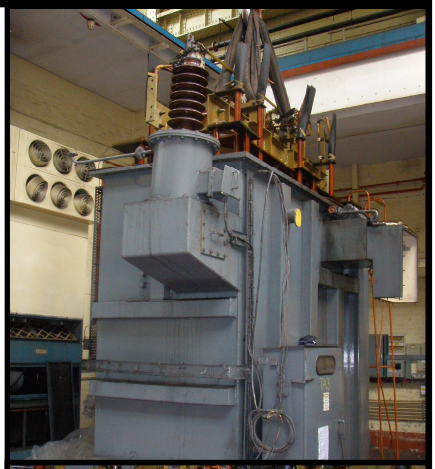
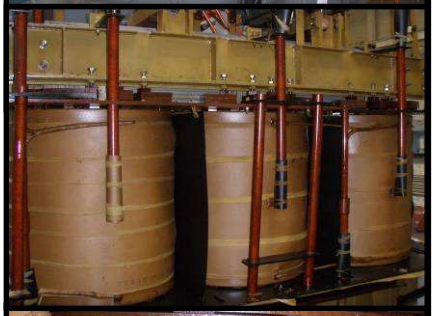
TP POWER SERVICES LIMITED

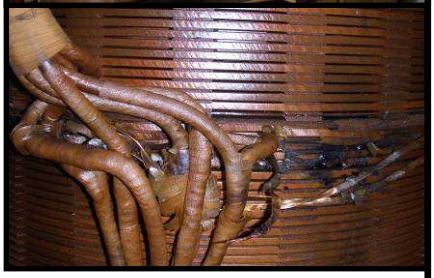
Contract Case Study

ELECTRICAL ENGINEERING SOLUTIONS FOR HIGH VOLTAGE NETWORKS

CONTRACT:	TPPS-06
SCOPE OF WORK:	Rewind of 37.5 MVA Power Transformer
END CLIENT:	Corus UK c/o Quartzelec Ltd
LOCATION:	TPPS Factory, Rugby
DURATION:	6 weeks
VALUE:	£ 168,200 GBP





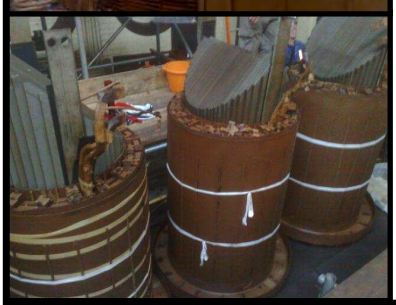


SUMMARY:

TP Power Services Ltd were approached by Quartzelec to provide consultancy services to investigate the electrical breakdown of one of Corus UK's transformers; a 37.5 MVA, 11 / 66 kV, Yd11, OFAN / OFWF manufactured by Bonar Long in 1976, located at their site in Redcar. Following its decommissioning and transport to our facilities in Rugby, the 34 tonne main tank had its core and winding assembly removed and inspected, whereby it was concluded that rewinding of the high voltage windings would be the quickest way to get the transformer back into service as a new unit would take up to 8 months to design and manufacture. Once agreed with the client, TPPS Ltd started the invasive repair package with premium options for copper delivery and double shift winding to provide an operational unit in 6 weeks instead of 10 weeks for this size of transformer. The unit underwent and passed testing to BS EN 60076 standards to ensure the entire programme from the units initial failure to its return to service took only 9 weeks.

FAULT INVESTIGATION:

The initial scope of works was to complete a failure analysis of the transformer requiring removal of the mineral oil and tank lid to de-tank the core and windings for visual inspection and testing if deemed necessary. It was evident without testing that a fault on the C phase had caused a number of high voltage turns to explode, and further studies would conclude that this may have been caused through constant operation at its highest tap setting to meet supply at site resulting in a short circuit failure. The client agreed that a rewind option was more cost efficient and quicker than a new transformer in any case, and the fact that LV windings and core were in an operational condition meant that only the three HV windings needed replacing.



WINDING SPECIFICATION:

TPPS Ltd had to reverse engineer the windings to identify the size of copper on the HV windings and tapping windings by analysing the number of layers and turns, method of winding and types and thickness of insulation. Once this data had been collated design calculations confirmed suitability of the winding specification for manufacture. All winding materials were procured on a premium delivery package which meant copper was delivered ready for winding to start in four days instead of the usual two weeks.

CORE & WINDING DISMANTLING:

The programme allowed only two days for dismantling of the core and winding assembly and measurements taken to wind new coils. It took engineers one day alone to dismantle the top yolk of the core steel and remove the core clamp assembly and winding connections, leaving the second day to remove the three HV coils being replaced using a purposely designed lifting frame. All core insulation and packing blocks were removed and new ones would be manufactured for assembly. Further investigations were completed to provide the client with a full report of the failure analysis.

