Procedure for Installation, Operation and Maintenance of Subsea Sensors

Siemens AS
Ternetangen 65
N-5420 Rubbestadneset

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## Revision List

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<tr>
<th>Rev</th>
<th>Date</th>
<th>Description</th>
<th>Author</th>
<th>Reviewed</th>
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<td>R</td>
<td>29.05.2012</td>
<td>Added abbreviations and reference list.</td>
<td>CF</td>
<td>PKS</td>
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<td>S</td>
<td>16.10.2012</td>
<td>Added CRC in abbrev. list</td>
<td>CF</td>
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<td>T</td>
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<td>Changed Logo</td>
<td>CS</td>
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<td>U</td>
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<td>Added Profibus info, added IR test warning.</td>
<td>EV</td>
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<td>New layout</td>
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<td>X</td>
<td>31.08.2015</td>
<td>New Teamcenter ID’s under chapter 3 References</td>
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<td>Y</td>
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<td>Updated references, Added info about 20K PSI, Updated ch. 7</td>
<td>EV</td>
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<td>29.03.2017</td>
<td>Added flange type to section 6.2</td>
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<td>Updated section for analogue sensors. Added ref. [38]</td>
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<td>AC</td>
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<td>Improved wording section 6.2, page 10</td>
<td>AE</td>
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<td>Revised wording section 4 and 8 – storage temp requirements</td>
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<td>AE</td>
<td>26.02.2019</td>
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# 1 CAUTIONS

<table>
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<tr>
<th>Icon</th>
<th>Text</th>
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<tbody>
<tr>
<td>![Triangle]</td>
<td><strong>PLEASE READ THE COMPLETE INSTALLATION, OPERATION AND MAINTENANCE MANUAL BEFORE ANY WORK START.</strong></td>
</tr>
</tbody>
</table>
| ![Triangle] | Avoid manual handling!  
Manual Handling by an individual at this weight should be avoided at all times.  
Suitable mechanical lifting aids should be identified, and used for the movement of Sensors, avoiding Musculoskeletal damage to the operator. The weight of the sensor will be found on the Weight Certificate for each individual type of sensor. |
| ![Triangle] | Unless the sensor is within its transport case, it shall only be handled by personnel authorised by the client.  
Installation shall only be undertaken by personnel authorised by the client. |
| ![Triangle] | Never use air tools when fixing the remote seal- and main body bolts.  
Avoid other types of shock and vibration impacts |
| ![Triangle] | At any time during any type of welding operations in vicinity of the sensor, all cables shall be grounded.  
Twist all leads of the sensor and ensure that they are properly connected to the sensor housing. |
| ![Triangle] | Membrane system must be handled with extreme care, do not:  
- Touch or come near the membrane surface by hand or any object.  
Note that the membrane is very thin and fragile, even the slightest contact with a sharp object may permanently damage the complete sensor |
# 2 ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>API</td>
<td>American Petroleum Institute</td>
</tr>
<tr>
<td>CAN</td>
<td>Controller Area Network</td>
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<tr>
<td>CANopen</td>
<td>CAN Standard based on EN50325</td>
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<td>CiA</td>
<td>CAN in Automation</td>
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<tr>
<td>CRC</td>
<td>Cyclic Redundancy Check</td>
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<tr>
<td>FAT</td>
<td>Factory Acceptance Test</td>
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<tr>
<td>FT</td>
<td>Fault Tolerant</td>
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<tr>
<td>HS</td>
<td>High Speed</td>
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<tr>
<td>NMT</td>
<td>Network Management, CAN Application Layer</td>
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<tr>
<td>PDO</td>
<td>Process Data Object</td>
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<tr>
<td>PFD</td>
<td>Probability of Failure on Demand</td>
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<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
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<tr>
<td>RTU</td>
<td>Remote Terminal Unit</td>
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<tr>
<td>SFF</td>
<td>Safe Failure Function</td>
</tr>
<tr>
<td>SIF</td>
<td>Safety Instrumented Function</td>
</tr>
<tr>
<td>SIL</td>
<td>Safety Integrity Level</td>
</tr>
<tr>
<td>SIS</td>
<td>Safety Instrumented System</td>
</tr>
<tr>
<td>SRS</td>
<td>Safety Requirement Specification</td>
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<td>SYNC</td>
<td>Synchronous Transmission</td>
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# 3 REFERENCES

