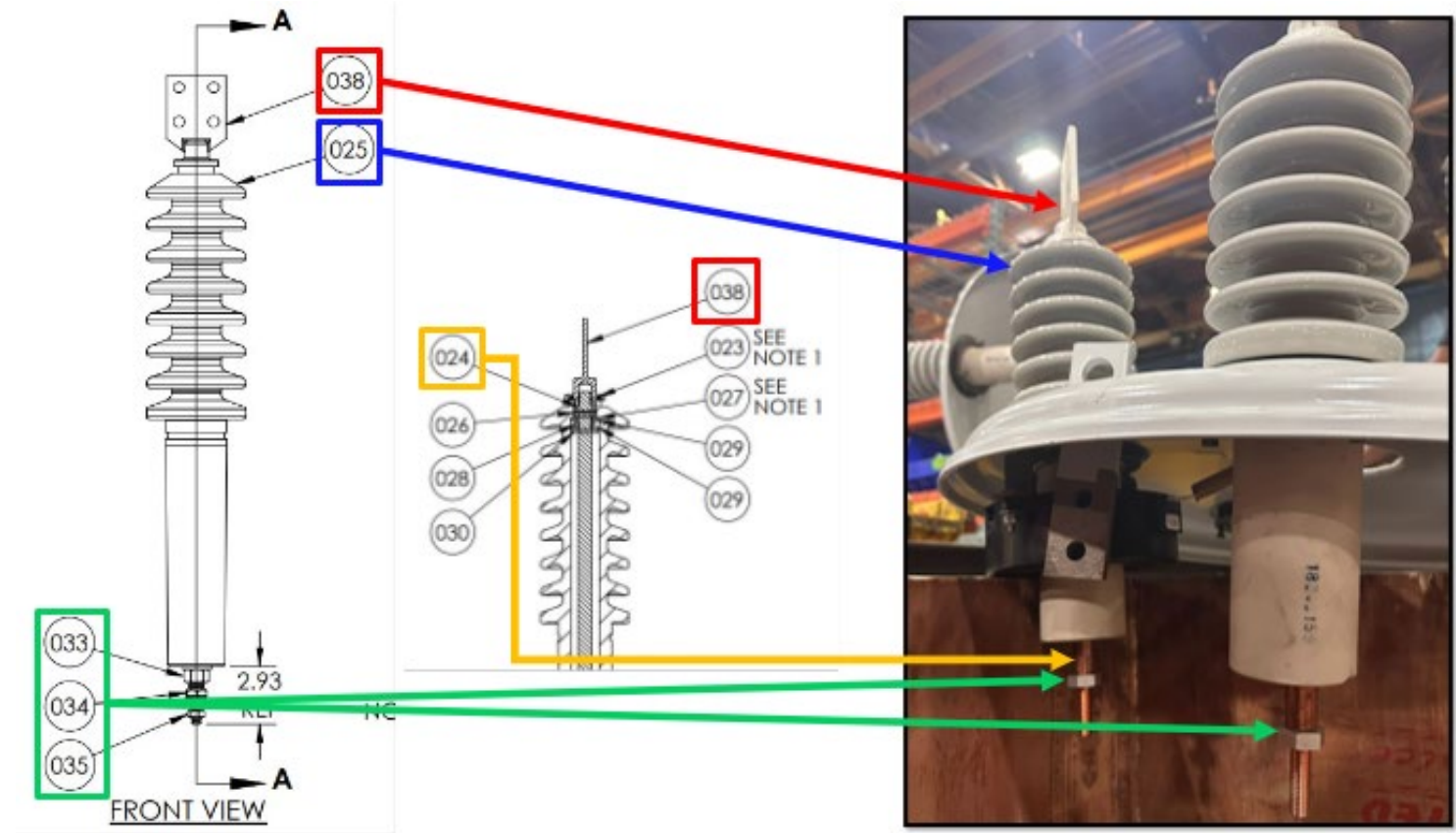
Extra Info	Child Item #	Description	Quantity
003	6205B004G04	PI SUPT-NO CHAN	1
002	6305B006P06	BAR LIFT	2
006	6305B012P01	COV 21" use 1701K088P21 blk	1
004	6305B017P02	RING RETAINING	4
014	7145B003P21	WELD NUT .500-13 303 SS	1



# Cover Assembly

< Single-BOM of 6215B003G02 [DWG]:

Extra Info	Child Item #	Description	Quantity
033	N245P35	NUT HEX .750-10 STANDARD	1
038	6315B003P26	TERMINAL BUSH CASTING	1
025	6315B005P26	PORCELAIN INSULATOR	1
024	6315B007P05	BU ROD	1
034	8020K012P76	NUT CONTACT .500-13 REGS	2
035	N213P29	NUT HEX JAM .500-13 REGS	1






## Regulator Components

- External Components
- Bushings




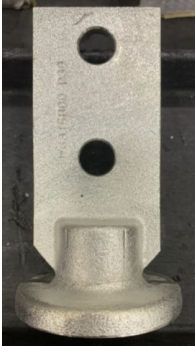
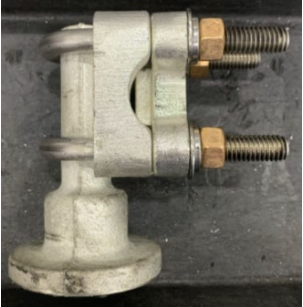

## Porcelain:

18" creep	26.5" creep	30" creep	36" creep
<ul style="list-style-type: none"><li>• Standard 95 kV BIL</li></ul> 	<ul style="list-style-type: none"><li>• Standard on S &amp; L for 150 kV BIL</li></ul> 	<ul style="list-style-type: none"><li>• High corrosion environments</li></ul> 	<ul style="list-style-type: none"><li>• Extremely high corrosion and pollution areas</li></ul> 



## Regulator Components

- External Components
- Terminals

Integral	
<p><b>1. I-Bolt</b></p> <ul style="list-style-type: none"><li>• #6-4/0 Clamp Type (standard &lt; 150A)</li></ul> 	<p><b>3. Two-Hole Nema</b></p> 
<p><b>2. U-Bolt</b></p> <ul style="list-style-type: none"><li>• #2-800MCM Clamp Type (standard <math>\geq 150A</math>) (Non-Integral)</li></ul> 	<p><b>4. Four-Hole Nema</b></p> 

Non-Integral		
<p><b>1. SEFCOR SNFT-27-4B</b> (Plated &amp; non-plated, w/1" threaded stud)</p> 	<p><b>2. SEFCOR SNFT-27-4A</b> (Plated &amp; Unplated, w/1" threaded stud)</p> 	<p><b>3. Two-Hole SEFCOR</b> (Plated &amp; Unplated, w/1" threaded stud)</p> 
<p><b>4. H-J Connector</b></p> 	<p><b>5. SEFCOR Sax</b></p> 	<p><b>6. SEFCOR SXR</b></p> 



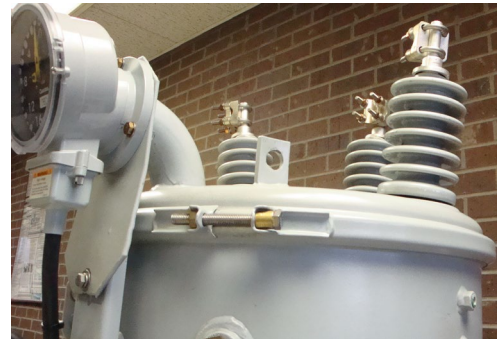
## Regulator Components

- External Components
- Cover Band

## 21" & 25" Tank

## 28" Tank

Round Covers.



Flat Covers.





## Regulator Components

- External Components
  - Position Indicator

# Position Indicator

- Indicates the current, minimum, and maximum tap positions.
- Serves as connection point between internal components and control cabinet.
- Limit switches allow users to decrease range of regulation mechanically.
- For VR-1 and SM2A controls, provides control plug disconnect that shorts CT secondary (only used on *obsolete designs that we don't offer anymore*).



## Position Indicator Options:

Two different suppliers:

- Huaming
- Qualitrol

*Note: We normally install any of them depending on availability, unless the customer's request a specific brand*

Two different angle options:

- 15° (used normally on substation units, installed at ground level)
- 45° (used normally on pole/platform units, installed above ground level)

*Note: If the customer doesn't specify which one they need, we select the angle per the above rules*





# Position Indicator

Tap position indicator

**Drag Hands** Max & min drag hands. Reset with switch on control panel.

**Limit Switches**  
(used to limit the load bonus)  
Set by opening glass cover, lifting tab and moving to new position.

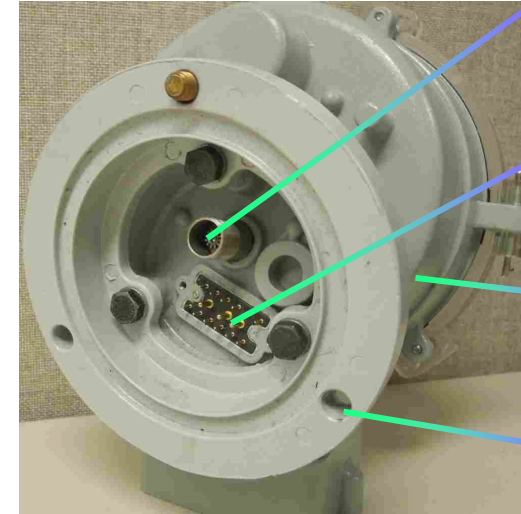


**FAQ # 14** What is the Load Bonus setting of the position indicator used for ?

Many regulators can be operated at a load current greater than that defined by Base KVA rating if the range of the regulator is limited. Most regulators are thermal rise limited and by reducing the amount of the winding that can be used, the regulator can carry more than the normal rated current.

**GUIDELINES:**

Not all regulators have a Load Bonus rating. Consult the nameplate to determine if the regulator has a load bonus rating. The regulator range is limited by adjusting the limit switches in the position indicator. There are independent switches for the raise and lower limit.



Connection to mechanical flex shaft

Electrical connector to get inside regulator signals

**Heavy duty aluminum housing** (Tested to withstand 10psi for 2 hours without leaks)

**Mounting flange and fasteners**



**Electrical connector to provide control cabinet signals**

This connector send all the required signals to the Control Cabinet:

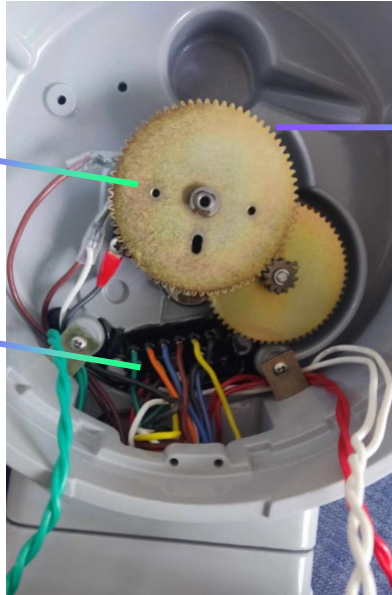
- Motor capacitor
- Power disconnect
- CT shorting function
- Etc.

