RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER **No. 314-30-1461c** dated 12.11.2020

Re:

amendments to the Rules for the Classification and Construction of Sea-Going Ships, 2020, ND No. 2-020101-124-E

Item(s) of supervision:

ships under construction and in service

Entry-into-force date: **15.12.2020** Valid till: **-** Validity period extended till: **-**

Cancels / amends / adds Circular Letter No. **-** dated **-**

Number of pages: 1+20

Appendices:

Appendix 1: information on amendments introduced by the Circular Letter

Appendix 2: text of amendments to Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships"

Director General Konstantin G. Palnikov

Text of CL:

We hereby inform that the Rules for the Classification and Construction of Sea-Going Ships shall be amended as specified in the Appendices to the Circular Letter.

It is necessary to do the following:

1. Bring the content of the Circular Letter to the notice of the RS surveyors, interested organizations and persons in the area of the RS Branch Offices' activity.
2. Apply the provisions of the Circular Letter during review and approval of the technical documentation on ships contracted for construction or conversion on or after 15.12.2020, in the absence of a contract, the keels of which are laid or which are at a similar stage of construction on or after 15.12.2020, as well as during review and approval of the technical documentation on ships, the delivery of which is on or after 15.12.2020.

List of the amended and/or introduced paras/chapters/sections:

Part XVII: Section 17

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"Thesis" System No. 20-231182

Appendix 1 to Circular Letter
No. 314-30-1461c dated 12.11.2020

Information on amendments introduced by the Circular Letter
(for inclusion in the Revision History to the RS Publication)

Nos.	Amended paras/chapters/sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
1	Section 17	Section has been completely revised considering the results of the scientific research	314-30-1461c of 12.11.2020	15.12.2020

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS, 2020,

ND No. 2-020101-124-E

PART XVII. DISTINGUISHING MARKS AND DESCRIPTIVE NOTATIONS IN THE CLASS NOTATION SPECIFYING STRUCTURAL AND OPERATIONAL PARTICULARS OF SHIPS

17 REQUIREMENTS FOR HULL MONITORING SYSTEM

Section 17 is replaced by the following text:

"17 REQUIREMENTS FOR SHIPS EQUIPPED WITH HULL STRENGTH AND STABILITY MONITORING SYSTEMS

17.1 GENERAL PROVISIONS

17.1.1 The ships equipped with automated hull strength and/or current stability monitoring system (hereinafter referred to as "HMS") compliant with the requirements of this Section are assigned the distinguishing mark **HMS** added to the character of classification. The information on completeness and features of the system in compliance with the symbols given in 17.2 shall be indicated in brackets.

17.1.2 This Section establishes the minimum requirements to the monitoring system necessary for assignment of the distinguishing mark to the class notation pursuant to 17.2.

17.1.3 The strength and stability monitoring system is intended for informing the ship's crew on loads exerted on the ship and changes in stability during the service and loading/unloading operations in a port.

The hull monitoring system is intended for supplying auxiliary information to the master but shall not substitute for the master's own judgement and shall not detract from the master's responsibility related to the decisions to be taken during the ship service.

17.2 DISTINGUISHING MARK IN THE CLASS NOTATION

17.2.1 For ships equipped with a monitoring system complying with the requirements of this Section, the distinguishing mark shall be added to the class notation specifying the system completeness:

.1 **HMS(STR)** — system is intended for monitoring of strength parameters;

.2 **HMS(STAB)** — system is intended for monitoring of stability parameters;

.3 **HMS(STR-STAB)** — system is intended for monitoring of strength and stability parameters.

17.2.2 Where the system is fitted with additional features, the distinguishing mark shall be specified as **HMS(…)+…**, and the following additional feature symbols shall be added after brackets:

.1 **BS** — availability of connection to the ballast, heel and trim systems of the ship;

.2 **C** — availability of connection to the onboard computer software for calculation of ship's strength and stability;

.3 **DD** — availability of directional data link ensuring monitoring data transfer to the shore;

.4 **DM** — availability of mutual data link ensuring monitoring data transfer to the shore and control of monitoring system from the shore;

.5 **N** — availability of connection to GPS/GLONASS receivers, log, echo sounder and indication of received data on the monitoring system display;

.6 **RPM** — availability of connection to the ship system for propeller shaft(s) speed measurement and recording;

.7 SI — availability of connection to the ship radar ice display with transfer of current ice condition data, their recording in the database and indication on the monitoring system display;

.8 SW — availability of connection to the ship weather station with transfer of current sea state parameters, their recording in the database and indication on the monitoring system display;

.9 TS — availability of connection to the ship system for the propeller shaft(s) torque measurement and recording;

.10 ThS — availability of connection to the ship system for measurement and recording of thrust along the propeller shaft(s) fore-aft axis;

.11 TVS — availability of connection to the ship system for measurement and recording of radial and longitudinal vibration displacements of the propeller shaft(s);

.12 W — availability of connection to the ship weather station with transfer of current apparent and true wind speed and direction, and sea state parameters including data indication on the monitoring system display.

17.3 TERMS AND DEFINITIONS

Definitions and explanations concerning the general terminology of the Rules are given in Part I "Classification".

For the purpose of this section the following definitions and explanations have been adopted.

After perpendicular means the after perpendicular as defined in Part II "Hull".

Calibration of a measuring instrument means a set of operations performed for determination and verification of actual values of metrological characteristics and/or suitability for purpose of a measuring instrument not subject to state metrological control and supervision.

Forward perpendicular means the forward perpendicular as defined in Part II "Hull".

Intermediate waterline means the waterline determined as the arithmetic mean position between draughts corresponding to the ice loadline and ballast waterline. The ice loadline and ballast waterline shall be determined in accordance with 3.10.1.3.2, Part II "Hull".

Length L means the length as defined in Part II "Hull".

Local deformation means changes in shape and sizes of individual structural members of the ship's hull (framing members and plating connected thereto) caused by external effects. Such changes are characterized by tension or compression, and/or bending, and/or shear of the structure in general and/or its parts.

Midship section means the midship section as defined in Part II "Hull".

Solid state drive means a nonmechanical storage device based on storage integrated circuits.

Upper deck means the upper deck as defined in Part II "Hull".

17.4 SURVEY SCOPE

17.4.1 General provisions pertaining to the procedure of surveys, as well as the requirements for the technical documentation submitted to the Register for review and approval are specified in General Regulations for the Classification and Other Activity and in Part I "Classification".

17.4.2 The Register performs review of technical documentation for the monitoring system and survey of the system during installation and service.

17.4.3 Testing of the monitoring system shall be carried out under the RS supervision according to test programmes approved by the Register.

17.4.4 When changes affecting main parameters or internal ship subdivision are introduced in the ship design, or approved documentation on stability and/or strength is amended, the approval of the monitoring system becomes invalid. Upon introduction of required changes the system shall be submitted for repeated review.

