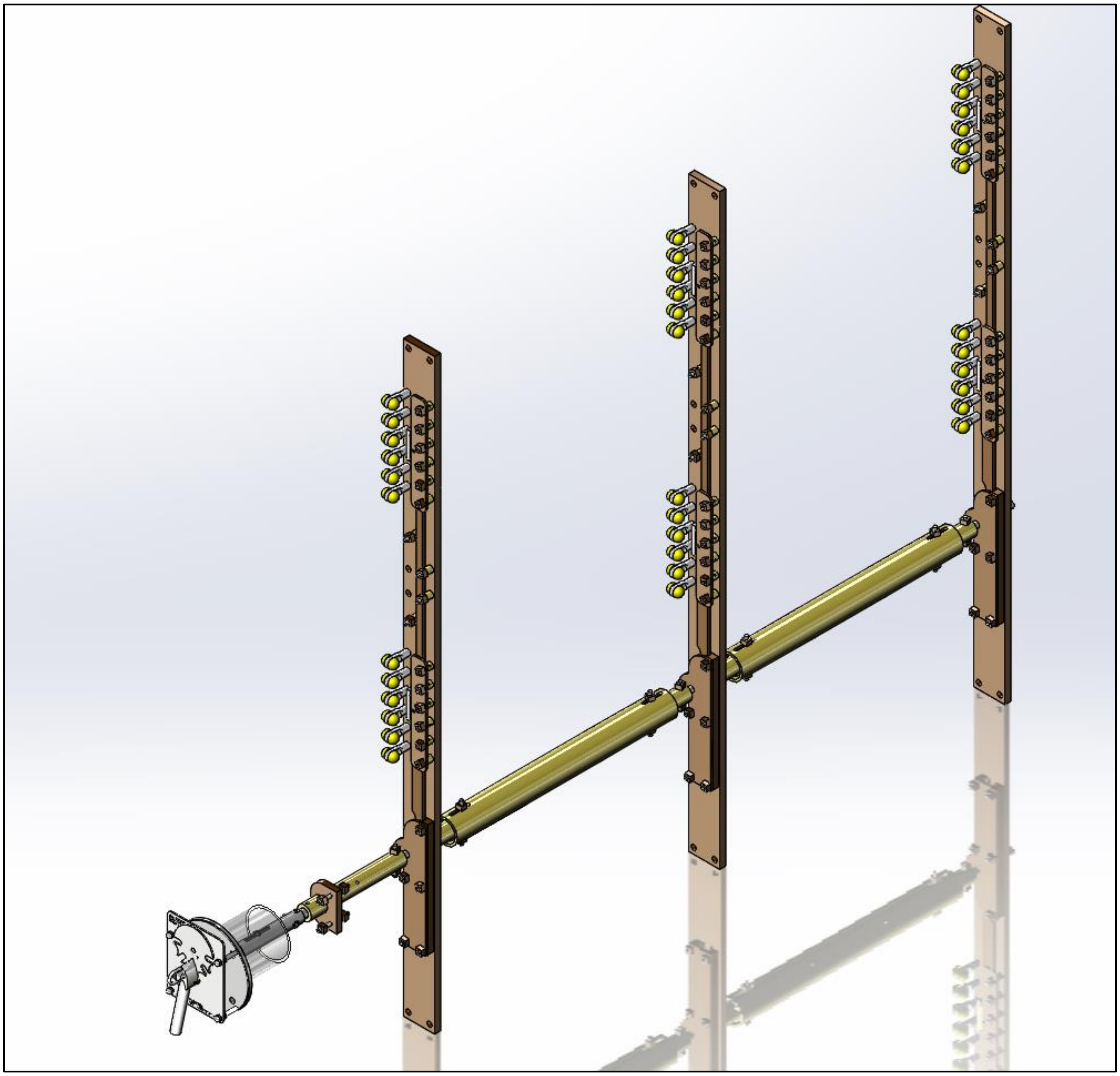
TYPE QS-DLS™ Non-Metallic Geneva Drive DETC:



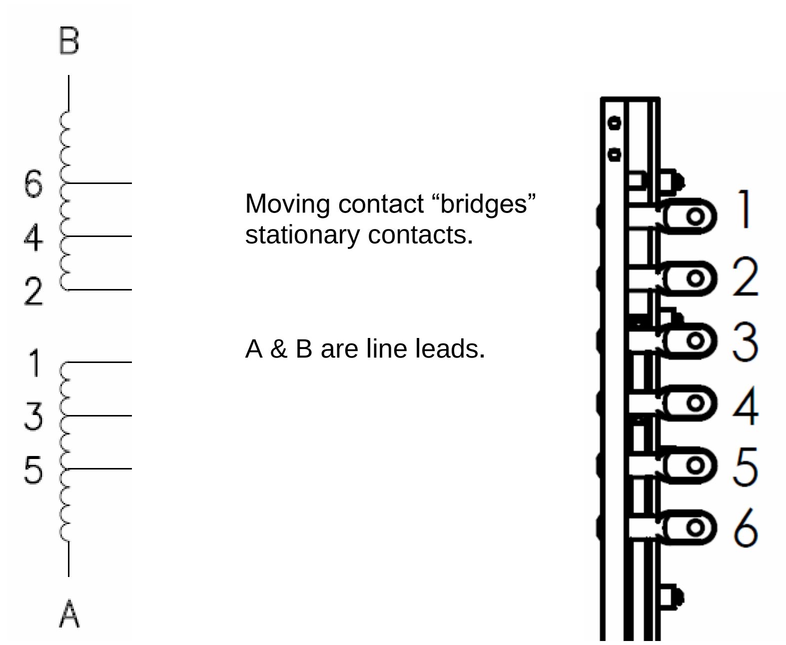
SCOPE:

This document contains general information about applying and installing the QS-DLS™ non-metallic Geneva driven de-energized tap changer. These instructions do not describe all possible issues that may arise during installation, operation, or testing of the tap changer. It also does not describe all of the details and variations of the equipment. Consult the drawings supplied with the order for additional information. In addition, if there is a special application, the switch may be adaptable or customized in some aspects, so please contact Quality Switch for special requests.

INTRODUCTION:

The type QS-DLS™ tap changer is one family of the Quality Switch tap changers that is designed for power transformers. A de-energized tap changer (DETC) is intended to be connected to the winding of the taps of a transformer. When the DETC is moved from one position to another, the amount of tap winding connected into the circuit is changed. The DETC is typically installed into the high voltage circuit and is generally used to adjust the primary voltage of the transformer within a 10 percent range in 5 steps. The QS-DLS™ non-metallic Geneva Drive DETC is modular and designed as a bridging type DETC with an external operating mechanism. It is commonly used as a 5 position DETC and is made of individual tap decks (one group or two tap groups per deck). The switch is designed to be mounted and secured to the transformer structure (made of insulating wood or insulating pressboard) built up around the core and coil assembly of the transformer. Figure 1a shows one typical mounting arrangement. The tap decks can be mounted in the center of the core and coil assembly which allows the tap leads to be short and avoid long routing of the cable or they can also be mounted in between the coils (in the belly) to save space. One advantage of the non-metallic Geneva drive system is that the entire tap deck gear drive and coupling tube system is non-metallic, so the drive can be located at the bottom as shown in Figure 1a, in the middle of the tap groups (Figure 1b), or even at the top of the unit (Figure 1c) since there is no floating or grounded metal in that part of the system. This allows some flexibility over some competing designs because the handle can be located where desired without adding cost for external gear drives. All three of these figures are shown with two tap groups, but they can be applied to single tap group arrangements as well (see Figure 1d for example of single and Figure 1e for example of one single group and one double group DETC arrangement). These switches are very modular and customizable, so please inquire if you have any questions on how to make these best fit your transformer layout and we will work with you.

Figure 1: Bridging Contacts (1 tap group shown)



*NOTE: SEE OUTLINE DRAWING FOR CONNECTION DIAGRAM FOR A SPECIFIC DESIGN

Figure 1a: Mounting Arrangement (handle near ground level)

*Note that the handle is shown exiting ANSI segment 2 in this example. The handle can exit either segment 2 or 4, however it is recommended that the stationary contacts be kept on the tank wall side (opposite of the coils) to better shield the moving contact edges. Clearances between the tank wall and live parts on the switch need careful consideration. Often, pressboard barriers are installed on the transformer structure between the tank wall and the DETC depending on the voltage class of the transformer and clearances available.

