

## GENERATOR TROUBLESHOOTING AND REPAIR

A crude oil tanker built in 2008 with 228m overall length and 32m beam, and a gross tonnage of 41676t, experienced a winding failure on a Main Alternator.

### Equipment data:

Maker: Taiyo Electric Co.  
850kVA, 1091A, 8 poles / 900 rpm, 450V, 60Hz.

Due to Metalock's good reputation and successful past experience, the company was appointed by Taiyo Electric Co. as its representative for Brazil. Accordingly, Metalock was approached by the customer to inspect the burnt stator winding at Salvador, Brazil.

Initially, a visual assessment identified stator lamination damage affected by winding failure inside the slots. The Rotor and Exciter were showing a low insulation condition. This guided METALOCK to believe that the stator core was damaged and therefore renewal of the core or other possible repairs were necessary, but, adequate core testing would have to be done and the equipment totally dismantled in METALOCK's workshop.

Due to logistic considerations, the owners decided to contract a third party. Immediately after disconnecting and dismantling the alternator and removing the burnt windings, limited core tests on board led to same conclusions expressed by METALOCK. The job was directed and given back to METALOCK as Taiyo representatives.

The Generator was landed and transported to METALOCK BRASIL's workshop in Santos, SP.



### After dismantling, the following inspections were effected:

- Rotor and Exciter (rotor and stator): Resistance measurements of coils (separately and connected), surge tests, loop tests and analysis of the Exciter Rotor.
- Rotor shaft trueness run out check.
- NDE Bearing seat was found to be worn.
- Stator winding : Loop test and measurements.

Due to high temperature findings with the presence of various hot spots, it was decided to change the core and not reshuffle the laminations or effect any repair attempt.

### Two options were presented to owners :

1. Acquire a new stator pack from our principals TAIYO ELECTRIC Co.. Delivery time of four months was considered excessive.
2. Place an order for a new stator pack from a third party in Brazil. Delivery time of one month. This option was accepted by the client and the new pack was delivered to owners satisfaction.

The damaged Bearing Case was repaired at a third party workshop in Brazil by thermal aspersation process, including pre-machining, rectification and final polishing of the repaired surface. A new bearing was supplied by the client.

The new stator core was assembled in the Generator frame and the rewinding was done by METALOCK as follows, to guarantee a high quality traceable winding:

- Original manufacturer's winding procedures and data were followed.
- Stator core pack and frame was cleaned and anti-corrosion coated.
- All coils were made with lacquered class H 180°C factory traceable wire.
- Each slot was independently insulated with class H material.
- Each coil was manually installed respecting maker's original pitch and phase position.
- All slots were duly closed with slot wedges.
- Winding heads at both ends were duly tightened by using class H tying cords supplied by AEV UK.
- All connections were soldered and insulated at every point.
- All cabling was duly tightened to winding head and crimped with terminal eyes.
- Stator was pre-heated prior to varnishing.
- Stator winding was varnished 4 times by the trickle method to guarantee a adequate penetration.
- Stator was placed in the oven for 8 hours, at 100°C controlled temperature.
- After cooling, stator was cleaned and excess varnish on stator pack surface was removed.
- Busbars were cleaned and checked.
- Cabling was connected to busbars.
- Stator was tested at 1000V + 2 x nominal voltage, surge test on all phases, resistance measurements and PI/DAR presented to satisfactory results (over 1 Gohm).

Main rotor initially presented low insulation. Several tests were effected, including separate loop test to each coil, surge test to each separate coil and impedance test with AC supply connected to each pole coil. Separate testing with a Kelvin bridge was also effected. Results were considered normal. The Rotor was washed and placed in the oven to reach acceptable value above or equal to 1 Giga ohms. The Rotor was trickle varnished and final readings were satisfactory.

Exciter Rotor and stator: Exciter rotor was initially measured / checked and found in good order with acceptable insulation resistance, surge wave forms and balanced resistance. Exciter stator presented good insulation resistance. Both were cleaned, re-varnished and found with very good insulation after final treatment.

Dynamic balancing of the Rotor was performed based on ISO 1940, quality balance grade G6.3

Practical testing of generator after its repair completion at METALOCK BRASIL was arranged at a third party electrical machinery factory in Sao Paulo, Brazil. Metalock developed and produced a dummy cover at DE side to emulate the generator's real condition, thus enabling full running test. A short-circuit, temperature raise and partial load test were carried out in the presence of the client's representative. Full test reports were recorded, which proved to be in line with original testing performed to alternator type approval by ABS with Taiyo, prior delivery of vessel at shipyard, during her construction.



The generator was tested at nominal rpm, at no-load, short circuit and 233.8 KVA inductive load, also the output voltage has been checked with the generator self-excited. After the workshop test the generator has been returned to METALOCK for dismantling and preparation, to be returned to the vessel. The Stator and the Rotor were separated and packed in two wooden boxes.

The generator was transported and, with the use of a service barge and ship's crane, placed on board. After maneuvering the equipment to the engine room, it was reassembled and coupled to the auxiliary engine. Satisfactory deflection readings were taken.

Alternator was then tested in no-load and on-load, single and parallel condition. Insurance representative and ABS class surveyor attended the ship and approved the repair effected by removing ship condition of class related to the generator.

The generator was tested and maximum bearing temperature readings were recorded considering a no-load and no excitation condition as well as an on-load condition.