17.5 TECHNICAL DOCUMENTATION

17.5.1 Prior to installation of the system on board the ship, the following technical documentation for the monitoring systems shall be submitted to the Register for review (upon the positive review results the documents shall be stamped "Approved" (A), "Agreed" (AG) or "For information" (FI)):

.1 technical description (AG);

.2 schematic diagram (AG);

.3 function block diagram (AG);

.4 list of measuring channels (AG);

.5 arrangement plan with indication of measuring instrument locations, cable laying and hardware installation (A);

.6 general electrical diagram (AG);

.7 schematic circuit diagram (AG);

.8 permissible values of parameters used for monitoring in sensor location points (AG);

.9 technical description of software, including procedure for calculation of parameters used for monitoring, based on results of measurements (AG);

.10 monitoring system operating manual (AG);

.11 maintenance instruction manual including calibration procedure (AG);

.12 installation drawings (A) (to be reviewed by the RS Branch Office performing technical supervision of the system installation at the stage of mounting);

.13 installation, commissioning and adjustment instruction (AG) (to be reviewed by the RS Branch Office performing technical supervision of the system installation at the stage of mounting);

.14 programme of periodical surveys of the system in service (A).

17.5.2 For the monitoring system having connection with other systems, the following technical documentation shall be additionally submitted:

.1 schematic diagram of monitoring system connection with other systems (AG);

.2 diagram of hardware arrangement and cable routing for monitoring system connection with other systems (A);

.3 schematic circuit diagram for monitoring system hardware intended for connection with other systems (AG).

17.5.3 Where a computer model of ship is used for the monitoring system calculations, the model shall be approved in compliance with 12.2.4.1 to 12.2.4.3, Part II "Technical Documentation" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships.

17.5.4 Along with the technical documentation, the reports of previous tests may be submitted, as well as the available certificates confirming the compliance of hardware and software components used in the monitoring system with the requirements of RS rules.

17.5.5 The following technical documents shall be permanently available on board every ship equipped with the monitoring system:

.1 monitoring system operating manual;

.2 maintenance instruction manual including calibration procedure;

.3 list of measuring channels;

.4 schematic diagram;

.5 function block diagram;

.6 arrangement plan with indication of measuring instrument locations, cable laying and hardware installation;

.7 general electrical diagram;

.8 schematic circuit diagram;

.9 monitoring system record book;

.10 programme of periodical surveys.

17.5.6 Where the monitoring system has connection with other systems, the following technical documentation shall be additionally available on board:

.1 schematic diagram of connection system;

.2 arrangement diagram of connecting unit hardware, cable routing and wireless local link antennas;

.3 schematic circuit diagram of connection system.

17.5.7 The technical documentation of the monitoring system available on board shall be drawn up in working language of the ship's crew. Where the ship is engaged in international voyages, the documentation shall be translated into English.

17.6 GENERAL REQUIREMENTS

17.6.1 The monitoring system shall ensure:

.1 on-line collection and processing of measurement results;

.2 on-line monitoring of variations of the parameters which are indicative of the ship's strength and/or stability state;

.3 calculation of parameters used for monitoring based on measurement results;

.4 on-line sorting of parameters by hazard levels;

.5 preservation and visualization for results of processing of measurements, calculations and sorting of parameters by hazard levels;

.6 generation of alarms and warning messages based on results of parameters sorting by hazard levels;

.7 data import/export between the monitoring system and other ship equipment (where provided by system design version);

.8 transmission of monitoring data to the shore (where provided by system design version);

.9 configuring of operating modes of the monitoring system and calibration of measuring components;

.10 self-diagnostics of components;

.11 preservation of measurement, processing and calculation data in case of power failure and automatic resumption of normal operation upon power supply return;

.12 continuous round-the-clock operation.

17.6.2 The hardware shall ensure reliable operation in marine conditions and meet the requirements specified in Part XV "Automation".

17.6.3 Hardware components located in the spaces with the vibration level in excess of values specified in part XV "Automation" shall be designed to ensure reliable operation in such conditions or shall be installed on appropriate shock absorbers.

17.6.4 The protection degree of hardware shall be at least as specified in 2.4.4, Part XI "Electrical Equipment".

17.6.5 Hardware components located on open decks and in cargo hold spaces shall be protected against accidental mechanical damage.

17.6.6 The requirements for marking of the instruments shall be determined in the technical documentation for products.

17.6.7 Hardware components of the monitoring system shall meet the requirements for:

.1 electrical safety specified in part XI "Electrical Equipment";

.2 electromagnetic compatibility specified in 2.2, Part XI "Electrical Equipment".

17.6.8 The software shall be protected against unintended and unauthorized access.

17.6.9 Automatic control of software functioning and user warning in case of its malfunctions shall be provided in the monitoring system.

17.7 COMPLETENESS

17.7.1 The type and minimum number of measuring components within the monitoring system shall be specified depending on the ship type, its particulars, area of navigation and system features.

17.7.2 The minimum list of the values to be measured when the system is intended for strength monitoring is given in Table 17.7.2.

17.7.3 Where the system intended for strength monitoring is installed on board the ice class ships, the values given in Table 17.7.3 shall be additionally measured.

17.7.4 Where the system is intended for stability monitoring, the ship shall be equipped with a dynamic displacement measurement device with 6 degrees of freedom for measurement of angular motions, angular rates of heel, trim, yaw and vertical, transverse and longitudinal displacements and accelerations. The device shall be installed at midship both on port and starboard, and at after and forward perpendiculars.

17.7.5 The control areas shown in Figs. 17.7.3-1 — 17.7.3-7 and in Table 17.7.3 are approximate.

Actual points for installation of sensors shall be specified at the stage of monitoring system development depending on structural particulars of the ship, possibility for sensor installation and cable route laying.

17.7.6 The minimum configuration of equipment, to which the monitoring system shall be connected for distinguishing marks specified in 17.2.3 to be added to the class notation is given in Table 17.7.6.