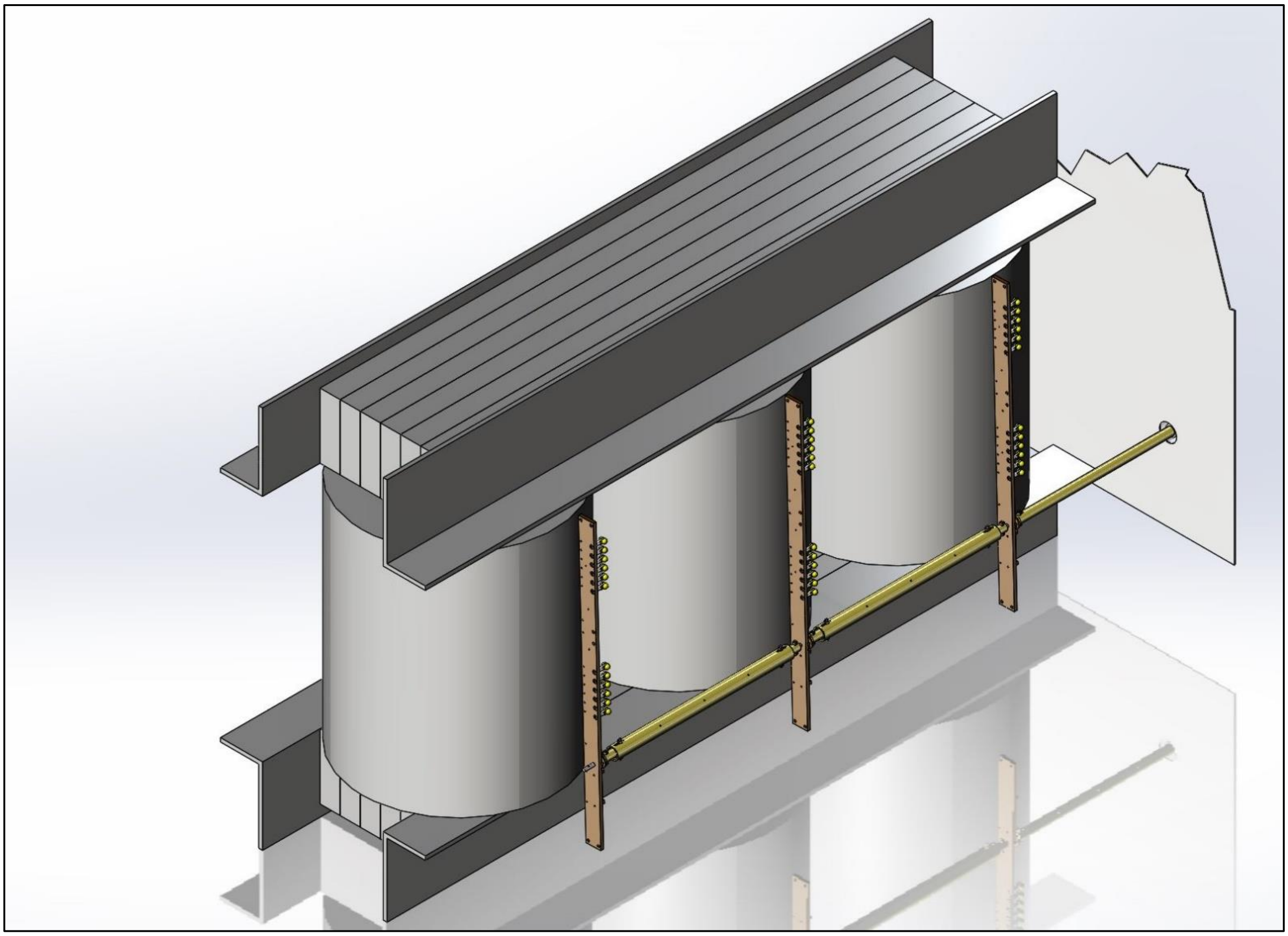


Figure 1b: Mounting Arrangement (handle middle of coils)

*Note that the handle is shown exiting ANSI segment 4 in this example. The handle can exit either segment 2 or 4, however it is recommended that the stationary contacts be kept on the tank wall side (opposite of the coils) to better shield the moving contact edges. Clearances between the tank wall and live parts on the switch need careful consideration. Often, pressboard barriers are installed on the transformer structure between the tank wall and the DETC depending on the voltage class of the transformer and clearances available.

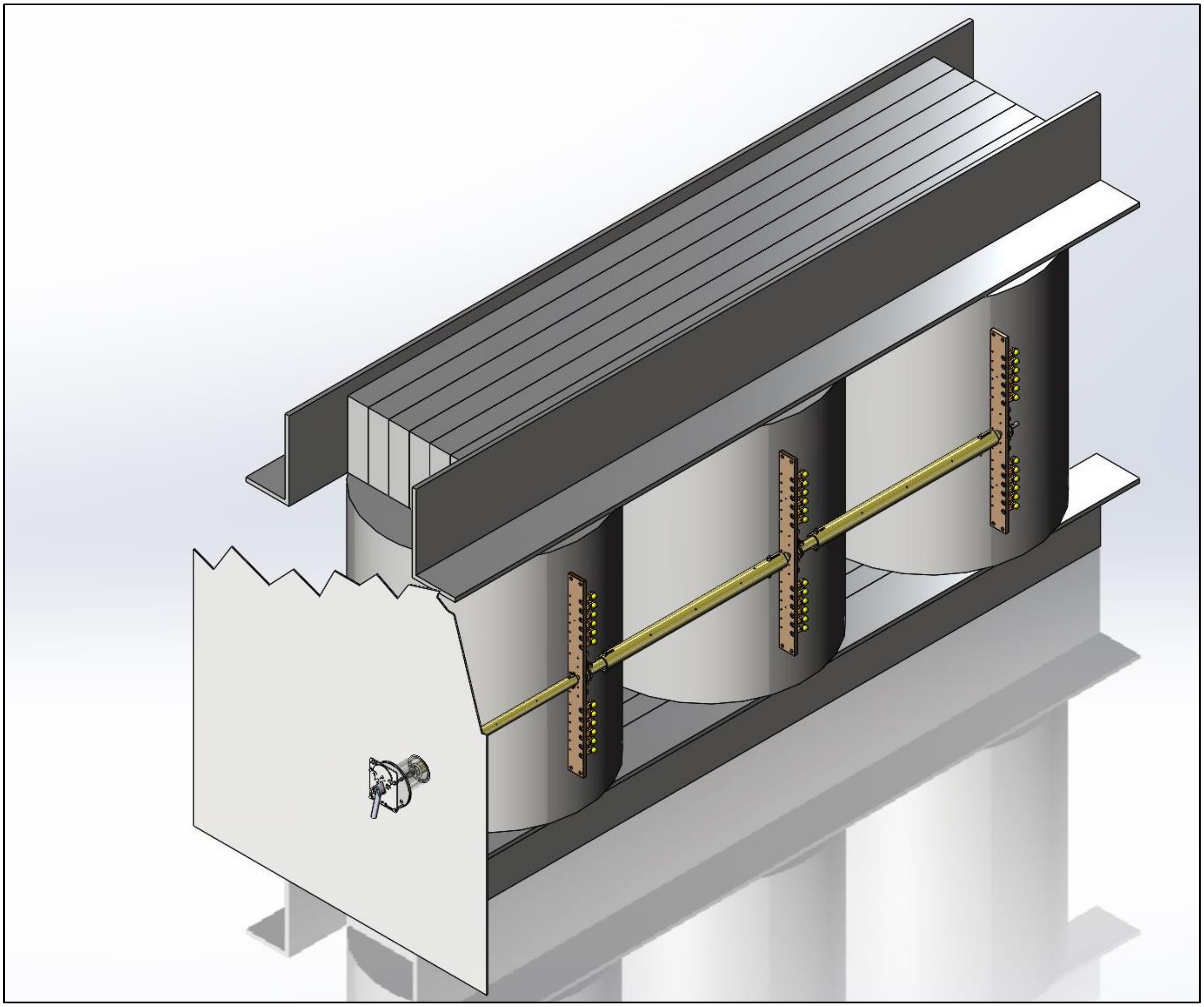


Figure 1c: Mounting Arrangement (handle top of coils)

*Note that the handle is shown exiting ANSI segment 4 in this example. The handle can exit either segment 2 or 4, however it is recommended that the stationary contacts be kept on the tank wall side (opposite of the coils) to better shield the moving contact edges. Clearances between the tank wall and live parts on the switch need careful consideration. Often, pressboard barriers are installed on the transformer structure between the tank wall and the DETC depending on the voltage class of the transformer and clearances available.

