LET'S BE PACIFIC™

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Benefits of Owning a Medium-Voltage Federal Pacific VPI Transformer

When you are buying a Federal Pacific medium-voltage transformer, know that your investment will support: a top quality marketing response, a conservative engineering design, superb quality manufacturing practices, and on-time delivery.

When the inquiry for your transformer arrives in the marketing group at the Federal Pacific plant in Bristol, Virginia, the Sales and Application Engineer (SAE) carefully reviews your specifications for developing an accurate proposal. In many cases the Federal Pacific proposal will include suggested changes and clarifications, so you know that your inquiry has been thoroughly evaluated and pricing has been offered to match the clearly defined ratings within the proposal. In almost all proposals you will find the quoted shipment to be significantly the shortest in the industry either with a normal lead time of 6-8 weeks or an alternate Lightning Fast shipment that usually will not exceed four weeks and is sometimes shorter.

If you need drawings for approval, they will be available within 1-3 weeks. In some cases, when necessary, outline drawings will be supplied at the time of the quotation, as the transformer appears in a Unit Substation Line-up shown in Figure 1.

In the past several years Federal Pacific has secured orders where the medium voltage Unit-Sub transformer had to replace an existing transformer that was closely coupled to an existing HV switch and existing LV switchgear that could not be moved. In these cases a Federal Pacific factory representative went to the job site for measurements and to review exactly the proper locations for matching busses and enclosures. We obtained a firsthand understanding from the customer of what the transformer characteristics and features needed to be.

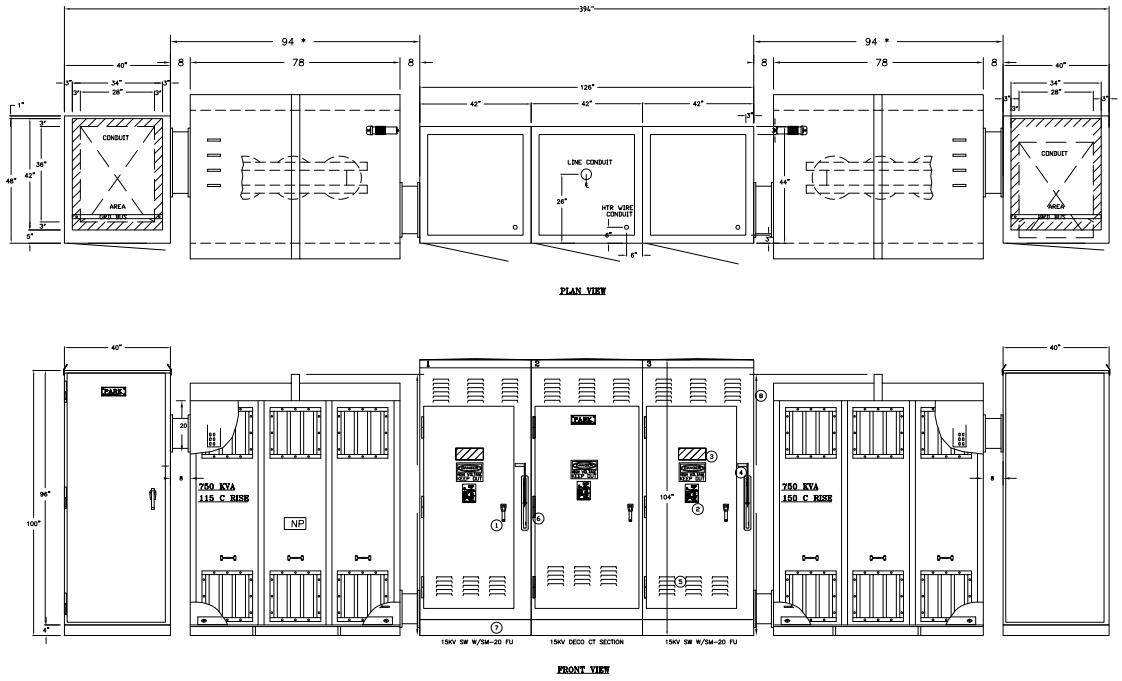

Figure 1. Outline drawing of Outdoor Unit Substation with closely coupled HV Switch, Transformer, and LV Switchgear.

