



Stator Thermal Expansion Analysis Boundary Dam Power Plant Unit U51

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1. Introduction

This case study examines the analysis and resolution of a stator thermal expansion issue in a hydroelectric generator at the Boundary Dam Power Plant, Unit U51. The study focuses on the crucial role of VibroSystM's monitoring system in proactively identifying potential problems and enabling timely intervention to ensure the generator's reliability and efficiency. In this instance, the monitoring system detected a discrepancy in the stator's thermal expansion, prompting further investigation and ultimately leading to corrective action that improved the generator's long-term performance.

2. Problem

In 2021, data from the plant's monitoring system revealed that the stator frame expansion was not proportional to the stator core expansion. This indicated potential issues with sole plates and core-frame attachments, which could lead to mechanical stress and potential damage to the generator. Additionally, the stator core exhibited non-uniform expansion due to the restriction from the stator frame sole plates.

3. Analysis

This issue was detected during the commissioning of the generator after a refurbishment. During this commissioning, a heat run was recorded using VibroSystM's ZOOM Monitoring System, which includes 8 displacement probes (1 for each sole plate) monitoring the stator frame expansion. These 8 probes are aligned with 8 air gap sensors monitoring the stator core expansion. The expansion of the stator core was found to be a lot bigger than the stator frame expansion, averaging at 13 mils more expansion. This is how the issue with the sole plates was detected.

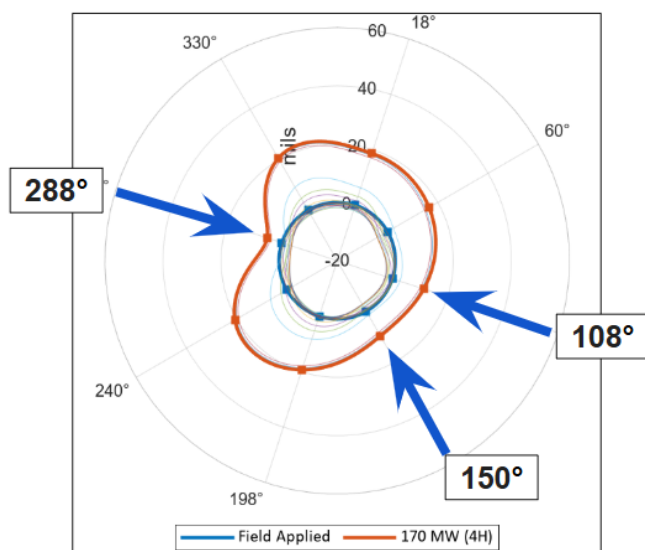


Here are the key points detected in 2021 :

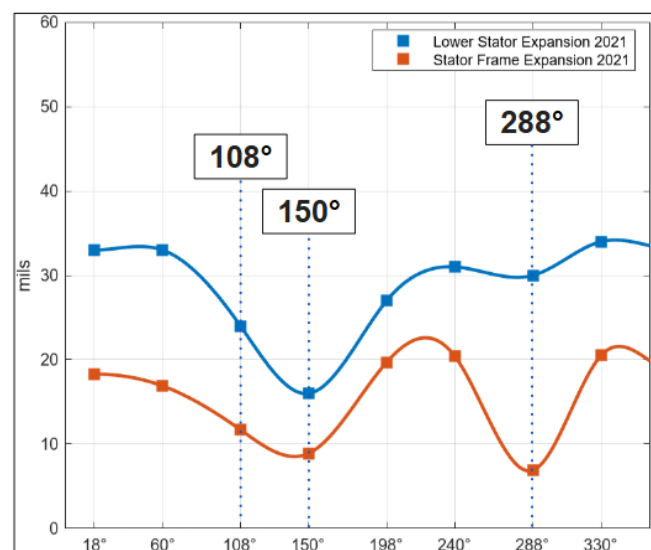
The frame expansion was not proportional to the stator core expansion, averaging at 15.5 mils for the Stator Frame compared to 28.5 mils for the Stator Core.