Once the core had been dismantled down to its LV windings each one was tested to ensure they had not been damaged by the fault and could be re-used, as were the HV and LV bushings and tap changer equipment. As a complimentary service the main tank was inspected and recommendations made to the client for refurbishment to take advantage of the unavoidable down time.

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HV COIL WINDING & ASSEMBLY:

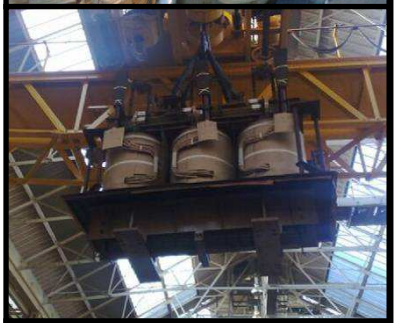
Templates for winding coils were made during the four days waiting for the copper to be delivered. The three HV coils and their respective HV tapping coils were manufactured over 9 days instead of 16 as the client had taken advantage of TPPS's double shift winding service which included weekend working. Each winding took 3 days to complete and was tested before being clamped and compressed to match the height of the LV windings being re-used before being put into the coil drying oven for 24 hours, removing any atmospheric moisture absorbed during manufacture before being retested.

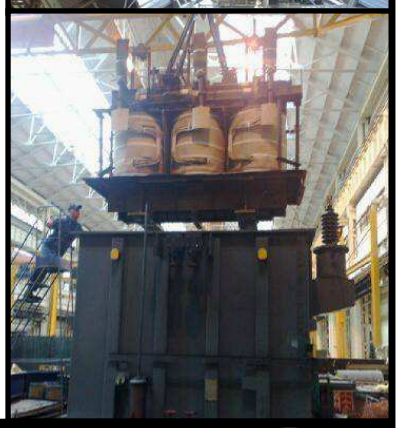
Each HV winding was lifted into position over the core limb and LV winding on each phase, then newly manufactured insulation and packing blocks, like-for-like to those removed, were repositioned as they had been removed, before the core clamps, top yolk and tapchanger were installed and secured. The LV busbar connections were reinstated, pre-made HV tapping leads connected to HV tapping ends, wrapped with insulation and terminated to the off-circuit tap changer mounted on the core assembly.

With the main core and winding assembly completed it underwent preliminary testing to check the polarity, phase sequence and insulation resistance. With preliminary tests confirmed, connections closest to tank walls had insulation added, each of the windings wrapped with sheets of insulation, barrier boards placed between each of the windings and lifted into the oven for a final 12 hour drying session. The rewind works took only 15 days continuous working instead of the 7 weeks it would have taken if the client hadn't chosen the premium options for quicker copper delivery and double shift working.

REFURBISHMENT SERVICES:

As the unit was being rewound the client took advantage of the unplanned down time to refurbish the transformer without extending the programme. TPPS Ltd were requested to degrease, clean and paint the main tank, replace all cables for the control systems on the main tank, and replace a winding temperature indicator. All control and protection were then inspected and tested ready for installation after rewind.





TANKING & FINAL TESTING:

The 23 tonne core and winding assembly was removed from the oven using overhead craneage following the final drying stage and then underwent final inspection to check all connections, terminations and insulation. The assembly was then lowered into the refurbished transformer tank, LV busbars terminated to the bushings within the cable box, the tank lid was lifted into position, secured, and the HV bushings installed and connected to the new HV line ends. A road tanker then delivered and pumped 14,500 litres of mineral oil to BS 148 into the main tank, and the unit was moved to the test bay for final testing to BS EN 60076. Integrity tests included:

- Winding Resistance test of LV and HV windings
- Applied high voltage (flash) test to each HV and LV individually at 105 kV and 21 kV respectively
- Induced high voltage (overpotential) test at 75% of load potential according to test standards
- No load loss and no load current test by applying 11.8kV to LV windings to establish losses in iron core
- Load loss and impedance voltage test to establish copper loss and check 5.9 % impedance as designed
- Polarity & phase displacement verification by testing HV and LV line ends in sequence
- Turns ratio at no load through a current & magnetisation ratio test on all tap positions in sequence
- Insulation Resistance test by testing HV to LV windings, HV windings to Earth, and LV windings to earth
- Oil sample and dissolved gas analysis (DGA) of oil within the transformer tank

Test results confirmed immediately that the unit met the industry standards for operation, and the unit loaded and transported back to site for installation two days later. Final reports would be issued to the end client within three working days to support final commissioning and energisation of the unit at site.

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