



# Detecting High End-winding Vibration to Prevent Failure

## Machine Data

Commissioning: 2017  
Turbine Type: Steam

Power: 250MW  
Speed: 3000 rpm

Insulation: Class F  
Cooling: Hydrogen

## VibroSystM Inc. and Dixtech Engineers India

This case study has been authored to demonstrate the benefits of implementing on-line end-winding vibration monitoring systems for early detection of high vibration and allowing preventative action to prevent insulation abrasion and catastrophic phase-to-phase or phase-to-ground short circuit faults in relation to turbogenerator machines. Demonstrating the invaluable benefits of using proper monitoring systems to enable the detection of underlying issues before they become catastrophic failures, with the end result being improved reliability and increased asset protection.

### Background

After a first incident on turbogenerating unit no.2 earlier in 2025, the end-user and OEM contracted Dixtech Engineers to install VibroSystM Fiber-Optic Accelerometers (FOA). A total of 16 FOA-100E sensors were installed, 8 on the exciter end and 8 on the turbine end, measuring the radial vibration of the end-windings and their supports. The accelerometers were paired to VibroSystM's ZPU-5000 acquisition unit running their patented high frequency data logging ZOOM software. For context, analog signals from the ZPU-5000 are also supplied to the end-users SCADA system.

The new system was commissioned December 2025 during steady-state operation. The data collected immediately revealed a significant mechanical anomaly concerning the machine's rotational frequency.

### Data Analysis

Normally, the primary vibration frequency of a machine's end-windings is double that of the grid frequency (which is also the rotational frequency). For example, for a 50Hz grid frequency, the main frequency of the end-windings would be 100Hz. In this case, the primary vibration frequency on many channels matched the grid frequency. Three channels showed consistent elevated levels including one peaking above 400  $\mu\text{m}$ . For a machine of this class, 400  $\mu\text{m}$  at 50Hz represents extreme mechanical energy. While 100Hz is expected due to the electromagnetic forces at work, a dominant 50Hz peak suggests the end-winding structure is no longer rigid and is responding to the rotor's residual mechanical forces.

