Line Inspection and Guided Hardware Testing (LIGHT) Lab Development

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Mooring lines and umbilical cables are critical component of marine energy technologies that need to be de-risked prior to deployment. LIGHT will enable validation of the mechanical properties and technical limitations of lines and cables, as well as their terminations. The facility will help determine the reliability and maintenance requirement of belt and rope components and thereby reduce the risk of at-sea deployments.

Introduction

The LIGHT Lab project will develop and commission a suite of integrated containerized tester modules for testing belts, mooring lines, and umbilical cables for marine energy applications, including those for power take-off (PTO) and mooring lines. The new tester modules are reconfigurable and will be housed in three 40-ft high-cube shipping containers connected end-to-end and side-to-side that are considered part of the module suite. The new tester modules are currently planned to be sited at Sandia Lake Facility Complex [a]. Locating the LIGHT Lab near the man-made lake at this facility will allow for the new testers to be dual purposed, providing standalone testing for belts, mooring lines and umbilical cables, as well as actuated testing of wave energy devices and components at the lake facility. The LIGHT Lab modules will enable automated short-term and long-term testing to better understand the mechanical properties and technical limitations of not only belt and rope materials, but also EOM umbilical cable assemblies. The LIGHT Lab is currently at the design stage. Development is expected to be completed in Summer 2027, after which it will be made available for industry use.

[a]https://www.sandia.gov/vqsec/facilities/water-impact/

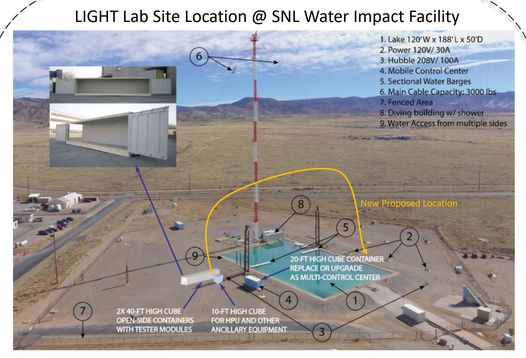
Collaboration and Automation

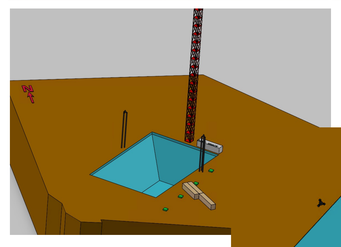
Discussion and inputs from marine energy developers, researchers and OEM manufacturers were used to drive the requirements for the design of the LIGHT Lab tester modules, along with the accumulated knowledge from experts at Sandia National Lab's Renewable Energy and Validation and Qualification Centers.

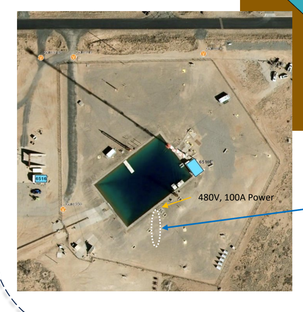
Automation is a key requirement and attribute of the LIGHT Lab. Due to the long duration cycling for of some test types, every effort is being made to automate the testing process and data acquisition for the tester modules. Model-based design and simulation of the control systems, along with fault tolerant data acquisition are key objectives in the design.