Gearing – 1 shaft revolution to 10° = 1 position change

Electrical connection between back and bottom connectors

Drag Hand Reset Solenoid

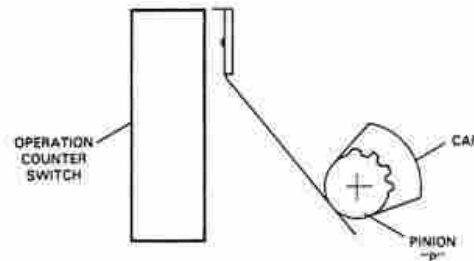
Electrical Limit switches Used to perform load bonus function



## Switch Mechanism:

The gearing is activated with a mechanical flex shaft that is connected on the OLCT. Which also makes the required tap operations with its own gearing mechanism:

Operation counter



Per Tap Change (1 Revolution):

- 360°
- 60°
- 10°



**Flex Shaft cable:** Provides the mechanical connection between the OLCT and PI.



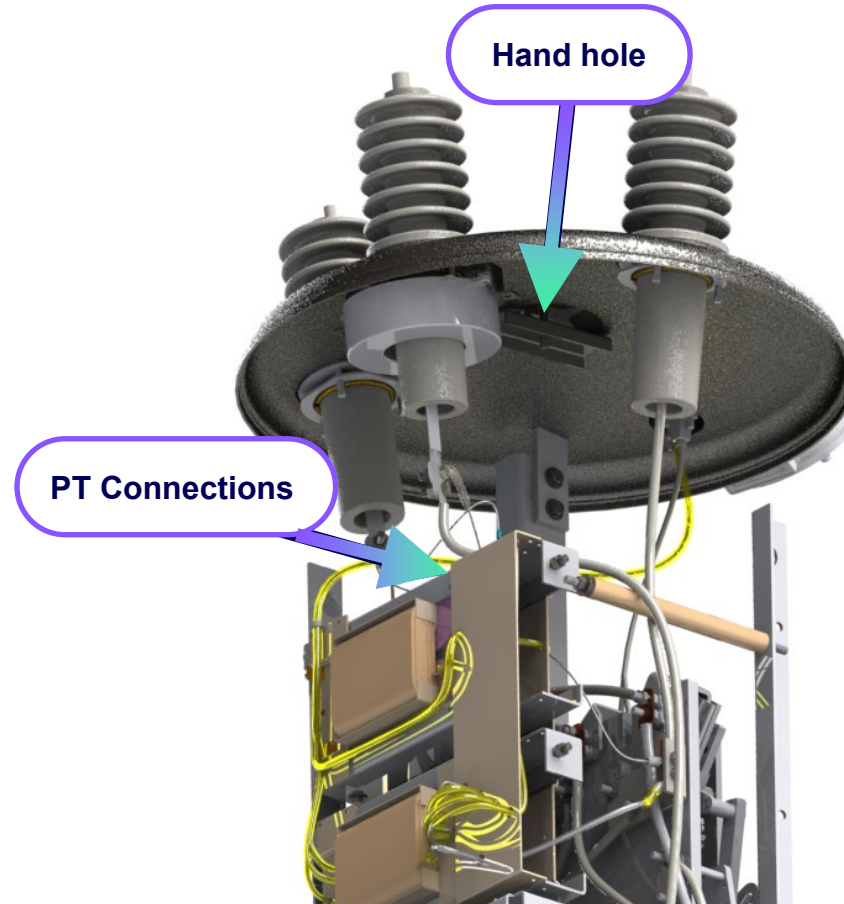


## Regulator Components

- External Components
  - Hand Hole

## Purpose:

- Oil filling – the hose is plugged in the hand hole to fill according to calculations.
- Access point on the cover that allows for quick inspection while de-energized, and setting other operating voltages based on the nameplate's connections.





## Regulator Components

- External Components
  - Pressure Relief Valve

Overpressure protection; which will automatically reseal once pressure has fallen.

## Position:

- In the elbow for the position indicator.

## Operating Characteristics:

- Unit operates at 10 PSI  $\pm$  2. We also have the option at 5 PSI.
- Flow 50 SCFM at 15 PSI.
- Reseal at 8 PSI  $\pm$  2.

## Model:

Qualitrol Valve #202-032-01





## Regulator Components

- External Components
- Sight Gauge

Required to check the oil level.

## Position:

- Welded into tank assembly, at oil level height.

## Characteristics:

- **Mounting:** 1 NPT thread.
- **Maximum operating pressure:** 100 psi.





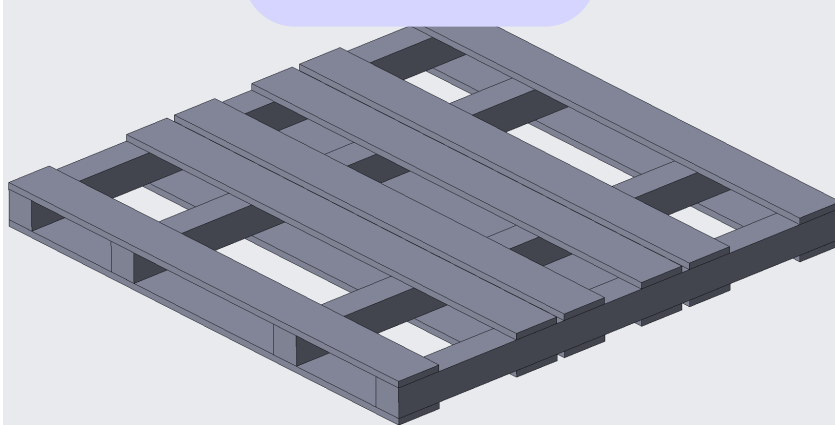


## Regulator Components

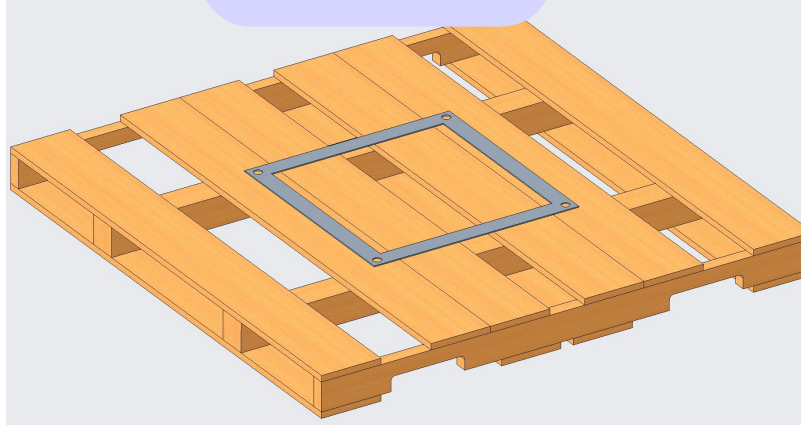
- External Components
- Pallets

# Pallets

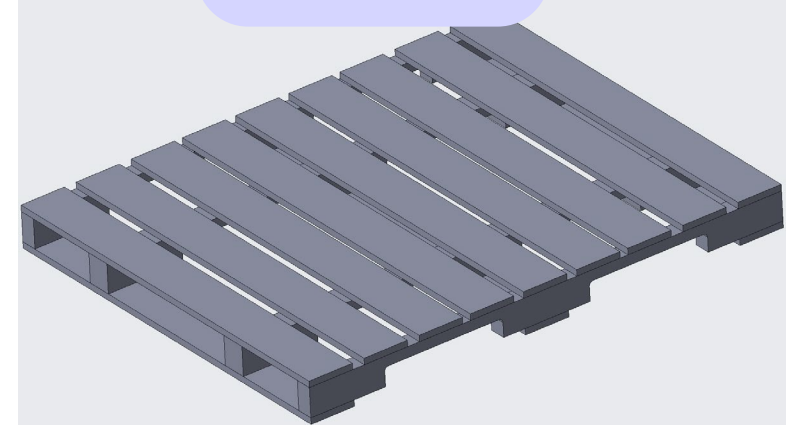
**PALLETRG4**



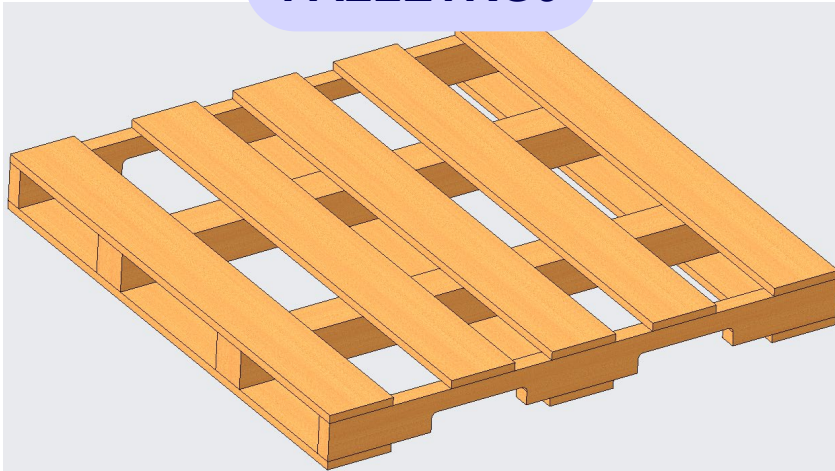
**PALLETRG5**



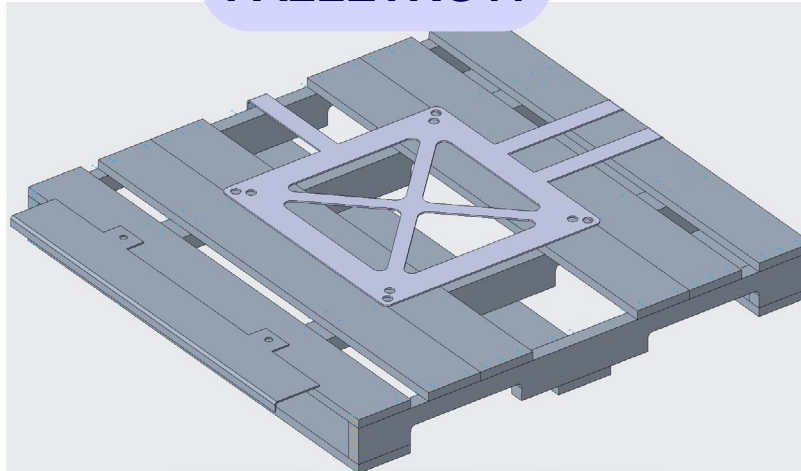
**PALLETRG8**



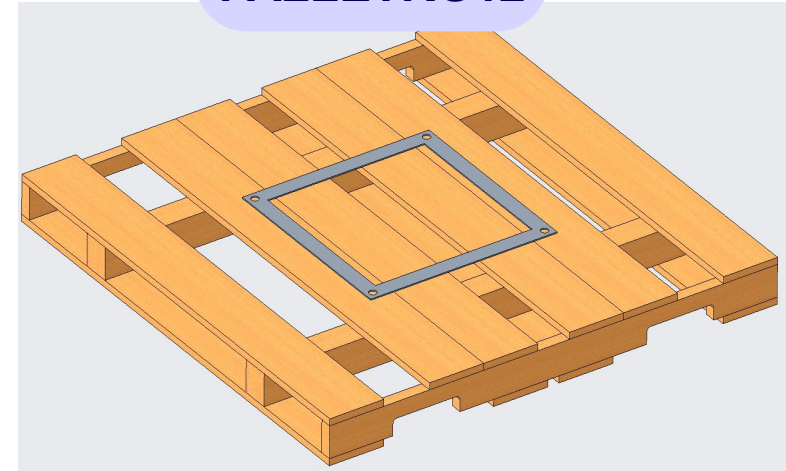
**PALLETRG9**



**PALLETRG11**



**PALLETRG12**





## Regulator Components

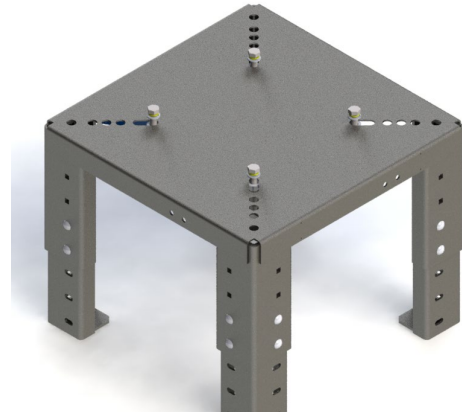
- External Components
  - Other Accessories  
(upon customer request)

- Sub bases
- Lightning Arresters (LA)
- Animal Guards
- Decals and Stencils
- Adapter Plates
- Thermometer
- External Grounds
- Special Painting (Inside Tank, 5 Mils, Zinc Primer, etc.)
- Valve Protector

