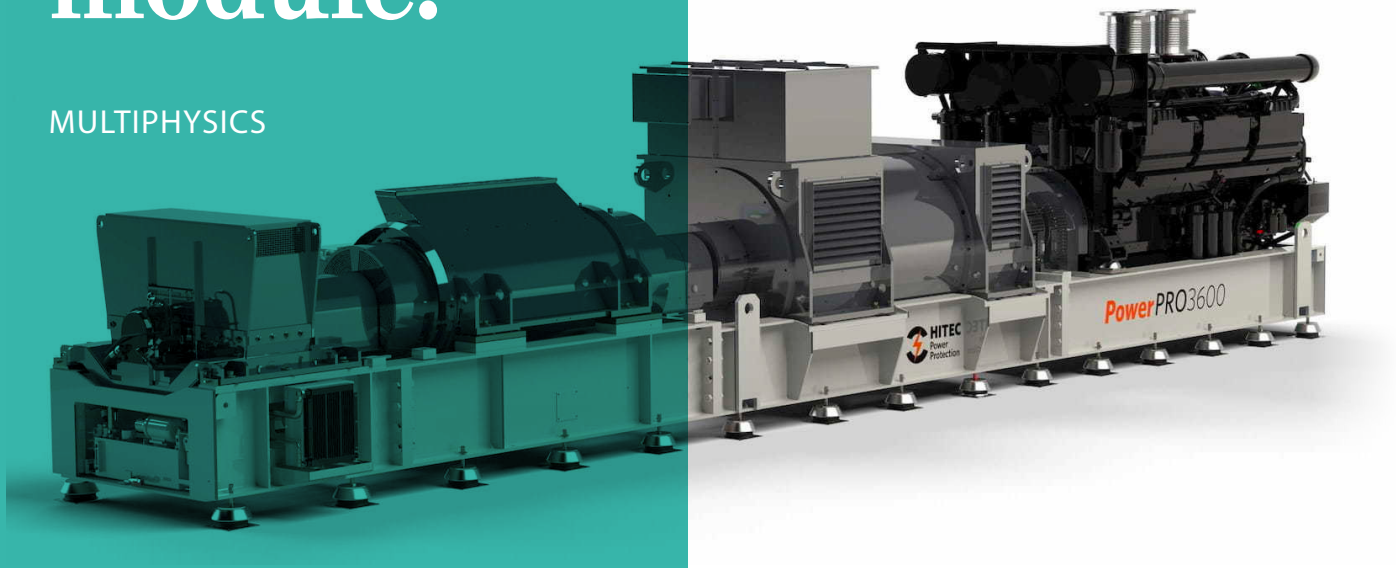
# custom silencer for flywheel module.

MULTIPHYSICS




**Goal**

HITEC Power Protection is a world-leading supplier of dynamics based uninterruptible power supply systems. These UPS systems are supplied into a variety of markets such as datacenters, finance and semicon.

Key components in the system are a flywheel, a generator and a diesel engine. When the main electricity supply fails, stored kinetic energy in the flywheel is released to drive the electrical generator, which continues to supply power without interruption. This creates a small time frame in which the diesel engine is started to take over the power demand from the draining flywheel.

HITEC has requested Demcon Multiphysics to solve a specific noise issue that occurred on a custom engineered and bespoke flywheel module. The particular system generated an unexpected high tonal noise in the 200 Hz 1/3 octave band, which led to unacceptable hindrance for the end user.

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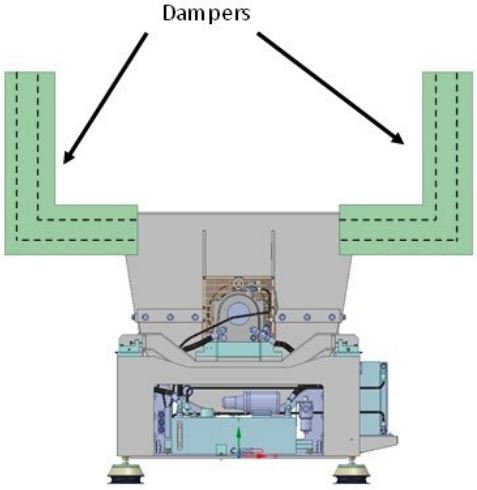
## Approach

Experts from Demcon Multiphysics in the area of acoustics and flow visited the engineering and production site of HITEC in the Netherlands to assess the issue and discuss potential solutions with the responsible product owner from HITEC.