DESIGN

LIGHT Lab Site Location @ SNL Water Impact Facility

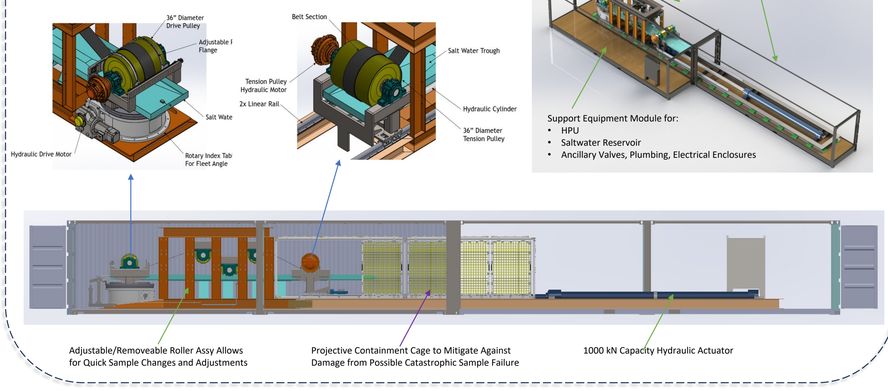


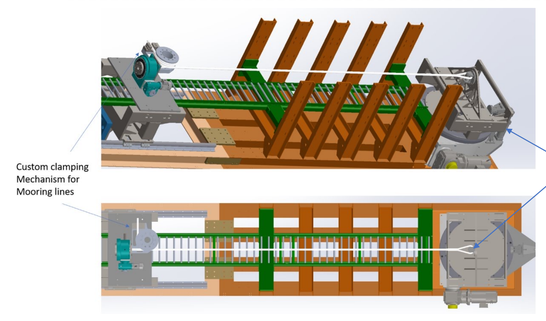


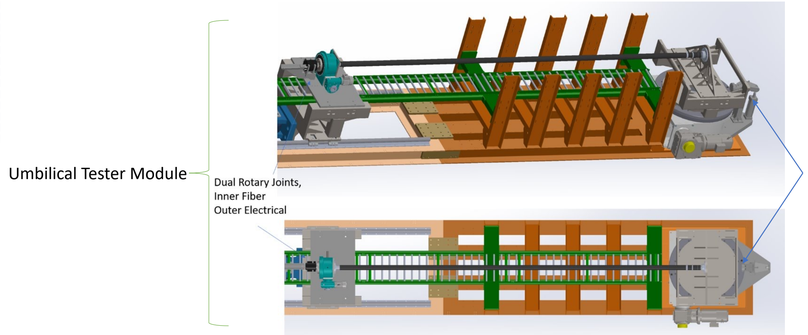


New Proposed Location and Orientation for the LIGHT Lab Modules at the WIF

Belt Tester Module







Belt Tester Module

The LIGHT Lab Belt Tester Module (BTM) is the baseline for the other modules in the system. The primary purpose of this module is to test mooring and PTO belt samples of various widths (0.2 m to 0.8 m) and thicknesses (4 mm to 22 mm) in a reverse bending configuration. Belts will be exercised in a wrap/unwrap motion across a set of three offset rollers in order to induce accelerated fatigue in the belts. Belts can be cycled at a rate of representing a typical wave period. Belt tension loads of up to 1000 kN can be achieved. A fleet angle of up to 3-degress can also be applied to the belts during testing. In addition to reverse bending, two belt samples can be tested simultaneously in a cyclic bend over sheave (CBOS) configuration. All test samples in this module can be tested with the sample wetted in a saltwater bath to evaluate any corrosion impacts to the strength of the test samples as applicable.

Mooring Line Tester Module

The LIGHT Lab Mooring Line Tester Module is a derivative of the Belt Tester Module. This tester module is a simple configuration change to the BTM allowing for straight tension testing of mooring line "rope" samples up to 40 mm in diameter utilizing pin diameters of up to 1.5 m. Applied tension for this testing can be up to 1000 kN and line elongation of up to 100% ± 10% can be accommodated during the testing for samples up to 8 m in length.

Umbilical Tester Module

The LIGHT Lab Umbilical Tester Module is also a derivative of the Belt Tester Module. Again, with a simple configuration change to the BTM, umbilical samples between 5 m to 8 m long and up to 63.5 mm in diameter can be tested. The module will be able to induce umbilical strains of up to 100% ± 10% with a max tensile force of approximately 50 kN in a cable sample. The tester will be capable of torque testing an umbilical cable between 3 to 10 revolutions for an 8 m long cable. Long duration cycle testing of the cable samples of between 100K and 1M cycles will be possible. Roller supports will be used to support the cable during testing to prevent sagging. Both copper and fiber conductor continuity can be monitored during testing, along with acquisition of cable axial and flexural rigidity data.

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