



MIDS under Pressure

Danfoss Deep Sea Hydraulic Pump



Team Members

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Project Sponsor

Danfoss Hydraulic Solutions

Background: Danfoss is an international company based out of Denmark, but has a hydraulic power division with facilities in Ames, Iowa. This facility designs and manufactures many different hydraulic components--such as pumps, motors, valves, and controls--that mainly serve the agricultural and construction industries. Danfoss Hydraulic Solutions was approached by a company called Oceaneering that specializes in deep sea Remotely Operated Vehicles (ROVs) about using one of Danfoss' products on board some of Oceaneering's ROVs. Specifically, the Series 45 open circuit medium power axial-piston pumps are of interest to Oceaneering because of its Electronic Proportional Control (EPC). When Danfoss conducted an inquiry with its suppliers for the EPC parts, it found that the control was not recommended for use in a deep ocean environment. Since Danfoss applies most of its product to heavy machinery and vehicles used in industrial or agricultural environments, Danfoss has not done much research of marine applications for their products at this time, and did not apply resources to solve the issue for Oceaneering.

When contacted by a student of the United States Naval Academy about a possible senior capstone project, the above paragraph was the situation explained by Danfoss. Our team, the MIDS Under Pressure, was assembled and traveled out to Ames, Iowa to visit the facilities and discuss the project with the point of contact, Vincent Ewald, who is the Product Application Engineer for the Series 45 medium power open circuit pumps. Over the course of three days, the MIDS under Pressure team learned about Danfoss as a company, the Ames Facilities, and the general design, function, and application of the Series 45 E-frame pump which was selected as the best fit for the project. An excellent working relationship was established between Danfoss and the Naval Academy throughout the training and discussion. At the conclusion of the visit, the scope of the project as well as objectives, requirements, and constraints were established to guide the Midshipmen through the process.

Objectives: Determine what modifications to the Danfoss Series 45 E-frame pump are necessary to allow it to fully function at a rated ocean depth of 10,000 feet with a 10% design margin.

Results: So far the team has developed a series of tests which would evaluate the functionality of the EPC. The first is the 1000 series test. This includes disconnecting the EPC from the pump housing and creating a rig consisting of a fluid reservoir, a pump which pumps hydraulic fluid into the EPC, a flow meter which measures the flow rate of the fluid, and a voltage source to supply the EPC with current. This test will be conducted outside of water and will only experience an external pressure of atmospheric pressure. The 2000 series test is identical to the 1000 series except that the test rig will be slightly submerged in water. The 3000 series is the same as the 2000 series except the EPC will have a different design in order to restrict water flow inside the EPC.

The final product for this project is a design for the the Series 45 E-Frame that would enable the pump to operate at 10,000 ft. This design will be mostly theoretical and based off of calculations and small experiments due to the difficulty of testing the entire pump in a deep sea environment.



Figure 1. Team Mids Under Pressure