PROSJEKT OCEAN SPACE CENTRE

REQUIREMENTS FOR TOWING TANK WAVE GENERATOR CONTROL- AND SAFETY SYSTEM

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1 Introduction

1.1 Objectives

The existing towing tank in SINTEF/NTNU premises at Tyholt in Trondheim shall be shortened down to allow space for the new building for the new Ocean Basin as well as the Seakeeping and Maneuvering Basin. The existing towing tank will later be taken out of service the new Ocean Basin and Seakeeping and Maneuvering Basin are completed and taken into use. The shortened towing tank shall be equipped with new state of the art wave generation units including electrical motor drives as well as local control system. Scope of delivery shall include detailed engineering, manufacturing, transportation and delivery, installation at site, mechanical completion and commissioning.

The purpose of this document is to specify requirements for the local control- and safety system for the new towing tank wave generation system.

1.2 Definitions and abbreviations

Definitions:

Company:	Statsbygg, which is the Norwegian government's key advisor in construction and property affairs, building commissioner, property manager and property developer.
Contractor:	Means the party named as such in the Form of Agreement
Subcontractor:	Means a Third Party who has entered into an agreement with the Contractor for the supply of goods or services in connection with the Work.
End-user:	SINTEF Ocean and NTNU
Work:	Means all work which Contractor shall perform or cause to be performed in accordance with the Contract
Company Materials:	Means equipment, systems, and/or materials supplied by Company, and which are to be incorporated in the Contract Object.

Abbreviations:

GUI	-	Graphical User Interface
HLCC	-	HydroLab Centralized Control
NEK	-	Norsk eletroteknisk komité (NEK is member of International Electrotechnical Commission (IEC) and European Committee for Electrotechnical Standardization (CENELEC)
OB	-	Ocean Basin
OSC	-	Ocean Space Centre
PLC	-	Programmable Logic Controller
PTP	-	Precision Time Protocol
SMB	-	Seakeeping and Manoeuvring Basin
WGCS	-	Wave Generation Control System

1.3 Information about HLCC

Ocean Space Centre will have a common centralized control system called HydroLab Centralised Control (HLCC). The system will be provided by Company. HLCC shall cover all OSC fixed and mobile laboratories.

Laboratory tests and scientific experiments will be planned, managed, and performed from HLCC. HLCC will be interfaced with local control- and safety systems for all the laboratory equipment packages and systems.

All 3rd party systems shall be able to receive remote commands from HLCC. These commands shall cover all functionality necessary for running a complete set of experiments.

Main functions of HLCC are:

- Preparation of testing program/recipe
- Preparations for start-up before start of testing program
- Uploading of weather conditions and other environmental parameters
- Start and stop of tests and experiments.
- Status reporting
- Alarm handling

1.4 Standards and Regulations

The following standards/requirements and norms applies for the Work:

- Voltage system 400V TN-S
- NEK 400
- CE marking of products according to European Union standards
- Machinery Directive

Contractor shall issue Declaration of Conformity as part of the Documentation of the delivery.

2 Main requirements

The wave generation system for the shortened towing tank shall be delivered with a local control system as well as a software package running on a computer in the laboratory network.

2.1 General requirements

2.1.1 Local / Internal functionality in wave maker control system:

- Wave Generation Control System (WGCS)
- An operator shall be able to generate regular and irregular waves by manually setting some parameters:
    1. Period [s], Wave height [m], gamma, etc.
- Experts at OSC must have access to adjust the WGCS transfer function.
- The operator shall be able to load, start and stop a time series file manually.
- The operator shall be able to mute/unmute a wave manually at any time. Mute means that the flap shall be ramped down until it's not moving, while the time series control signal still is running.
- WGCS shall continuously send WGCS Status.
- WGCS shall be able to import wave maker paddle time series
- It should be clear where active wave absorption can be enabled in the different operational modes.
- WGCS shall continuously send Real-Time measurements.
- The operator shall be able to change the WGCS control mode:
    1. Local mode

       In this mode WGCS is working as a stand-alone system. The operator controls WGCS by the built-in GUI.
    2. Remote mode
        - Time series file.
          HLCC controls WGCS operator commands.
        - Real-Time streaming.
          HLCC controls flap position set points.

2.1.2 Remote mode

- There are 2 different ways of running waves in remote mode:

  2.1 Time series file.
  Running Time series files locally stored on WGCS computer.
    - Generate and modify wave spectrum.
    - Load time series.

- Start and stop.
- Mute and unmute.

2.2 Real-Time streaming.
Streaming Real-Time control signals.

- Enable and disable WGCS.
- Mute and unmute.

- WGCS shall continuously send WGCS Status.
- WGCS shall continuously send Real-Time measurements.
- Active wave absorption shall be available for enabling and disabling in remote mode
- Paddle wave measurements shall be available for the possibility of development of wave absorption algorithms

2.1.3 Data logging (internal on WGCS)

- Flap position.
- Wave elevation on flap.
- All relevant internal conditions of the WGCS.
- Each sample must the time stamped by correct global time (from PTPv2).

