April 2013

Multi-voltage Testing Transformers

Anyone familiar with Pacific Crest Transformers is aware that the company offers a wide range of specialty transformers to suit a host of load applications. This month's paper will focus on transformers built for two OEMs that required multiple voltage arrangements to energize and test a variety of manufactured electrical equipment. Some requirements were straightforward while others required creative solutions.

As stated in their Web site: "Eaton is a diversified power management company providing energy-efficient solutions that help our customers effectively manage electrical, hydraulic and mechanical power. The company is a global technology leader in electrical products, systems and services for power quality, distribution and control, power transmission, lighting and wiring products; hydraulics components, systems and services for industrial and mobile equipment; aerospace fuel, hydraulics and pneumatic systems for commercial and military use; and truck and automotive drivetrain and powertrain systems for performance, fuel economy and safety."

The view of the transformer to the right reveals the low voltage side of a 5000 kVA order built for Eaton. The specifications required 4 separate but full capacity secondary voltages.

The design for this product was rather straightward since all 4 voltages were to be wye connected. The construction consisted of one "tapped" low voltage winding per phase with the conductor beginning with the largest cross sectional being wound first, accomodating the current requirements for the lowest voltage (highest current),

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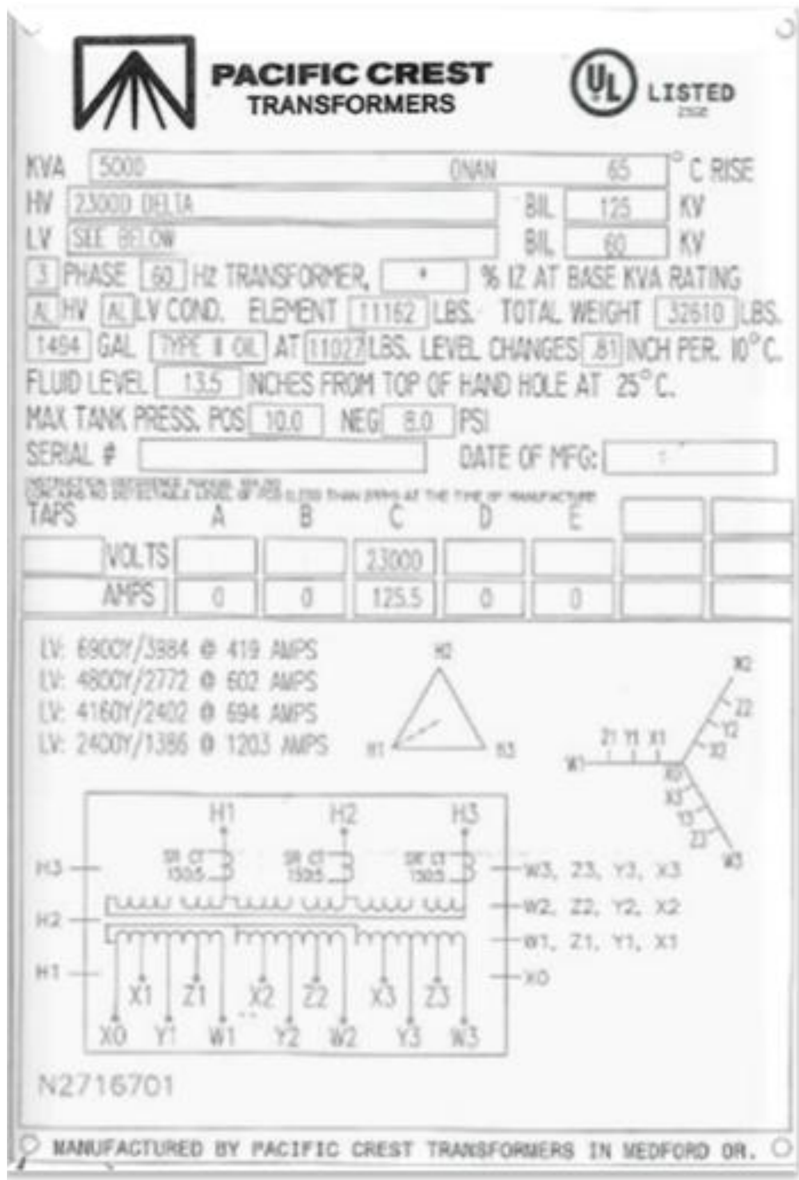
followed by series connected sections of progressively decreased cross sectional conductor in line with the full capacity current requirements for the remaining three voltages. At the end of each of the four sections, phase bushings were brought out through the tank wall.

