LIGHT STRUCTURES
Passion for Monitoring

Concept note

SENSEFIB
Sloshing Monitoring System

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Customer reference	
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System scope	Sloshing Monitoring
Customer contact	
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Change Log

REV	SECTION	CHANGE DESCRIPTION
01.00	All	First revision

CONTENTS

1 SUMMARY OF CONCEPT

Light Structures proposes Sloshing Monitoring Systems by using short-base fiber optic sensors detecting and characterizing the forces acting on the containment system and tank structure during sea-going operations by measuring stress in key positions.

All monitoring will be connected through Light Structures extensive SENSFIB software suite.

The SENSFIB system is ATEX certified.

Configurations are varying upon ship design, tank systems and scope, so examples are for illustration purposes.

More detailed technical proposals will be given on project to project basis.

2 INTRODUCTION

2.1 SENSFIB Sloshing Monitoring System

Sloshing Monitoring is a *SENSFIB* module that can be used along with the Hull Monitoring product or as a stand alone system. Existing owners of *SENSFIB* Hull Stress Monitoring Systems may include Sloshing Monitoring in their current system by upgrading with a number of sloshing impact sensors and associated hardware/software to their systems.

Sloshing monitoring adds the capability to measure the number of impacts on designated locations of the tank, and assess the acting forces. At each location, a single SS1 or a pair of SS2 fiber optic sensors are installed, depending on the sensor purpose. The installation scope will depend on the following factors:

- The number of tanks to be monitored
- Monitoring of all 4 top tank corners, or only two
- Several vessels have experienced damages on the lower (10%) filling level. Monitoring some locations in the tank(s) carrying heel is therefore also recommended.
- If the vessel operates with partially filled tanks, monitoring of tank locations corresponding to partial filling levels are also recommended

For the lower filling levels the priority is the tank(s) where liquid heel is carried during normal operations.

In the engineering phase, Light Structures works closely with GTT and/or DNV and the yard to recommend the optical sensor scope and locations. Two elements will determine the ideal sensor configuration.

- Which sloshing phenomena the project aims at detecting/measuring, and the

number of different tank sloshing modes that are of interest.

- How the ship will be operated (this is especially important for the low filling levels, which are handled differently by different operators.)

2.2 Predictions and Experience Sharing

The HullInfo SLOSHING module uses a statistical model to predict the maximum likely load within a configurable time frame, given current conditions. This module is particularly useful for Sloshing and other situations where extremal loads are of primary concern. Although the currently observed maximal load may well be within safe limits, the real-time analysis of the distribution of the observed load may reveal that there is an unacceptable probability for a high load in the near future, warranting immediate corrective action.

This function provides a significant step forward in safety and damage avoidance, as compared to a pure monitoring system that reveals the severity of recent and historical events.

The EXPERIENCE SHARING module allows sharing collected experience among crews and sister vessels in the same fleet. It uses stored data to show which course/speed combinations have acceptable loading levels in a given sea environment and tank filling situation, guiding the vessel operator to safety in situations where corrective actions are required.

The sea environment is characterized by ship motions from the MRU and/or wave spectra from a wave radar. Although the database may be seeded with simulator data, the primary source of information is the actual experience gained by the fleet. This module provides a direct coupling between measured impact frequencies and loads and environmental characteristics, bypassing uncertainties in simulation-based systems.

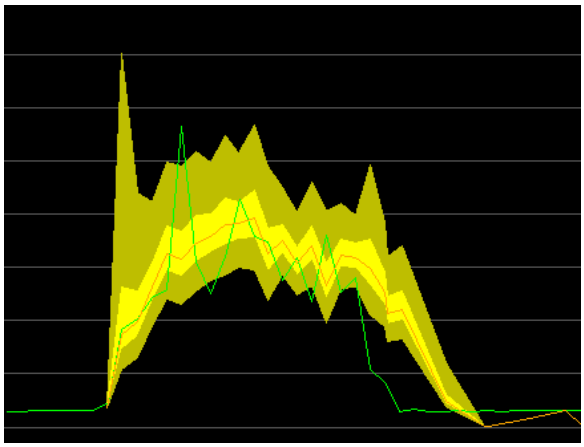

Figure 2-2: SLOSHING module. The yellow areas show the prediction range of future loading events. The green line shows the actual loads measured. This demonstrates the advance warning

feature provided by the SLOSHING module. (Data axes removed)

The primary advantage of this approach to advanced sloshing monitoring is that the predictions are not dependent on tank simulations or scale model tests. As the vessels in the fleet gather experience data, the database is continuously refined by full scale observations of the real situation. The end result is an optimal guidance database for the vessel/fleet, giving the vessel operator a competitive edge over those vessels sailing with systems based on a less precise simulator or model test data.