Table 17.7.2

List of values to be measured by system intended for strength monitoring

Parameter	Area of installation	Measuring instrument	Type of ship	Remark
1	2	3	4	5
Vertical impact acceleration	At forward perpendicular	Single-axis accelerometer	All ships	Area of installation: not exceeding $0{,}01L$ from forward perpendicular
Longitudinal bending of hull	At midship on port and starboard at upper deck	Single-axis long base linear surface strain sensor	All ships	For multi-hull ships: at cross-structure between hulls at midship on port/starboard
	At intersection of midship section and ship centreline on inner side of bottom		**Container ship**, **Timber carrier**, ships without descriptive notation in class notation	Applicable to ships $L \geq 200$ m. Area of installation on double bottom ships: on inside of inner bottom
	At distance of $L/4$ from midship section forward and aft on port and starboard at upper deck		**Bulk carrier**, **Ore carrier**, **Bilge water removing ship**, **Chemical tanker**, **Gas carrier**, **Oil recovery ship**, **Oil tanker**, **Oil/bulk carrier**, **Oil/ore carrier**, **Oil/bulk/ore carrier**, **Tanker**, **FPSO**, **FSO**, **Container ship**, **Timber carrier**, **Ro-ro ship**, **Ro-ro passenger ship**, **Fishing vessel**, ships without descriptive notation in class notation, except for multi-hull ships	Applicable to ships with descriptive notation **Ro-ro ship** and **Ro-ro passenger ship** $L \geq 200$ m, **Fishing vessel** $L \geq 100$ m and for ships with other descriptive notations listed in column 4, $L \geq 300$ m
Transverse bending of hull	At forward perpendicular at upper deck	Single-axis long base linear surface strain sensor	**Bulk carrier**, **Ore carrier**	Applicable to ships with large deck opening $L \geq 150$ m. Area of installation: not exceeding $0{,}01L$ from forward perpendicular
	In way of forward part of cargo area at upper deck in centreline		**Bilge water removing ship**, **Chemical tanker**, **Gas carrier**, **Oil recovery ship**, **Oil tanker**, **Oil/bulk carrier**, **Oil/ore carrier**, **Oil/bulk/ore carrier**, **Tanker**, **FPSO**, **FSO**	Applicable to ships $L \geq 150$ m
	At midship on port and starboard at upper deck		**Container ship**, **Timber carrier**, ships without descriptive notation in class notation	Applicable to ships with large deck opening $L \geq 200$ m
Vertical linear acceleration	At forward perpendicular	Single-axis accelerometer	**Container ship**, **Timber carrier**, ships	Applicable to ships $L \geq 200$ m. Area of

1	2	3	4	5
			without descriptive notation in class notation	installation: not exceeding $0{,}01L$ from forward perpendicular
			Ro-ro ship, **Ro-ro passenger ship**	Applicable to ships with descriptive notation **Ro-ro passenger ship** $L \geq 100$ m. Area of installation: not exceeding $0{,}01L$ from forward perpendicular
Vertical, transverse and longitudinal linear accelerations	In forward and aft sections of cross - structure in ship centreline	Three-axis accelerometer	Multi-hull ships	
1. One accelerometer may be installed for two kinds of measurements, when the amplitude and frequency ranges of the accelerometer and other parameters comply with the requirements for both kinds of measurements. 2. A dynamic displacement measurement device may be used instead of accelerometer. It is permitted not to install accelerometer, when the amplitude and frequency ranges of the dynamic displacement measurement device and other parameters comply with the requirements of both kinds of measurements.				

Table 17.7.3

List of values to be measured by system intended for strength monitoring installed on board of ice class ships

Parameter to be measured	Control area	Measuring instrument	Remark
1	2	3	4
Local deformations (bending/ shear, tension/ compression)	Bow region. Port/starboard in stem area in spans of nearest primary transverse members (frames); orientation based on ice loadline, ballast waterline and intermediate waterline[1] levels (Fig. 17.7.3-1) — 3 control points per each member span	Short base linear strain sensor	
	Bow region. Port/starboard in area corresponding to the maximum values of the shape factor[2] determined in compliance with 3.10.3, Part II "Hull" in frame spans; orientation based on ice loadline, ballast waterline and intermediate waterline levels (Fig. 17.7.3-2) — 3 control points per each member span		
	Midbody region. Port/starboard in spans of the following frames: 1. Nearest to the midlength of the midbody region. 2. Nearest to the coordinate of 1/4 of length of the midbody region forward from the boundary of the midbody and stern regions. 3. Nearest to the coordinate of 1/4 of length of the midbody region aft from the boundary of the bow region; orientation based on ice loadline, ballast waterline and intermediate waterline levels (Fig. 17.7.3-4) — 3 control points per each member span.		Installation of sensors in control points 1 and 2 only for ships $L \geq 200$ m
	Stern region. Port/starboard in frame spans in sternframe area. Areas corresponding to the maximum ice loads; orientation based on ice loadline, ballast waterline and intermediate waterline levels (Fig. 17.7.3-5) — 3 control points per each member span		For ships having distinguishing mark **DAS** in class notation
Vertical, transverse and longitudinal impact accelerations	Bow region. Port/starboard in stem region in spans of nearest primary transverse members (frames); orientation based on ice loadline, ballast waterline and intermediate waterline levels (Fig. 17.7.3-1) — 1 control point per each member span	Three-axis impact accelerometer	
	Bow region. Port/starboard in area corresponding to the maximum values of the shape factor (refer to 3.10.3, part II "Hull") in frame spans; orientation based on ice loadline, ballast waterline and		

1	2	3	4
	intermediate waterline levels (Fig. 17.7.3-2) — 1 control point per each member span		
	Bow region. Port/starboard in frame spans in compliance with Fig. 17.7.3-3 — 1 control point per each span		
	Bow region. Port/starboard in spans of bottom stringers (Fig. 17.7.3-6) — 1 control point per each span		
	Stern region. Port/starboard in frame spans in sternframe area. Regions corresponding to the maximum ice loads; orientation based on ice loadline, ballast waterline and intermediate waterline levels (Fig. 17.7.3-5) — 1 control point per each span		For ships having distinguishing mark **DAS** in class notation
	Stern region. Port/starboard in spans of bottom stringers nearest to mid-length of stern region and to line passing at the distance of 1/4 of ship's breadth in parallel to ship centreline (Fig. 17.7.3-7) — 1 control point per each span		For ships having distinguishing mark **DAS** in the class notation
Vertical impact acceleration	At forward perpendicular	Single-axis accelerometer	For ice class ships **Icebreaker6**, **Icebreaker7**, **Icebreaker8**, **Icebreaker9**
Longitudinal bending of hull	At midship on port and starboard	Single-axis long base linear surface strain sensor	
Angular motions and angular rates of heel, trim, yaw. Vertical, transverse and longitudinal displacements and accelerations	At midship on port and starboard. At forward and after perpendiculars	Device for measurement of dynamic displacements with 6 degrees of freedom	
[1] The applicate of the intermediate waterline is determined as the arithmetic mean between the draughts corresponding to the ice loadline and ballast waterline. [2] In accordance with 3.10.3.2.1, Part II "Hull".			

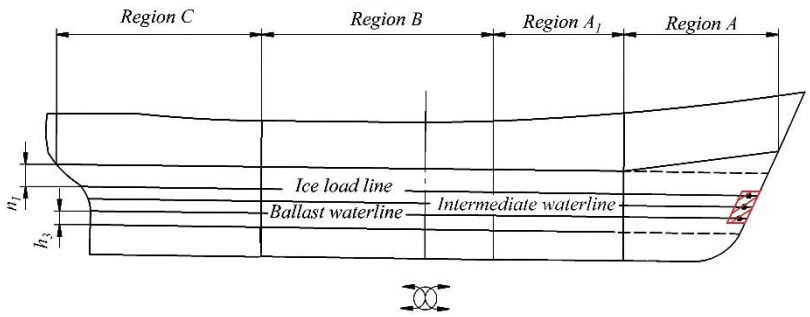

Fig. 17.7.3-1
Diagram showing control points for local deformations in region A in stem area