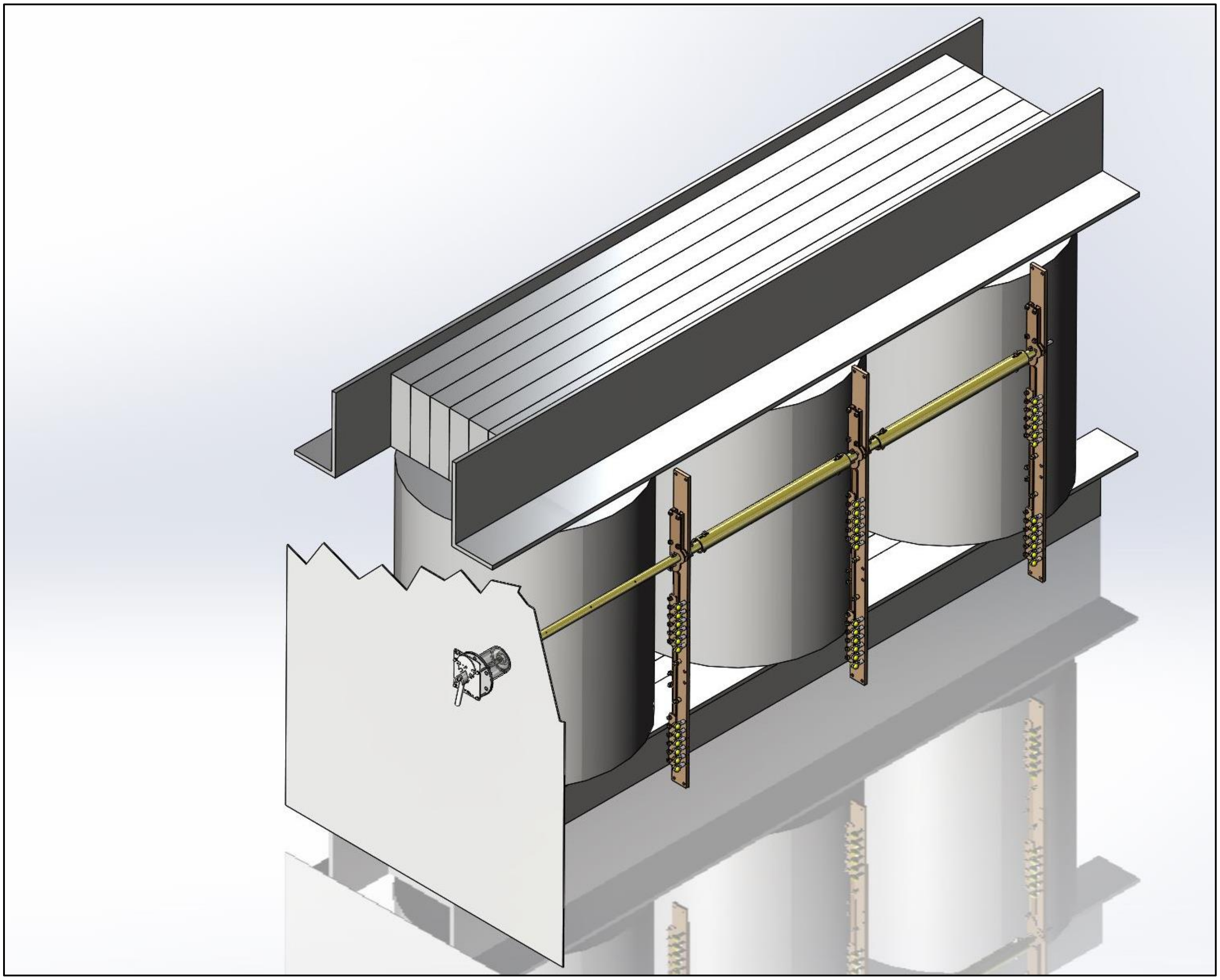


Figure 1d: Three Single tap group Mounting Arrangement

*Note that the handle is shown exiting ANSI segment 4 in this example. The handle can exit either segment 2 or 4, however it is recommended that the stationary contacts be kept on the tank wall side (opposite of the coils) to better shield the moving contact edges. Clearances between the tank wall and live parts on the switch need careful consideration. Often, pressboard barriers are installed on the transformer structure between the tank wall and the DETC depending on the voltage class of the transformer and clearances available.

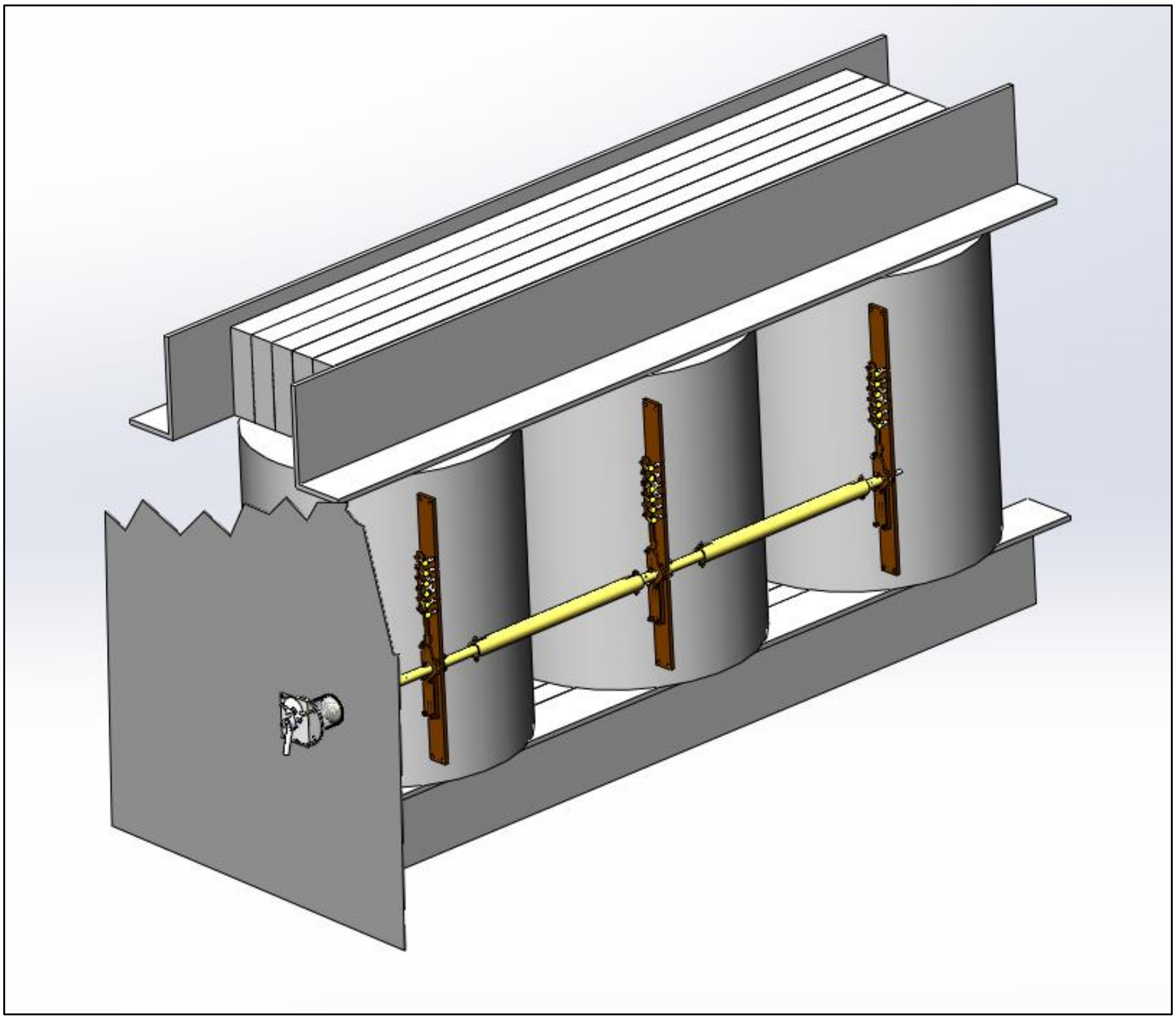
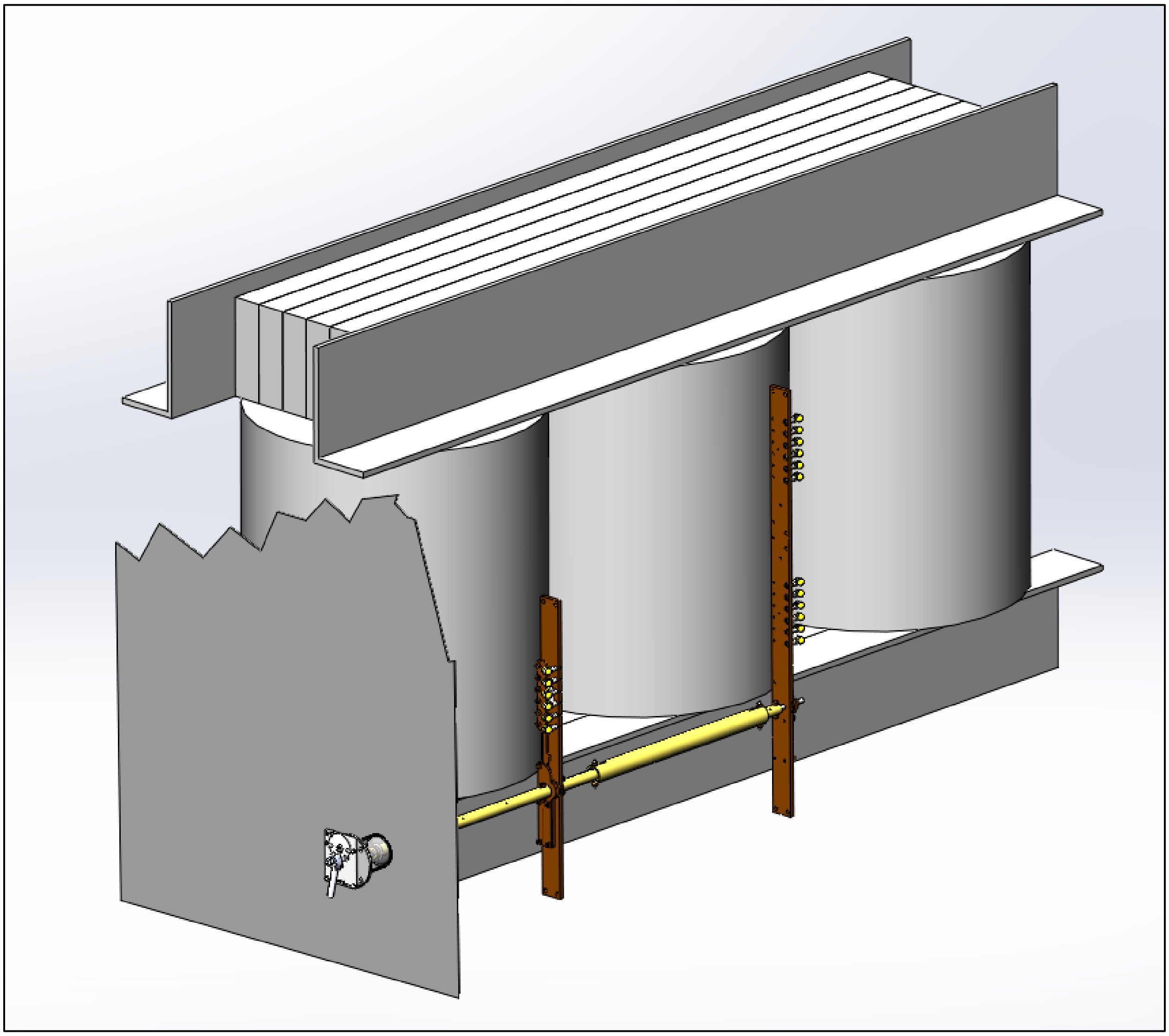


