

## ELECTRICAL ENGINEERING SOLUTIONS FOR HIGH VOLTAGE NETWORKS

CONTRACT:	TPPS-16
SCOPE OF WORK:	Transformer & Switchgear Maintenance
CONTRACTOR:	Natural Power Ltd
END CLIENT:	Renewable Energy Suppliers & DNO's
LOCATION:	Various Sites
DURATION:	Ongoing
VALUE:	£ 120,000 GBP (current)

### SUMMARY:

Natural Power Ltd is a global renewable energy consultancy offering clients a variety of solutions from construction management and operational asset management to technical support services, and currently manages 26% of the UK's onshore wind farm capacity for DNO's such as E-On and Scottish Power, and independent providers such as ESB. TPPS Ltd initially completed inspection and maintenance on a 30 MVA grid transformer at a wind farm in Durham, which has now developed into a partnership delivering multiple solutions at multiple client sites around the UK supporting asset management.

Our continued delivery of reliable and competent services for inspecting and maintaining transformers, switchgear, control and protection systems, including G59 testing, has built relationships and trust with Natural Power's clients' to include substantial refurbishment and repair works to their power assets. Our ability to deliver solutions and respond quickly to emergency situations has been fundamental in building relationships which are going from strength to strength with each project.



### WIND FARMS:

We have completed inspection, maintenance, repair or G59 protection testing services on plant at multiple sites:

West Durham	ESBI	24 MW	12 turbines
Bowbeat	E-ON	32 MW	24 turbines
Hare Hill	E-ON	5 MW	2 turbines
Holmeside	E-ON	5 MW	2 turbines
High Volts	E-ON	8 MW	3 turbines
Butterwick Moor	E-ON	20 MW	10 turbines
Haswell Moor	E-ON	10 MW	5 turbines
Great Appleton	E-ON	8 MW	4 turbines
Hare Hill	SPPS	13 MW	20 turbines

### WORKS COMPLETED:

The works delivered to Natural Power and their clients are both proactive and reactive solutions for maintaining critical plant and equipment, and demonstrate our core business and ultimate goal of ensuring plant is efficient and safe for operation.

- Inspection, maintenance and testing of oil filled and cast resin power transformers
- Inspection, maintenance and operational testing of HV and LV Switchgear
- G59 testing of control and protection relays
- Technical consultancy to investigate transformer faults and unit failures
- Replacement of LV Bushings on Grid Transformers
- Refurbishment, repair and modification of distribution and voltage transformers
- Topping up transformers with mineral insulating oil

### G59/1-2 PROTECTION TESTING:

Engineering Recommendation G59/1-2 implements parameters required for the connection of generating plant up to 5 MW, such as wind farms, to the distribution system of DNO's; covering tolerances that must be followed to guard against unplanned system failure, and dictates actions to be taken when faults do occur. TPPS have supplied engineers and test equipment to complete testing at 5 sites so far, with all tests witnessed and approved by the DNO, including:

Single or Dual stage Voltage, Single or Dual Stage Frequency, Vector Shift, Rate of Change of Frequency (R.O.C.O.F), Current Unbalance (phase failure), Negative Phase Sequence and Directional Over Current Tests.



### PLANT & EQUIPMENT DETAILS:

TPPS Ltd has completed proactive maintenance and G59 protection testing on the following plant:

- ABB SafeRing Ring Main Units
- Self Powered MPRB-99-1.0-GF Protection Relays
- Areva Visax 20 kV Switchboards
- Areva FBX Circuit Breaker & Disconnecter Units
- Associated SEG WIC Protection Relays
- MICOM G59 Protection Relay Panels
- 33/66 kV Oil Filled Grid Transformers
- 0.69/33 kV Oil Filled Distribution Transformers
- 0.69/20 kV Cast Resin Distribution Transformers

## FAILURE OF 700 kVA TRANSFORMER:

When a distribution transformer failed at a wind farm in Ayrshire owned by Scottish Power, TPPS Ltd were sent the unit to investigate and repair the 700 kVA 33 kV ONAN Dyn11 unit incorporating a 2500A ACB with fuse assembly sets mounted on the core and windings. After removal of the tank lid it was identified that one of the 36 kV Current Limiting fuses had blown, so a temporary fuse was connected and the transformer underwent and passed testing. Like for like fuses had an 8 week lead time but this was too long for the client so alternative fuses were procured which were available in 3 weeks. However, these fuses were shorter with a larger diameter, meaning they would not fit in the existing mount assembly and would breach the minimum clearance distance of 60 mm between 33 kV fuses.