This is the nameplate for the transformer. Note that with the exception of the tapped secondary windings, the vector diagrams are standard.



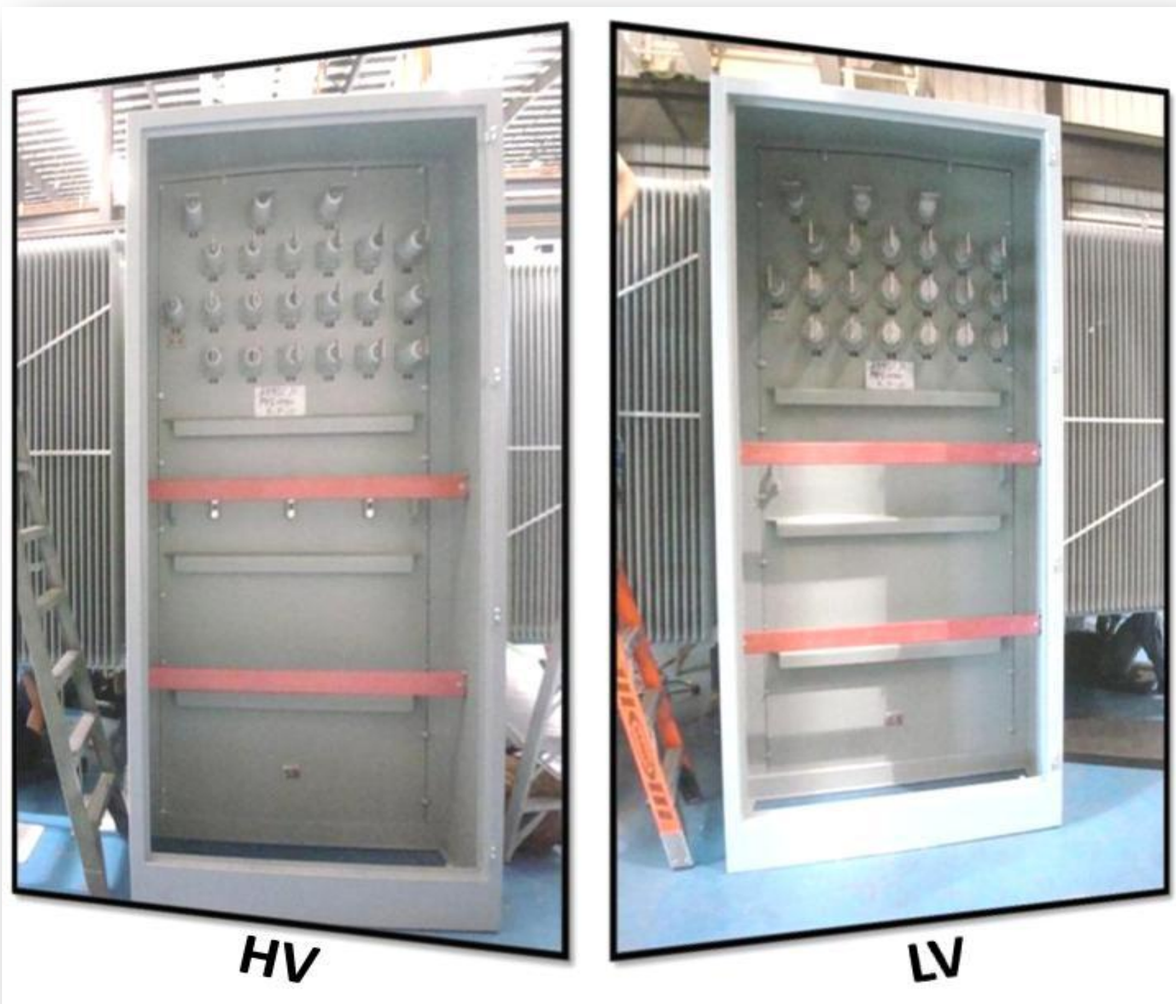
The primary windings utilize current transformers so as to enable monitoring of the transformer load during periods of test.