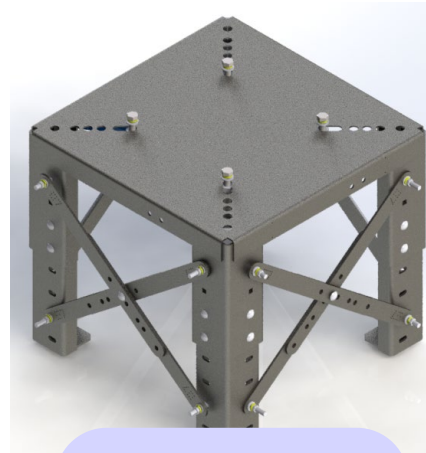
- Prolec GE can provide subbases for our standard Tank diameters 21", 25" & 28"
- They are adjustable height & they can be either seismic or non-seismic

Tank 21" & 25"  
Diam

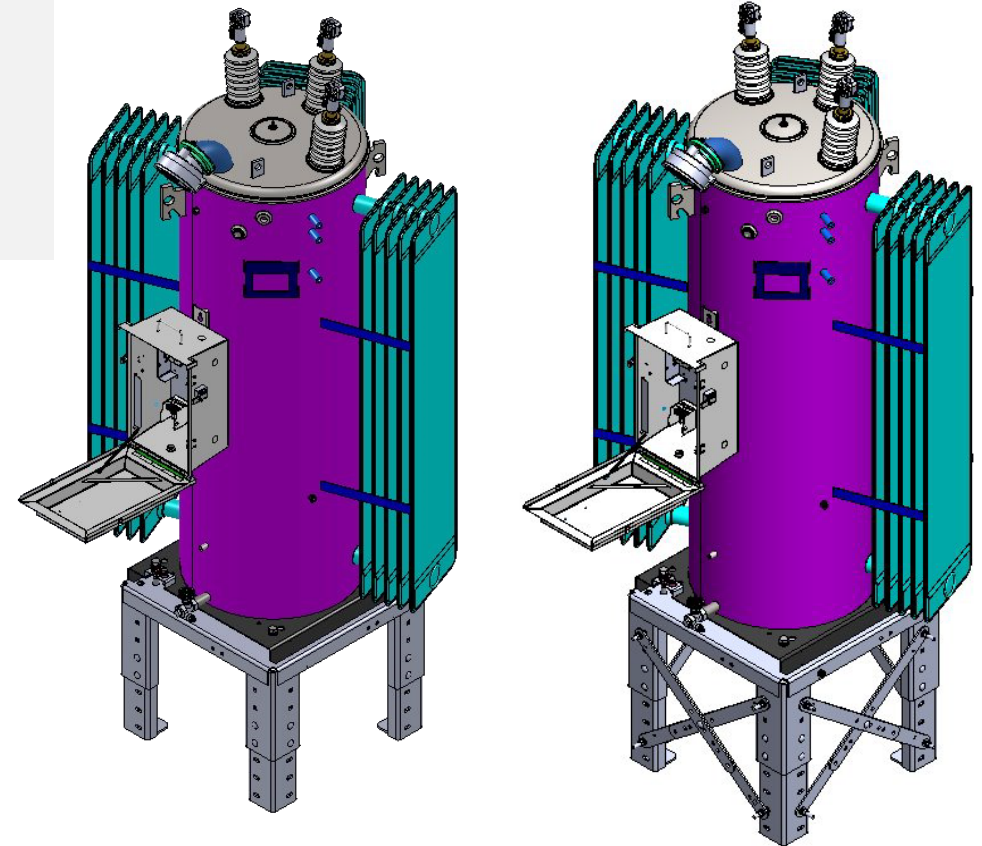
- Adjustable Leg: (24.5" – 33.5")
- Adjustable Leg: (15.5" – 24.5")
- Adjustable Leg: (33.5" – 42.5")
- Adjustable Leg: (45" – 54")



**NON-SEISMIC**



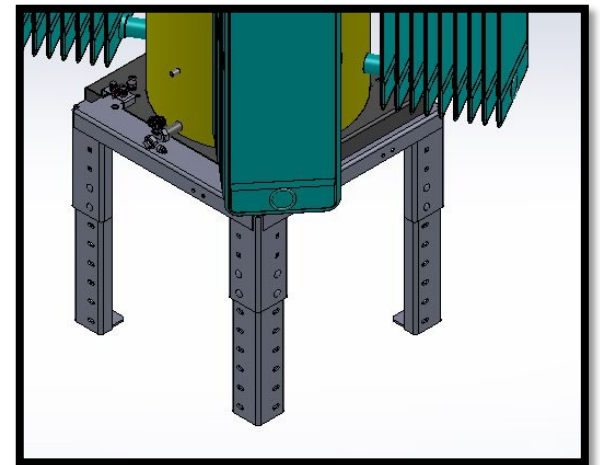
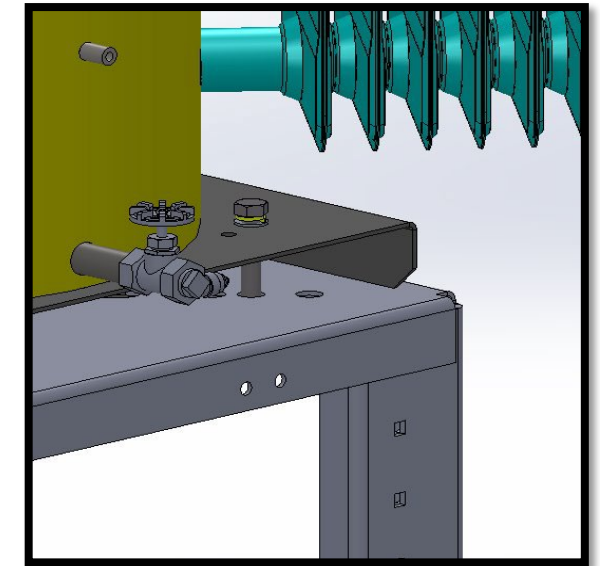
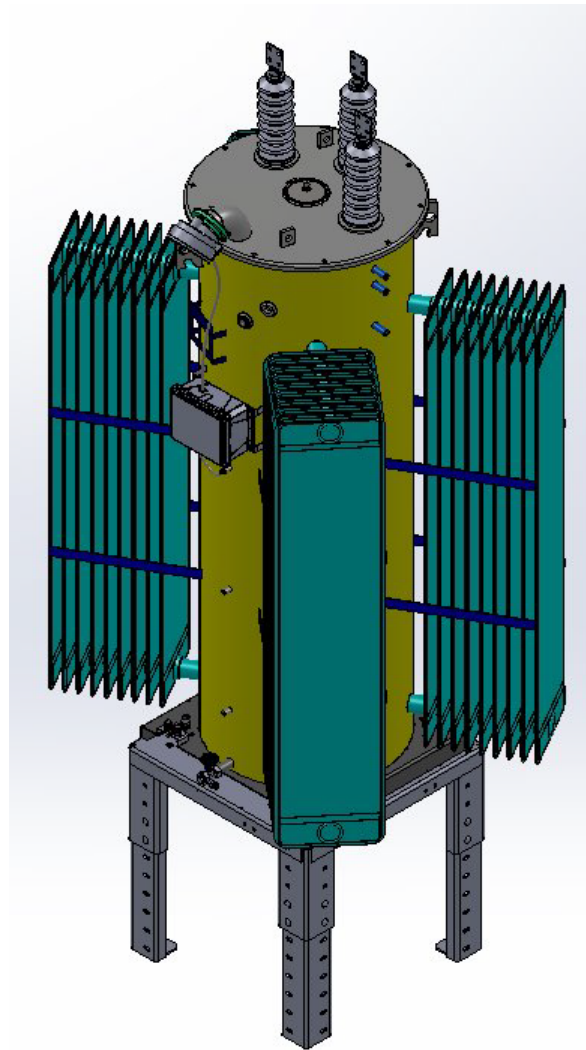
**SEISMIC**



- Prolec GE can provide subbases for our standard Tank diameters 21", 25" & 28"
- They are adjustable height & they can be either seismic or non-seismic

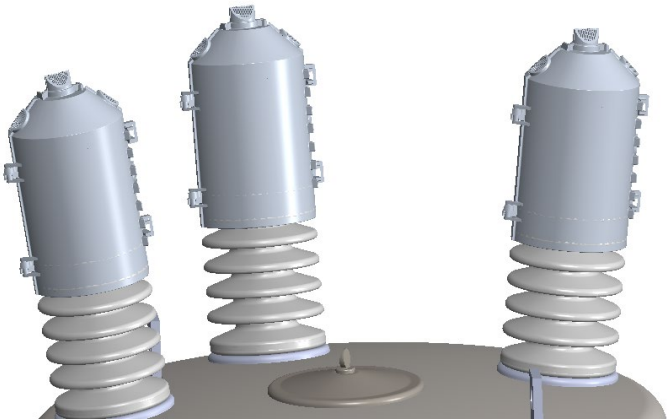
Tank 28" Diam

- Adjustable Leg: (24.5" – 33.5")
- Adjustable Leg: (15.5" – 24.5")
- Adjustable Leg: (33.5" – 42.5")

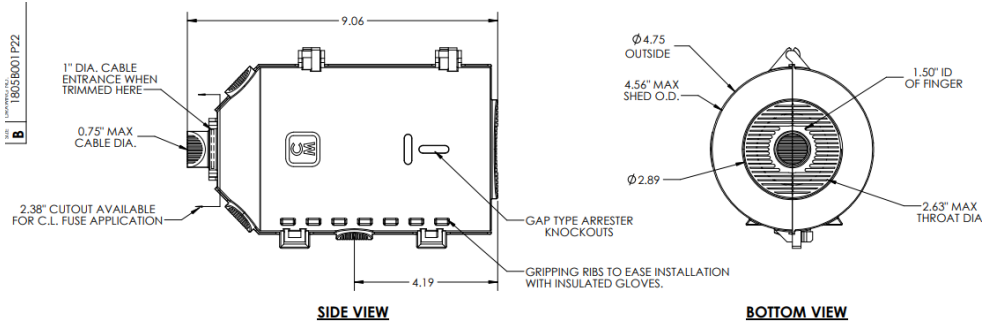




# Animal Guards



Animal guards protect bushings from animal and bird contact that can cause power outages. They are selected according to the terminal type that's being used.





- Prolec GE provides standard decals, such as “Caution” labels & can also provide stencils and decals according to customer requirements.