Figure 1d: One Single and One double group Mounting Arrangement

*Note that the handle is shown exiting ANSI segment 4 in this example. The handle can exit either segment 2 or 4, however it is recommended that the stationary contacts be kept on the tank wall side (opposite of the coils) to better shield the moving contact edges. Clearances between the tank wall and live parts on the switch need careful consideration. Often, pressboard barriers are installed on the transformer structure between the tank wall and the DETC depending on the voltage class of the transformer and clearances available.



RATINGS:

The QS-DLS™ non-metallic Geneva Drive tap changer is available with a current rating of 400amps per group or 600amps per group (see Table 1 & 2 below). The switch is intended to be used on transformers rated up to 650 kV BIL, however, the switch can be applied on a higher BIL transformer (750 to 900 BIL) if a specific winding arrangement falls within the design limits of the tested values between contacts (typically wye connected with the taps located near the neutral of the winding). In addition, the ratings are dependent on how the DETC is applied to the transformer, i.e., distance to the tank wall and distance between phases must be carefully considered. Shielding can be added around the ends of the tap groups at additional expense if desired (see Figure 2C for reference).

Table 1:

400 AMP QS-DLS™ Non-metallic Rack & Pinion Tested values	
Test	Result
FW Impulse between contacts (1.2X50 µs)	Passed 6 tests (+3 and -3) @ 210kV
60 Hz. Applied Voltage between contacts	85 kV for 1 minute
Temperature Rise in oil	9°C @ 400amps
*Typical Operating Torque (3 single groups)	≤ 5 ft-lbs
*Typical Operating Torque (6 groups)	≤ 10 ft-lbs
Short Circuit Withstand	2 seconds- 7.1kA RMS 10.2kA peak

Table 2:

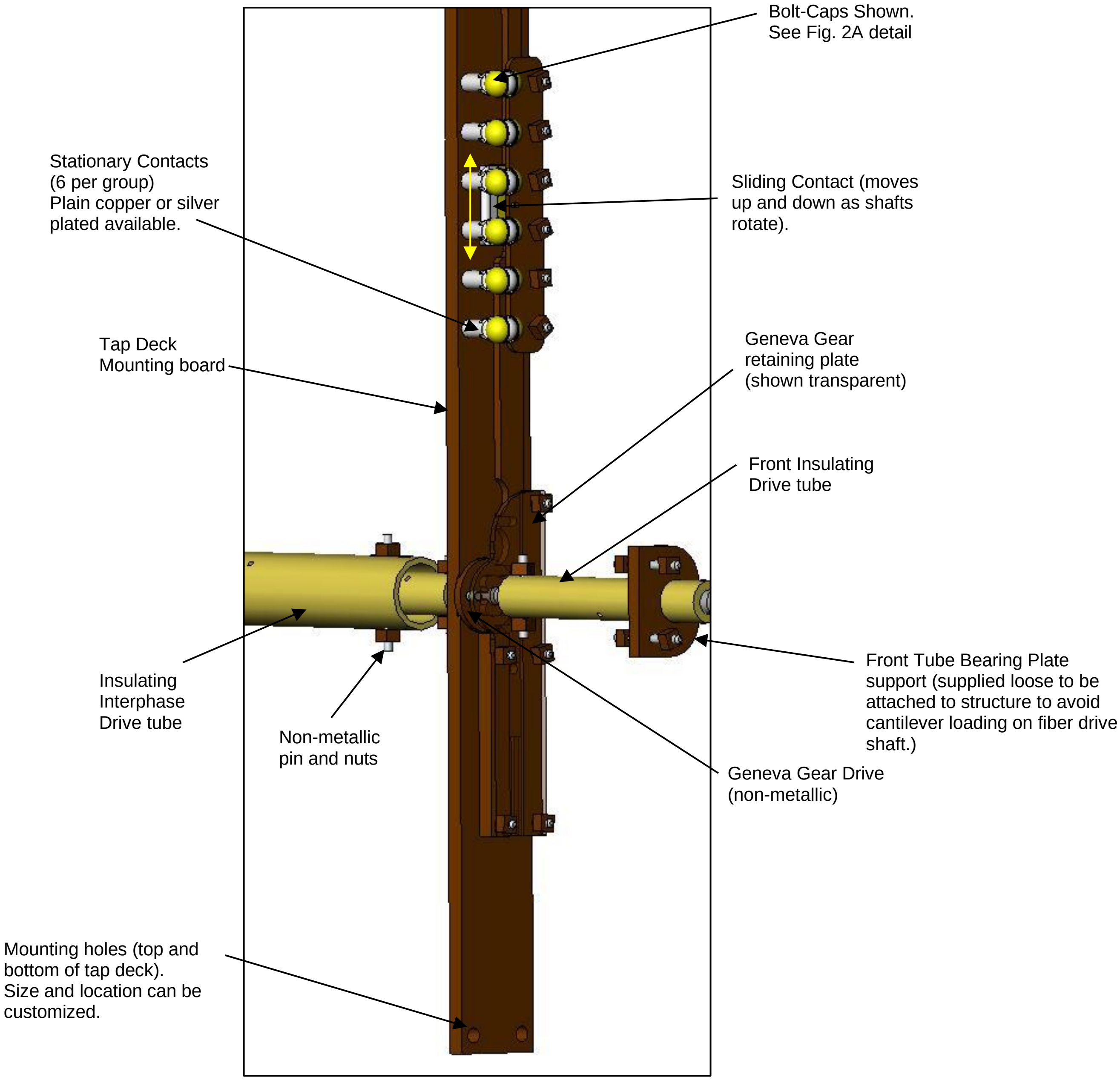
600 AMP QS-DLS™ Non-metallic Rack & Pinion Tested values	
Test	Result
FW Impulse between contacts (1.2X50 µs)	Passed 6 tests (+3 and -3) @ 260kV
60 Hz. Applied Voltage between contacts	145 kV for 5 minutes
Temperature Rise in oil	14.8°C @ 600amps
*Typical Operating Torque (3 single groups)	≤ 7 ft-lbs
*Typical Operating Torque (6 groups)	≤ 13 ft-lbs
Short Circuit Withstand	2 seconds- 7.5kA RMS 10.6kA peak

*Typical Operating torque listed is measured on a workbench. Mounting the switch assembly to a transformer structure may increase the operating torque measurement, but caution should be taken to avoid putting the switch mechanism in a bind due to mechanical mounting stresses.

DESIGN FEATURES & DETAILS:

The QS-DLS™ non-metallic Geneva Drive DETC is assembled with some basic components shown in Figure 2.

Figure 2: Tap deck features



TAP DECK MOUNTING BOARD:
The QS-DLS™ non-metallic Geneva Drive tap changer mounting board is machined of a 3/4" thick high pressure laminate manufactured and specifically tested for high voltage applications. The board is typically supplied with mounting holes to secure the tap changer to the transformer framework. These holes are located on the top and bottom of the board to allow flexibility in mounting and can be customized to match up to the transformer structure (see outline drawing for mounting locations).