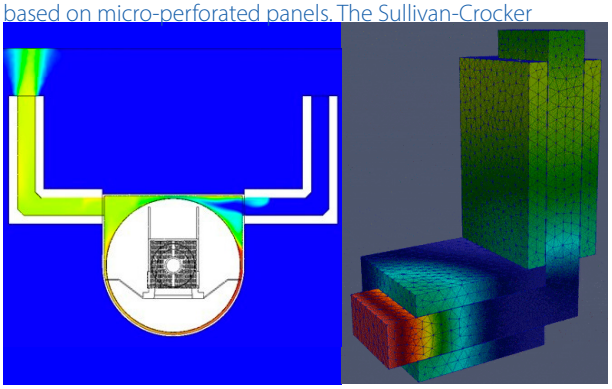

The available 1/3 octave band sound power level measurement data was reviewed and a running unit was investigated in the workshop. After extensive review, it was decided that the most cost effective and lowest technical risk solution for this case was to design a custom low frequency silencer specifically designed to reduce the tonal noise.

From a mechanical point of view, two requirements emerged.

- The silencer should easily fit on the existing system.
- A rough order of magnitude calculation revealed that the required acoustic lengths would exceed the normal installation footprint of the system. It was therefore decided to orientate the outlets of the silencers upwards.

The first step in the design of the custom silencer was to collect a more detailed acoustic signature. Therefore, an independent measurement was conducted by Demcon. Using an advanced sound intensity probe, the required narrow band source power spectra was obtained.

Based on the acoustic signature, one of Demcon's acoustic specialists designed the silencer. The silencer working principle is based on cavity resonators separated by an acoustic liner based on micro-perforated panels. The Sullivan-Crocker



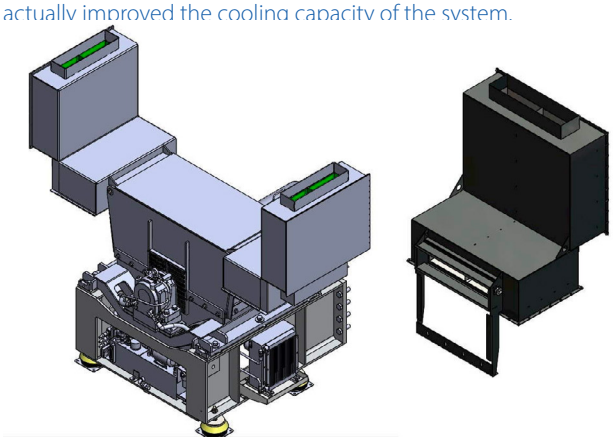
model for cavity resonators was used to find the optimal configuration within the spatial constraints. The final design was verified using an acoustic Finite Element Method (FEM) simulation.

The figure below shows a concept overview of the silencer and the propagation of the acoustic waves.

The team also recognized the importance of the silencer on flow resistance by mounting the silencers on the inlet and outlet of the flywheel module. This was important as the flywheel is continuously running in air at atmospheric pressure, which generates (frictional) windage losses and causes the release/production of heat.

To ensure that the flywheel does not overheat and that good ventilation is maintained, a CFD analysis of the air flow in the flywheel system was made. Moreover, this allowed verification of the pressure levels at the bearings to ensure that no oil is extracted from the bearing due to a local under pressure.

The CFD analysis confirmed that the temperature of the flywheel would still be within the specifications after installation of the custom silencer. The better-guided flow actually improved the cooling capacity of the system.



The next step in the development was to complete the mechanical design and tou prepare technical procurement documentation. Here, the multi-disciplinary strength of Demcon Multiphysics proved beneficial, as not many high-end Multiphysics consultancy services exist which have mechanical engineering, procurement and production all under one roof.

A number of specific mechanical requirements had to be implemented during this step as well. The silencers should be easy to mount and drilling additional holes in the flywheel housing was to be avoided. Moreover, an exchangeable filter was installed to protect the acoustic materials from dirt and dust.

## Results

The final step in the project was the execution of a verification measurement (FAT/SAT) to demonstrate the effectiveness of the silencer. This test was conducted at the test facility of HITEC.

The running machine was divided into a series of connecting planes. Using an acoustic intensity probe, the sound power flow through the individual planes was measured, after which the software calculated the total sound power level of the system. For reference the same measurements were performed on an otherwise similar system without the silencer and plotted together for comparison. The chart beneath shows the successful reduction of the peak around 200Hz for which the silencer was designed.

To finish the project some sessions, for properly documentation about the improvements, were organized between HITEC and Demcon.