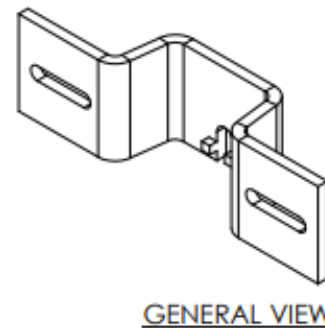
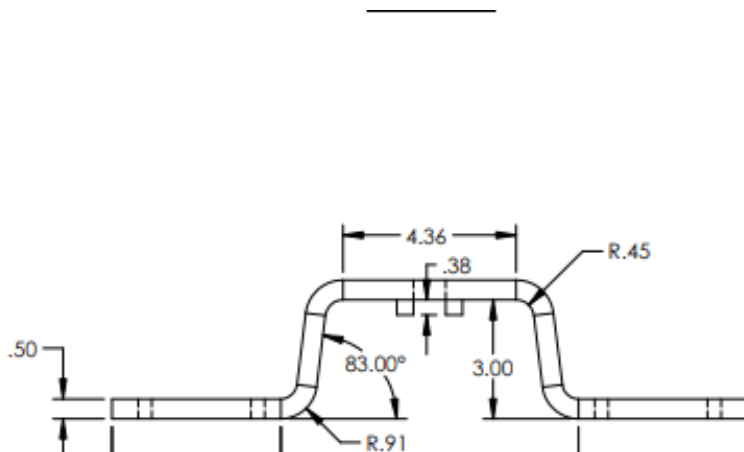
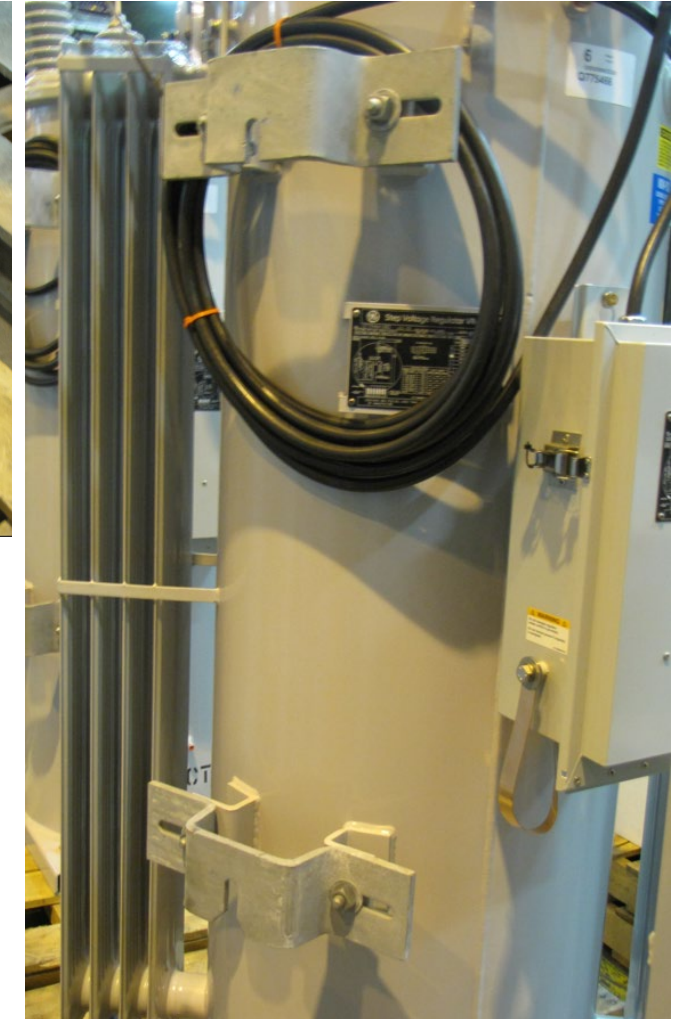
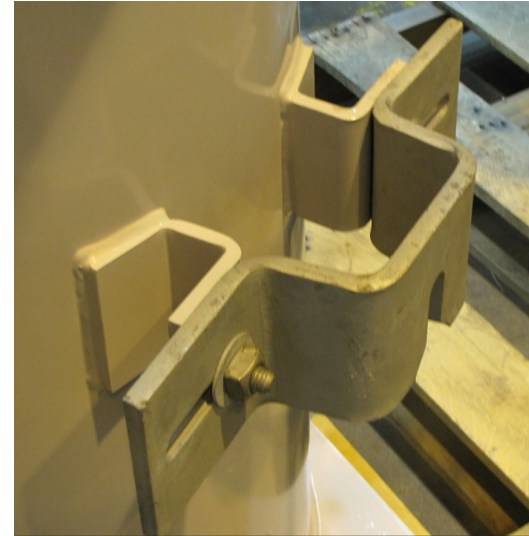
## Standard Decals



Special Requirements			
STENCIL	DECAL	DECAL	STENCIL
			<p>7620 V 114.3 KVA 150 A</p>

# Adapter Plates

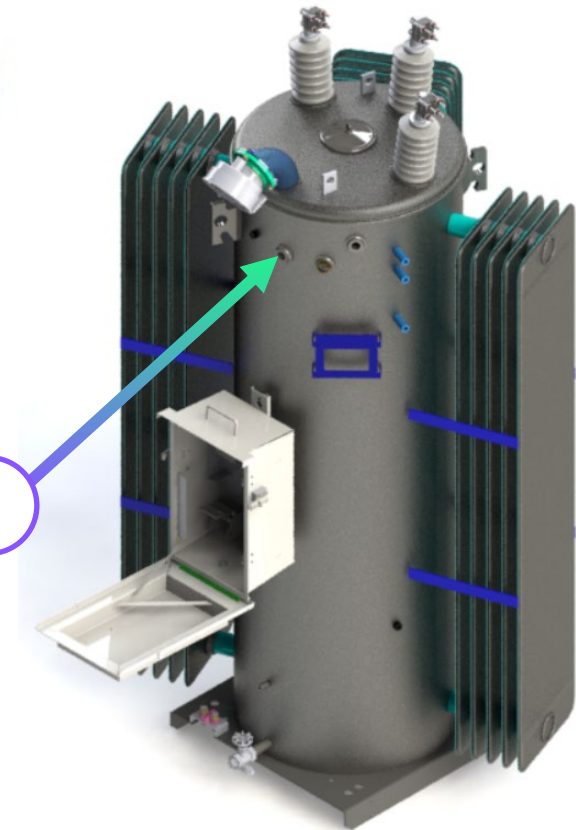
Hang regulators in Pole/Line applications. Only hanger brackets type C are used since type B are not required. It's limit weight is between 2600 lb – 4640 lb, depending on the part number that's being used.



- Prolec GE can provide a temperature indicator if customer requires
- Description: Side mounting bi-metal thermometers with temperature indication and resettable maximum temperature pointer. Clear indication of temperature with 4" (101 mm) dial
- Dial ranges: 0-120°C, 0-160°C
- Accuracy:  $\pm 2\%$  of dial range
- Material: Stainless steel and brass external parts
- Ambient operating temperatures: -40 to 140°F (-40 to +60°C)

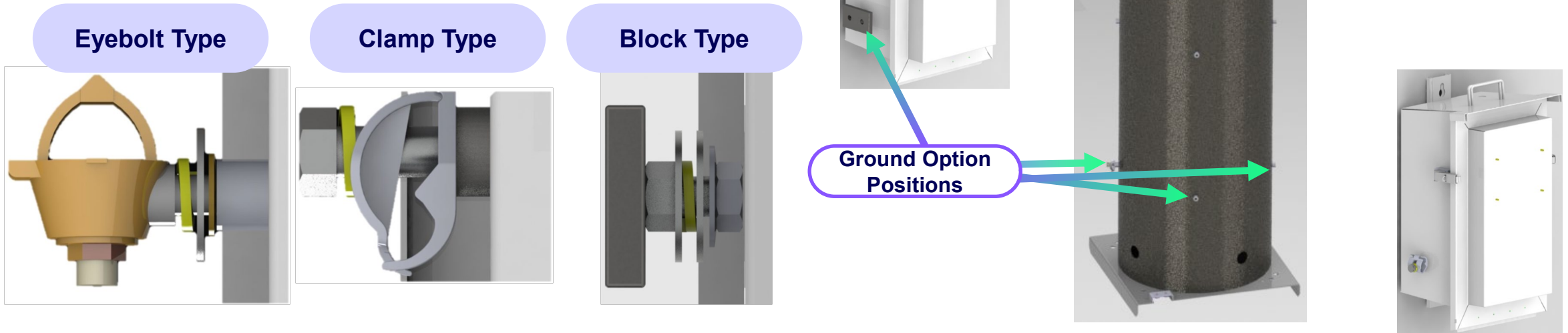


Thermometer  
Position



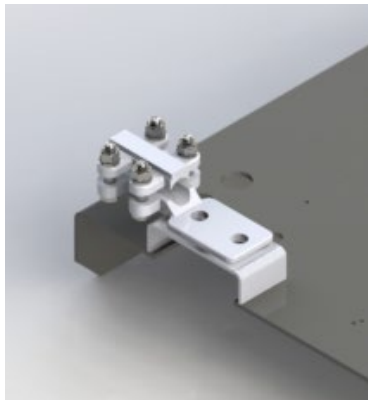
# External Grounds

- Besides the default grounds installed on the regulator (Base ground block, cover ground, etc.). We have the option to provide additional grounds:
  - Installed on the control cabinet.
  - Installed on the tank provisions.
- And we have the next types:

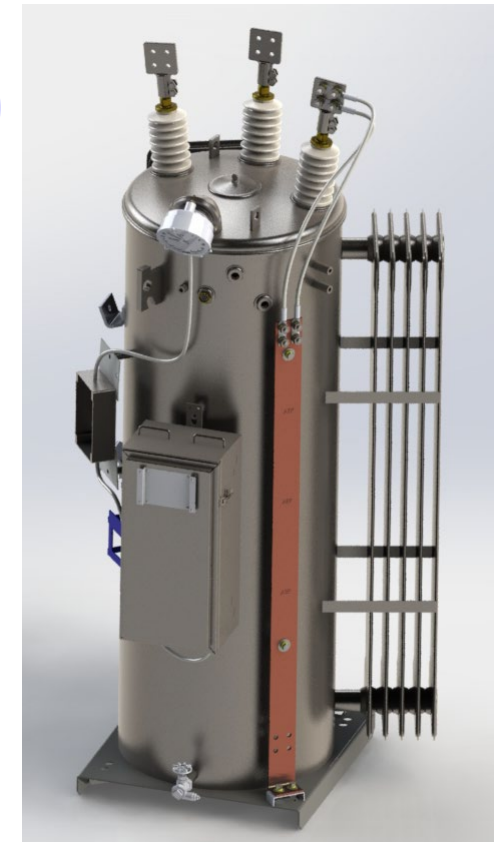
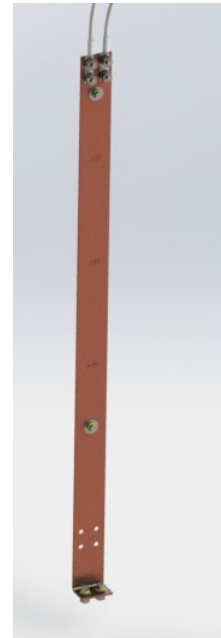


- Special grounds per customer specs:

SEFCOR  
Ground



Cooper Grounding Bar



- Standard superior powder-coat finish with average 3 mils on the tank and in compliance to salt spray ASTM B117 and IEEE Standard C57.12.28.
- Paint color: Light Gray No. 70, Munsell 5BG 7.0/0.4.
- Prolec GE can provide these coatings and paintings upon customer request:
  - Inside Tank, above liquid level only.
  - Inside Tank, fully painted.
  - Average 5 mils paint.
  - Zinc Rich Primer coating.



**Paint Inside above  
Liquid Level**



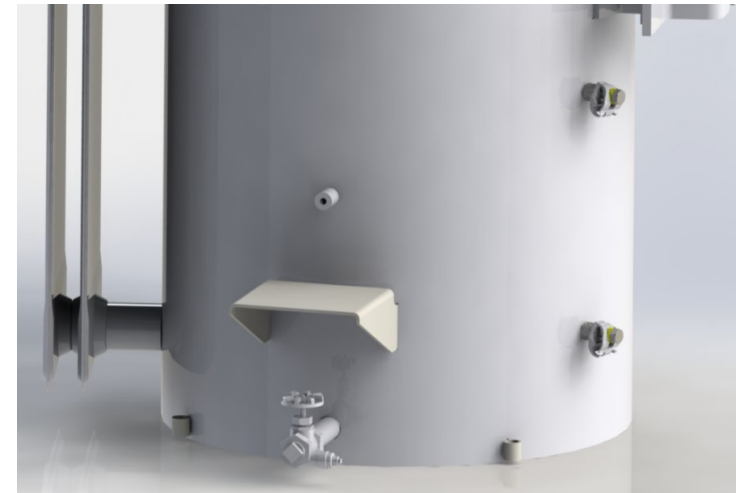
## Previous Design

When the regulators are installed in the field, the operators use to step on the drain valve, and damage it, causing leaking.



## Improved Design

A welded platform was developed and welded on the top of the valve, to avoid the operators to step into the valve, and use the platform instead.







# Regulator Components

- Control Assembly

- Control Modules
- Cabinet Enclosure
- Position Indicator Cables
- Control Accessories
- Junction Box



**Prolec GE Voltage Regulators** do NOT require voltage adjustment in control's software.

Input voltage from PT, display voltage on control, and voltage on meter out terminals will all match via nameplate ratios outputting to 120 Vac.

Also, a true 120 Vac coming from the NN terminal block. And should be the same as your meter out terminals



## Regulator Components

- Control Assembly
  - Control Modules

# Controller Options

Each controller manufacturer has their own options on communication ports, displays, etc.



