Turbogenerators
Case Studies

Presented by
Abhilash Chandra Aron
Consultant, Turbogenerators
Managing Partner, Eron Services
Bhusawal TG Core Damage

THW-210 Bhusawal-2 TG overhauled in 1993 and then in 2002. During this overhaul, ELCID readings were high for slots 51-52 near 1st end packet on TE.

After removing few bars, core melt seen between slots 51 and 52.

Tooth between 51-52 was cut off, molten iron removed to reach clear laminations.
Bhusawal Core Damage -2
View From Turbine End

Core Melt
Later, after the tests, few more hot spots near end packets detected and repaired. A dummy tooth was made out of glass textolite and glued in place of removed metal position.
Melting of Core Iron

Zone upto which iron to be cut off

10 - 15 mm

Healthy core

Core iron melt
Core Repair - 6

Dummy Tooth

Slot Wedge

Core Iron
## ELCID Test Results

<table>
<thead>
<tr>
<th>Packet:</th>
<th>91</th>
<th>92</th>
<th>93</th>
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<tbody>
<tr>
<td>Slot 54</td>
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<td>16</td>
<td>26</td>
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<tr>
<td>Slot 53</td>
<td>64</td>
<td>73</td>
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<td>Slot 52</td>
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<tr>
<td>Slot 51</td>
<td>65</td>
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<tr>
<td>Slot 50</td>
<td>48</td>
<td>145/196</td>
<td>229</td>
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<td>Slot 49</td>
<td>92</td>
<td>275/298</td>
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<td>Slot 48</td>
<td>111</td>
<td>342/343</td>
<td>218</td>
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<td>Slot 47</td>
<td>46</td>
<td>179/203</td>
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</table>
Core Loss Test

- Test is done at flux density of 1 - 1.5 Tesla for 90 - 45 min. Teeth temps. are checked with infra red devices.

- At the end, temp. rise of hottest point to be < 25°C and difference between the hottest and coldest be within 15°C.
## Core Loss Test

Temp. Rises °C after 90 min.

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<td>Slot 52</td>
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<td>Slot 47</td>
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</table>
Turb End: Temp Rises after 30 min. Max. rise permitted 25° C
O’Haul: Dec. 2004

Overheating seen at core back near core bars in the repaired zone.
Stator Damage

• A 760 MVA Angara-Brazil: Core repaired after 13,400 Hrs. Hot spots repaired using electro-chemical process.

• M/c tripped on stator faults, after another 1200 Hrs. Huge core melt seen on ExEnd. High burrs; Insulation thickness too less. Core was poorly clamped at two ends.

• Machine was rebuilt at site by KWU.
Stator winding Leakage

- Leak in stator winding caused H₂ gas to enter into it. H₂ consumed @ 25 cylinders per day. Gas pressure reduced and water came out at leaking point, causing flash over between phases. Machine rewound.

- Ran for 30,000 hrs without mandatory initial overhaul. H₂ leak detected in the gas trap device and in expansion tank. Leakage was in 3 bars on EE side.
THW: Stator Winding Vibrations

Radial Vibrations

Upper Bar

Lower Bar

Teflon Tubes

Tangential Vibrations
Chandrapur 500 MW U-7

- TG having clocked 63,734 hours, running with gas cooler leak, tripped on electrical faults. Melting of copper lugs, Teflon tubes water headers seen on turbine side.
- Mostly, replaceable lug ends got damaged but in one joint, 4 hollow strips melted.
- A copper chamber was made in this lug by brazing in situ, to restore water flow.
Damage at 7 O’Clock
Upper half box removed
Brazed jacket
Brazed top box cover
High Cold Gas Temps.
NEYVALI THW - 210 MW TG

• CW temp. remains high in summer and machine operated at maximum MVAR.
• 2 RTDs were defective due to cold solder
• Hot gas leaks bypassed H2 cooler inside stator. Rubber seals in coolers were corrected.
210 MW: Motoring
North Chennai

- 2 ph steady state asynchronous motoring for 6 minutes without excitation.
- Generator: 12.9, 12.8, 12.3 kV stator volts and load: 2.8, 4.4, 3.0 kAmp; 0.5 MW.
- Calculations showed: 'I²' was 5110 Amp (56.5% FL) duration 3 sec., So, I²  t ~ 3, which was permissible
- Rotor was cleared without any inspection.
TG Motoring - 2

- A 200 MW Mitsubishi generator motored in asynchronous mode for almost 34 minutes due to GCB fault.
- $I_2^2 \cdot t$ value was computed by OEM as more than 110.
- Retaining rings were removed but no physical damage seen.
• Machines started as induction motor from standstill.
• Rotor barrel ends got overheated and winding insulation got damaged.
• In Wanakbori ‘GT’ also got damaged.
• Stator windings were damaged.
Local Repair of a Lower Bar

- After rewinding works, during final HV lower bar failed at 70 mm from core end in overhang.

