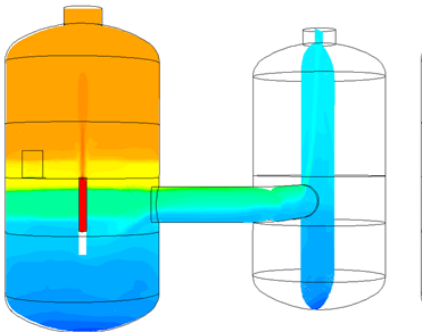
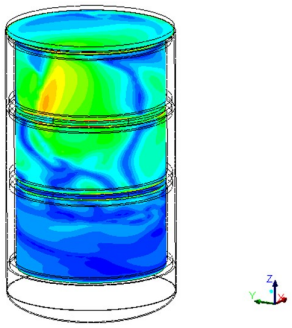
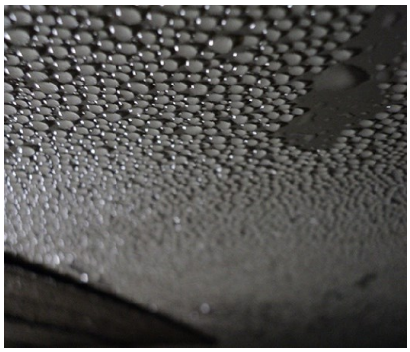
# Verification and Validation of CFD for Nuclear Containment Vessels







### Project Summary

ALDEN developed condensation capability within a commercial CFD modeling tool, and did extensive validation and verification of the tool for determining transient species mixing and heat transfer within containment volumes in nuclear power plants during severe accident conditions.

### Client

U.S. Nuclear Regulatory Commission
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Rockville, MD 20852

### Year

2014-2016

## Project Overview

During postulated severe accident scenarios in a nuclear power plant, hydrogen is released due to oxidation of zirconium in fuel cladding with steam at high temperatures. This hydrogen can collect and stratify in pockets of the containment with the potential for deflagration or detonation. Currently, the US Nuclear Regulatory Commission (NRC) is utilizing computational fluid dynamics (CFD) to study some of these test scenarios as part of a long term strategy of code development and validation. ALDEN developed user-defined functions within the CFD software in order to account for steam condensation and re-evaporation, and performed extensive validation and verification of CFD for this application.

## Work Performed

ALDEN evaluated the ANSYS Fluent CFD tool for multi-species flow and heat transfer occurring in containment vessels simulating severe nuclear accident conditions, determining the state-of-the-art. Conditions included transient injection of helium and steam into the volume, as well as the use of coolers that would locally reduce temperature. Numerous meshing, solver algorithms, and turbulence modeling options were investigated and compared against experimental data from two separate test facilities. A user defined function (UDF) was written to include condensation of water vapor in the presence of several non-condensable gas species in Fluent's conservation equations. A feature to the UDF allowing for re-evaporation under the appropriate conditions was also developed, and these features were also validated and verified using experimental data.

## Project Highlights

- ALDEN validated and verified the use of CFD for containment vessel analysis.
- Documentation of the state-of-the-art of CFD for simulation of transient heat transfer and condensation.
- Development of condensation and re-evaporation capabilities for a CFD tool.

**FOR MORE INFORMATION,**

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