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<td>[1]</td>
<td>CiA-443</td>
<td>1.0, 2.0 or 3.0</td>
<td>CANopen Device Profile for SIIS level-2 devices</td>
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<td>[3]</td>
<td>CiA-301</td>
<td>4.2.0</td>
<td>CANopen application layer and communication profile</td>
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<td>[5]</td>
<td>00002015</td>
<td>B</td>
<td>Safety Manual WEPS-100 Series 4-20 mA SIL</td>
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<td>[8]</td>
<td>00004615</td>
<td>D</td>
<td>Specification for WEPS-100 Series Modbus Interface</td>
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<td>[12]</td>
<td>00004623</td>
<td>L</td>
<td>Specification Weps-100 Series CANopen Interface</td>
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<td>[15]</td>
<td>0004799</td>
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<td>[16]</td>
<td>0004805</td>
<td>F</td>
<td>Specification WEPS-25 CiA-443 v1.0 Interface</td>
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<td>[17]</td>
<td>0004833</td>
<td>C</td>
<td>Specification for WEPS RS485 KOS Interface</td>
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<td>[18]</td>
<td>0004836</td>
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<td>Specification for WEPS-612 and WEPS-615 CiA-443 v.2.0 Interface</td>
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<td>[22]</td>
<td>0007070</td>
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<td>Specification WEPS-3 Profibus Interface</td>
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<td>[23]</td>
<td>0010690</td>
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<td>Specification for WEPS-3 CiA-443 v.2.0 Interface</td>
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<td>[27]</td>
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<td>[34]</td>
<td>10033064</td>
<td>D</td>
<td>Software Manual for WEPS-900 HP Series CANopen CiA-443 SIL3 Interface</td>
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<tr>
<td>[37]</td>
<td>SIIS_RP</td>
<td>01</td>
<td>Subsea Instrumentation Interface Standardisation (SIIS) Recommended Practice</td>
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</table>

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4 PACKING AND TRANSPORTATION

Avoid excessive shock and vibrations during transport and handling, even though the equipment itself is resistant towards shock and vibration, this is only true when the units are properly fixed and secured.

A Special transport case is prepared for packing, storing and transport of the Subsea Sensor. We strongly advice that the units is kept secured in this box until the final installation destination is reached.

The transportation case must be in its upright position at all times (see marking on the case).

The Subsea Sensors high own weight makes a dangerous combination if the transportation cases is handled roughly (dropped, turned from upright positions etc).

Storage temperature limits are defined as -40 to +70°C, however it is recommended to store the subsea sensors at room temperature if possible. Humidity control is not required.

Note: For further information regarding packing, handling and storage specifications, see ref. [6].
5 HEALTH AND SAFETY STATEMENTS

It is recommended that the Client performs a “Risk Assessment” for all aspects of the Sensor Installation from initial delivery to final dispatch, to identify the hazards associated with the work.

Each Sensor Unit weighs 15 to 35 Kgs. Those staff preparing to move a Sensor Unit from the Delivery Box must ensure that they “Assess the Identified Hazards” for each movement of the Sensor.

Manual Handling by an individual at this weight should be avoided at all times. Suitable mechanical lifting aids should be identified avoiding Musculoskeletal damage to the operator.

Personal Protective Equipment in the form of:
- Safety Shoes/ Boots
- Protective Gloves

Is highly recommended for the protection of staff whilst working with Sensors. Additional PPE may be required for the working environment / Client Safety Rules.

The Sensors do not contain any chemicals or compositions that could be hazardous upon exposure.

During Soldering Operations it is recommended that fumes are removed from the immediate working area to avoid inhalation by the operator.

<table>
<thead>
<tr>
<th>Warning</th>
<th>Any soldering shall not take place unless the soldering procedure and/or soldering company have the appropriate skills and are approved by Siemens.</th>
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<table>
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<tr>
<th>Warning</th>
<th>Care in the selection of the correct tools for the final “Torque Setting of the API Bolts” is important to avoid accidents through damaged/poorly maintained tooling.</th>
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<tbody>
<tr>
<td></td>
<td>See API 6A ref. [4]</td>
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6 INSTALLATION

6.1 INSTALLATION INSTRUCTIONS

CAUTION: UNLESS THE SUBSEA SENSOR IS WITHIN ITS TRANSPORT CASES/CRADLE IT SHALL ONLY BE HANDLED BY PERSONNEL AUTHORISED BY THE CLIENT.