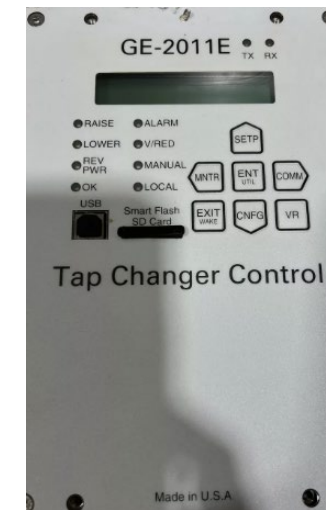
SEL-2431



Beckwith M6200A



GE-2011C



GE-2011E



\*Cooper/Eaton CL-7

**\*Note:** The controller Cooper/Eaton CL-7 is compatible with our voltage regulator, but we do not provide it as option. When it has required by a customer, we send an empty cabinet assembly, with the required brackets and cable harnesses to allow to the customer to install them in our cabinets. However, the CL-7 controller should be purchased and installed directly by the customers.

Old options, not offered anymore:



ICMI UVR-1



ICMI USC-II



GE 2011B & D



## Regulator Components

- Control Assembly
  - Cabinet Enclosure

Our cabinets are designed in compliance with NEMA 250-2008 (4X) and IEEE/CSA Standard (IP66).



- Carbon Steel or Stainless-Steel Cabinet
- Front Door



- Polycarbonate Cabinet
- Front Door



- Polycarbonate Cabinet
- Side Door

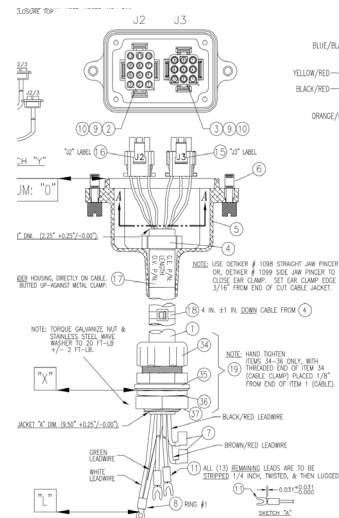




## Regulator Components

- Control Assembly
  - Position Indicator Cables

The position indicator cable brings the signals from the inside of the voltage regulator to the control cabinet. It is physically connected between the position indicator and the control cabinet (either to the top or the bottom, as required by customers).

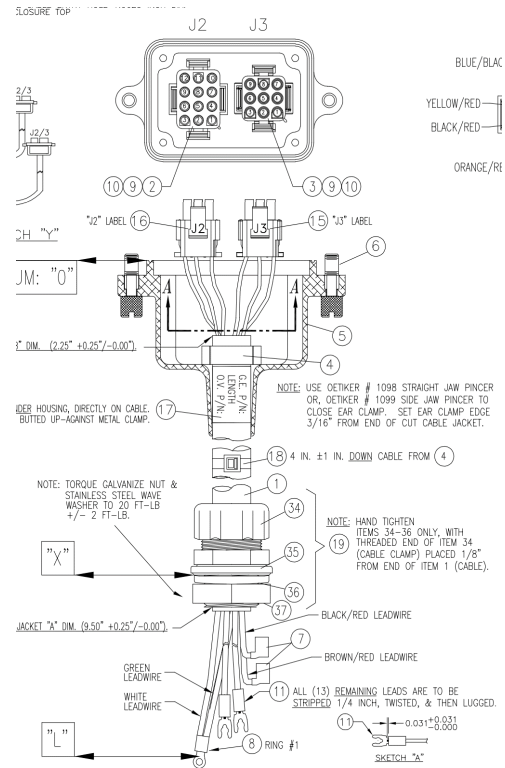


We have the next available options:

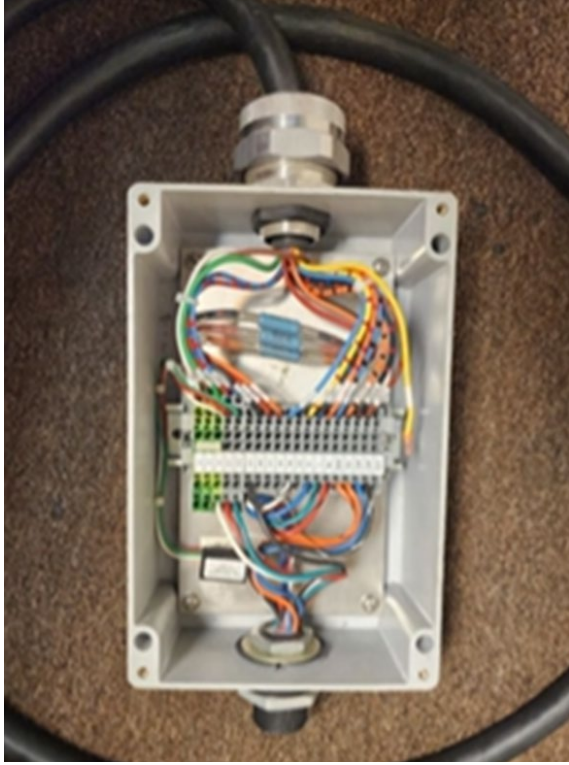
Cable Length (Ft)
3
5
10
15
20
25
30
35
40
50
60
70
120

Cable protection
Non-Armored
10 Ft Armored
Fully Armored

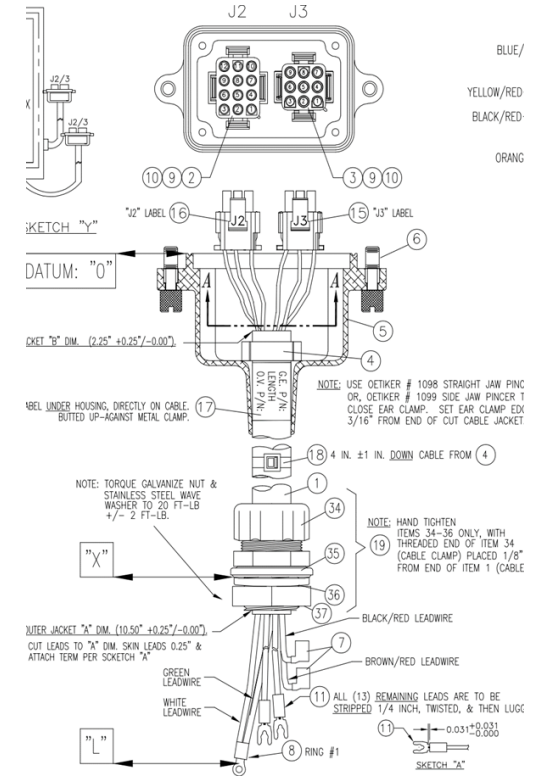
Here are some examples of special cable options we have provided in the past:



**Standard Cable**



**Cable for Eaton universal interface. 12 pin and 19 pin**



**Cable for sliding link terminals.**



## Regulator Components

- Control Assembly
- Control Accesories

## Control Alerts:

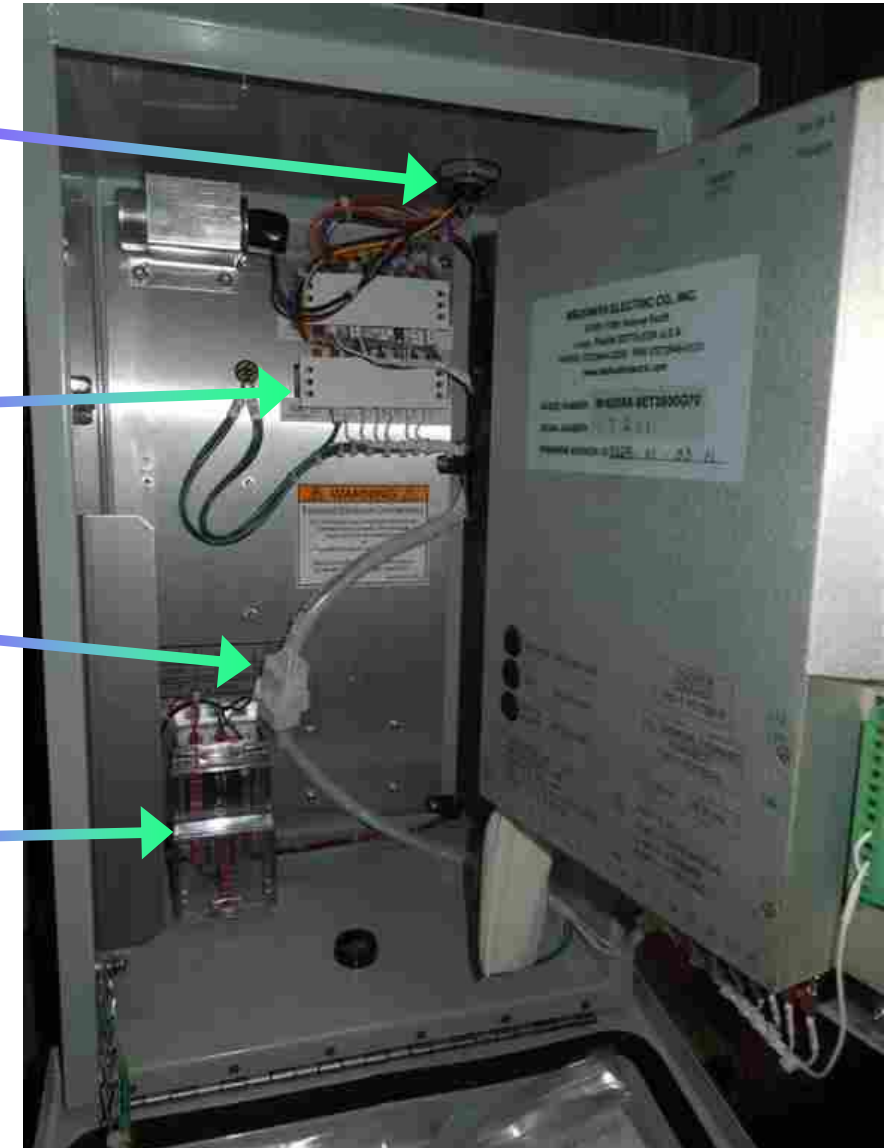
**Position Indicator connectors:**  
Regulator must be de-energized before disconnecting. Do not energize regulator unless a control is attached.

**NN PT Jumper:**  
MUST BE SET CORRECTLY BEFORE ENERGIZING REGULATOR !

**Panel disconnect:**  
Turn power off and Short CT before opening this connector.

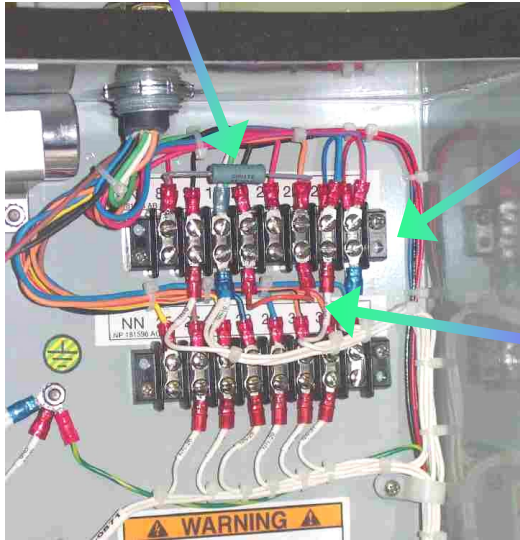
**Control Power & CT Shorting Switch:**

- IN SERVICE
  - Left switch: CLOSED
  - Right switch: OPEN
- OUT OF SERVICE
  - Left switch: OPEN
  - Right switch: CLOSED



## Main Accessories (Not all included):

Jumper with Resistor, for In-wound PT designs\*

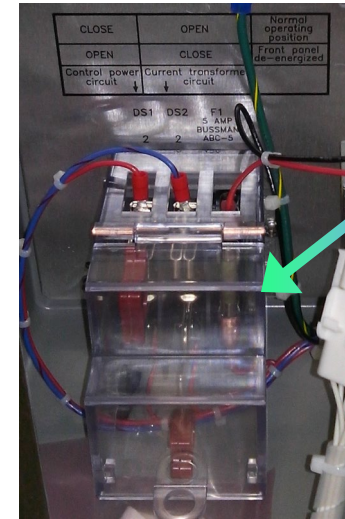


Heater (Provided upon request only)