- Puncture point was filled with epoxy. On top, a ’Π’ shape 4 mm thick insulation 125 mm long was tightly glued and tied. Passed 21 KV. In operation for >25 yrs.
Repair of Lower Bar - 2

Core

Puncture Point

Cap

Glue

Cord
Repair of Upper Bar

- Core Iron Wedge
- Barrier
- Db Thick
- Fault Point
- Upper Bar
- Lower Bar

=2Lb
THRI-210: Rotor Damage

- Set started without water in gas coolers and loaded to 77 MW.
- High gas pressure alarm comes. H₂ gas pressure seen 2.6 against 2 atg normal.
- It was estimated that gas temp. went up to about 129°C and rotor hot spot temp. went up to 200°C.
Set resynchronized. Rotor current higher by about 20%, confirming rotor inter-turn insulation damage.

Advised to increase H₂ pressure from 2 to 3 atg & restrict rotor current to rated, giving 170 MW and 20 MVAR.

Rotor ran for 18 months in this condition.
*About 2800 creepage paths in rotor cause creepage resistance to fall.
Fire Around Slip Rings

- In a 210 MW generator, slip rings had depressions due to non-uniform wear. They were not machined as required and machine continued to run.
- Fire broke out on brushes around the rings. All the holders + brushes melted causing a forced and long shut down.
Slip Rings

- Brushgear centering, stagger of brushes, mounting of brush holders, & alignment and clearances, brush pressure & grade are important.
- Dust + oil vapours, give high sparking.
- HM-100 grade, though softer had better performance. Slightly higher pressure reduces sparking and brush jumping.
Oil Starvation

- 210 MW set reached 570 rpm. Sound heard from rear bearing. Coast down was quick. Babbit had melted, shaft journal dia 400 mm developed cracks.

- Shaft had hardened to 315 BHN from 246, because of rubbing. Cracks upto 200 mm length and 1.75 mm depth had developed.
Oil Starvation - 2
Damage To Bearing Journal

- Machined to Ø 320 mm, till all cracks disappeared & normal BHN achieved.

- Rotor was reused after machining.
Damage to a THW-210 TG

- During overhaul, old strip type cracked lock washers were reused. As a result during operation, M24 bolts came out, releasing a 5 kg steel segment inside.
- Plate fell on stator overhang and was sucked by magnetic pull into the airgap hammering stator and rotor surfaces & damaging them.
THW-210: Thrust Seal Failure
Kolaghat-4, Bokaro-1

• At 120 MW, abnormal sound is heard near TS bearing. Press falls by 0.3 Kg.

• TS seal-oil drain high. Hydraulic seal oil level high. Overflow of oil from the damper tank to hydraulic seal occurs. Babbit RTD on TE not working.

• Smoke comes out of Turb S seal area momentarily. Mating surfaces of hole and locking pin were damaged.
Thrust Seal Failure - 2

- TS seal collar face damaged & was cut by 13 mm. Seal liner babbitt was worn out, parent metal damaged 5 mm deep. Pins were loose and found shifted.
- Collar face was machined to get 36.7 mm collar thickness.
- Seal body flange thickness increased by 13.5 mm. Long bolts and new seal liners used.
THW-210: Thrust Seals

A-A
With Bush

A-A
Without Bush

Locking Pin

Brass Bush

Seal Liner

Sec B-B

Damage Here

CASES by AC ARON
Fire in a 500 MW TG

- Six LP last stage blades towards IP side failed at roots in quick succession after 11 years service. All bearings, H₂ shaft seals damaged; H₂ escaped.

- Oil and leaking H₂ catch fire. H₂ fire extinguished promptly by venting H₂ out and CO₂ feed. Oil fire stopped by extinguishers. No damages due to fire.

- PMG, exciter armature, generator rotor compressor blades were damaged.
Explosion in Generator

• 110 MW TG fed O₂ instead of H₂ for make up. Explosion occurred after 8 hours. Ten cylinders of O₂ were fed upto explosion.

• Purity-meter having 90% low range, was not working, purity unknown. TG end walls welding broke, gas coolers axially pushed

• A stator coil had flashover marks in its overhang portion, copper had melted. Set tripped on its protections.
Best Wishes!

AFSHA CLASS 5