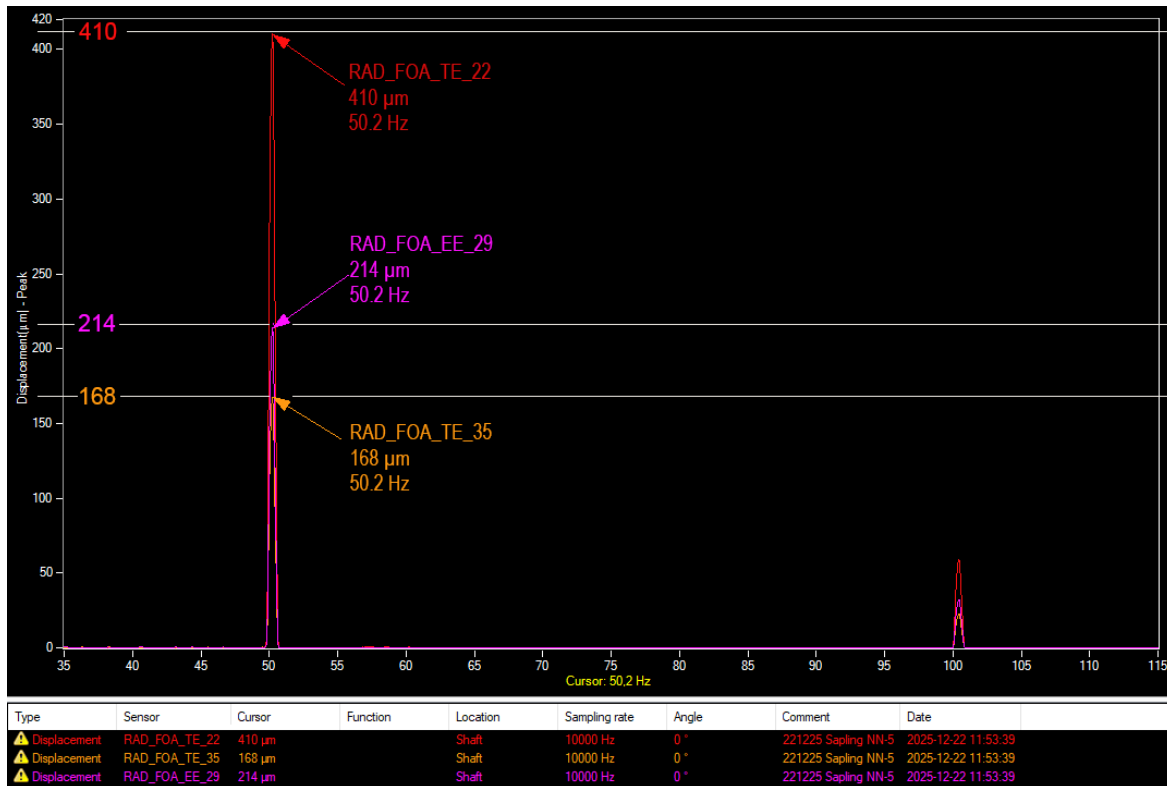


**Fig. 1 - FFT of the sensors showing the highest vibration amplitude at 50Hz frequency**

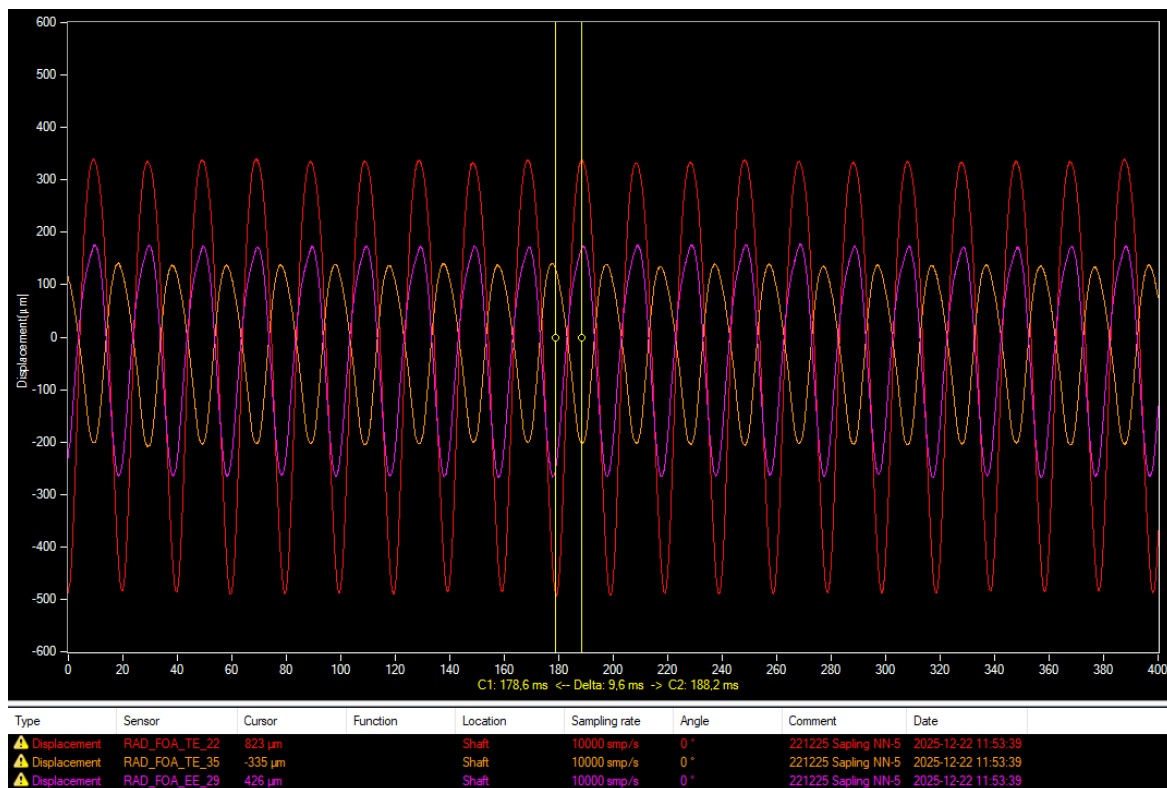


**Fig. 2 - Waveforms of the same 3 sensors showing consistency**

The time waveform shows a consistent, high-amplitude sinusoidal pattern. The lack of modulation indicates a permanent structural looseness or a resonance condition rather than a transient operational spike.



### **Correlation: Digital Data vs. Physical Evidence**

The FOA sensor data provided an internal view, which was subsequently confirmed by a physical visual inspection. They found significant white dusting or powdering on the spacers and winding surfaces in the critical areas identified by the FOA results.

This powder is the byproduct of insulation abrasion. As the bar vibrates, the mica-tape insulation rubs against the support bracing. The resulting dust is essentially the sanding down of the generator's primary dielectric protection.

The correlation between the highest recorded FOA displacement and the heaviest concentration of dusting confirms the system's accuracy in identifying the exact location with the highest mechanical degradation.