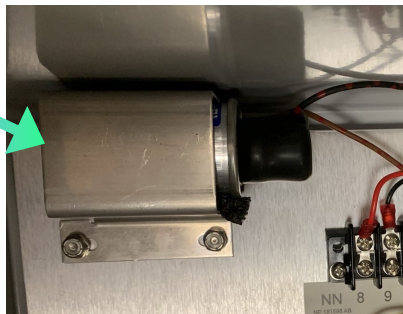
NN Terminal Blocks  
(Top covers installed later)

Voltage Tap Selection Jumper

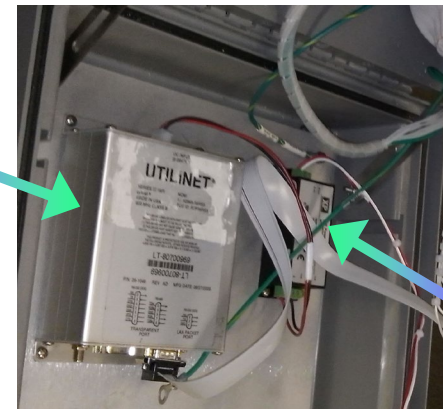


Knife Switch and cover

Motor Capacitor

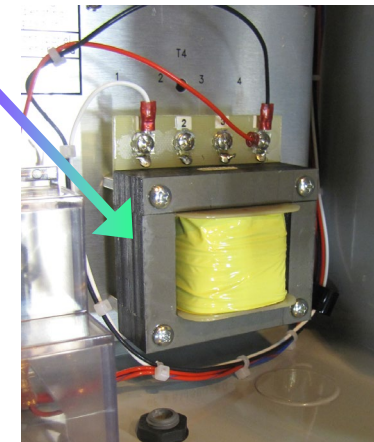


Radio (Special request)



Ratio Correcting Transformer

(RCT. Provided when customer request special operating taps)



Power Supply (Special request)

\* For In-wound PT designs, the impedance of Potential winding is very low. A 0.75 ohm resistor is added to the NN terminal board to limit short circuit and provide an impedance similar to the externally potential transformer.



## Regulator Components

- Control Assembly
- Junction Box

In the latest revision of the IEEE C57.15, 2017, the section 11 was added related to an “Universal Interface”.

It describes a feature that can be offered by the voltage regulator manufacturers, a universal connector that can be used by any manufacturer:

IEC 60076-21:2018  
IEEE Std C57.15-2017

## 11 Universal interface

### 11.1 Connection between control enclosure and apparatus

A universal interface, when specified, shall be made available between the voltage regulator control enclosure and apparatus. This is accomplished by way of an auxiliary enclosure. The auxiliary enclosure shall include the following features:

- universal interface receptacle;
- a means of shorting the current transformer secondary; either mechanically or electronically;
- terminal boards and wiring for managing signals between voltage regulator apparatus and control enclosure;
- minimum IP rating of 24 (NEMA 3R);
- capacitor for the tap-changer motor (if not included within the control enclosure);
- grounding provision shall be provided for metal enclosures. For proper control operation and improved safety, interface enclosure shall be grounded using the same ground used for the voltage regulator apparatus and control enclosure.

NOTE 1 Refer to NEMA Standards Publication 250-2003 [30] or IEC 60529 [15] for details regarding the various degrees of protection provided by electrical circuitry enclosures.

NOTE 2 Other types of enclosures are available that are more resistant to dust and water. These options can be specified by the purchaser based on discussions with the manufacturer.

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- 117 -

Universal interface shall withstand an applied voltage of 1,5 kV, < 500 Hz from all terminals to ground for 1 min.

Table 23 – Socket pin identification for connector

Terminal pin/socket	Function
A	Ground
B	Operations counter contact closing to ground
C	Neutral light switch contact closing to ground
D	CT secondary (polarity)
E	CT secondary
F	Voltage supply (“L” bushing)
G	Raise circuitry from tap-changer motor
H	Lower circuitry from tap-changer motor
J	Raise circuitry from tap-changer motor capacitor
K	Lower circuitry from tap-changer motor capacitor
L	Drag hand reset of mechanical position indicator
M	Feedback circuitry of Raise and Lower circuitry of tap-changer motor
N	Neutral light switch contact closing to phase
P	Voltage supply (“S” bushing)
R	Auxiliary AC voltage supply <sup>a</sup>
S	OPEN <sup>b</sup>
T	OPEN <sup>b</sup>
U	OPEN <sup>b</sup>
V	OPEN <sup>b</sup>

<sup>a</sup> Pin R has its voltage rating documented.  
<sup>b</sup> Open pins are available for additional circuitry between the apparatus and control specified by a purchaser. Circuitry is documented and the compatibility with other controls or apparatus is verified.

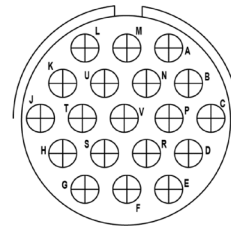
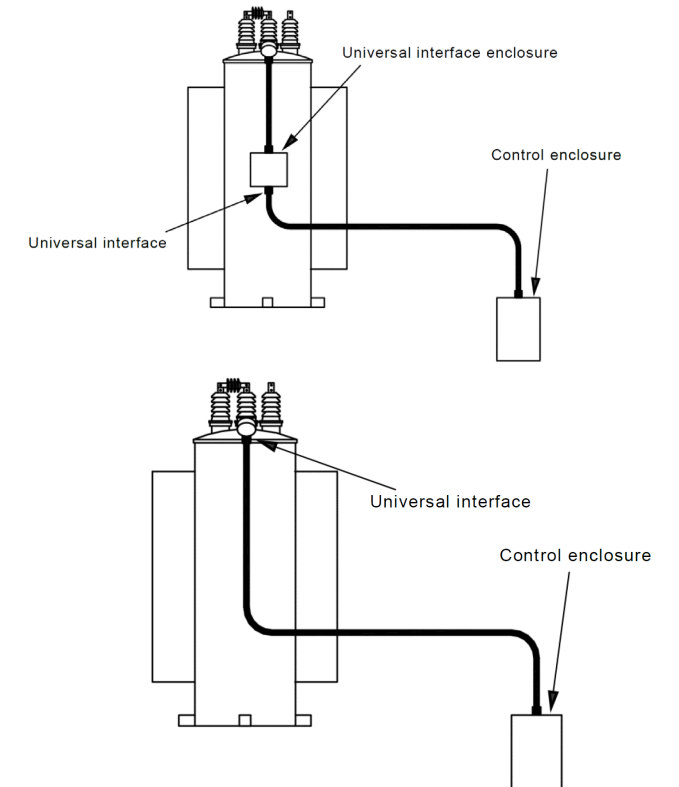


Figure 23 – Socket/pin detail for universal interface

Figure 24 – Universal interface locations

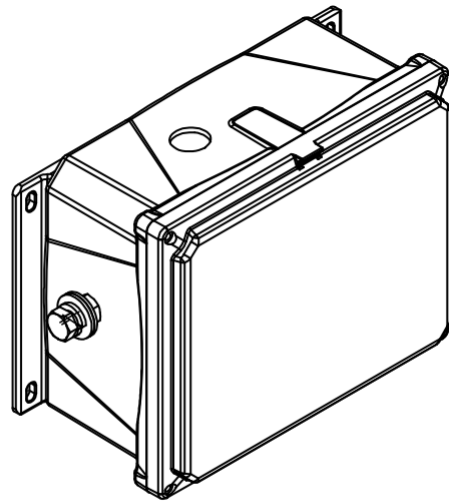


The figure 24 gives two examples of locations for the universal interface on the regulator. Prolec GE only provides currently the offering from the first picture.

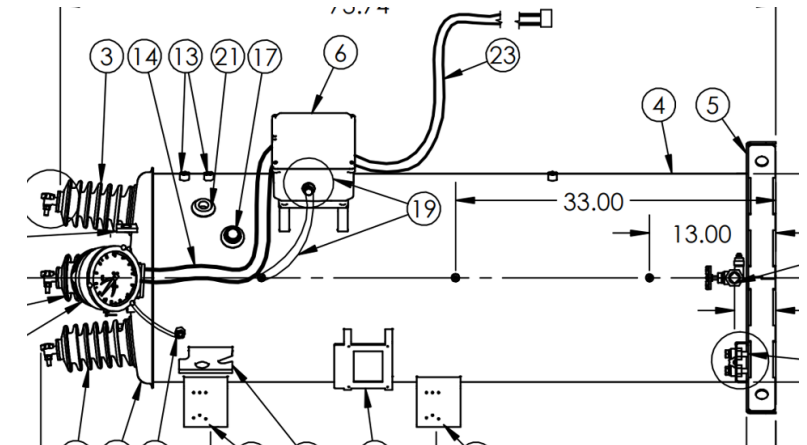
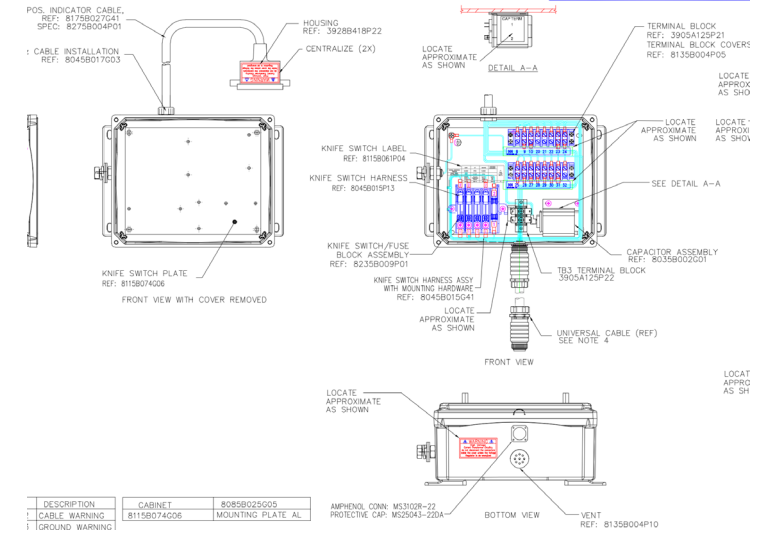
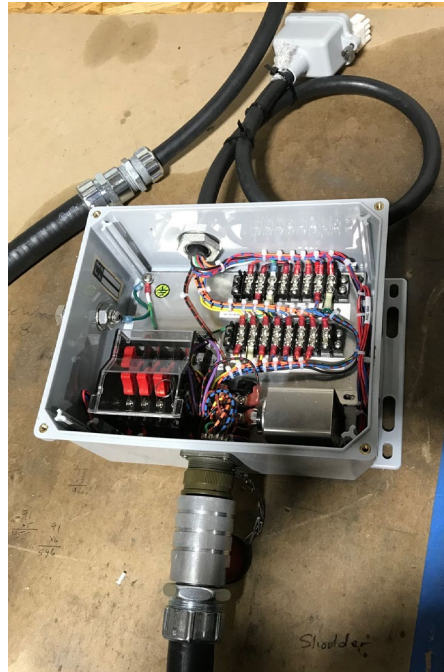


# Control Assembly – Junction Box

In 2021, we made a new development to start to offering the universal junction box and the universal cable, to the customers that request them:



**GENERAL VIEW**



The junction box is mounted to the regulator tank, connected electrically to the regulator with the position indicator cable.

Inside the box, all the required connections are made, to give the output of the signals requested by the C57.15-2017 on their exact positions.



## Regulator Components

- Control Assembly
  - Control Set-Up

The set-up of the controllers and their settings will be explained in detail by the controller manufacturers during their presentations.