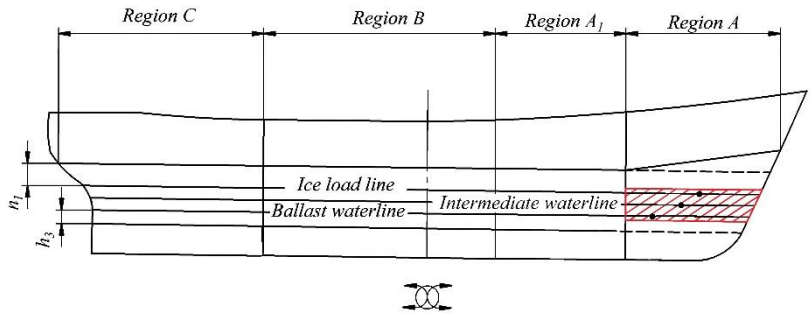

Fig. 17.7.3-2
Diagram showing control points for local deformations in region A in area corresponding to maximum values of shape factors

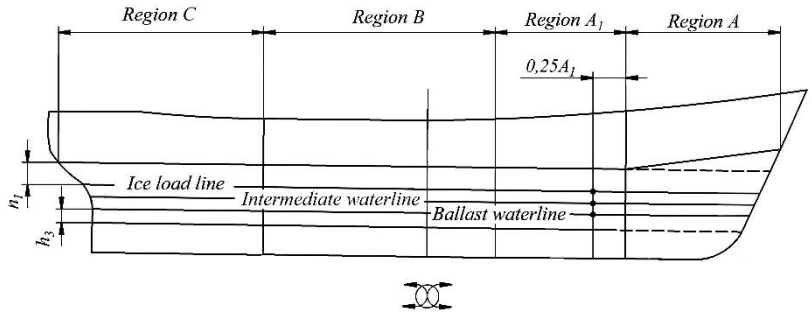

Fig. 17.7.3-3
Diagram showing control points for local deformations in region A_1

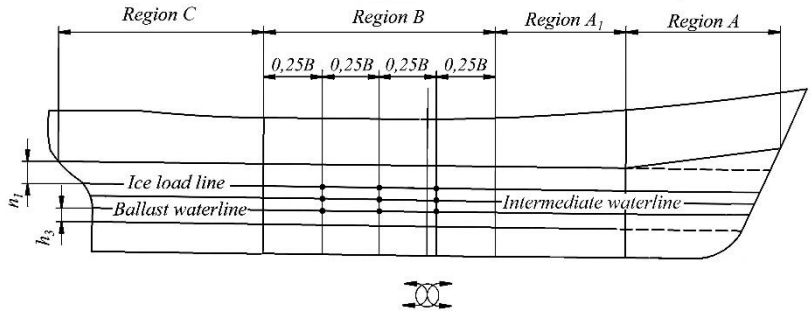

Fig. 17.7.3-4
Diagram showing control points for local deformations in region B

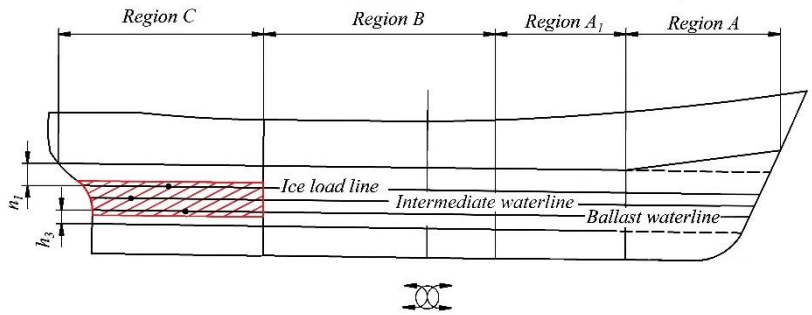

Fig. 17.7.3-5
Diagram showing control points for local deformations in region C

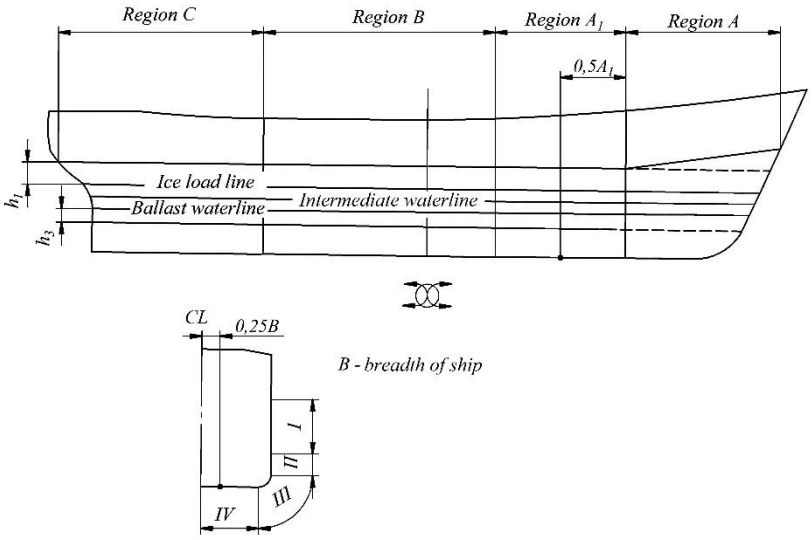

Fig. 17.7.3-6
Diagram showing control points for local deformations in region A_1 in bottom area

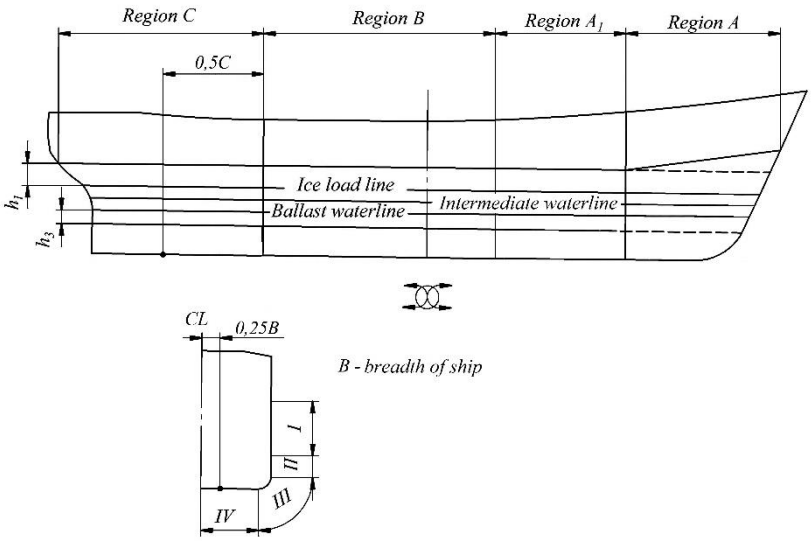

Fig. 17.7.3-7
Diagram showing control points for local deformations in region C in bottom area

Table 17.7.6

Minimum list of equipment to which the monitoring system shall communicate

Designation of system functions (Z)	Equipment to which the monitoring system is connected
BS	Ballast, heel and trim systems of the ship
C	Onboard computer software for ship strength and stability calculations
N	Receiver of global navigation satellite systems GPS/GLONASS, log, echo sounder
RPM	Propeller shaft speed sensor
SI	Radar ice display
SW	Weather station including sensors for sea state parameters
TS	Propeller shaft torque sensor
ThS	Record of thrust along propeller shaft fore-aft axis
TVS	Sensor for radial and longitudinal vibration displacements of propeller shaft
W	Weather station including sensors for sea state and wind parameters

17.8 MEASURING CHANNELS AND MEASURING COMPONENTS

17.8.1 All measuring components being part of the monitoring system shall be calibrated in compliance with the requirements and instructions of the manufacturer.

