CASE
Helen

Prolonged generator lifetime after resolving persistent vibration issues

Helen Ltd, with its 450 000 customers, is one of the largest energy companies in Finland. It produces electricity, heat and cooling in production plants that are mainly located in Helsinki. A major part of electricity and district heat in Helsinki is produced in the Vuosaari combined cycle power plants, using natural gas as fuel.

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Prolonged generator lifetime after resolving persistent vibration issues

Helen had suffered from a worsening vibration problem of the generator at its Vuosaari A site, commissioned in 1991. One of the generator bearings had high vibrations, even over the normal trip levels in operation. Due to this, the unit could once not even be started, as it would trip on the run-up to speed.

It had already been identified that it was mainly the exciter bearing at the far end of the generator that was causing problems. In 2013 it had become critical when vibration levels up to 20 mm/s were recorded. Normal levels for this type of installation would be less than 6 mm/s.

“In general the problem with too high vibrations is that it may cause damages on bearings as well as on other parts of the generator, which in the end lead to unplanned outages and downtime for repair,” says Ph.D. **Gabor Csaba**, from Fortum eNext Turbine and Generator Services.

Helen had tried to solve the problem on their own and together with other partners. Some temporary measures had been done, like attaching weights and balancing the exciter rotor. With this some improvements had been achieved, but the problem was not really solved.

Re-alignment and attaching weights to patch up the vibration issue

After Helen approached Fortum eNext (VG Power Turbo at the time, now part of Fortum) in early 2015, a desktop study was performed, where all available vibration data since 1991 as well as maintenance reports were analysed. The remark was that vibrations had started to increase already in 2008 and become critical in 2013.

It was concluded that, most likely, a structural problem in the stator and exciter housing were causing the problem, and not so much the rotors. This was why attaching a 150 kg weight on exciter housing had had a positive effect.

In addition, as inspections on the generator were conducted during operation, it was concluded that the generator was no longer correctly aligned to its foundation. Basically it was standing on 3,5 feet instead of 4. This had also contributed to the vibration issue.

“Too high vibrations may cause damages on bearings and other parts of generator.”

Gabor Csaba, Fortum eNext Turbine and Generator Services

Based on the initial findings, Fortum eNext proposed to the customer an action plan, which was also executed during spring 2015. It was then discovered that the generator was standing even less on its feet than seen before. Additionally, the so-called impact test (knocking tests) revealed that the structure would very easily start vibrating; the resonance frequency rose close to 50Hz.

“By performing knocking tests on the generator exciter housing we found resonances that could easily be excited during operation,” Gabor Csaba notes.

After analysing all the findings, Fortum eNext experts proposed to re-align the generator and to attach a 400kg weight onto the far end of it. Both actions were implemented, and as a result the vibration was reduced – but not back to the level before year 2008. The downside to this was that the additional weight made maintenance of the generator more difficult.

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Additional problems with electrical connections emerge

After the actions implemented in 2015 the unit was operated normally for a couple of years. In summer 2017 during a planned outage, Fortum eNext was called to perform inspections of the main and exciter rotors, and to determine if some Service Bulletins given by the OEM were applicable.

In these inspections it was discovered that the electrical contact between the main rotor and the exciter rotor was in a bad shape.

"This type of electrical connection has its weaknesses and has even caused failures on other rotors. High vibrations during start up, shut down and operation, like was the case with this particular generator, has a very negative impact on the lifetime of the connections, Gabor Csaba explains.

To avoid additional downtime, a temporary repair was done, and a long-term solution was developed and planned for implementation for the next outage in 2018.

Preparations for impact test of generator and check of alignment to foundation at stand still.

Weights (black steel plates) were attached to reduce generator vibrations.

Backing of Vuosaari G3 main and exciter rotor – after balancing, ready for assembly.

Clear savings and a longer lifetime for the rotor

In summer 2018, Fortum eNext returned to Vuosaari A site to implement the planned electrical connection upgrades. The repairs were done at Fortum's own generator workshop in Västerås, Sweden, where also balancing of both the main rotor and the exciter rotor was done in the high-speed balancing facility - the only independent high-speed balancing facility in the Nordic countries. Finally, both parts were aligned together before sending them back to Finland for installation.

With the stator re-aligned and the rotors in perfect balancing conditions, the vibration levels were brought down significantly, back to the level they were in 1994–1995.

Vibration levels were brought down significantly.

"In practice clear savings were achieved as a longer lifetime for the rotor as well as for the bearings can now be expected. Also the risk of problems on other parts, which could have been caused by high vibrations, were reduced," Gabor Csaba summarises the benefits for the customer.

Finally, the additional 400 kg weights could be removed, giving less static stress on the exciter housing and making maintenance a lot easier.

Even though it took some time to come to the final solution, the customer was very pleased with the process. Mostly this was because all work was done without causing any additional downtime. But also because issues with the stationary parts as well as main and exciter rotors were identified, analysed and, in the end, corrected.

"To me the vibration levels seem the same as when the generator was brand new," says **Karl-Gustav Pihl**, maintenance manager at Helen.

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Fortum eNext

Customer
Helen Oy, Helsinki, Finland

Site
Vuosaari A in Helsinki, Finland, producing electricity and heat

- Type: ABB GTL 1200EP, manufactured in Västerås, Sweden
- Power: 50 MVA, operates at 3000 rpm
- Fuel: natural gas
- Generator and turbine delivered by ABB in 1991
- Running season: fall – spring

CASE Helen

Customer challenges

- Persistent and worsening vibration issue with the generator bearings, even over the normal trip levels in operation. As a result, the unit could not be operated normally
- Finding a specialised partner to discover the root cause of the issue and implement needed repairs

Solution by Fortum eNext

- Thorough investigations by highly specialised generator experts
  - Initial action plan for corrective measures to enable normal operation
  - Further inspections and a temporary repair to avoid additional downtime
- Fixing the root cause and implementing planned upgrades
  - Repairs as well as balancing of both main rotor and exciter rotor at Fortum's workshop and high-speed balancing facility in Västerås, Sweden

Customer benefits

- The vibration levels were brought down to the level they were at installation in the mid 1990s
- Clear savings, thanks to prolonged equipment lifetime
- Reduced risk of problems with other parts, thanks to reduced vibration
- Easier maintenance, thanks to removal of extra weight

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