

# Comprehensive Seismic Assessment of Autotransformer for a Naval Base

## Case study

**Our client designed and manufactured a large autotransformer as part of backup power supplies in the HMNB Clyde naval base. In order to fulfil the requirements of Nuclear Safety Essential (NSE) safety function, a seismic assessment/qualification was required. EASL received a request to provide a safety case for the earthquake resistance of the autotransformer. Subsequent to the successful completion of this project, our client asked our assistance with another autotransformer from the early design stage to avoid any issues prior to the manufacturing.**

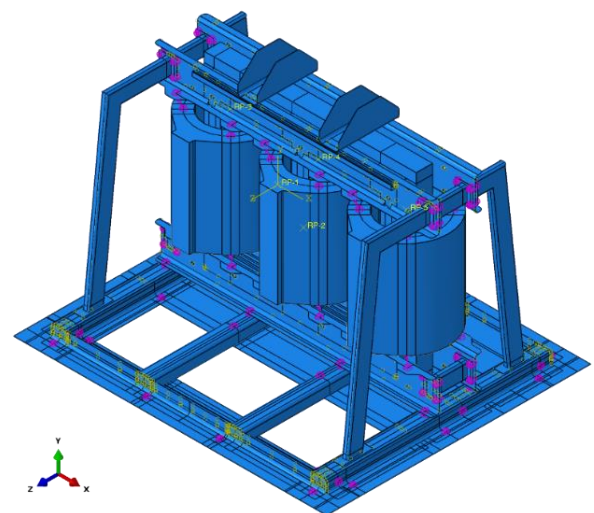
### The problem

Our client was contracted to install a large autotransformer as part of backup power supplies in the HMNB Clyde naval base. The system was already manufactured, and required a seismic qualification. With historic expertise in assessments for a wide variety of safety structure codes, EASL was chosen as an ideal candidate to provide with a detailed seismic assessment for the autotransformer.

EASL was requested to provide a safety case for the earthquake resistance of the autotransformer. The system is considered as class 1 for the Safety Classification of Structures, Systems and Components (SCC) and is required to fulfil the Nuclear Safety Essential (NSE) safety function.

The assessment followed the DGD-508 and DGD-507 Royal Navy design

guidance documents for the Seismic qualification methods for Mechanical and Electrical Equipment and Post-Drilled Seismically Qualified Anchors.



*Figure 1 Autotransformer FE Model and modelled joint connections (purple points).*

## Our solution

Our engineers developed a detailed Finite Element (FE) models using ABAQUS to extract the static and dynamic forces and stresses acting on various components. A response spectrum analysis was carried out to derive the seismic demand and the critical natural modes of vibration were identified.

The comprehensive seismic assessment included the key transformer coils, supporting members, connections, adaptor plate assembly and the autotransformer anchorage. This was conducted according to Eurocode 3 (BE EN 1993-1:2005) for design of steel structures, Eurocode 8 for the design of structures for earthquake resistance and ACI 349-13. The collapse of the external casing was also considered and qualitatively evaluated.

Certain complex connections were modelled in different ways and sensitivity studies were carried out to produce results that inspired confidence.

## The outcome

The structural integrity assessment identified which components were code compliant under the Operation (OBE) and Design Basis (DBE) and Seismic Margin (SME) earthquake conditions. For the components not satisfying the design code requirements, appropriate strengthening modifications were recommended with minimal intervention since the system was already manufactured.

The modified system was finally installed on site. Overall, the client was very pleased with the comprehensive analysis carried out by the EASL engineers. Subsequent to this project, the client requested EASL get involved with another autotransformer, this time from the very early design stage to avoid any issues prior to manufacturing.

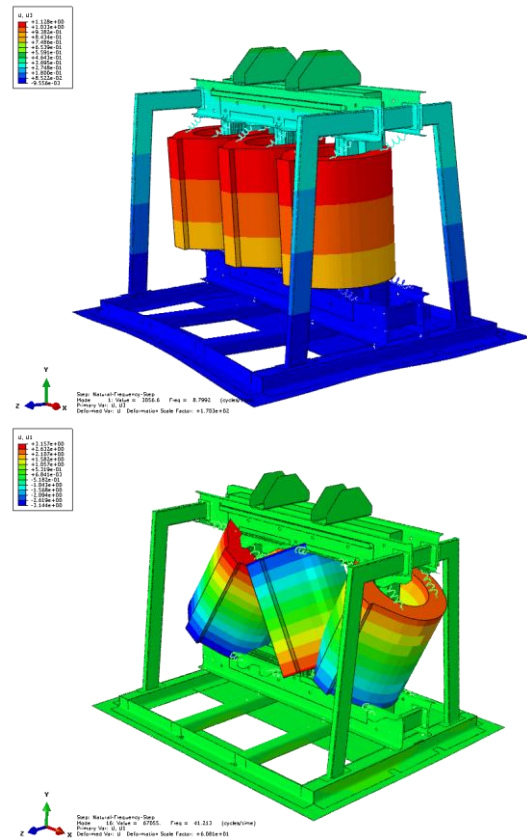


Figure 2 Autotransformer FE Model: Two natural modes of vibrations from the same model.

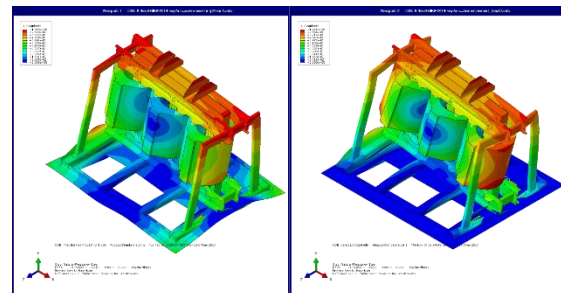


Figure 3 Autotransformer FE Model: Two natural modes of vibrations from two sensitivity models.

## Analysis services at any stage

Using our extensive understanding of industry recognised design codes and standards with expert knowledge of advanced analysis methods, we can provide bespoke solutions to complex problems at any stage of the design. If you would like to discuss how EASL can help your business, please get in touch.

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