The locations with the least expansion for the Stator Frame were 108°, 150° and 288° indicating a sole plate issue at these locations.

At 288°, the expansion of the Stator Frame is especially low when compared to the expansion of the stator core at this location.



Stator frame expansion in 2021



Stator frame vs lower stator thermal expansion in 2021

Fig. 1 - Stator frame thermal expansion during the June 2021 heat run

4. Solution

Based on the analysis, maintenance was performed on Unit U51 between 2021 and 2024 to address the identified issues. This included:

- Removal and cleaning of the stator frame sole plate dowels, with some dowels machined down to reduce their tightness.
- Removal and reinstallation of the rotor.
- Installation of a new thrust runner and thrust shoes with PEEK pads.
- Addition of a high-pressure oil lift system in the thrust bearing.
- Re-centering of the unit and shimming of the guide bearings.

The most important point relating to this case study is underlined. A description of the work follows.



Inspection was performed on the sole plates to confirm that they are be separated to the stator frame, cleaned and lubricated. Also a means must be provided to allow installation of lubrication in the future.

Visual inspection of the dowels for galling was performed. Dowels should be checked during routine maintenance outages to ensure they can be pulled in freely and are not seized. For any dowels that are seized, machine dowel OD (outer diameter), minimum material removal to achieve proper clearance.

The time frame during the rewind is the perfect time to do this. The core and winding are out, the frame is light and easy to move, and there are no electrical connections that need to be removed or that will be stressed when the frame is raised.

Following the rewind, engineering will perform frame expansion testing and inspections using the VibroSystM equipment. Since there are 4 units which all have the same frame to sole plate design, this change to the sole plate will allow SCL to gain insight into improvements needed on the other units during their future rewinds.