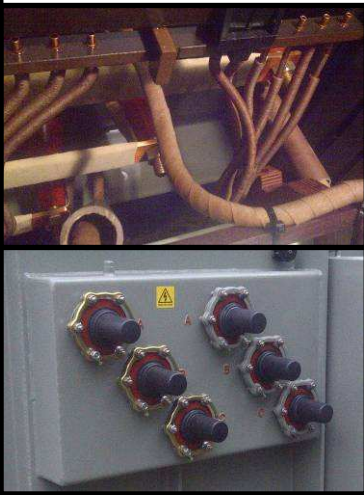
TPPS resolved the issue by re-engineering the existing mount assembly to secure new fuses and ensure minimum clearance distances were achieved. The integrated 2500A ACB was also repopulated with 630A LV fuses, inspected and maintained. During the 3 week lead time for the replacement HV and LV fuses the unit underwent painting of the main tank and inspection and maintenance of all auxiliary control, protection, monitoring and operational components.



## 700 kVA TRANSFORMER REFURBISHMENT:

The failure of a 700 kVA transformer (above) meant the site could not generate. As TPPS would investigate the failure, the project was extended to modify a sister unit to allow generation. The failed unit had two sets of HV bushings whilst the sister unit only had only one set, however the units where designed to be interchangeable and already had pre-cut holes to allow for another set. Internal HV connections required re-engineering to ensure all electrical clearance and creep distances were maintained with both sets of bushings installed.

Scottish Power supplied the 36 kV bushings from their stores to negate lead times, and TPPS had to design and manufacture the replacement connections. HV leads to the existing bushings would breach clearance distances, so needed to be removed, replaced and re-routed. Both sets of bushings were interconnected via insulated copper busbars rated at 800A; above the 630A fuses being installed in the ACB; then new HV leads were made and connected to the new bushings. Once all connections were secured the unit underwent and passed ratio and magnetising current, vector group, insulation resistance tests and oil integrity tests. Works were completed within 5 days including painting of the unit and final test reports issued to site for commissioning.



## 30 MVA FAULT INVESTIGATIONS:

TPPS Ltd were called to site to investigate the heat damage on the yellow phase LV bushing of a 30 MVA 66/33 kV Grid Transformer at West Durham wind farm, owned by ESBI. TPPS Ltd mobilised to site to inspect the unit and concluded that the fault may have caused by a cracked connection flag. A replacement LV bushing was sourced and delivered within 5 days. Engineers decanted oil into a tanker and connected a dry air machine to purge the transformer to protect its integrity before removing the damaged bushing. The main LV connections were inspected for any sign of heat damage, and with no concerns, the replacement bushing and connection flag were inspected and installed. The new bushing had Ductor and Megger tests completed, passed as satisfactory by the client, and the unit refilled with mineral oil, trapped air vented, and unit inspected for oil leaks. Works were completed and approved by the client and the unit energised the same day.



## VOLTAGE TRANSFORMER REFURBISHMENT:

TPPS Ltd investigated the failure of a three phase 200 VA 33000/110/63.5V GEC Voltage Transformer after it was transported from Scottish Power's Whitelee Wind Farm. Engineers dismantled each bushing assembly to inspect the 36 kV HRC fuses and found the primary fuse on the B phase had blown which required the fuse in each phase to be replaced. New fuses were installed, gaskets replaced on each HV bushing assembly and the unit refilled with new mineral oil ready for testing. The unit underwent tests to check the insulation resistance, primary fuses and turns ratio to meet BS 3941 standards. The main tank was painted along with each of the HV bushing caps in their respective phase colours, identification labels replaced and the bushings protected ready for dispatch. All works were completed in only 3 days from receiving the unit to dispatch, and inspection and test reports were issued to Scottish Power to support commissioning of the unit.