SLIDING CONTACT:
The QS-DLS™ sliding contact is a solid copper contact (silver plated available) that has a fully rounded contact edge to avoid sharp edges and provides a line type contact with the stationary terminal which in turn allows a relatively low operating torque. The sliding contact is spring loaded and riveted to the non-metallic drive rack in order to provide ample contact pressure to withstand blow-off forces under fault conditions. This operation of the tap changer creates a sliding action that wipes the contact surfaces of the moving and stationary contacts. See Figure 2 for details of the drive system.

STATIONARY CONTACTS:
The stationary contacts are fastened to the tap board using button head cap screws with a specifically designed lock patch to prevent them from loosening once the tap changer is installed in the transformer and tap leads are connected. After dry-out of the transformer, the button head cap screws may need to be re-tightened due to expansion and contraction of the insulating material during that process. The torque when re-tightening should be limited to 40 ft-lbs max (480 inch-lbs). When re-tightening these contacts, be sure to hold them in place to keep the flattened face of the stationary contact as shown in Figure 2A. The stationary contacts are provided with a 7/16" diameter hole in a flattened face to attach the tap leads. For applications above 350 BIL, it is recommended to attach the tap lead terminals using bolt cap shields that will be supplied with the DETC to remove the sharp edges of the bolts and nuts and aide with better shaping the electric field. It may also be desirable for these connections to then be wrapped in some form of insulation (crepe paper or aluminum backed crepe paper). Also available, if preferred, customized crimp connections can be used rather than the bolt-on lug. Elpress compatible crimps are available upon request (specify cable size during quotation process). Each customer may have a preferred method they use within their transformer connections appropriate to the voltage class. See Figure 2A and 2B for a sample view of the connections.

Figure 2A: Bolt-on type Contact Connections Example

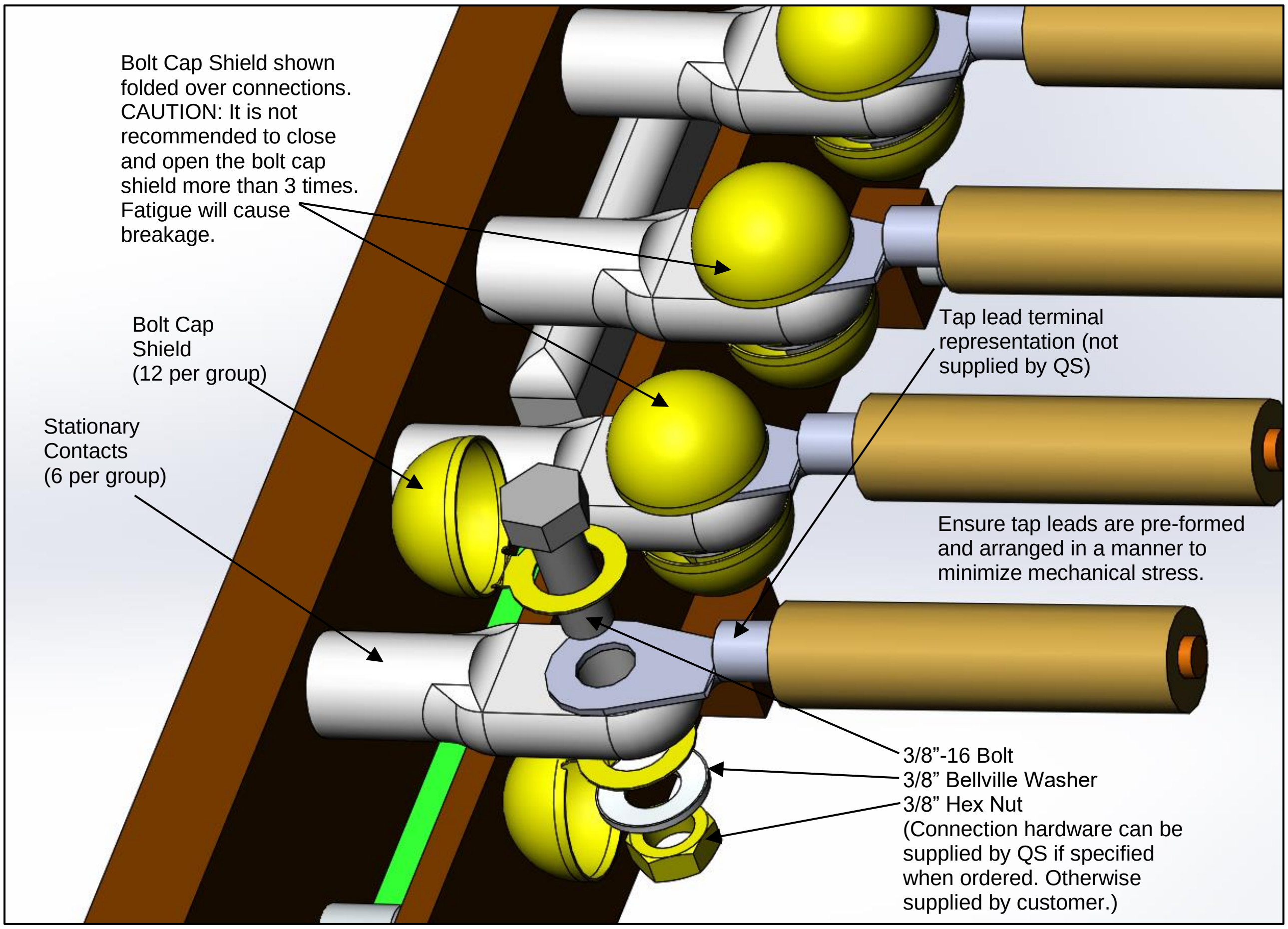


Figure 2B: Crimp type Contact Connections Example

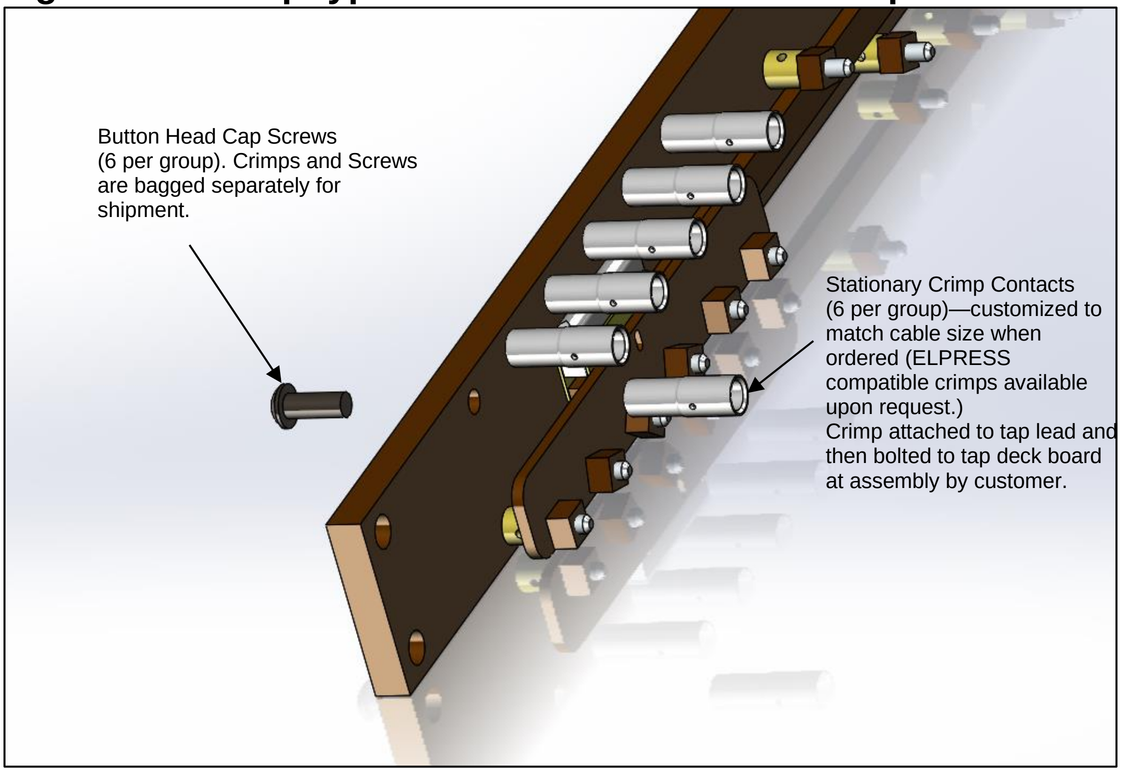
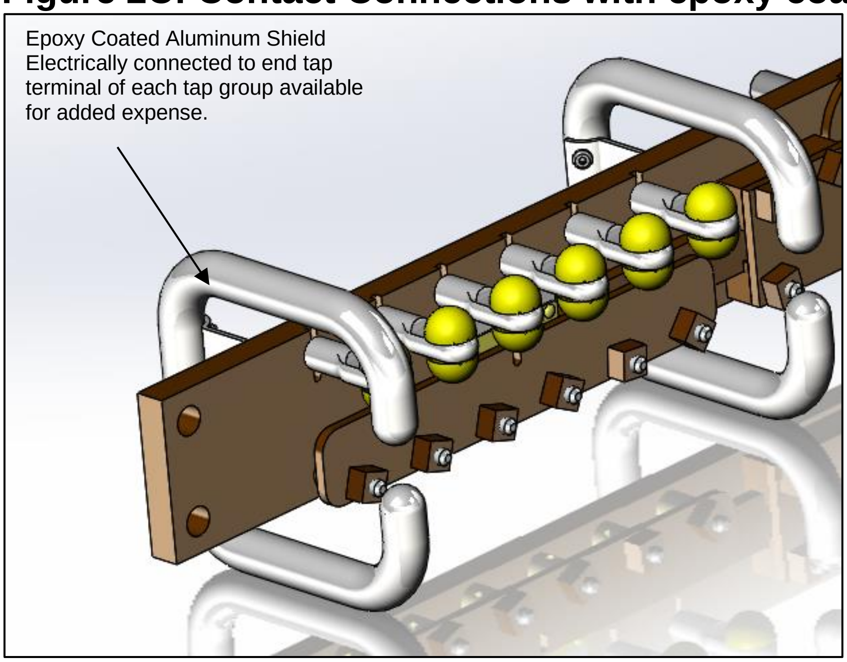