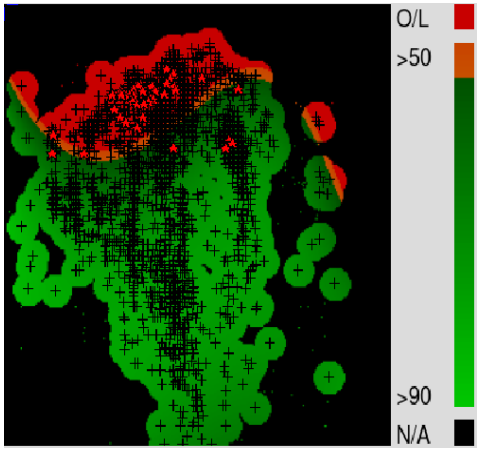

Figure 2-3: Parameter map showing areas with acceptable (green) and (red) overloading probability. Red stars represent previously observed overloading events

3 SYSTEM CONFIGURATION

3.1 Sloshing monitoring, illustrative examples

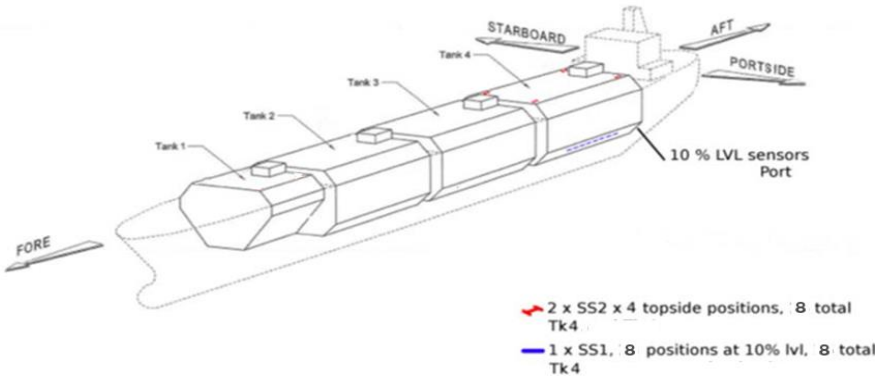

Figure 3-1: Example Sensor locations in the tank top and heel level of Tank 4

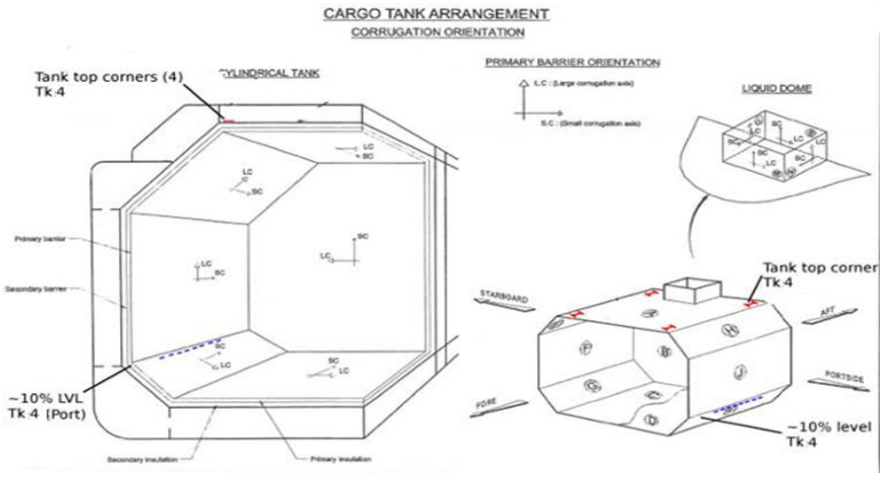

Figure 3-2: Example SENSFIB Sloshing monitoring. Overview of the sensor locations. Details on sensor locations to be set in engineering phase depending on system and total scope involved.