Upon receiving the order Federal Pacific carefully reviews all of the dimensional (like width) and electrical requirements that prescribe impedance, BIL, and winding voltages and connections.

The interpretations of the customer requirements are confirmed by approval drawings and other pertinent communications. In this process Federal Pacific is using the highest quality materials and very conservative design practices that have proved successful over the past forty years of building medium-voltage dry transformers. For closely coupled transformers very prompt and accurate coordination information is obtained from the major switchgear and bus duct manufacturers, as Federal Pacific assumes responsibility for everything fitting together, and properly coordinated, when installed for service.

As the transformer manufacturing process is started the coils are wound in **round** configuration for maximum short circuit withstand. At voltages of 15 kV and above the HV coils utilize **continuous pancake disc** construction supported by strong notched spacers with a high temperature rating. This construction, similar to large power transformers, as shown in Figure 2, has maximum dielectric surge withstand capability and will strongly resist vertical (axial) and radial forces during short circuit events.

Taking a closer look at the conductor used to wind the coil in Figure 2, the reader will notice that the conductor appears white in color. This appearance is due to the high temperature (220 Deg. C) Nomex® insulation material that is applied to the conductor prior to winding by a special wire wrapping machine, shown in Figure 3. Wrapping the insulation on our coil wire in our factory allows Federal Pacific to control the precise thickness of the Nomex® insulation needed for the voltage rating of the coil being manufactured.

To many customers the conductor material used for the coils can be very important. Perhaps the most important message for the conductor that is used by Federal Pacific is that we have been using very successfully both copper and aluminum for over forty years. Figures 4 and 5 illustrate a very reliable process of employing both TIG welding for joining aluminum low voltage strip to the low voltage coil lead. MIG welding, shown in Figure 5, is used to attach the low voltage aluminum coil leads to the low voltage aluminum bus bar. Using the TIG and MIG welding processes eliminates any of the typical "cold flow" problems associated with aluminum conductor.

Figure 2. Continuous pancake disk round coil.

Figure 3. Nomex® tape being wrapped on the coil conductor.

Figure 4. TIG welding LV coil to LV lead.

Joining copper coil conductors is a somewhat different process from joining aluminum. Federal Pacific uses a high quality silver solder rod in the presence of a controlled torch to make the copper joints of the coil leads to the copper coil conductor. Figure 6 shows this brazing process. The low voltage copper coil leads have been brazed to the copper bus bar in Figure 7

As part of the manufacturing process of medium-voltage coils Federal Pacific has adopted a vacuum pressure impregnation process (VPI), used successfully for many years in large electric motors to make the motor windings impervious to moisture.

In Figure 8 is shown a fully rated pressure vacuum vessel used by Federal Pacific to apply the VPI process to the transformer coils. After undergoing baking and an almost perfect vacuum to eliminate moisture from the coils, the coils in Figure 9, which have been impregnated with a 100% solids 70VT varnish, are being removed from the pressure vessel on their way to the baking oven to completely cure the varnish.

Figure 7. Brazed copper LV lead to Cu bus.

Figure 5. MIG welded leads to AL bus.

Figure 8. Pressure rated vessel for VPI

Figure 6. Copper brazing LV coil to LV lead.

Figure 9. Coils after VPI process ready for baking in the oven.

While all of the coil manufacturing process has been underway, the step lap mitre core has been cut by one of the Georg machines, shown in Figure 10, to form a high quality step lap mitre core for low sound and low core losses. The core cutting machine, the step lap mitre core steel pieces, the core stacking, and the completed core with its three legs ready for the coils are shown sequentially in Figure 10 through Figure 15.