## Basic Settings:

- Voltage Level
- Bandwidth
- Time Delay
- Timer Type
- CT Ratio
- Clock setting
- Intertap Delay
- Line Drop Compensation
- Regulator Type
- Limits and Runback
  - Block raise / lower
  - Current limits

## Advanced Settings:

- Reverse Power Flow Modes
- Reverse Power Flow Settings
- Voltage Reduction
- Programmable Alarms



## Regulator Components

- Customer Approval Drawings (PA's)

- Nameplate
- Outline
- Wiring Diagram



## Regulator Components

- Customer Approval Drawings (PA's)
- Nameplate

# Nameplate

The nameplate drawing is part of the set of drawings that we send to the customer for approval, prior to start the order manufacture.

The nameplate electrical characteristics were discussed already into the electrical theory section. We are going to mention just some additional options for the customers into this section.

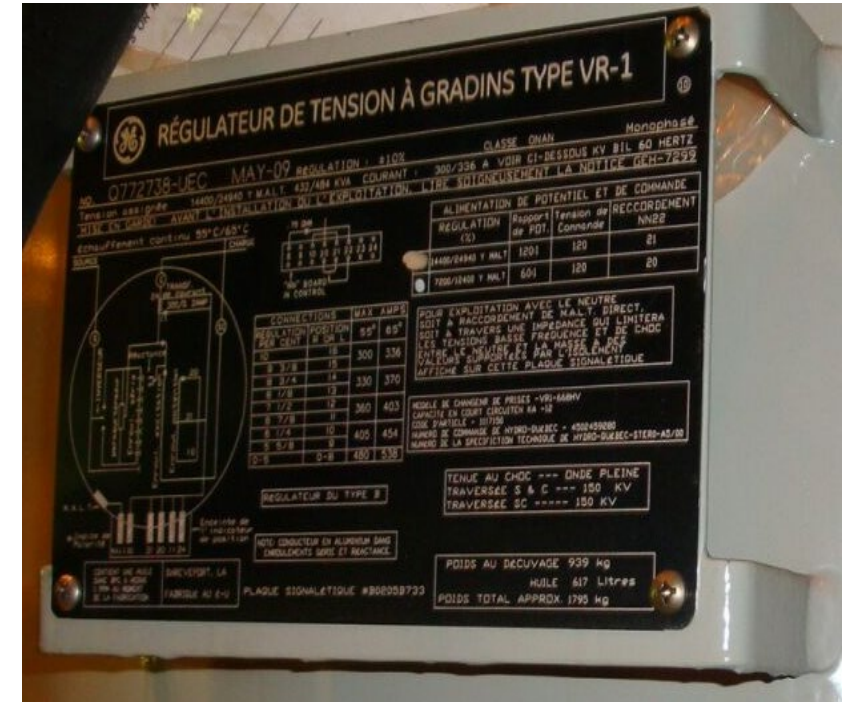
**Nameplate installation:** It is installed in two positions for all the regulators.

- Front of the cabinet
- Tank support.



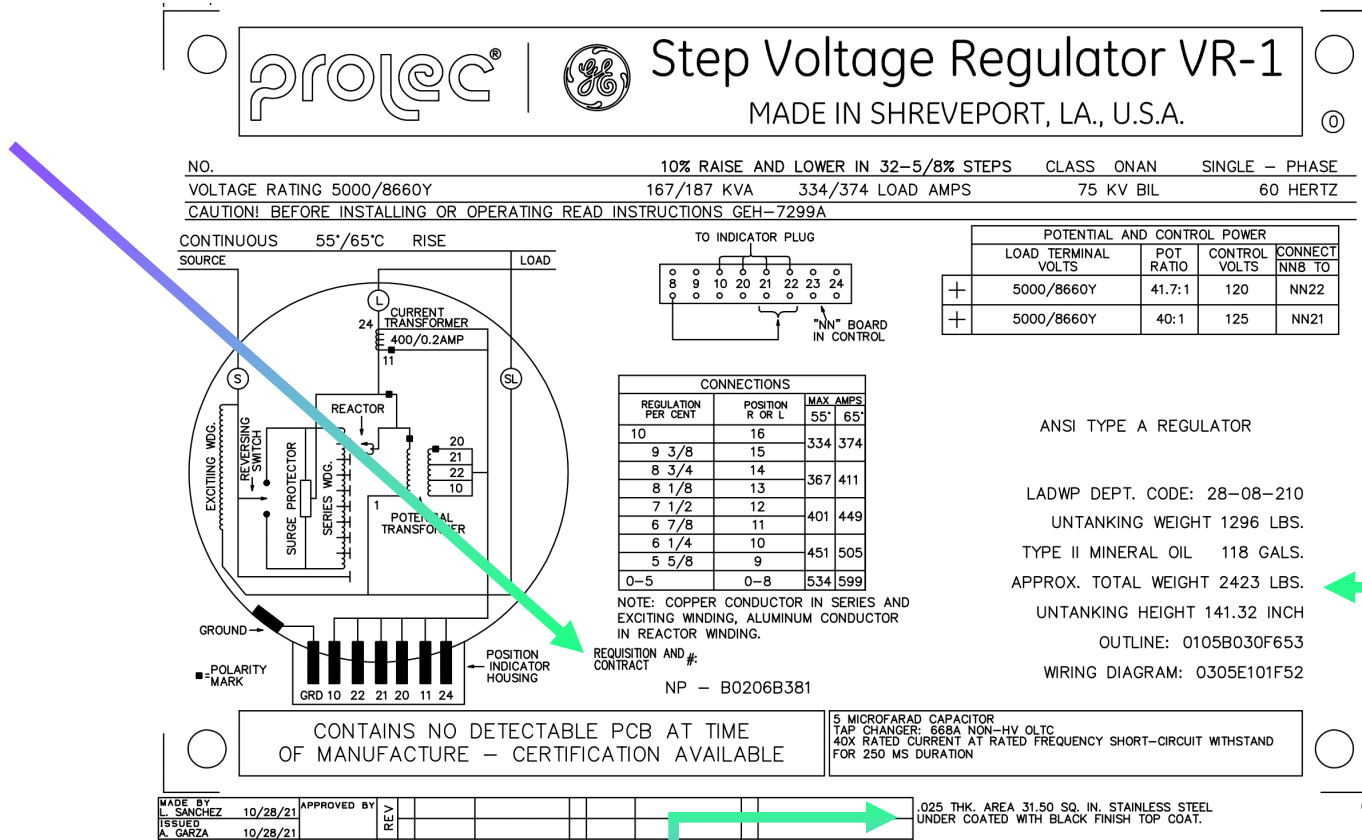
**Nameplate languages:** Four languages available.

- English
- Spanish
- French
- Russian



**Nameplate notes:** Beside the standard notes, tables and views that we added to our nameplates, some customers request special notes such as the next ones.

- EQ #
- PO #
- Internal Arrester Note
- Etc.



**Nameplate materials:** Two materials available.

- Aluminum
- Stainless Steel.

**Nameplate units:** Two units offered.

- Imperial
- Metric





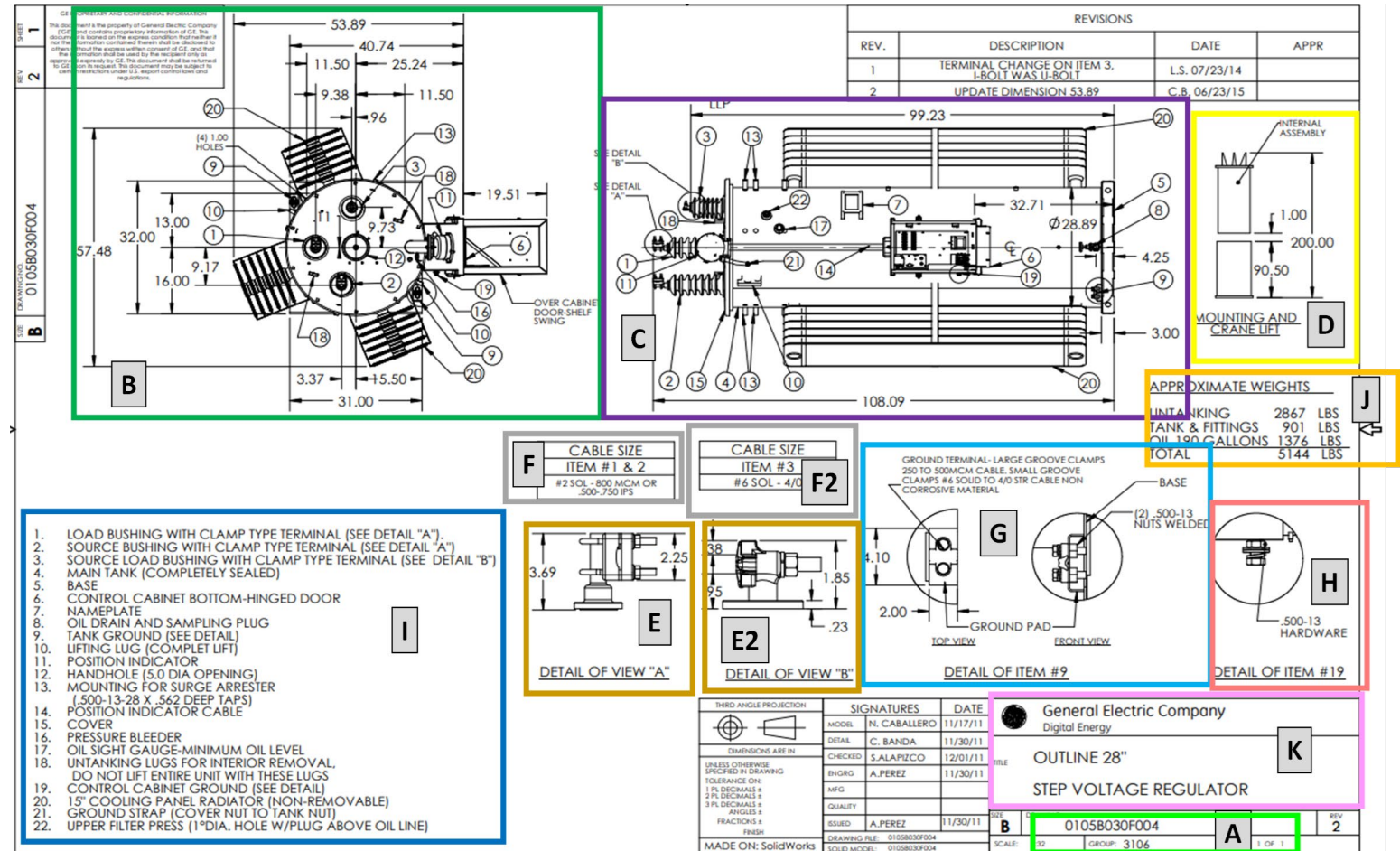
## Regulator Components

- Customer Approval Drawings (PA's)
- Outline

The outline drawing is also part of the set of drawings that we send to the customer for approval, prior to start the order manufacture.

