

HyperWorks used in the Design, Development & Testing of Nuclear Encapsulation Vessels

Overview

Assystem UK Ltd was tasked by a customer working in the nuclear industry to provide design, simulation, prototyping and verification testing of an encapsulation vessel.

By using the HyperWorks tools - HyperMesh, HyperView, RADIOSS and HyperStudy – Assystem was able to design and develop an overpack to provide a safe method of containment for product cans. Overpacks are designed to act as protective barriers to the environment should product cans become damaged under certain conditions.



Business Profile

Assystem is an international engineering and innovation consultancy group with a presence in 14 countries and 8500 employees. With main offices in Bristol, Derby, Preston and Sunderland, UK, they are supported by 1400 staff delivering key capabilities in a wide array of industries, from Aerospace and Energy (including nuclear power) to Defence and Transport.

As a leading European independent nuclear engineering specialist, Assystem is involved throughout the cycle, from fuel production to reprocessing to the design, commissioning and decommissioning of nuclear installations.

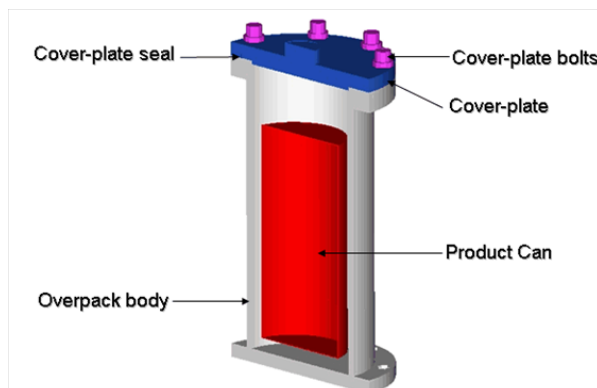


Fig. 1: Basic Elements of an Encapsulation Vessel

Challenge

The challenge was to create an overpack which could provide both a protective barrier to the environment and withstand dynamic loading, i.e the result of being dropped whilst in transit from the current storage facility or falling to the ground once in storage. The design had to withstand drop heights of 3.5m (transportation in lifting gear within the plant) and 1.5m (drop within storage facility) with impact onto either a flat surface or angled target.

Furthermore, because of the possibility of internal pressurisation resulting from gasses inside the product can, the assembly had to be designed as a pressure vessel to the rules of PD5500 and demonstrate a design life of 10 years.

"HyperWorks is the best pre-processing tool. It's immediate, intuitive and enabled us to demonstrate efficiency savings to our customers"

Dr Adam Towse
Assystem UK

Solution

HyperMesh was used to mesh the design of the overpack components and analysed using RADIOSS. The RADIOSS solver was also instrumental in simulating the pressurisation of the overpack at the moment of impact.

Once the model had been generated, various drop scenarios of pressurised and non-pressurised overpacks were simulated to establish the worst case impact orientations. A Design of Experiments approach used HyperStudy to rapidly generate, run and post-process the impact scenarios. During these simulations, movement of the cover plate seals was monitored along with the integrity of the pressure boundary of the vessel.

The results from each drop simulation were reviewed and a small number of design iterations took place to refine the design, ensuring that the exterior design space was not violated, the interior design space would meet specification, the impact performance was acceptable and that the final design complied with PD5500.

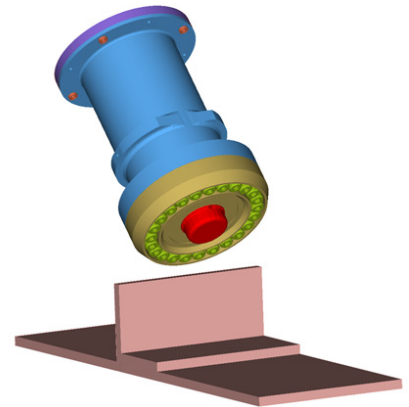


Fig. 2: Illustration of one Impact Scenario

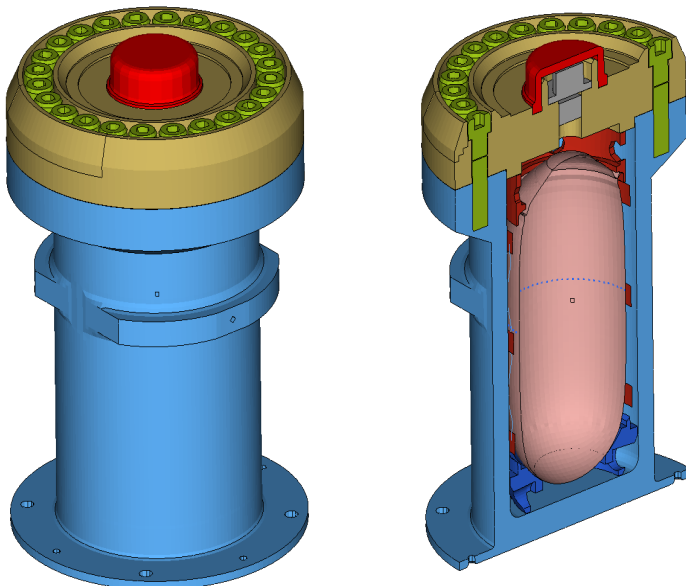


Fig. 3: Exterior & Interior Final Design of the Pressure Vessel

Results

The use of the HyperWorks suite facilitated the design and development of an encapsulation vessel subject to complex loading and interactions.

Following completion of the design and simulation phase, prototypes were built and tested to verify the engineering design and analysis. The testing showed that simulation driven design was successful in creating a solution for the product can encapsulation and that the final design satisfied pressure vessel code PD5500. Assystem gained external accreditation for the pressure vessel's compliance to code.

The results proved the design robustness of the vessel and went into production for use in the unlikely event that encapsulation of the product cans became necessary.



Fig. 4: Physical Prototype of an Encapsulation Vessel

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