Figure 2C: Contact Connections with epoxy coated shielding example



OPERATING MECHANISM (main drive shaft and external mechanism):
The operating mechanism attaches to the Geneva gear that drives the sliding contact. The Geneva gear is installed thru the tap changer mounting board and is contained by a retainer plate. The gear shaft is supplied with holes on each end to attach the front insulating drive tube and attaches to the interphase insulating drive tubes using non-metallic pins and nuts. The front drive tube has a shaft and pin attached and is coupled with a spring-loaded coupling assembly that is connected to a mounting plate and handle assembly shown in Figure 3. This method requires a flange by the customer with a gasket seal to the mounting plate with the proper bolt pattern to secure the mounting plate, but no access panel is required. The handle will rotate 360 degrees for one position change (CW or CCW) and then the plunger of the handle can be padlocked in position. Figure 3a and 3b are variations that also require a flange by the customer, but rather than spring coupling, these options use a universal joint. Also, an operating mechanism is available with a handle and mounting arrangement that requires the sealing boss be welded directly to the tank (Figure 3c). This method uses a flexible steel coupling on the end of the insulating drive tube to be coupled with a brass shaft that will have a pin. This brass shaft will then be inserted thru the tank wall (from the inside) and sealing mechanism. The handle will then fasten to the shaft with a pin. This method requires four mounting posts be welded to the tank in a pattern to secure the position plate.

Figure 3: Spring loaded operating mechanism

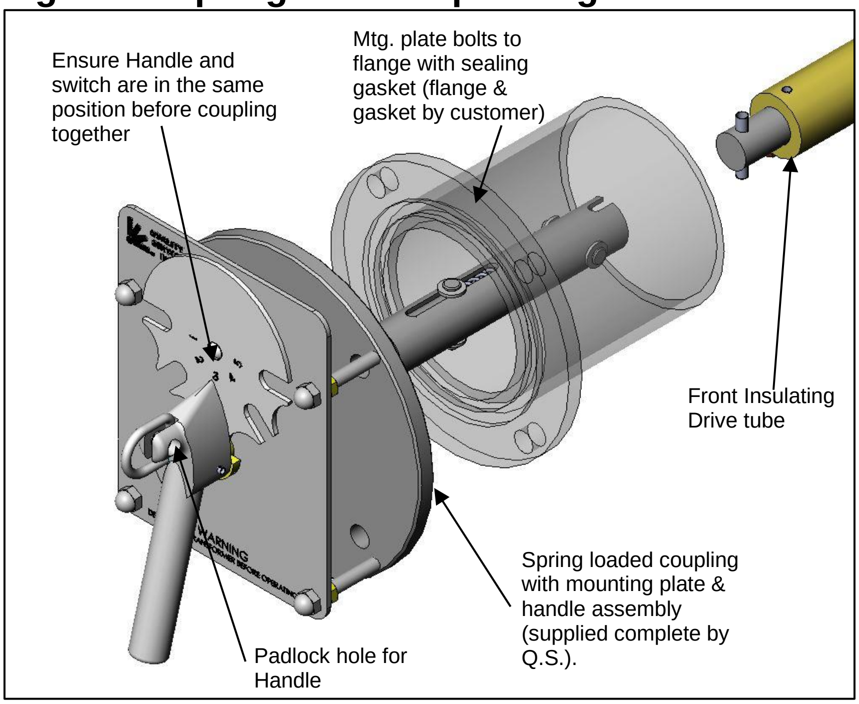


Figure 3a: Universal Joint operating mechanism (direct connect)

*Note: This method requires access to the first tap deck after the active part is tanked. Typically, this is done via a gasketed manhole access panel on the side of the tank. If universal coupling is desired, but access is not available after tanking, the telescoping coupling with the universal joint shown in 3b may be an alternative.

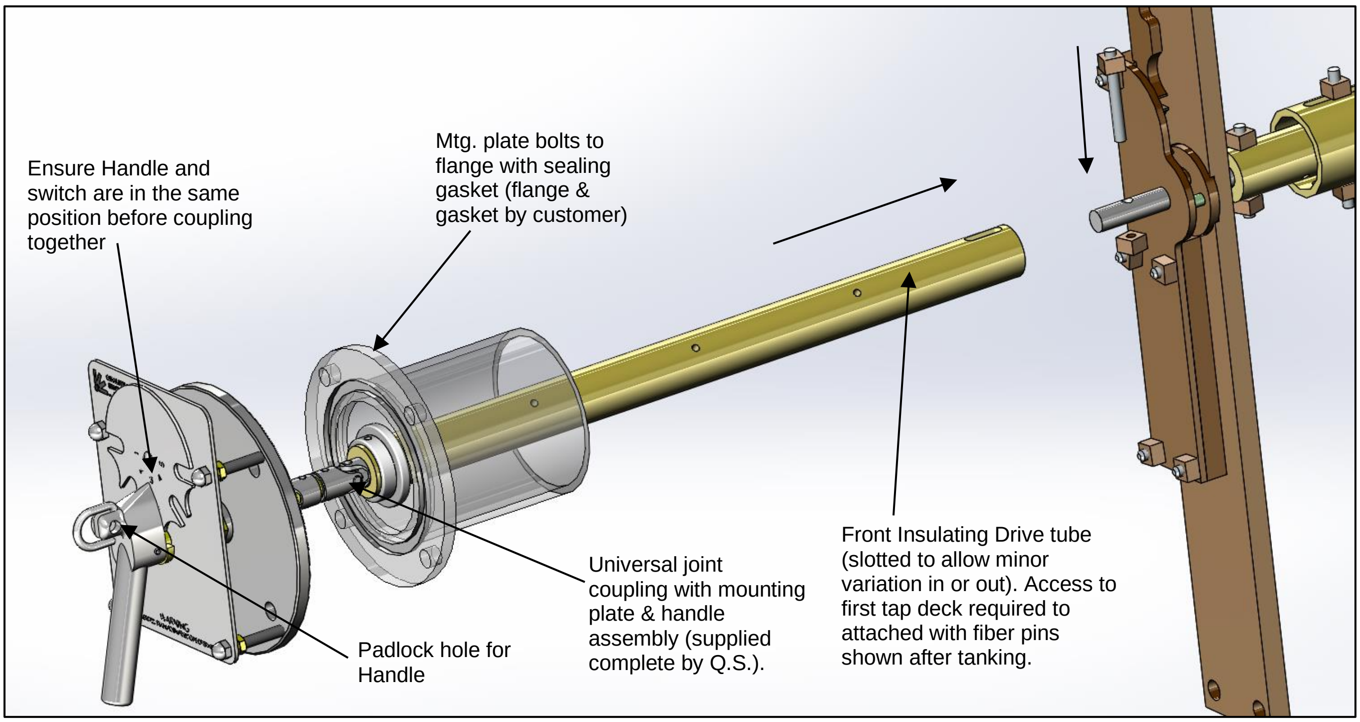
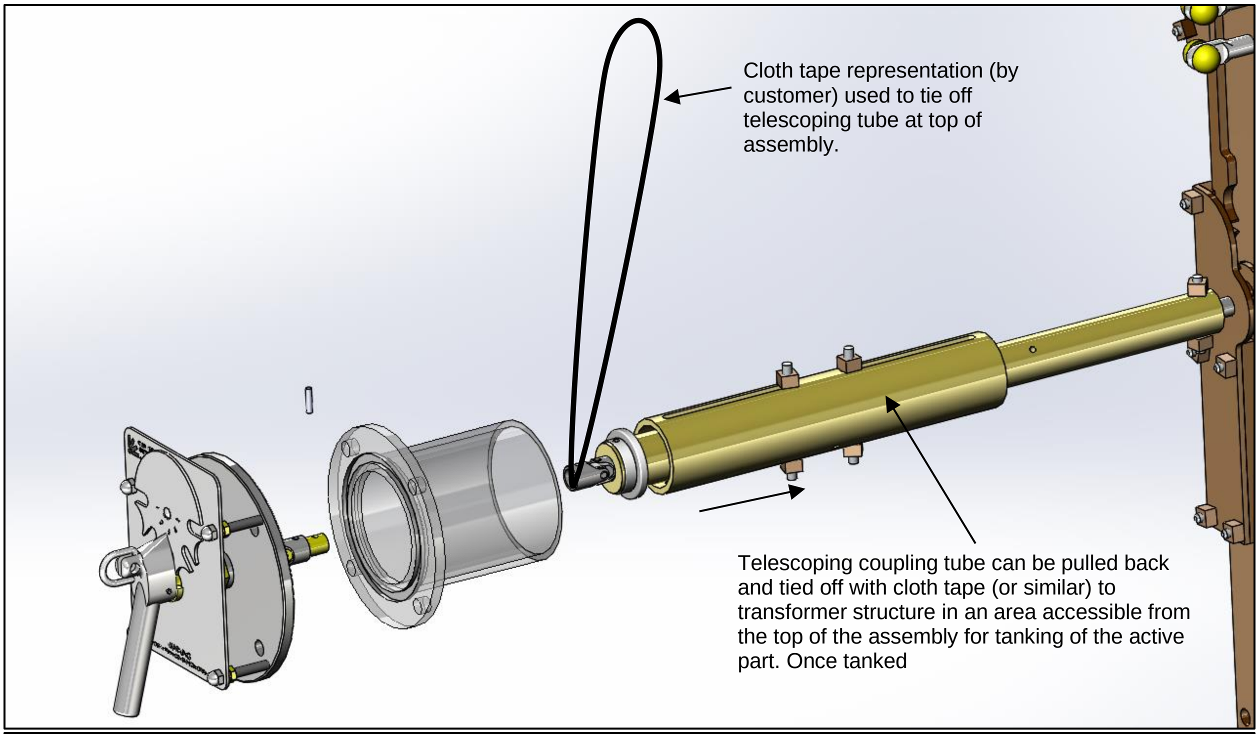