INSTALLATION SHALL ONLY BE UNDERTAKEN BY PERSONNEL AUTHORIZED BY THE CLIENT.

HANDLE THE SUBSEA SENSOR WITH CARE - HEAVY SHOCK AND/OR VIBRATIONS, HIGH TEMPERATURES MAY DAMAGE THE UNIT.

6.2 MECHANICAL INTERFACE

The Subsea Sensor shall be installed with BX Ring in accordance with the respective mechanical interface drawing for the Subsea Sensor.

Available flanges according to API 6A, ref. [4]:
- 2 1/16", 5k PSI, BX-152, 8 bolts.
- 2 1/16", 10k PSI, BX-152, 8 bolts.
- 1 13/16", 5k PSI, BX-151, 8 bolts.
- 1 13/16", 10k PSI, BX-151, 8 bolts.
- 1 11/16", 5k PSI, BX-150, 4 bolts.
- 1 11/16", 10k PSI, BX-150, 4 bolts.
- 2 1/16", 15k PSI, BX-152, 8 bolts.
- 3 1/16", 10k PSI, BX-154, 8 bolts

In addition following flange alternatives:
- 2 1/16", 15k PSI, BX-152, 10 bolts.
- 2 1/16", 20k PSI, BX-152, 10 bolts.

Nuts and bolts used for installation : According to Clients specifications.
Material : According to Clients specifications.
Torque Settings : According to Clients specifications.

No Requirements regarding orientation.
All surfaces shall be cleaned before installation.

Nuts, bolts and gaskets are not part of Siemens delivery, however sensors are designed to be used with nuts, bolts and gaskets according to API 6A ref. [4].
CAUTION:
AT ANY TIME DURING ANY TYPE OF WELDING OR SAND BLASTING OPERATIONS
ON THE XMAS TREE OR OTHER STRUCTURES NEAR THE SUBSEA SENSORS, ALL
SUBSEA SENSOR(S) INSTALLED AND SUBSEA SENSOR(S) TO BE TIG WELDED
OR SAND BLASTED SHALL BE GROUNDED.

ALL THE INSTRUMENT ELECTRICAL CONDUCTORS SHOULD BE ELECTRICALLY
BONDED TOGETHER AND IN TURN ELECTRICALLY BONDED TO THE
INSTRUMENT BODY. WHERE THE INSTRUMENT IS FITTED WITH A
ELECTRICAL CONNECTOR OR FITTED TO A HARNESS A SUITABLE TEST
CONNECTOR SHOULD BE USED.

IT IS RECOMMENDED TO KEEP THE ELECTRICAL CONDUCTORS BONDED
TOGETHER AND TO THE SENSOR HOUSING AT ALL TIMES UNTIL FINAL
CONNECTION IS MADE TO THE SYSTEM.

Never use air tools when fixing the remote seal- and main body
bolts. Also avoid other types of shock and vibration impact.

Insulation Resistance Test:
Test voltage shall never exceed 50 VDC.
7  OPERATION INSTRUCTIONS

After installation, check the Subsea Sensor(s) at ambient pressure and/or temperature to control that the sensor is still functioning properly.

7.1  ANALOGUE SENSORS

The output can be measured by the use of a loop tester. The loop tester should be according to SIIS RP, ref. [38], capable of providing 24 Volt for minimum of 40mA during start up.

Recommended loop tester: Drück UPS III

Note: The Fluke 707 instrument has a current limitation lower than SIIS RP and could prevent the sensor to start up correctly and cannot be used as an instrument to read this sensor.

The pressure output(s) shall give a mA output according to the calibrated range and the ambient pressure. The temperature output(s) shall give a mA-value corresponding to the calibrated range and the ambient temperature.

The pressure output(s) are calibrated from: MinCalibPress to MaxCalibPress. This is the calibrated sensor range for pressure. See sensor marking.

The temperature output(s) are calibrated from: MinCalibTemp to MaxCalibTemp. This is the calibrated sensor range for temperature. See sensor marking.