17.8.2 Measuring components based on different operating principles may be used in measuring channels.

17.8.3 The design of measuring components shall rule out influence of the following factors on measurement accuracy:

.1 ambient temperature during operation, with additional or alternative provision for automatic thermal compensation within the design ambient temperature range, but at least from minus 25 °C to plus 45 °C for measuring components installed on open decks and in open hold spaces and from 0 °C to plus 45 °C for measuring components installed in closed spaces;

.2 external influence of general low-frequency ship vibration;

.3 local deformations in the mounting pad area.

17.8.4 The design of measuring components installed on open decks of ice class ships shall ensure icing protection.

17.8.5 The measuring components installed in hazardous areas and spaces shall comply with the requirements specified in 2.9 and 2.10, Part XI "Electrical equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

17.8.6 Measuring channels for ship's hull deformations.

17.8.6.1 The design of the measuring component for longitudinal and transverse bending shall balance out any effects on the results of bending, shear and local deformation measurements at the measurement area.

17.8.6.2 The measuring component shall ensure continuous measurement of multiple changes of the base length of the control section of hull structure.

17.8.6.3 The value of the base length of the measuring component for longitudinal and transverse bending shall be taken based on the design values of the maximum permissible ship's hull deformation in the control area.

The maximum permissible hull deformation shall be determined based on the strength provision as per 1.4 and 3.1.4.1 (where applicable), Part II "Hull" taking into consideration the actual section modulus of the hull in way of the sensor location and shall be specified in the documentation required by 17.5.1.10.

17.8.6.4 The detection limit of the measuring component shall be at least 0,1 μm/m.

17.8.6.5 The measuring channels of longitudinal and transverse bending of the ship's hull shall ensure:

.1 measurement error not exceeding ±1 μm/m or 5 % of the measurement range, whichever is less;

.2 performance capacity from 0,01 Hz to 5 Hz (except for the measuring channels of mid-base sensors installed in the forward perpendicular area);

.3 sampling rate at least 15 Hz (except for the measuring channels of mid-base sensors installed in the area of forward perpendicular coordinate).

17.8.6.6 The measuring channels of the mid-base sensors installed in the forward perpendicular area shall ensure performance capacity from 0,01 Hz to 100 Hz and sampling rate at least 300 Hz.

17.8.6.7 The measuring channels of the ship's hull local deformations shall ensure:

.1 measurement error not exceeding ±1 μm/m or 5 % of the measurement range, whichever is less;

.2 performance capacity from 0,01 Hz to 500 Hz;

.3 sampling rate at least 1 kHz.

17.8.7 Measuring channels for accelerations.

17.8.7.1 Measuring channels of vertical, longitudinal and transverse linear accelerations shall ensure continuous measurement of accelerations:

.1 in amplitude dynamic range ±5*g*[1];

.2 with error not exceeding ±0,02*g*;

.3 with performance capacity from 0,01 Hz to 50 Hz;

.4 with sampling rate at least 200 Hz.

17.8.7.2 The measuring components of vertical, longitudinal and transverse linear accelerations shall comply with the shock resistance requirements within the peak value range of at least ±15*g*.

17.8.7.3 The measuring channels of vertical impact accelerations measured in the forward perpendicular area shall ensure measurement of accelerations:

.1 in amplitude dynamic range at least ±2000*g*;

.2 with error not exceeding ±1 % of the measurement range;

.3 with performance capacity from 0,04 Hz to 1 kHz;

.4 with sampling rate at least 2 kHz.

17.8.7.4 The measuring components of vertical impact accelerations measured in the forward perpendicular area shall comply with the shock resistance requirements within the peak value range of at least ±5000*g*.

17.8.7.5 The measuring channels of vertical, longitudinal and transverse linear impact accelerations measured at frame spacings of ice class ships shall ensure measurement of accelerations:

.1 in amplitude dynamic range ±20*g***;**

.2 with error not exceeding ±0,02*g*;

.3 with performance capacity from 0,01 Hz to 500 Hz;

.4 with sampling rate at least 1 kHz.

17.8.7.6 The measuring components of accelerations caused by ice loads shall comply with the shock resistance requirements within the peak value range of at least ±50*g*.

17.8.7.7 The converter of the measuring component shall include a filter minimizing "zero offset" and a filter for elimination of electromagnetic interference.

17.8.7.8 The converters being part of acceleration measuring channels shall include a computation component ensuring continuous conversion of measured values of linear accelerations to respective values of linear displacements and velocities with the conversion error not exceeding ±0,01 %.

17.8.8 Measuring channels for angular and linear displacements.

17.8.8.1 The measuring channels of angular and linear displacements shall ensure continuous simultaneous measurement of the following angular motions, angular rates of heel, trim, yaw, linear vertical, transverse and longitudinal displacements:

.1 heel and trim angular motions:

.1.1 within range of at least ±90°;

.1.2 with error not exceeding ±0,02°;

.1.3 with sensitivity of at least 0,001°;

.2 yaw angular motions:

.2.1 within range of at least ±180°;

.2.2 with error not exceeding ±0,02°;

.2.3 with sensitivity of at least 0,001°;

.3 heel, trim and yaw angular velocities:

.3.1 within range of at least ±150°/s;

.3.2 with error not exceeding ±0,02°/s;

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[1] g — gravity acceleration, 9,81 m/s^2

.3.3 with resolution of at least 0,01°/s.

.4 linear vertical, transverse and longitudinal displacements:

.4.1 within range of at least ±50 m;

.4.2 with error not exceeding ±5 cm or 5 % of the measurement range, whichever is less.

17.8.8.2 The measuring channels of angular and linear displacements shall ensure the following measurements:

.1 within periods of angular and vertical displacements from 1 s to 40 s;

.2 with performance capacity from 0,01 Hz to 50 Hz;

.3 with sampling rate of at least 200 Hz.

17.8.8.3 The design of the measuring component shall comply with the shock resistance requirements within the peak value range of at least ±500*g*.

17.8.8.4 The converters being part of measuring channels of angular and linear displacements shall ensure continuous conversion of the measured values with the conversion error not exceeding ±0,01 %.

17.8.9 Requirements for converters.

17.8.9.1 The measurements synchronization value ensured by the converters used in the measuring channels of the monitoring system shall be at least 0,001.

17.8.9.2 The converters being part of the measuring channels for longitudinal and transverse bending (except for mid-base sensors installed in the area of the forward perpendicular coordinate) shall ensure filtration of low-frequency components corresponding to the lower limit of the operational frequency range and shall be based on the analog-to-digital converters (ADC) with at least 12 effective bits.

