

**INITIAL TYPE APPROVAL OF HSI TRO SENSORS FOR
BALLAST WATER TREATMENT SYSTEM**

Evaluation test report – Amperometric TRO sensors of Halogen Systems Inc.

Halogen Systems, Inc.

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4 CONCLUSIONS

HSI has carried out an extensive set of tests to qualify the specifications and limitations of the HSI TRO sensor for comparison to the DPD measurement method applied by the TRO sensors currently used by BWTS. HSI has engaged DNV GL to evaluate the results from testing their amperometric TRO sensor. It is DNV GL's opinion that the testing performed by HSI demonstrated that the amperometric TRO sensor by HSI may be applied by BWTS for measuring the TRO of the treated ballast water both during ballasting and deballasting operations. The HSI TRO sensor offers comparable performance to the online DPD based TRO sensors currently applied by BWTS.

The use of the amperometric TRO sensor by HSI as an alternate TRO sensor for a specific BWTS must be evaluated on a case-by-case basis. The HSI TRO sensor may be installed directly in the ballast water pipe in addition to the option of being installed on a side stream, where a small volume of the ballast water pipe is diverted to the TRO sensor, similar to how online DPD based TRO sensors are installed. When replacing an online DPD based TRO sensor with an amperometric TRO sensor by HSI that is directly installed in the ballast water pipe, an evaluation has to be made for each BWTS on a case-by-case basis on how this may impact the TRO control functionality of that BWTS. The direct measurement of TRO in the ballast pipe typically provides a faster response compared to the measurement of the TRO in a side stream, which has a measurement cycle of typically one minutes and as well as a delay of typically 2 to 4 minutes for the sample to reach the TRO instrument. The HSI TRO sensor was also subject to environmental testing by LabTest Certification Inc. as per the requirements of USCG Federal Register 46 CFR part 162, subpart 162.060-30 and the DNV GL class guideline DNVGL-CG-0339 (November 2016), which incorporates the requirements of IACS UR E10 (rev. 6). DNV GL type approved the TRO sensor for installation on all vessels classed by DNV GL (refer to DNV GL type approval certificate TAA00002XU).