The nameplate rating of this transformer is 5000 kVA. Each of the secondary windings are rated at full kVA, but only when independently connected to a load. Simutaneous multiple secondary loads can however be accomodated at reduced loads.

This type of construction is a rather “standard” approach in providing the customer with multiple secondary voltage/load test requirements. The bushings are clearly labeled and easily “translate” to the nameplate labeling.

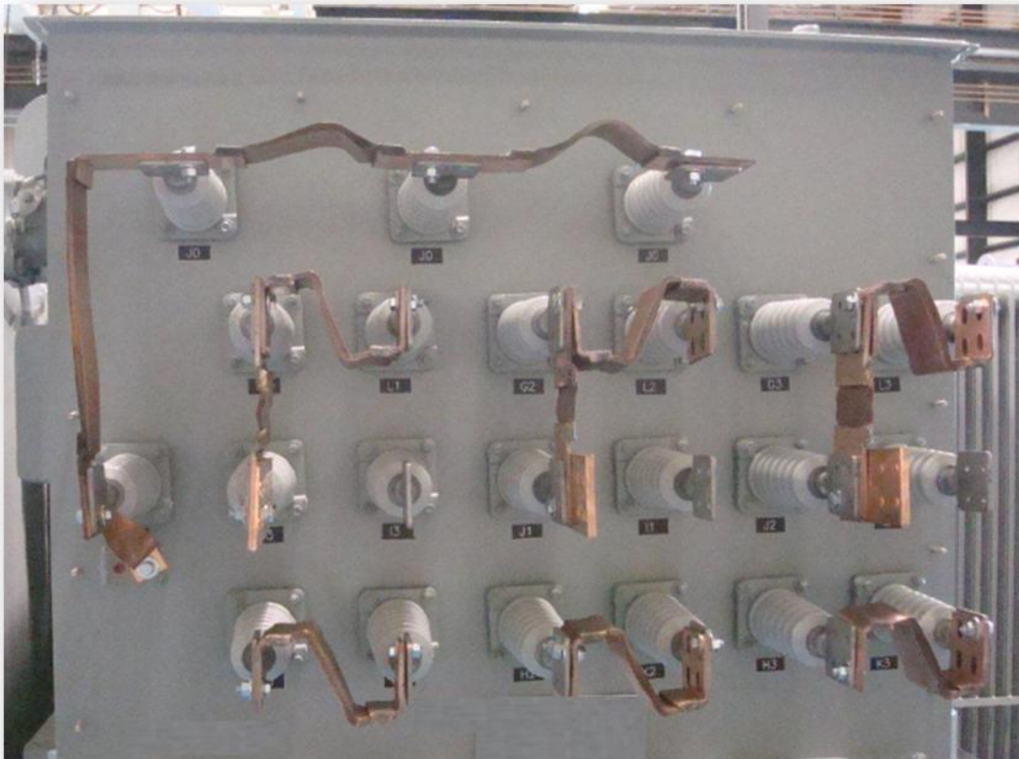
When multiple voltage and connection requirements exist, the challenge becomes somewhat more complicated. This is especially true with larger transformers where current ratings exceed most available externally operable internal switch options.

An example of such a case is a transformer requirement supplied to Goulds Pump. As quoted on their Web site: " ITT Goulds Pumps is among the most widely recognized and respected brands in the global pump industry, serving customers in the oil and gas, mining, power generation, chemical, pulp and paper, and general industrial markets. As the only manufacturer to make digital monitoring standard on every process pump, ITT Goulds Pumps continues to lead the industry in both mechanical pump design and the adoption of smart technologies." Below is a picture of the high voltage and low voltage terminations of the supplied 7500 kVA transformer.