17.8.9.3 The converters being part of the measuring channels of mid-base strain sensors installed in the area of the forward perpendicular coordinate, local deformation sensors and accelerometers shall:

.1 be based on sigma-delta ADCs with at least 24 effective bits;

.2 ensure filtration of low-frequency components of the initial output signal corresponding to the lower limit of the operational frequency range;

.3 contain an anti-aliasing filter of analog signals to exclude the spectrum aliasing in the dynamic ranges of the low-frequency region;

.4 ensure automatic setting to the actual frequency range of input signal.

17.8.9.4 The converters being part of the measuring channels (except for the channels of the devices of inertial dynamic displacement measuring modules) and ensuring the above functions may be partially and/or completely combined in individual electronic multi-channel modules (assemblies) for control of multiple type measurement processes, collection and processing of measurement data.

17.8.9.5 Electronic multi-channel modules shall ensure:

.1 autonomous control (adjustment) for each measuring channel of each measuring component;

.2 reception of upper level digital control commands and their conversion, transmission of return signals on status of execution of control commands, including duplexing while transferring test signals of measuring channel self-diagnostics;

.3 parallel generation and reception of analog "input/output" signals from the measurement sensors;

.4 parallel processing of analog signals from the measurement sensors and digitization of these signals;

.5 parallel digital transmission of measurement data;

.6 measurement synchronization for all enabled measuring channels.

17.8.10 The protection degree of measuring components shall be at least as specified in 2.4.4, Part XI "Electrical Equipment".

17.9 COMPUTATION COMPONENTS

17.9.1 The computation component software shall ensure processing of measurement data and automatic generation of the database for monitoring data results.

17.9.2 The speed of the system components shall timely feed the user information taking into consideration the operating conditions of the ship and the requirements of this Section.

17.9.3 The time frame and number of observations to be recorded which are adopted for measurement processing shall be representative and sufficient taking into consideration the operating conditions of the ship.

17.9.4 Accuracy of computation shall comply with the requirements for accuracy of respective measuring channels.

17.9.5 The processing results shall be stored and visualized in tabular form based on 30 minute periods with reference to the unified time scale.

17.9.6 The system intended for monitoring of ship's strength shall ensure calculation of stress values due to bending moments based on the measurement data, and comparison of the obtained results with the permissible ones being specified based on the approved hull documentation.

Permissible stresses shall be determined based on the permissible design bending moment and torque (if applicable) affecting the ship's hull.

The permissible stresses shall be determined with regard to reduction of hull section modulus determined in compliance with 2.2 of Annex 2 "Instructions for Determination of the Technical Condition and Repair of the Hulls of Sea-Going Ships" to the Rules for the Classification Surveys of Ships in Service, where such reduction was made.

17.9.7 The system intended for monitoring of ship's strength installed on ice class ships shall ensure calculation of values for stresses in ship structures fitted with the sensors, due to local loads, based on the measurement data, and comparison of the obtained results with the permissible ones as specified in the approved hull documentation.

The permissible stresses of the structure shall be determined based on the values of permissible local load acting on the structure as specified in documentation.

17.9.8 The system intended for monitoring of ship stability shall ensure calculation of at least transverse metacentric height and its comparison to the permissible values. It is recommended to include in the system the possibility of calculating all the applicable stability criteria, as well as their comparison to the permissible values.

When the stability monitoring is performed only based on the transverse metacentric height, the applicable values shall be determined based on the stability curve as required by 4.1.8, Appendix I to Part IV "Stability", from the approved Stability Booklet.

17.9.9 During the tests performed upon installation of the monitoring system on board the ship in the presence of the RS surveyor, the error of the calculation results shall be checked. The check shall be performed based on comparing the parameters calculated by the monitoring system to the reference values.

17.9.9.1 The calculation results of the system intended for monitoring of ship strength shall have deviations from the reference values of stresses originating under influence of bending moment, not exceeding ±10 % or ±10 MPa, whichever is greater.

The value as given in the documentation of the monitoring system determined for the loading case used during the tests shall be the reference value.

17.9.9.2 The calculation results of the system intended for monitoring of ship stability shall have deviations from the reference values not exceeding:

longitudinal centre of gravity of ship: ±1 % of ship's length or ±0,5 m, whichever is greater;

transverse centre of gravity of ship: ±0,5 % of ship's breadth or ±0,05 m, whichever is greater;

vertical centre of gravity of ship: ±1 % or ±0,05 m, whichever is greater;

transverse metacentric height : ±1 % or ± 0,05 m, whichever is greater.

The value given in the approved Stability Booklet is used as the reference one.

17.9.10 The calculation results shall be sorted by hazard levels based on the following conditions:

healthy state — arithmetic mean value of absolute peaks over the period less than 60 % of the maximum permissible value;

pre-hazard — arithmetic mean value of absolute peaks over the period greater than or equal to 60 %, but less than 80 % of the maximum permissible value;

hazard — arithmetic mean value of absolute peaks over the period greater than or equal to 80 %, but less than 100 % of the maximum permissible value;

emergency — arithmetic mean value of absolute peaks over the period greater than or equal to 100 % of the maximum permissible value.

17.9.11 The updating time for results of sorting shall not exceed 10 seconds.

17.9.12 The calculation results shall be stored and displayed using appropriate color indication with addition of percentage values for each parameter relative to the maximum permissible value.

The duration of the monitoring data storage shall comply with 17.10.3.3 and 17.10.3.4.

17.9.13 The indication colours shall change depending on the hazard level.

17.10 AUXILIARY COMPONENTS

17.10.1 The monitoring system shall include the following auxiliary components:

display device;

data storage device;

control device;

electric power source.

17.10.2 Display device.

17.10.2.1 Visualization of the monitoring results shall be available on the monitor display located at the workstation of the monitoring system operator in the wheelhouse of the navigation bridge of the ship.

17.10.2.2 The displays being part of the system shall have a diagonal of at least 23 inches and comply with the requirements of 7.7.3, part XV "Automation".

17.10.2.3 Presentation of data, text information, symbols and graphic information shall ensure clear legibility in any light conditions that may be encountered at the navigation bridge in day time, in half light and in night time (using supplementary illumination, where necessary).

17.10.2.4 Font and its size selected for display of alphanumeric data shall ensure easy reading of the information by the operator.

17.10.2.5 Text information shall be simple, understandable and minimized in terms of volume.

17.10.2.6 Clear explanations shall be given in operating documentation for all symbols used for display of information.

17.10.2.7 Flashing display of data displaying is permitted for alarms only.

17.10.2.8 The following basic information shall be visualized:

location of sensors on board the ship in graphical form;

results of calculation of the required parameters in percentage relative to the maximum permissible design value per each sensor;

current status of system functioning;

current data and time in the following format: hours, minutes, seconds.

17.10.2.9 When the monitoring system is connected with other systems, the basic imported data shall be displayed: ship's positioning coordinates, speed, course, wind speed and direction, sea state parameters, ice conditions, loading condition of the ship, basic trim and stability data (applicate of the gravity centre, metacentric height, draught), etc.