2.2 Main safety functions

The machine safety is taken care of by WGCS.

HLCC needs positive status messages from all local system before tests can be started. Errors on local system that will cause failure on local machinery or reduced functional quality will stop the ongoing test.

Automatic unmanned tests require monitoring of critical functions on systems and barriers to avoid people getting in contact with moving mechanical machines. Therefore, the WGCS needs an emergency shutdown input, directly connected to the to the main controller such that external systems can shut down the WGCS if a barrier is broken. Emergency push buttons must also be available in addition to the emergency input.

In addition to the shutdown inputs, two output signals need to be available, to warn people of the WGCS status. The first signal is defined as true if the WGCS is enabled, and the second signal is defined true if the WGCS is running.

2.3 Time synchronizing

WGCS shall be connected to the Ocean Space Centre industrial control network and shall support time synchronisation. Recommended time synchronisation protocols are:

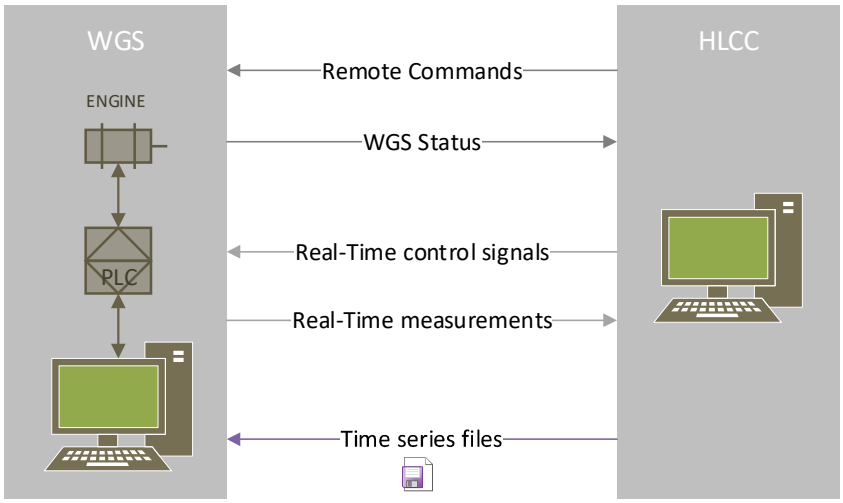
- IEEE 1588-2008, also known as PTP Version 2
- IEEE 1588-2019

The Precision Time Protocol (PTP) is a protocol used to synchronize clocks throughout a computer network. In the Ocean Space Centre local area network, it achieves clock accuracy in the sub-microsecond range, making it suitable for both measurement and control systems.

IEEE 1588-2008 (PTP Version 2) is not backward compatible with the original 2002 version. IEEE 1588-2019 was published in November 2019 and includes backward-compatible improvements to the 2008 publication.

If another protocol than PTP Version 2 is chosen (such as IRIG etc.), the internal clock of WGCS needs to able to synchronise within less than 60 seconds and with an internal clock accuracy less than 1 millisecond.

2.4 Communication with HLCC



WGCS must be controlled though an API or a centralized system without accessing the WGCS GUI. WGCS has to be configurable from HLCC. Only exception from this is the mode changes between Local and Remote (See section 2.1)

Proprietary GUI's would be additionally and not replacing others.

2.4.1 Remote Commands:

Description: See section 2.1.2

Examples:

Load time series, start and stop, mute and unmute. See section 2.1.2

Protocol options:

- TCP/IP

2.4.2 WGCS Status:

Description:

All relevant status of the WGCS is continuously sent to HLCC. See section 2.1.2

Examples:

Power state, Error status, Running, Error description.

Protocol options:

- TCP/IP
- UPD

Frequency: Minimum 10 Hz.

2.4.3 Real-Time control signals:

Description:

Flap position setpoints are sent continuously to WGCS. Only relevant in Real-Time streaming mode. See section 2.1.2

Protocol options:

- EtherCAT
- Profibus
- ProfiNet

Frequency: Minimum 100 Hz.

2.4.4 Real-Time measurements:

Description:

Time stamped flap position measurements and flap wave elevations are sent continuously to HLCC. Relevant in all modes.

Protocol options:

- EtherCAT
- Profibus
- ProfiNet

Frequency: Minimum 100 Hz.

2.4.5 Time series files:

Description:

HLCC shall be able to transfer time series files to WGCS.

Transfer options:

- FTP
- WebDAV
- Shared network drive

2.5 Digital twin functionality

2.5.1 Wave machine operation and signal simulation

In order to develop and test control systems the possibility to connect and operate wave machine without running the motor and generating waves is a requirement. Proposed functionality around this from supplier will be important for evaluating the quote.

2.5.2 Wave simulations

A target for the future is to enable the possibility to deterministically predict accurate waves as function of both time and position on the water surface. Any contribution from wave generator supplier on this topic either related to existing functionality or plans for future development would be appreciated and relevant for the quote evaluation.