Figure 3b: Telescoping Universal Joint operating mechanism



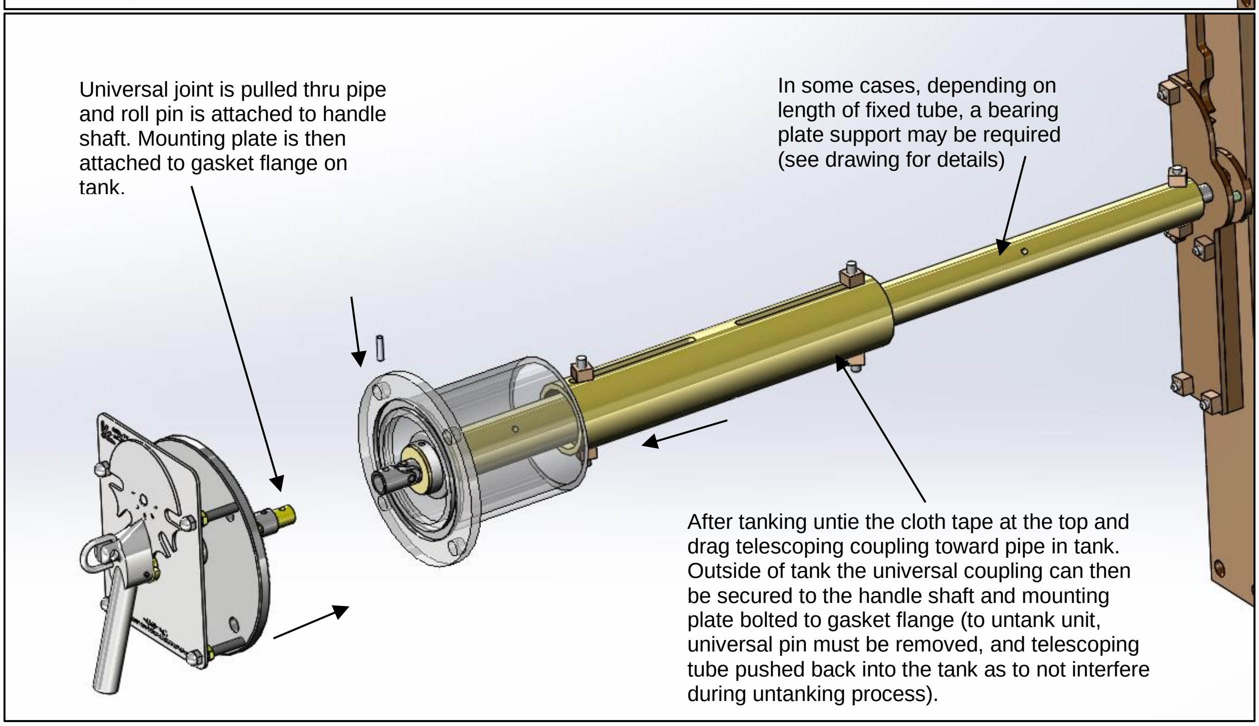
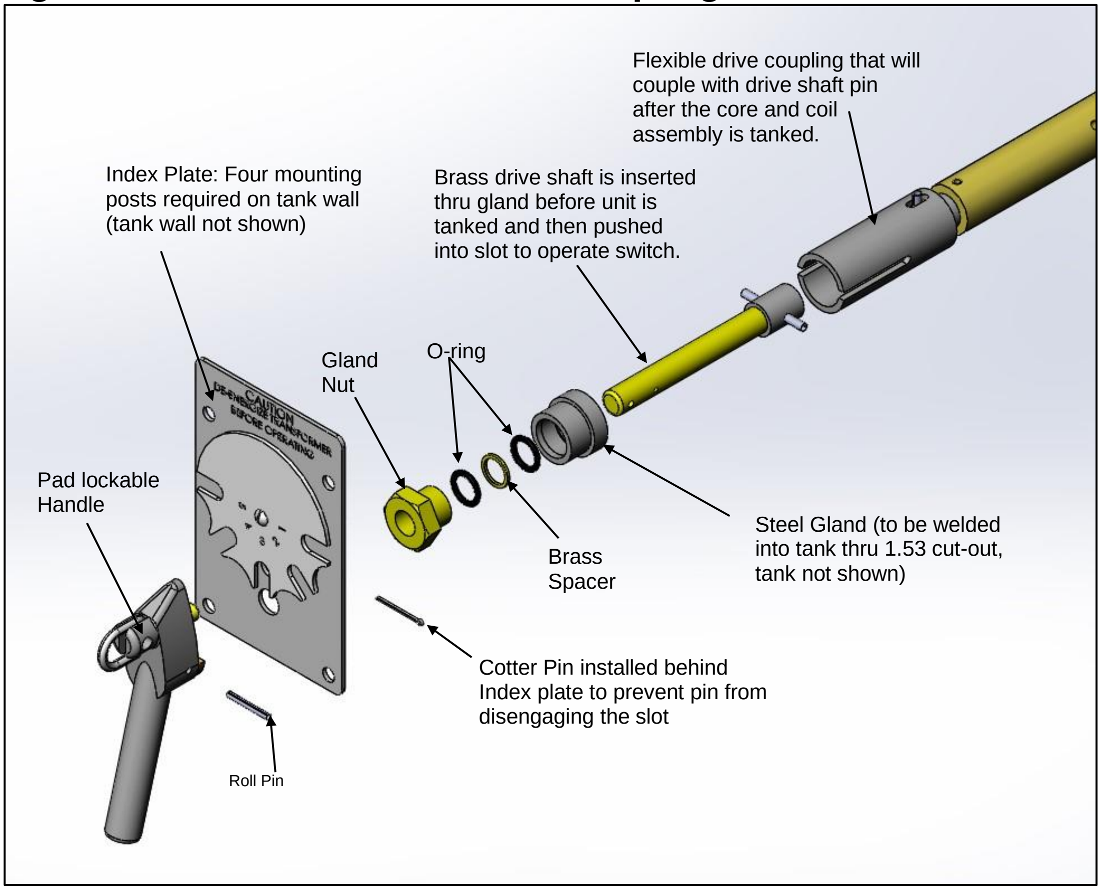
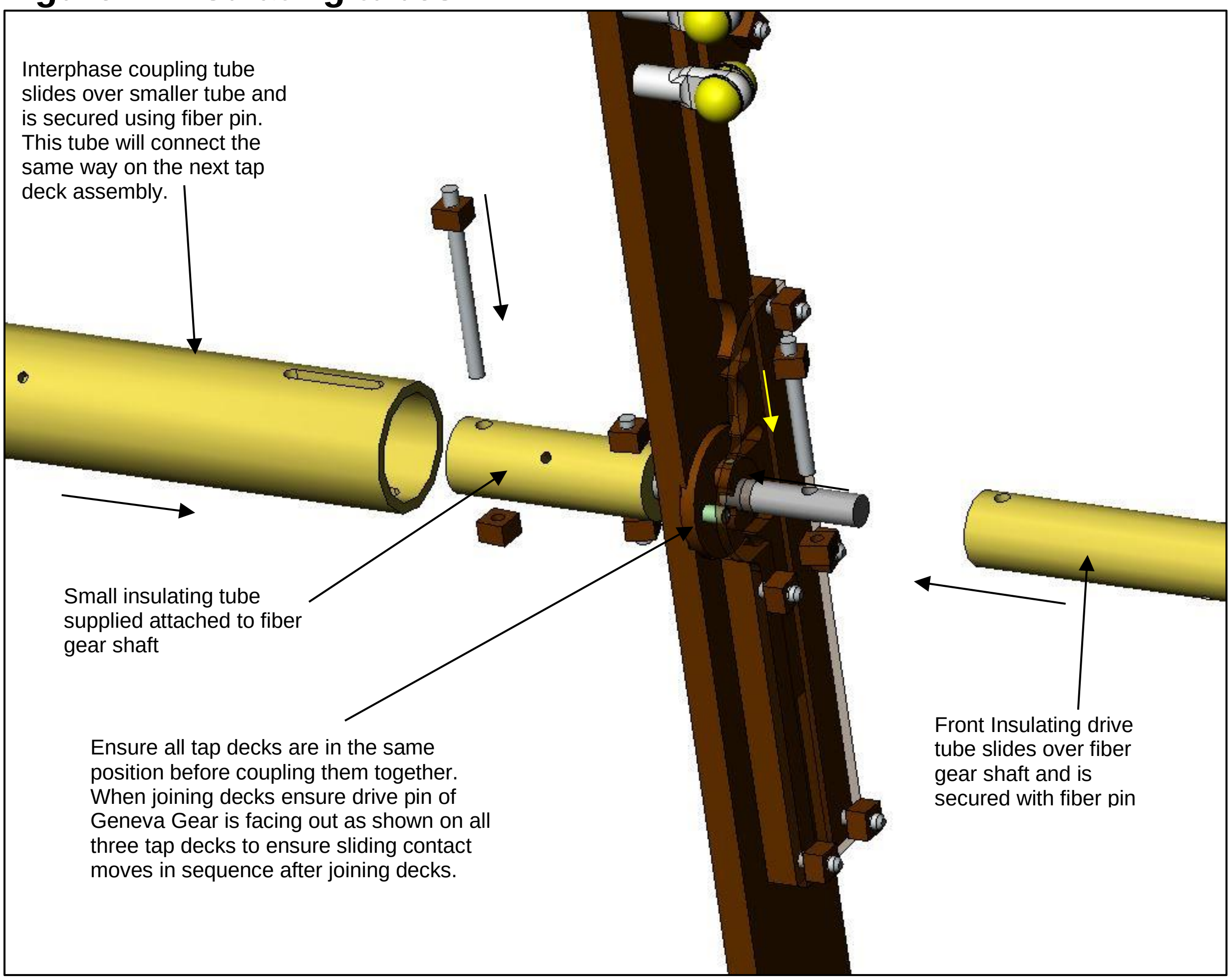