The standard outline drawings includes the next information:

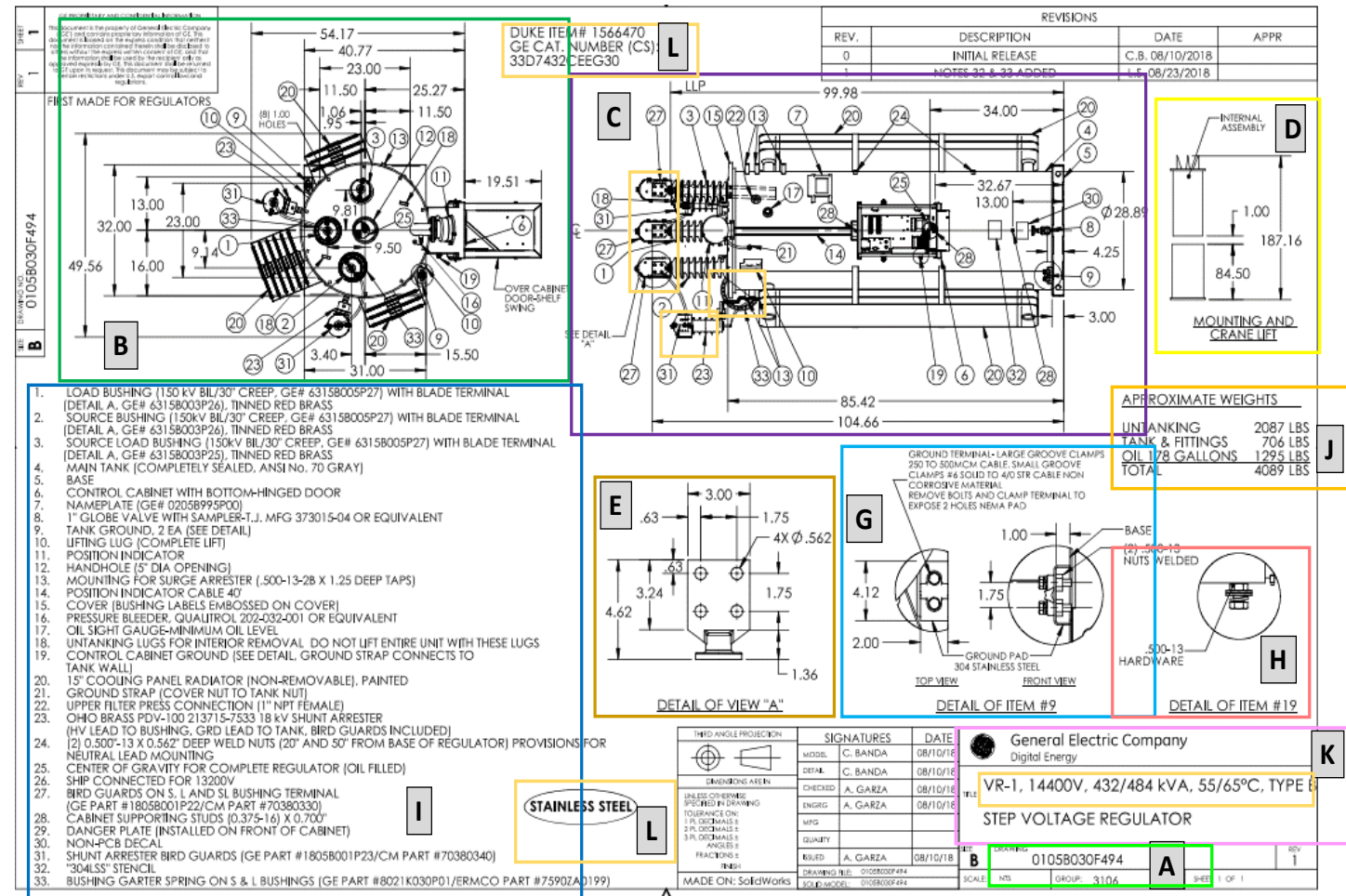
Outline part number	A
Top View	B
Front View	C
Mounting and Crane Lift	D
S and L Terminals Detail	E
S and L Terminals Cable Details	F
SL Terminals Detail	E2
SL Terminals Cable Details	F2
Tank Base Ground Details	G
Control Ground Details	H
Components List	I
Approximate Weights	J
Title Block Information	K



We have also some outline drawing that includes special information or views requested by the customers.

Special outline drawing example below:

Outline part number	A
Top View (Special features displayed: Guards, LA's, Antitracking kit, Decals, CoG, etc.)	B
Front View (Special features displayed: Guards, LA's, Antitracking kit, Decals, CoG, etc.)	C
Mounting and Crane Lift	D
S and L Terminals Detail	E
S and L Terminals Cable Detail (Not displayed on this terminal type)	F
SL Terminals Detail (Not added when terminal type is the same)	E2
SL Terminals Cable Details (Not added when terminal type is the same)	F2
Tank Base Ground Details	G
Control Ground Details	H
Components List (Additional notes requested, 33 notes in total)	I
Approximate Weights	J
Title Block Information (Special descriptions)	K
Other Special sections: CS Number, SS Note, Birdguards, LA's, Decals, etc.	L





## Regulator Components

- Customer Approval Drawings (PA's)
- Wiring Diagram

# Wiring Diagram

The wiring diagram drawing is the last one of the set of approval drawings. It has 3 or 4 pages, depending on the controller type.

**Diagram Page 1:** The features displayed here are the next ones:

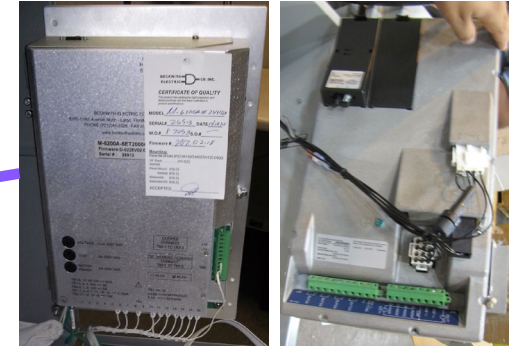
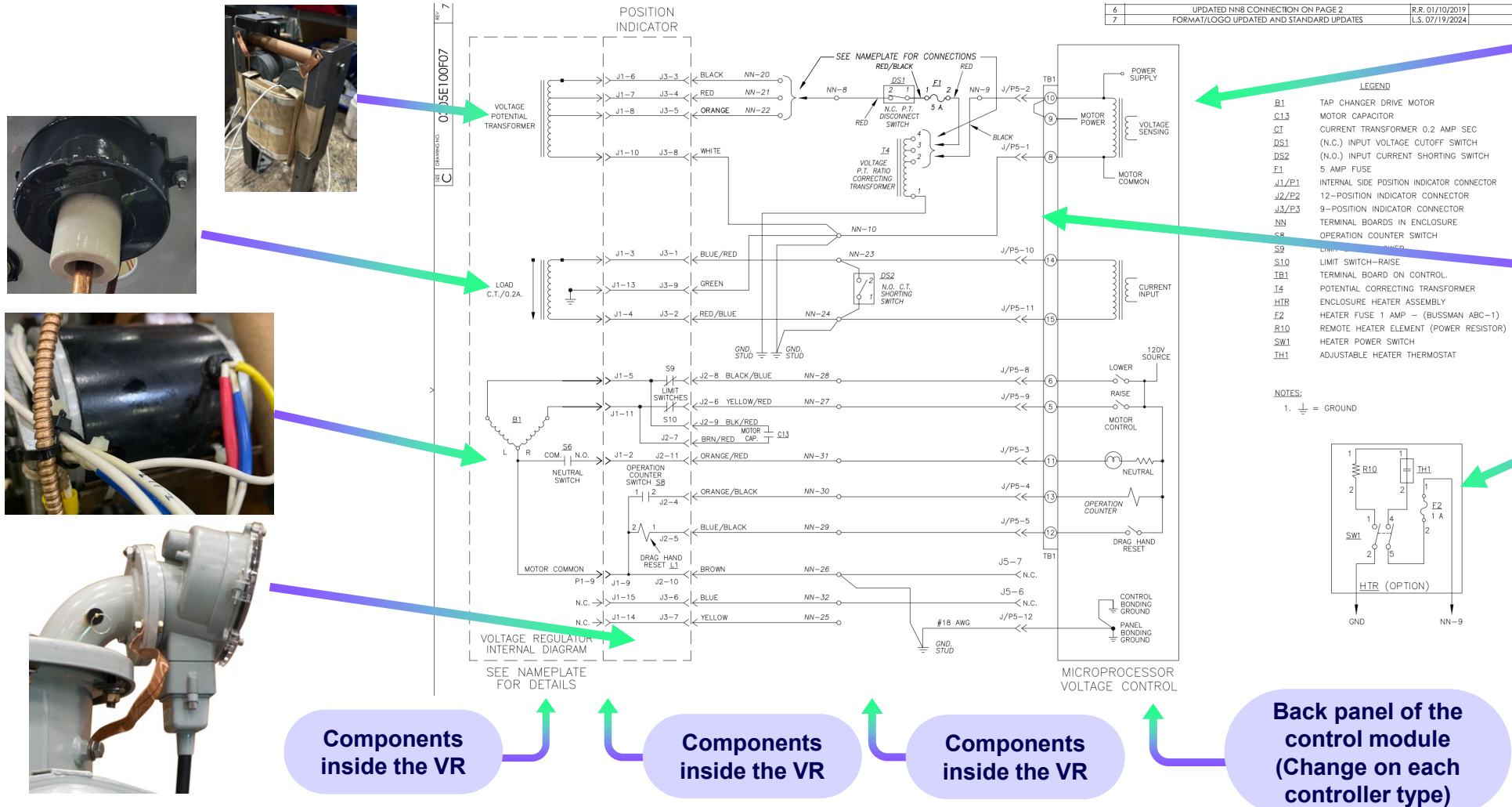
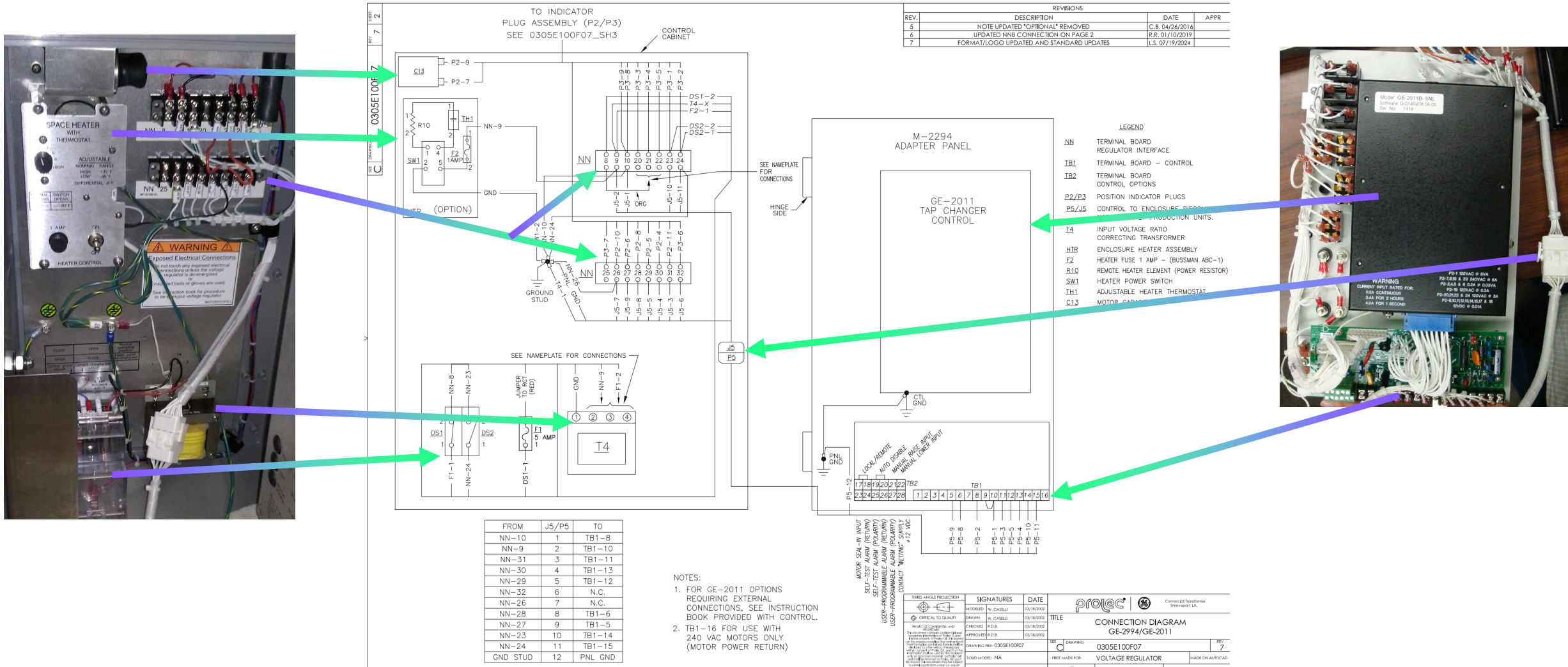


Diagram Page 2: The features displayed here are the next ones:



# Wiring Diagram

Diagram Page 3: The features displayed here are the next ones:

Components inside the VR. See page 1.