Figure 10. Large Georg core cutter

Figure 11. Ends of the middle and outer legs of a step lap mitre cut core.

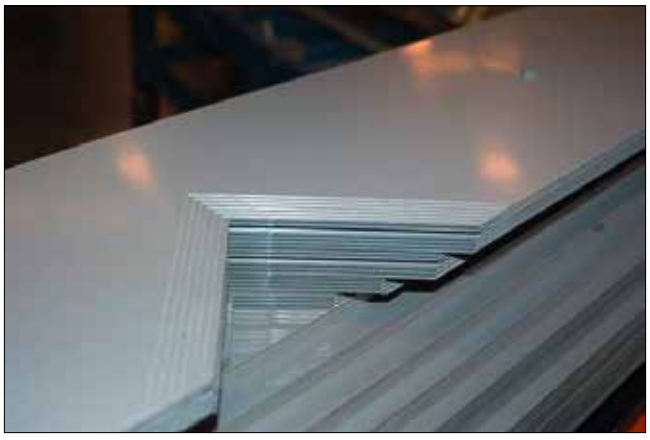

Figure 12. Bottom and top yoke of step lap mitre core.

Figure 13.

Figure 14. completely stacked core on rotatable table.

Figure 15. Step-lap mitre core ready for coils.

After the coils are landed on the core, the top core yoke, Figure 16, is laced into place and the core is clamped firmly together to provide structural and short circuit strength for the core and coil assembly.

While the core and coil are being manufactured, in another part of the Bristol transformer facility all of the metal fabricated structural members and panels are made in a modern fabrication department, Figure 17, containing CNC machinery. The fabricated parts are then processed through a state-of-the-art powder coat paint facility, Figure 18, utilizing a five stage preliminary washing cycle.

The paint applied to the metal fab parts permits UL® to certify the Federal Pacific transformer enclosures (Figure 19) to the outdoor rating of 103R covered in IEEE C57.12.55. Besides the standard ANSI 61 light grey other powder coat paint colors are available from Federal Pacific.

After all the fab parts are made and painted, the completed core and coil is now ready for final assembly

Figure 20 shows the beginning of this final assembly activity.

Figure 16. Insertion of top yoke.

Figure 17. Metal fab facility (shearing, punching, and bending).

Figure 18. Powder coat paint facility.

Figure 19. MV transformer in 103R outdoor enclosure.

Figure 20. First stage of final assembly.

Prior to the completion of installing the panels on the transformer in final assembly, the transformer undergoes final testing per IEEE C57.12.91. The medium voltage test area is shown in Figure 21

All of the tests listed in Figure 22 can be performed in the UL® certified Bristol factory of Federal Pacific.

Whenever an Audible Sound Test is performed by Federal Pacific, the transformer is placed in an anechoic chamber (Figure 23) able to provide accurate test results for special low sound units down to 40 db.

Prior to shipping the medium voltage transformer Federal Pacific confirms per our ISO 9001:2008 procedures that all the work and testing have been properly performed and then wraps the transformer as shown in Figure 24 in a protective covering to prevent moisture and dirt from getting on the finished transformer during shipment.

The transformer will arrive on time at the customer's site with proper instruction books, final test reports, and a spare set of outline drawings, if needed.

Federal Pacific is proud of its high quality medium-voltage transformer, designed and built per customer specifications to the highest quality internal and industry standards and practices.

Figure 21. Final test area for Medium-Voltage transformers.

Standard (IEEE C57.12.91)

- Dielectric (Induced and Hi-Pot)
- Ratio
- Impedance
- Partial Discharge (Standard for Federal Pacific)

Optional Special Tests

- IEEE C57.12.91 Impulse

Figure 22. Standard and special final tests.

Figure 23. Large anechoic sound test chamber.

Figure 24. Medium-Voltage transformer ready for shipment.