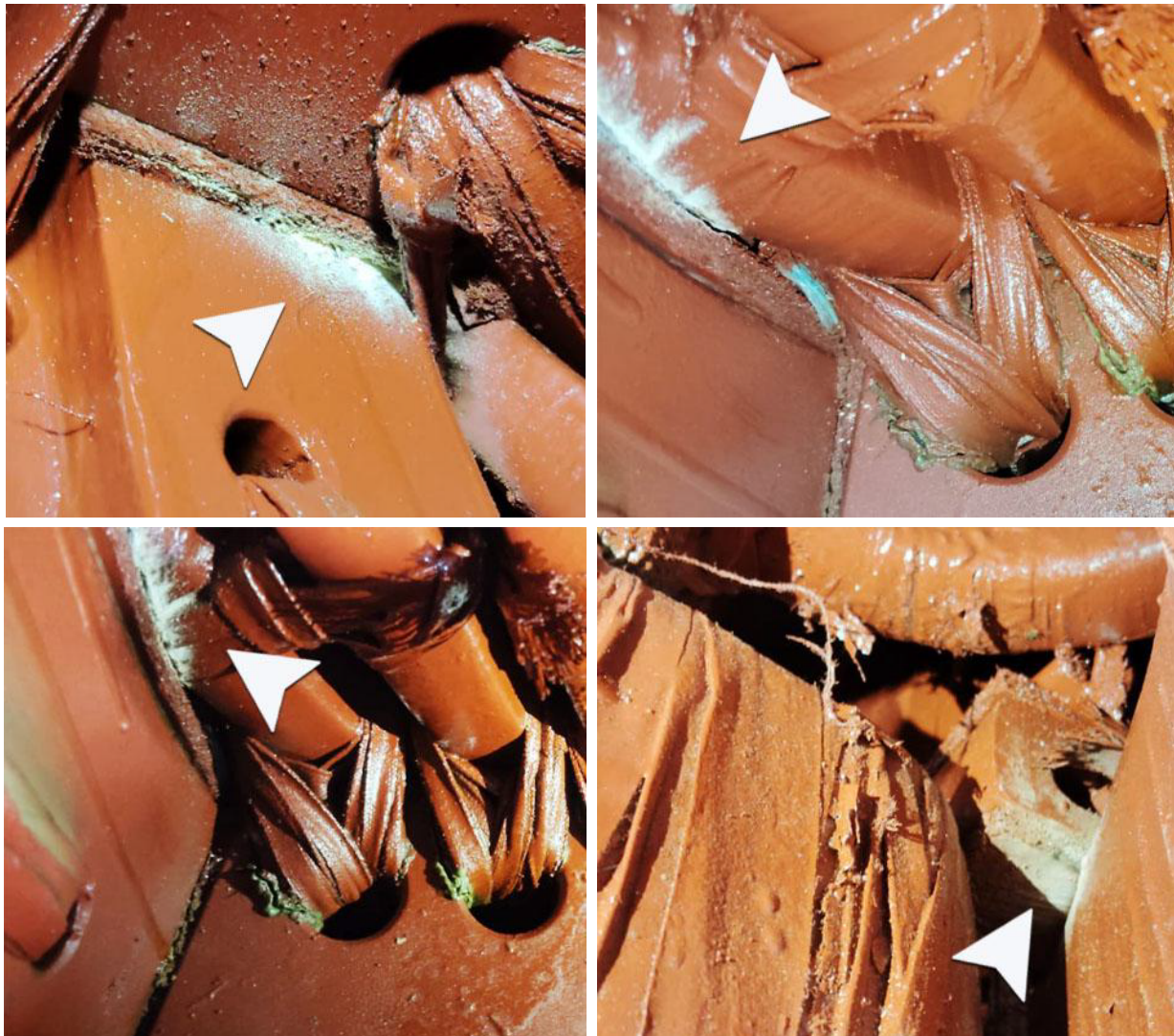


***Fig. 3 - Evidence of white dust found on spacers, bracing and winding surfaces where the highest vibration was detected***



## Root Cause Analysis

Based on the frequency signature and physical symptoms, the most probable causes are as follows:

1. **Mechanical Resonance:** The end-winding assembly's natural frequency could be too close to that of the network frequency. This can amplify even a minor rotor imbalance into a massive displacement issue.
2. **Support Degradation:** The localized stiffness has been reduced due to the aging or loosening of the support ties and blocking.
3. **Cyclic Fatigue:** The high 50Hz vibration creates a feedback loop; the vibration causes more abrasion (dusting), which further loosens the supports, which in turn leads to even higher vibration levels. **i.e.** a runaway effect.
4. **Global Structural Looseness:** The high amplitude at 100 Hz (~150  $\mu$ m) indicates that the end-basket could have lost its intended prestress. While the 50 Hz vibration is the most immediate threat, the 100 Hz levels indicate that the electromagnetic forces are also exciting the loosened structure, significantly increasing the risk of copper fatigue and secondary insulation wear.

## Engineering Recommendations

To restore the structural integrity of the generator and mitigate the 50Hz resonance, the following actions are recommended:

1. **Targeted Structural Reinforcement:** Perform a detailed inspection and re-wedging/re-lashing of the end-basket, specifically focusing on the zones where white dusting was identified.
2. **Stiffness Analysis:** Conduct an offline Impact Test (Bump Test) to map the natural frequencies of the end-windings. The goal is to shift the structural resonance further away from the 50Hz/100Hz operating zones.
3. **Post-Intervention Validation:** Have an RIS diagnostic report produced immediately following the first start-up post maintenance to verify that the overall vibration has been decreased to an acceptable level.
4. **Long-Term Trending:** Have periodic RIS update reports produced to identify potential creep in vibration levels as the machine cycles thermally.

## Conclusion

Through the intervention of Dixtech Engineers, the implementation of the VibroSystM ZOOM monitoring system transformed a potential catastrophic failure into a managed maintenance event. Through the monitoring of structural movements that are invisible to the naked eye but destructive over time, identifying the 50Hz vibration early and avoiding the exponential wear phase, where insulation abrasion accelerates exponentially towards a phase-to-ground fault. Therefore shifting the end-user's maintenance philosophy from Reactive (fixing a failed machine) to Condition-Based (fixing a machine because the data dictates it).