17.10.2.10 The following extended information shall be visualized:

schematic diagram of the system indicating the actual functioning state of the system in the form of light/colour-coded indication;

current data and time in the following format: hours, minutes, seconds.

17.10.2.11 The examples of display screens shall be given in the monitoring system operating manual.

17.10.3 Data storage device.

17.10.3.1 The data storage device shall ensure:

.1 storage and automatic and manual output of the results of measurement data processing and data on actuation of the alarm system;

.2 output of data on the maximum permissible design values of the parameters in compliance with the conditions of ship's loading and operational conditions;

.3 transmission of measurement processing results from the monitoring system to the voyage data recorder;

.4 transmission of measurement processing results to the shore (where provided by the monitoring system design version).

17.10.3.2 The data storage device shall:

.1 have sufficient memory capacity for the storage of the total data volume within the time period specified in 17.10.3.3;

.2 have the speed corresponding to the data processing rate of the computing device;

.3 provide for substitution of solid-state drives and connection of external USB drives not being part of the system;

.4 provide for creation of backup files of information data on external devices;

.5 be protected against power failures with provision for saving of all information data sets in case of complete power failure and data reproduction upon power recovery;

17.10.3.3 The data storage device shall ensure recording and storage of the monitoring data on board the ship:

.1 for at least 24 hours on a continuous basis;

.2 for at least 30 days using a set of mass storage devices and/or external USB drives.

When the scheduled voyage time exceeds 30 days, the set of mass storage devices shall be formed based on the provision of recording and saving the monitoring data on board the ship during the entire voyage.

17.10.3.4 Duration of data storage ashore shall be specified by the shipowner. The minimum data storage period ashore shall be 1 year.

17.10.4 Control device.

17.10.4.1 The control device shall consist of the following:

supervisory computer (processing unit) being part of the workstation of the monitoring system operator together with keyboard and integrated trackball located in the wheelhouse of the navigation bridge of the ship;

time synchronization electronic module.

17.10.4.2 The control device shall make it possible for the operator of the workstation of the monitoring system to:

supply power and send "on/off" commands to all components of the monitoring system;

adjust the monitoring system in compliance with the conditions of ship's loading, where necessary;

adjust the monitoring system in compliance with the operating conditions of the ship, where necessary;

adjust the measuring channel configuration;

start the test programmes;

represent and display the processed data of any time series with information on them stored in the storage device, without blocking continuous network traffic of information received via measuring channels;

control the alarm system.

17.10.4.3 The control device shall ensure automatic self-checking of the monitoring system and make it possible to keep track of the system status by detecting and indicating the following conditions:

failure to supply power to any component of the monitoring system;

computer network shut-off or hang-up and/or malfunction of the electronic programmable components;

interruption of data entry via a measuring channel;

measurement results beyond the adjusted range of the measuring channel.

17.10.4.4 The time synchronization electronic module of the control device shall communicate with the receiver of the radio navigation system/systems of ship navigation equipment complex.

The time synchronization electronic module shall ensure synchronization for:

.1 measurements via all measuring channels with timing cycle mismatching not exceeding 0,001 s;

.2 parallel-serial computing and logical operations and measurement data processing operations with timing cycle mismatching not exceeding 0,01 s.

17.10.4.5 The control device may be based on the electronic modules and general purpose protocols using IEEE 802.1 standards, including IEEE 802.1AS PTP (precision time protocol) and IEEE 802.1Qav (queuing and forwarding protocol) standards.

17.10.4.6 The hardware of the control device shall have storage capacity and speed ensuring execution of the control algorithm implementing all functional options in compliance with the requirements for timing cycles.

17.10.5 Electric power sources.

17.10.5.1 The power for all equipment of the monitoring system shall be supplied from the ship primary electrical power source.

17.10.5.2 All devices of the monitoring system shall be supplied via separate feeders from one common board of the monitoring system.

The switchboard of the monitoring system shall be supplied form the main switchboard.

17.10.5.3 Where the current and voltage parameters for individual hardware items of the monitoring system shall be different from those of the ship electric mains, the power for these items may be supplied from other additional switchboards fed via separate feeders.

17.10.5.4 The power for the converters shall be supplied from the same electric power sources as for the measuring components and other hardware being the sources of input signals received for conversion.

17.10.5.5 The switchboards shall be equipped with switches and fuses or current-limiting circuit breakers in outgoing lines to each type of the system hardware.

17.10.5.6 The consumers not related to the system shall not be connected to the system board.

17.10.5.7 Where connection with other types of ship equipment is implemented by the monitoring system design version, de-energization of the system shall not impair the functioning of this equipment.

17.10.5.8 Arrangement of electrical equipment of the system, cable network laying and connection to the ship electric power system shall be carried out in compliance with the requirements specified in part XI "Electrical equipment".

17.11 INTERCONNECTION COMPONENTS

17.11.1 The design of the interconnection components of the system shall ensure noise resistance, data transmission rates, redundancy for normal functioning of the system in compliance with the technical requirements of the manufacturer.

17.11.2 The system components shall be interconnected via the common local information and interswitch communications forming a set of interconnection components.

17.11.3 The interconnection components shall ensure transmission of control and monitoring information via two independent communication channels.

17.11.4 Where the wire communication channels are used, they shall meet the requirements of Part XI "Electrical equipment".

17.11.5 The interconnection components (cable line connectors) installed on open deck, in open cargo holds, in shafting space shall have the degree of protection at least as specified in 2.4.4, Part XI "Electrical equipment".

The interconnection components installed on the frame webs or transverse web frames in the ballast tanks of tankers shall have the degree of protection at least as specified in 2.4.4, Part XI "Electrical equipment".

The interconnection components (repeater units, switches/routers, etc.) installed in the closed service spaces of the ship except for the above mentioned shall have the degree of protection at least as specified in 2.4.4, part XI "Electrical equipment".

17.12 ALARM SYSTEM

17.12.1 General requirements.

17.12.1.1 The alarm annunciator being part of the monitoring system as its component part, is intended for urgent notification of the watch crew in the wheelhouse of the navigation bridge on any situations related to deviations of the normal operation of the ship detected by the monitoring system.

17.12.1.2 The alarm system shall meet the requirements specified in 3.2.24.3 and 3.2.24.5, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships.

17.13 CONNECTION OF MONITORING SYSTEM WITH OTHER SHIP EQUIPMENT

17.13.1 The monitoring system shall be connected with the ship's universal time system and voyage data recorder being parts of the ship's complex of navigational equipment.

17.13.2 Connection of the monitoring system with other ship systems shall not affect the performance of these systems, and failure or malfunctions of the monitoring system shall not result in failure or malfunctions of the ship systems linked with the monitoring system.

Failure or malfunctions of the systems linked with the monitoring system shall not result in failure or malfunctions of the monitoring system.

Failures or faults of communication with one system shall not affect the functioning of communications with other systems.

17.13.3 Electronic interconnection units, including appropriate software, and cable communications links are the components for connection of the monitoring system with ship equipment.