Figure 3c: Flexible slotted drive coupling



OPERATING MECHANISM (front tube, interphase drive tubes and couplings):
The operating mechanisms that attach the other tap decks together are done by connecting slotted insulated drive tube couplings to a smaller tube that is fastened to the fiber shaft on the non-metallic gear drive mechanism. This insulating tube is slotted and has an oversized inside diameter to accommodate some minor misalignment between each tap deck assembly. After the tubes are installed, they are fastened together using a non-metallic drive pin and nuts. It is critical to ensure all tap decks are in the same tap position before installing the coupling tubes (sliding contacts and also orientation of Geneva Gear pin should be verified to be the same when joining together).

Figure 4: Insulating tubes



HANDLING, INSTALLATION AND MOUNTING:

Receiving the Type QS-DLS™ Non-metallic Rack & Pinion DETC:

-Upon receiving the type QS-DLS™ non-metallic Geneva Drive DETC, check for visible damage. Notify Quality Switch if any damage is found.

-All DETC tap decks are shipped with the contacts in the same position. These may shift during shipping, so ensure each tap deck sliding contacts are all in the same position before assembly (both the sliding contact and Geneva Gear pin need to be verified on all three tap decks before joining tap decks together).

-Verify that the shipment is complete and contains all loose components. Several smaller components (i.e. handle assembly, insulating drive tubes, bearing plate, fiber pins, nuts, etc.) will be wrapped individually for protection during shipping and marked with a yellow sticker that states ‘Parts Enclosed’, so take caution not to discard them with the packing material in container. These components will be listed in the description of the item on the packing list provided with the shipment.

-Check that the packing list matches the order numbers and part numbers included on the order acknowledgement. A serial number will be engraved on each tap deck board that should correspond with a sales order number found on the order information.

Preparation required by Customer:

-Prior to installing the DETC, appropriate mounting in the transformer tank is required. Depending on the operating mechanism, a steel boss will need to be welded (gas tight) into the tank, or a mounting flange with the appropriate bolt pattern and gasket seal is required. The gasket mounting flange is not supplied by QS. The appropriate dimensions and specifications will be included on the outline and/or detail drawings of the DETC.

-The transformer structure needs to be prepared with holes appropriate for mounting the type QS-DLS™ tap deck. The hole patterns are also shown on the DETC outline drawing. Hardware to secure the switch to the structure is not supplied with the switch but can be ordered separately if required. This must be non-metallic hardware.

-Only standard tools are required for installation.

Mounting:

-The type QS-DLS™ non-metallic Geneva Drive DETC requires a support structure constructed of appropriate insulating material to secure the tap deck mounting boards. In most cases, the boards are mounted in a vertical manner and secured using the holes on each end of the board. The holes are provided on top and bottom to allow them to be secured the structure. The structure is typically the same structure that supports the HV leads in the transformer design. Also, support is required on the front insulating tube that extends from the first tap deck to couple with the drive handle.

-Refer to the switch outline drawing for specific mounting dimensions for your switch.

Installation Steps (in general):

1) Make sure that all of the tap decks are in the same position (the moving contact should align and Geneva Gear pin on all of the tap deck assemblies). An alignment hole/slot is provided in the moving contact that allows a 3/16" diameter pin to be inserted thru the tap deck board and the moving contact to ensure all are aligned properly in the nominal position. If a pin is used for position verification, be sure to remove the pin(s) before operating the switch.

2) Install the first deck by inserting fiber threaded rod or bolts thru the supplied mounting holes in the tap deck and secure the tap deck to the transformer structure with non-metallic nuts. These holes need to be slightly oversized to avoid forcing the bolts into the holes.

3) To mount the second tap deck, also install the threaded bolts into the holes on the tap deck mounting boards and slide them thru the transformer structure. However, do not snug up the nuts that will secure the board to the transformer structure and allow it to be loosely held in place.

4) Install the insulating drive tube between the first and second tap deck by sliding the coupling tube over the insulating shaft already attached to the fiber drive shaft. Install the supplied threaded pin thru the slot and attach non-metallic nuts to each end of the pin to secure the coupling (see Figure 5.)

5) Repeat the process for the third tap deck.

6) To confirm that the installation has been done properly, after tightening all mounting hardware, turn the operating shaft and observe the movement of the sliding bridging contacts on all three tap deck assemblies. All three phases should move together from one end of the tap range to the other in a synchronized fashion.

7) The insulating shaft between the tap deck and the handle operating mechanism external to the tank are coupled together after the core and coil assembly have been installed into the tank. When required, a bearing support shall be provided (see outline drawing for details) near the end of the tube to prevent deflection and keep the insulating tube aligned with the hole in the tank. The coupling method will vary depending on the type of arrangement ordered (see Figures 3, 3a,3b, & 3c). A slot w/universal joint or a spring-loaded coupling shaft can compensate for minor variations in expansion and contraction.

8) Connecting tap leads to the tap deck assemblies is done by bolting a terminal with approximately a 3/8" stud hole (either brazed or crimped onto the tap lead) to the stationary contact on the tap deck mounting board. The tap leads should be pre-formed and arranged to not apply any mechanical stresses to the tap deck mounting board. If the crimp connection method is used (shown in Figure 2B, tap leads are brazed or crimped directly to the stationary contact and then secured to the tap deck using button head cap screws with lock patch that QS will supply with the switch. These leads are also to be formed in a manner that minimizes mechanical stresses on the tap deck mounting board. These bolts shall be secured using 35-40 ft-lbs of torque maximum to secure the stationary crimp contacts to the DETC board and will need re-tightened after dry-out.

9) It is recommended for these connections on applications over 350 BIL to use bolt-cap shields to cover the hardware (see Figure 2A). It may also be wrapped in some form of insulation (crepe paper or aluminum backed crepe paper) to aide in eliminating sharp edges. Each customer may have a preferred method they use within their transformer on bolted connections appropriate to the voltage class.

10) After the drying out process all non-metallic hardware will need to be re-tightened (snug up nuts finger tight similar to all the other non-metallic hardware on the transformer structure). Then apply electrical epoxy (i.e. Glyptal or equivalent) to prevent them from vibrating loose.

11) Before operating the DETC after dry-out, it is recommended to apply lubricant on the contacts (either Vaseline or transformer oil is recommended). Operating dry contacts risks contact galling.

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