The conversion from mA to engineering units such as Bara and deg C is as follows:

Pressure = {(mAValue - 4)*((MaxCalibPress - MinCalibPress/16))} + MinCalibPress.

Temp. = {(mAValue - 4)*((MaxCalibTemp. - MinCalibTemp)/16))} + MinCalibTemp.

For more details regarding the 4-20 mA interface for WEPS-100 Series of sensors please see the following interface specifications:

- WEPS-100 Series PT: Ref. [31].
- WEPS-100 Series TT: Ref. [32].
- WEPS-100 Series SIL: Ref.[16].
- WEPS-5 FR SIL: Ref. [28].

NOTE:
Regarding SIL rated analogue sensors please see also ch. 7.3 – 7.6.
7.2 DIGITAL SENSORS

The Subsea sensors will communicate with the supply/receiver circuitry through RS485 (KOS/Modbus/Profibus) protocol or on CANopen.

The sensor signal is transmitted in engineering units. Most often this is in Bara/°C, but sensors can also be delivered with PSI /Fahrenheit on request.

After installation subsea, the signal from the subsea sensor will form a part of the client’s main system, and all operational instructions should be according to the client’s procedures.

7.2.1 RS485 Modbus

The master unit can start communication with the sensor 5 seconds after power up. The master needs to send request to the sensor, then it will transmit messages with sensor data in return.

The electrical interface between the master and the sensor is based on the RS485 standard.

The format of each byte in RTU mode is:

- Interface: RS485 (two-wire)
- Baud rate: default 1200 (2400, 4800, 9600, 19200 and 38400 is available)
- Coding system: 8-bit binary
- Number of start bits: 1
- Data bits: 8
- Parity: No
- Stop bits: 1 (2 stop bit is available on request)
- Error checking: CRC

For more details regarding the Modbus interface, please see the corresponding interface specification:
- WEPS-100 Series Modbus: Ref. [9].
- WEPS-600 Series Modbus: Ref. [12].
7.2.2 RS485 PROFIBUS

The electrical interface between the master and the sensor is based on the Profibus DP standard, EN 50170.

- **Interface**: RS485 (two-wire)
- **Baud rate**: Auto (9600 or 19200)
- **Address**: 2 to 125

For more details regarding the Profibus interface, please see the corresponding interface specifications:
- Weps-3 Profibus: Ref. [23].

7.2.3 RS485 KOS

After power up, the sensor starts transmitting messages within 5 seconds. The protocol is unidirectional.

Messages are sent from the sensor when new measurements are ready, twice a second.

The electrical interface between the master and the sensor is based on the RS485 standard, optional Rs422.

- **Interface**: RS485 (two-wire)
- **Baud rate**: 1200
- **Coding system**: 8-bit binary
- **Number of start bits**: 1
- **Data bits**: 8
- **Parity**: No
- **Stop bits**: 1
- **Error checking**: Checksum

For more details regarding the KOS interface, please see the corresponding interface specifications:
- WEPS-100 Series RS485 KOS: Ref. [10].
- Other Sensors with RS485 KOS: Ref. [18].
7.2.4 CANopen

The sensor can be configured before delivery to support two different device profiles: CiA-401 or CiA-443.

**Device Profile 401**

If the sensor is configured for device profile 401, ref.[2], the sensor enters the application and NMT pre-operational mode after power-on. In pre-operational mode, the sensor application starts to read and calculate process values (typically pressure and temperature). When the sensor receives the “NMT start command” it will enter NMT state operational (if no failures detected). After the start command is received the sensor will start to transmit process data according to the transmission type and configuration.

Process measurements are transmitted periodically (according to configuration) by the means of PDO, using transmission type 254. It is possible to use SYNC transmission 1-240. See CiA-301, ref.[3].

For more details regarding the sensor interface, please see the corresponding interface specifications:

- WEPS-100 Series with CiA-401 : Ref. [13].
- WEPS-6153 CiA-401 : Ref. [8].
- WEPS-612 CiA-401 : Ref. [25].
- WEPS-615 CiA-401 : Ref. [25].
- WEPS-6121 CiA-401 : Ref. [20].
- WEPS-6151 CiA-401 : Ref. [20].
- Other sensors with CiA-401 : Ref. [7].