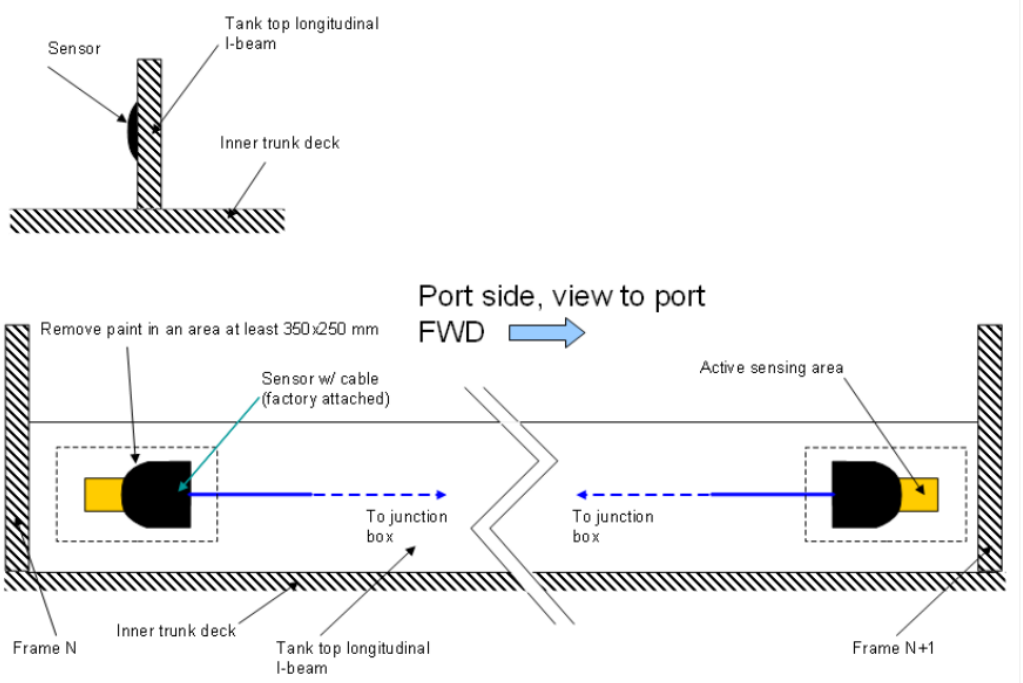

Figure 3-3: SENSFIB Sloshing monitoring. Sensor locations for high fill rate.

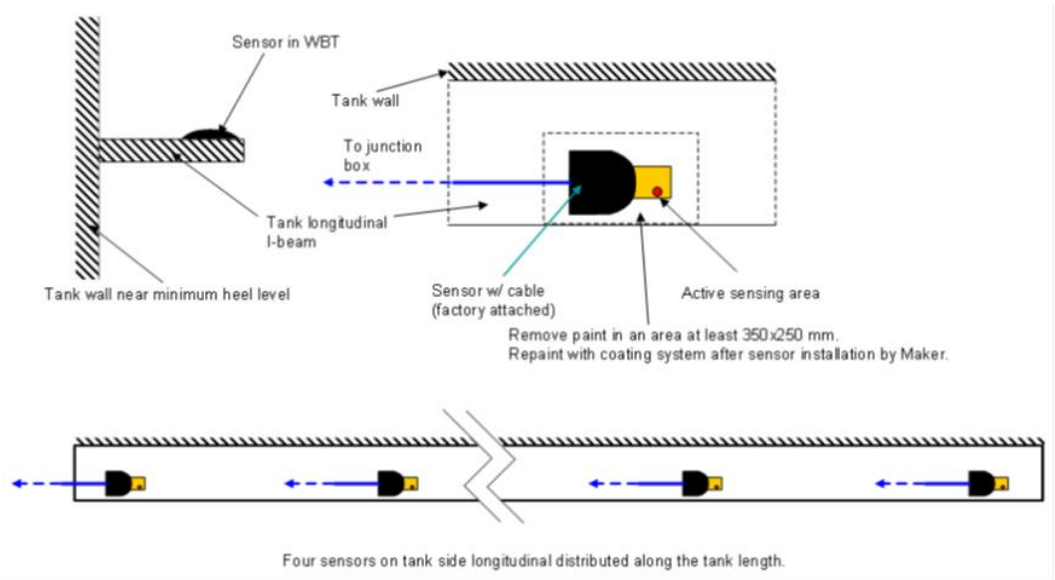

Figure 3-4: SENSFIB Sloshing monitoring. Sensor locations for low fill rat

3.2 Scope of supply

Subject to individual project proposals

3.3 Technical requirements – yard support

- Shipyard to install all cables (fiber optic and cables to connected systems), support for cables and cable penetrations to WBT. All sensor cables to be run in cable trays, in underdeck passage, or in pipes
- Shipyard to install Junction boxes. Junction box is for wall mounting (alternatively on vertical bracket).
- Shipyard to prepare all surfaces for short base sensor mounting (strip & Prime and paint surface), and paint sensor locations after finished installation.
- Shipyard to provide heating arrangements if steel temperatures are less than 20C during short base sensor mounting.
- Shipyard to provide and erect scaffolding, where necessary for safe conduction of LS field engineers work, and ensure safety during work in confined space (trunk deck)
- Shipyard to prepare interface cabling to GPS, Gyro and Loading computer, and provide details for configuring the serial communication.