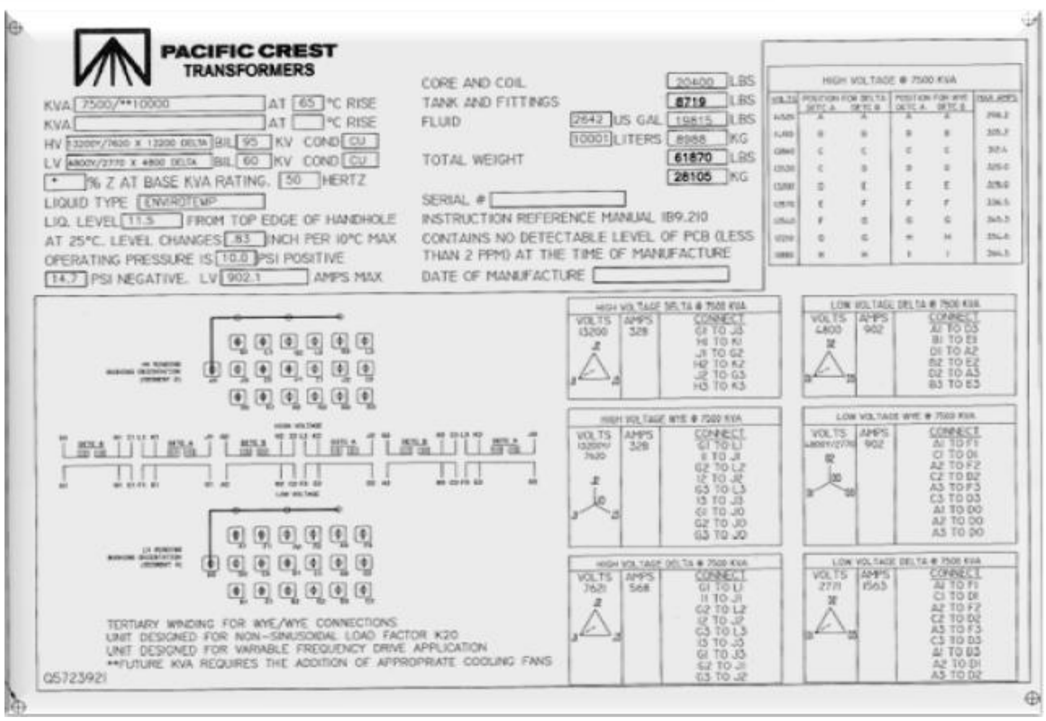


The rated amperages, winding connections, and multiple voltage requirements resulted in the decision to terminate all winding starts and finishes externally via bushings where they could be connected to provide a wide variety of inputs and outputs.

Here is a picture of the high voltage side of the transformer complete with external bushings per the nameplate. The placement of the bushings are such as to accommodate all connection requirements with the shortest possible jumpers.