17.13.4 Schematic diagram of the monitoring system connection with ship equipment and functioning status of components of such connection shall be displayed on the visualization components.

17.13.5 All connections of the monitoring system with the navigational equipment of the ship shall be performed in compliance with the International standard for digital interfaces for navigational equipment, IEC 61162.

17.13.6 To introduce the symbols of additional functions **DD** and/or **DM** in the class notation, the connection of the monitoring system with the ship's complex of telecommunication equipment shall be available.

The system for transmission of information data via "ship-shore-ship" channel shall ensure integrity, confidentiality and accessibility of the transmitted data.

17.14 INSTALLATION

17.14.1 Installation and testing of the monitoring system on board the ship shall be carried out under the technical supervision of the Register according to the RS-approved technical documentation.

17.14.2 The requirements for installation of measuring components depending on their physical principle of operation and design features shall be specified in the set of installation drawings and in the installation instruction.

17.14.3 During the installation of the strain sensors, the following requirements shall be met:

.1 sensors shall be fixed directly to the structural member of the ship's hull. Use of any intermediate components between the mounting pad on the structural member and the sensor is not permitted;

.2 surface of the mounting pad on which the sensors are installed shall be prepared and free of paint or any other protective coatings, rust, grease of other contaminations;

.3 surface of the mounting pad shall be flat, free of indentions, scratches, scoring or any other mechanical damage (permissible conditions of out-of-flatness and roughness of the mounting pad surface shall be specified in the set of installation drawings);

.4 no welding seams shall be present in the mounting pad area;

.5 it is permitted to install the strain sensors by means of permanent or detachable mechanical joining to the structural member of the ship's hull.

The joint design shall ensure its strength under the loads during the deformation of ship's hull structure.

Use of arc welding for installation of the strain sensors is not permitted.

Welding technology shall ensure the minimum residual stresses and deformations in the welded connection area.

The joint design and technology shall ensure a gap between the joining surfaces of the sensor and the mounting pad not exceeding 0,1 mm.

17.14.4 After the sensor installation, the protective coatings of the ship's hull structural member used prior to installation in the installation points shall be completely restored.

17.14.5 During the installation of accelerometers and devices for measurement of dynamic displacements, the following requirements shall be met:

.1 mounting pad in the installation point shall have sufficient stiffness and strength to introduce the minimum distortions in the measured motions of the structure;

.2 surface of the mounting pad shall be flat, shall have no indentions, scratches, scoring or any other mechanical damage; the surface shall be prepared and free of paint or any other protective coatings, rust, grease of other contaminations;

.3 prior to the installation, the sensitive axes of the accelerometer and/or dynamic displacement measurement device shall be marked (requirements for accuracy of positional relationship between the sensitive axes and measurement directions shall be established in the set of installation drawings);

.4 special paste shall be used to ensure tight contact between the device and mounting pad;

.5 use of various additional arrangements for installation of accelerometers and/or dynamic displacement measurement devices shall be avoided. Where used, the adapters shall have minimum inertial effect. If the mounting adapter is of a shaped type, natural frequency and oscillation moduli of this fixture shall be first identified.

17.14.6 The sensor outgoing cables in the points of sensor installation shall be rigidly fixed. Other requirements for cable laying are specified in 17.11.

17.14.7 All hardware of the monitoring system installed on board shall be grounded to the ship's hull.

17.14.8 Calibration.

17.14.8.1 During the monitoring system installation, the adjustment and calibration of the system shall be performed in the condition of ship's loading ensuring the minimum possible effect of bending moment from the cargo to the ship.

17.14.8.2 All sensors and converters being part of the measuring channels shall be calibrated and have a documentary evidence containing the information on calibration results.

During the calibration of sensors, the strain-stress state of the hull at the time of installation shall be considered with account of actual bending moments.

17.14.8.3 Where necessary, check of the monitoring system adjustment and re-calibration of the measuring channels shall be performed at least once a year.

17.14.8.4 All results of the initial and periodical calibrations of each measuring channel shall be recorded in the monitoring system record book stored on board the ship.

17.14.9 The monitoring system installation instruction shall specify the procedure and requirements for dismounting of measuring components for periodical verification.

Upon reinstallation the measuring components shall be recalibrated and appropriate entries shall be made in the monitoring system record book.

17.14.10 Types of maintenance, works frequency, nomenclature and procedure shall be established by the system designer in the technical documentation.

17.14.11 The maintenance results shall be recorded in the monitoring system record book.

17.15 TESTING

17.15.1 Upon installation on board prior to commissioning the monitoring system shall be tested.

17.15.2 All tests shall be carried out according to RS-approved programmes in the presence of the RS surveyor.

17.15.3 When the system design version provides for its connection with other types of ship equipment, all tests shall be performed according to the programmes containing the appropriate types of tests for verification of the operability of data export/import channels and lack of influence of the system connection with other systems on the operability and performance of the ship equipment.

17.15.4 The testing of the monitoring system onboard the ship under construction shall be performed at the stage of construction completion.

The testing of the monitoring system on board the ship in service shall be performed in the loaded condition of the ship where the moments affecting the ship (cargo, waves) are prevented to the maximum which enables the most accurate comparison of the stress values measured by the system to the reference values determined for the load case under which the tests are performed. It is recommended to perform such testing with a ship in ballast condition in the port.

17.15.5 The testing shall be performed after refinement and testing of software, adjustment of the system, including loading of the initial data sets.

17.15.6 The testing shall be performed for check and verification of:

operability of the system on board the ship;

compliance with electrical safety requirements;

availability of documentary evidence of the measuring component calibration;

execution of all functional options provided in all functioning modes;

operability of all functional interconnections between the system components;

system response to emergency situations or entry of incorrect information to the system;

provision of the required processing speed of computing and logical operations;

detection of necessity to carry out system modifications.

17.15.7 The test programme shall include:

description of the monitoring system;

description of components being part of the system including software;

description of interconnections between components;

description of the list of submitted documentation;

list of interconnections of components to be checked, functions and parameters to be tested;

sequencing, conditions, procedure and methods of testing, including software and equipment intended for performance of tests;

list and description of tests;

description of methods for processing of testing results;

description of test criteria.

17.15.8 The software testing programme is an integral part of the monitoring system test programme and shall include the following:

description and configuration of software;

description of interconnections of software modules;

description of software requirements;

procedure and means used for testing;

description of test methods including list and description of needed tests;

description of test criteria.

17.15.9 Any deviations detected during testing shall be eliminated. Upon elimination of deviations, the testing shall be repeated in the required scope.

17.15.10 Satisfactory results of tests, no deviations identified by the Register during testing are the basis for introduction of the distinguishing mark in the class notation.

17.16 POSSIBILITY OF RETAINMENT OF DISTINGUISHING MARK HMS IN SERVICE

17.16.1 During the annual, intermediate and renewal survey on board the ship in the presence of RS surveyor, the check of the monitoring system shall be performed.

The extent of the surveys and the procedure for documentation of results are specified in the Rules for the Classification Surveys of Ships in Service.".