UPRVUNL NIGAM HEADQUARTERS

Best Practices & Case Studies Repository

PREVENTION OF SHAFT VIBRATION DURING UNIT COLD STARTUP

CTPS Parichha Unit-5 Thermal Soaking Procedure Optimization

1. PROJECT DETAILS

Project Name	**CTPS Parichha 2×250 MW Units**
Location	**Parichha, Uttar Pradesh**
Unit Capacity	**250 MW**
Problem Date	**30.05.2026 (Initial Incident)**
Solution Implementation	**31.05.2026 (Successful Synchronisation)**
Implementation Status	**Operational & Validated**

2. PROBLEM STATEMENT:

1. Incident Description:

During cold startup on 30.05.2026, after achieving rolling parameters (Main steam pressure: 35-40 Kg/cm^2, Main steam temperature: ~350°C) and rolling TG set to 600 RPM with ~1 hour thermal soaking, the unit exhibited sudden and uncontrolled shaft vibration at Pedestal No.1 when accelerated to 2000-2500 RPM range.

2. Critical Issues:

- Rapid vibration escalation from normal to trip limit (>320 Micron) within seconds
- Increase of 100-150 Micron in few seconds during acceleration phase
- Risk of forced unit shutdown affecting generation
- Potential for serious mechanical damage to HP/IP rotor assembly
- Unpredictability in startup cycle creating operational constraints

3. Root Cause Analysis:

Investigation confirmed all monitored parameters were within specification (Top-Bottom temperature difference in IP turbines: 29-30°C, seal steam temperature: 210-250°C, lube oil temperature: 42-45°C, bearing temperatures, and axial shift). However, the HP rotor had NOT achieved stable thermal equilibrium. Localized thermal imbalances and residual stresses in the rotor persisted, manifesting as vibration instability during the acceleration phase.

3. METHODOLOGY & CORRECTIVE ACTION

A systematic procedure was developed to ensure thermal homogenization across the entire rotor under controlled conditions:

Step 1: Turbine Seal Steam Temperature Control

- Increased turbine seal steam temperature to 300-350°C (from previous 210-250°C)
- Prevented localized cooling at shaft ends
- Eliminated differential thermal contraction risk

Step 2: Lube Oil Temperature Management

- Maintained lube oil inlet temperature at 45°C ± 2°C
- Eliminated cold oil supply to prevent high viscosity-induced oil whirl at Pedestal-1
- Ensured consistent bearing lubrication and thermal environment

Step 3: Extended Low-Speed Thermal Soaking (Critical Innovation)

- After achieving rolling parameters and rolling to 600 RPM, held TG set at 600 RPM for extended period
- Allowed minor residual thermal imbalances to homogenize across rotor surface
- Low centrifugal stress at 600 RPM enabled uniform thermal distribution without mechanical stress

Step 4: Continuous Thermal Monitoring

- IP Out Casing Top & Bottom Metal Temperature difference (50% of load)
- HP Out Casing Top & Bottom Metal Temperature difference (50% of load)
- LP differential expansion monitoring
- Recorded at regular intervals during extended soaking period

Step 5: Progressive Rolling with Thermal Criteria

- Proceed to 3000 RPM ONLY when ALL conditions satisfied:
- IP Out Casing Top-Bottom temperature difference ≤ 20°C
- HP Out Casing Top-Bottom temperature difference ≤ 10°C
- LP differential expansion in increasing trend

4. QUANTIFIABLE RESULTS

Shaft Vibration Reduction (Primary KPI)

Parameter	Before Implementation	After Implementation	Improvement
Pedestal-1 Vibration (1X)	>320 Micron (Trip Limit)	150-168 Micron	52% Reduction
Pedestal-1 Vibration (1Y)	Escalating	69-75 Micron	Within Normal
Response Characteristic	Sudden Surge	Smooth Gradient	Controlled Ramp

Operational Success Metrics

- Unit successfully rolled and stabilized at full load on 31.08.2026
- Zero unscheduled trips during subsequent operations
- All thermal and mechanical parameters maintained within design specifications

- Predictable, repeatable startup procedure established
- Consistent performance confirmed across multiple startup cycles

Cost-Benefit Analysis

Metric	Planned Loss	Achieved (Saved)
Outage Duration	10 Days	0 Days ✓
Generation Loss Avoidance	54.6 Million Units Loss	54.6 MU Retained ✓
Revenue Impact	₹25.85 Crores Loss	₹25.85 Crores Saved ✓
Bearing Inspection Status	Required Inspection	Avoided turbine bearing dismantling and internal inspection ✓

5. TEAM CREDITS

Combined efforts of the O&M team of CTPS Parichha under the guidance of Director (Technical), with precision thermal management, continuous vibration monitoring, and detailed turbine parameter analysis.

6. REPLICABILITY ASSESSMENT

REPLICABILITY RATING: YES

Scope of Replication

- **Universal Applicability:** Applicable to all UPRVUNL 250 MW identical unit designs and similar thermal power plants.
- **Procedural Solution:** No capital equipment required - operational procedure-based, implementable immediately
- **Physics-Based:** Root cause (thermal imbalance) and solution (thermal soaking) based on proven turbine engineering principles
- **Knowledge Transfer:** Procedure can be standardized, documented, and replicated across all UPRVUNL facilities
- **Risk Mitigation:** Prevents catastrophic failure scenarios with zero additional cost