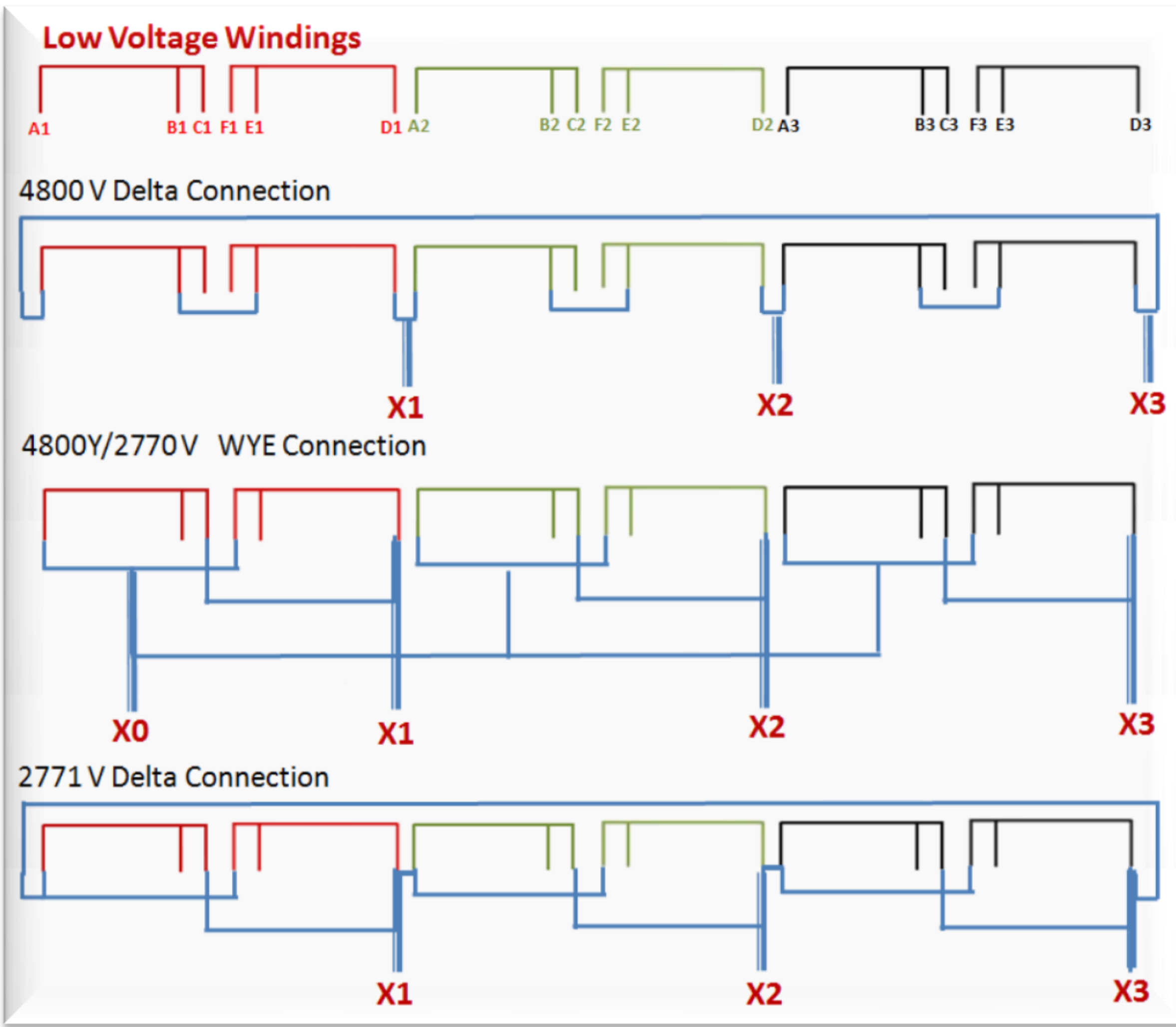


The nameplate details the placement of all high and low voltage bushings as well as the termination requirements for each configuration. Due to the possibility of making connection errors, it is recommended that after



altering external connections a low voltage ratio test be made prior to reenergizing the transformer.

The reconnections required to obtain the desired voltage configuration on such a design may seem a bit confusing. The following diagram provides a visual as to how the low voltage connections for each configuration are made.



The first schematic is a copy of the LV schematic as shown on the nameplate. For clarity, each phase is displayed in a different color (A=red, B=green, C=black). Interphase connections are blue in color.

Each low voltage winding is comprised of 2 each 2770 volt windings with a tap at 2400 volts.

The first configuration is for a 4800 volt delta output. Note that the 2 coils in each phase are connected in series to each other, but at a tap rather than full winding. The tap is at 2400 volt. The series connection at each phase results in an output coil voltage of 4800 volts. The interconnection of each phase coil to the others then completes the delta connection. The rated phase to phase low voltage current for this connection is 902 amps.

The next configuration depicts that required for a 4800Y/2770 connection. Note that in this case that the full windings for each phase are utilized, but connected in parallel to one another. This results in an output voltage of 2770 volts from phase to neutral. The starts of all 6 windings (2 per phase) are connected together providing the neutral (X0). X1, X2, and X3 are made by connecting the 2 finish windings in each phase together. The rated phase to phase low voltage current for this connection is also 902 amps.

The last configuration reveals the required connections to provide for a 2771 volt delta output. As with the previous connection, the full winding of each of the 2 per phase are connected in parallel. The phases are then interconnected to complete the delta. The parallel phase windings connected in delta provides for a phase to phase low voltage current of 1563 amps.

Regardless of the configurations, the transformers can be supplied with standard insulating oil for outdoor installation or with less flammable fluids for installation indoors.

Pacific Crest Transformers welcomes the opportunity to provide engineered solutions to meet both standard and load specific requirements. Dedicated engineering expertise coupled with flexible manufacturing capabilities and 94 years of experience insures the capability to meet and exceed customer expectations.