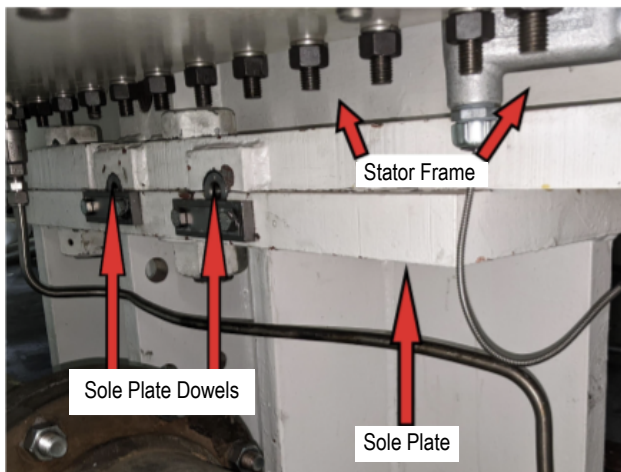


Fig 2 - Stator sole plate

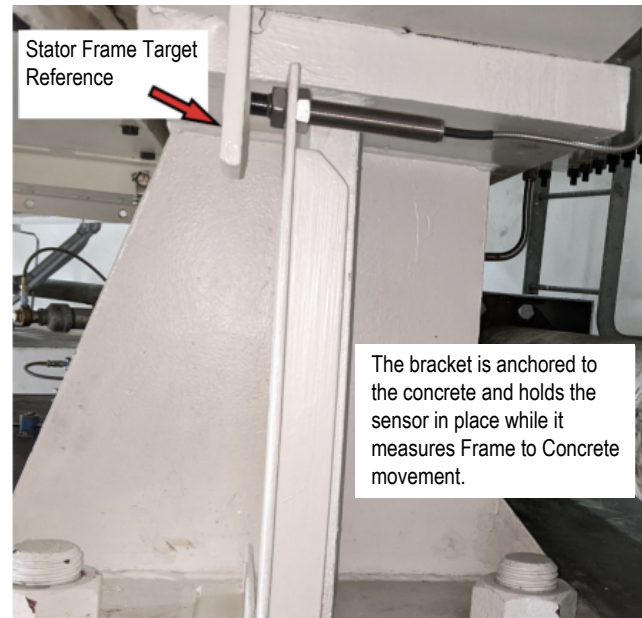


Fig 3 - Stator frame displacement probe located at the sole plate



Fig 4 - Stator sole plate

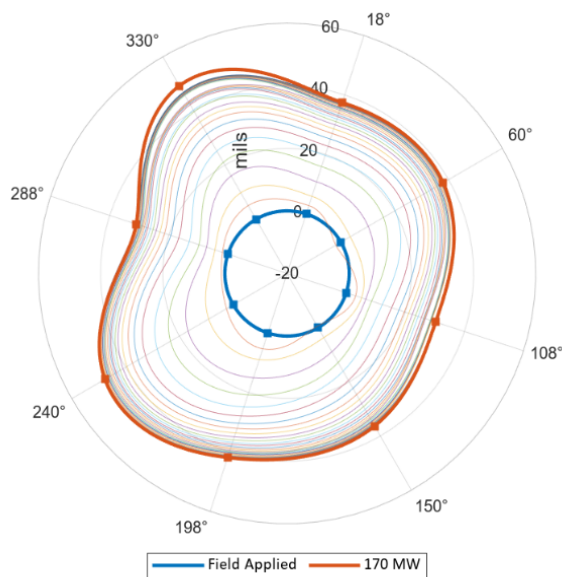


Fig 5 - Stator core lamination stacking

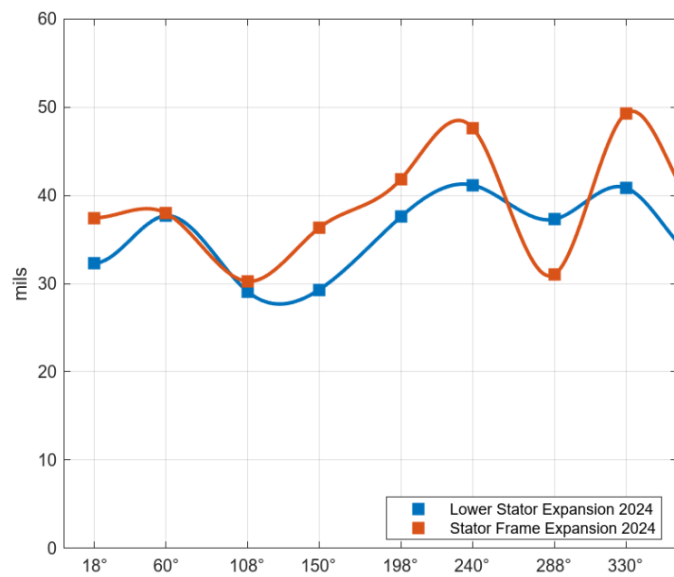


5. Results

Following the maintenance, another heat run was conducted in 2024. The results showed significant improvement in the stator frame expansion, which was now proportional to the stator core expansion and more uniform overall. The average expansion for the Stator Frame has increased significantly at 38.9 mils. It now exceeded that of the stator core currently at 35.6 mils. Also, the Stator Frame expansion at 288° has improved from 7 mils in 2021 to 31 mils in 2024. As a result, the stator core expansion is also much more uniform, indicating that the maintenance had successfully addressed the issue.



Stator frame thermal expansion in 2024



Stator frame vs lower stator thermal expansion in 2024

Fig. 6 - Stator frame thermal expansion during the December 2024 heat run

6. Conclusion

This case study demonstrates the importance of proper monitoring of the stator thermal expansion for reliable and efficient generator operation. By addressing the stator thermal expansion issues identified through the ZOOM monitoring system, the maintenance performed on Unit U51 has improved the generator's long-term reliability and performance. This case study highlights the value of continuous monitoring and analysis in identifying and resolving potential problems before they can cause significant damage or downtime.