**Device Profile 443**

If the sensor is configured for device profile 443, ref.[1], the sensor stays in boot loader program and enters NMT pre-operational mode after power-on.

In the boot loader program only the LSS layer and some dictionary objects are implemented. Process measurements and PDO are not implemented; hence setting the boot loader program in NMT operational mode makes no sense.

The application is started by using the dictionary object 1F51h Program Control, writing 1 to sub-index 1.

The application will then start up in NMT pre-operational mode and the sensor starts to read and calculate process values (typically pressure and temperature). When the sensor receives the NMT start command it will enter NMT operational mode (if no failures detected).

After the start command is received the sensor will start to transmit process data according to the transmission type and configuration.
Process measurements are transmitted continuously (according to configuration) by the means of PDO using transmission type 255. It is possible to use SYNC transmission 1-240, or transmission type 254.

- **Interface**: CANopen (two-wire)
- **Baud rate**:
  - CANopen FT: 50 (default) and 125kbit
  - CANopen HS: 10, 20, 50 (default) 125 and 250kbit

For more details regarding the sensor interface, please see the corresponding interface specifications or user manual:

- WEPS-100 Series with CiA-443: Ref. [13].
- WADS with CiA-443: Ref. [14].
- WEPS-25 with CiA-443 v.1: Ref. [17].
- WEPS-25 with CiA-443 v.2: Ref. [15].
- WEPS-3 with CiA-443: Ref. [24].
- WEPS-95 with CiA-443: Ref. [21].
- WEPS-612 CiA-443: Ref. [19].
- WEPS-615 CiA-443: Ref. [19].
- WEPS-900 HT Series: Ref. [34].
- WEPS-900 HP Series: Ref. [36].

NOTE:
Regarding SIL rated digital sensors please see the following chapters.
7.3 SIL RATED SENSORS

SIL is a measure of safety system performance, or probability of failure on demand (PFD) for a SIF or SIS. The higher the SIL level, the lower the probability of failure on demand for the safety system and the better the system performance.

SIEMENS SIL 1, SIL 2 and SIL 3 rated sensors are suitable for application in SIL 1, SIL 2 and SIL 3 Safety Instrumented System respectively.

All SIEMENS SIL rated sensor are independently certified and approved by certification authority.

Type of communication protocol that is suitable for SIL rated sensor is dependent on type of platform for which sensors have been developed, for example 4-20mA, CAN bus etc.

Please refer to independent sensor’s interface speciation, software manual or safety manual for SIL rated sensor. This documentation will provide information about communication protocol being used, safe state indication, PFD and SFF etc.

- WEPS-6121 and WEPS-6151 SIL1 : See ref. [26], SRS for details.
- WEPS-6122 and WEPS-6152 SIL2 : See ref. [27], SRS for details.
- WEPS 6153 SIL3 : See ref. [29], SRS for details.
- WEPS-5 Fast Response SIL2 : See ref. [28], SRS for details.
- WEPS-100 Series 4-20 mA SIL3 : See ref. [5], Safety Manual for details.
- WEPS-900 Series HT SIL3 : See ref. [33], Safety Manual for details.
8 MAINTENANCE

Before installation, confirm if the Subsea Sensor(s) have been stored for more than six - 6 - months, if so, a test of the sensor signal at ambient pressure and temperature should be carried out. Use of calibrated reference instruments is required to ensure correct test results.

If the result from the test shows any discrepancy (≥1Bar / ≥1°C) in the sensor signal contact Siemens for further assistance. If required the sensors could be returned to the manufacturer for adjustment or a note should be made of the difference and adjusted on the Company’s topside system after installation subsea.

After installation subsea, it will not be possible to carry out any maintenance of the sensor. However, if possible, a periodically control of the sensors should be carried out. At known pressure the signal from the pressure outputs should correspond to the reference pressure. If it is possible to have a known temperature reference, a similar test should be carried out for the temperature outputs. In case of any drift, the sensor signal should be corrected on the topside system. The top side system has to have the facility of an offset adjustment of the sensors to be able to carry out this test.

SIL rated sensors should have proof test on regular basis, ref. Safety Requirement Specification (SRS) or Safety Manual for the specific sensor.

If the structure for any reason should be retrieved after installation, the sensor should be controlled as in ch. 7 (Operating Instructions) above or returned to the manufacturer for a complete check/recalibration.