RUSSIAN MARITIME REGISTER OF SHIPPING

GUIDELINES

ON THE SHIP HULL SCANNING PROCEDURE AND ASSESSMENT OF THE 3-D MODEL

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GUIDELINES ON THE SHIP HULL SCANNING PROCEDURE AND ASSESSMENT OF THE 3-D MODEL

The Guidelines on the Ship Hull Scanning Procedure and Quality Assessment of the 3-D Model Obtained have been approved in accordance with the established approval procedure and come into force on 1 December 2021.

The Guidelines are intended for surveyors, firms preforming ship hull scanning, as well as for ship designers.

REVISION HISTORY[1]

(Purely editorial amendments are not included into the Revision History)

For this version, there are no amendments to be included in the Revision History

[1] Amendments and additions introduced at re-publication or by new versions based on circular letters or editorial amendments.

1 APPLICATION

1.1 The requirements specified in these Guidelines apply to the hull scanning procedures of sea-going ships.

1.2 The scanning procedure is designed to obtain, with the help of specialized technical means (measuring instruments), a highly precise 3-D model of a ship hull.

1.3 The scanning procedure may be applied in case of:

necessity of performing trim, stability and damage stability calculations in case of absence/loss of required plan approval documentation;

necessity of preparing ship conversion project documentation in case of absence/loss of required plan approval documentation;

necessity of preparing ship design model to use in shipboard trim, stability and damage stability calculation software;

necessity of preparing ship design model to use by a shore-based emergency response service (ERS) on damage stability and residual structural strength calculations.

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2 DEFINITIONS AND EXPLANATIONS

2.1 For the purpose of application of these Guidelines, the following definitions and explanations have been adopted.

Reference surface is a surface or site, for example, in a dock or shipyard, which is used to install a measuring instrument for conducting hull scanning procedure.

Measuring instrument is a specialized device used in hull scanning procedure.

Reference point is special token mark that helps to determine the points by which the adjacent clouds of points can be stitched.

Cloud of points is an array of point measurements characterizing the distance from the measuring instrument to the reflected object, and, optionally, the object colour at the measured point. Cloud of points serves as the basis for preparation of final 3-D model.

Scanning operator is a person or an organization authorized by RS to perform the ship hull scanning procedure.

Computational model is a digital model of the ship hull created in the format of the software used for stability calculation based on the data obtained during the scanning.

Scanning is a set of engineering operations resulting in displaying geometric characteristics of an object in digital 3-D model format with the required accuracy with the help of special measuring instruments.

3 SCANNING TECHIQUES

3.1 LIDAR laser scanning

The method is based on the technology of receiving and processing information with via an active optical system. When working in automatic mode, lidar emits and receives a reflected signal from objects located in the lidar working area, determining the distance to the reflected point. The resulting cloud of points is intended for conversion into a 3-D model using specialized software.

3.2 Laser scanning with handheld laser rangefinder

The method is based on the principle similar to that described in 3.1, except that all measurements and handling of a measuring instrument are manually performed by an operator. The geometry data obtained during the measurements are used by the operator for creation of the computational 3-D model using specialized software.

3.3 Photogrammetry

The method is based on the principle of making a 3-D model of an object, formed of an array of photographs of all its scanned surfaces. The photographs are designed for further conversion into a final 3-D model using specialized software.

3.4 Alternative techniques

Techniques other than those described above may be permitted upon the agreement with the Register.

4 REQUIREMENTS FOR FIRMS PERFORMING 3-D SCANNING PROCEDURE

4.1 Firms performing 3-D scanning shall have RS recognition of service suppliers with the code 22007000.

5 REQUIREMENTS FOR TECHNICAL MEANS USED FOR SCANNING

5.1 Lidar scanning

Lidar used for scanning shall:

.1 have technical passport specifying accuracy and characteristics of the instrument;

.2 be in good working order and meet the characteristics specified in the technical passport;

.3 have built-in capability of determining its position and orientation in space for accurate stitching of the cloud of points based on the results of shooting from several stations;

.4 ensure the transfer of the cloud of points to a computer in a format that allows, using specialized software, to form a 3-D model accurately reflecting the geometry of the hull shape.

5.2 Handheld laser rangefinder scanning

Handheld laser rangefinder used for scanning shall:

.1 have a technical passport specifying accuracy and characteristics of the instrument;

.2 be in good working order and meet the characteristics specified in the technical passport;

.3 have the function of measuring own tilt angles;

.4 have a measuring range sufficient to carry out measurements in the existing conditions;

.5 have auxiliary means of precise fixation on the reference surface (tripods, tripod fine adjustment heads, etc.).

5.3 Photogrammetry scanning

Equipment used for scanning shall comply with the following requirements:

.1 camera and the applied lens shall be in good working order and shall be calibrated;

.2 marking shall meet the requirements of the software used to post-process the resulting array of photos;

5.4 Alternative scanning techniques

Requirements for equipment used in alternative scanning methods are determined by the Register.

6 REQUIREMENTS FOR ACCURACY OF SCANNING AND NUMBER OF MEASUREMENTS

6.1 Scanning accuracy

6.1.1 During hull scanning measuring instrument in use (lidar, laser tame measure/handheld laser rangefinder) shall ensure the accuracy of measurements on all three coordinate axes within the values given in Table 6.1.1.

Table 6.1.1

Coordinate axis	Notation	Relative to the ship planes	Measurement tolerances
X-axis	X	from the plane of the midship frame or aft perpendicular	± 5 mm[1] / 0,03 % of the ship length[1]
Y-axis	Y	from centerline plane	± 50mm / 0,02 % of the breadth of the ship
Z-axis	Z	from baseline	± 10mm / 0,01 % of the depth

[1] Per each 10 m of the hull length.

6.1.2 During photogrammetry hull scanning, the accuracy of measurements may be assessed at the stage of quality assessment of results in accordance with 9.1.

6.2 Number of measurements

6.2.1 During lidar scanning, measurements shall be taken from a number of points minimally required in order to obtain a full-scale 3-D model of a ship hull.

6.2.2 During scanning with handheld laser rangefinder, the measuring of each point shall be made at least three times with averaging to reduce the potential inaccuracy caused by manual work of an operator.

6.2.3 When photogrammetry is applied, it is necessary to ensure scanning of the whole surface of the ship hull so that the adjacent images overlap each other by at least 60 % horizontally and by 40 % vertically.

7 REQUIREMENTS FOR SCANNING PROCEDURE

7.1 Availability of ship technical documentation

7.1.1 When performing the scanning procedure, an operator shall have free access at least to the following ship documentation related to the ship scanned:

.1 general arrangement drawing or any other drawing of the ship containing the ship deck plan and side view, as well as data on the main particulars;

.2 Stability Booklet.

7.2 Requirements for scope of scanning procedure

7.2.1 When lidar or photogrammetry technique is used, the ship hull shall be scanned from both sides, bow, stern and bottom. In addition, if the hull is positioned with heel/trim on the scanning site, heel/trim values shall be accurately measured to perform the correct space orientation of the hull cloud of points obtained during the scanning process.

7.2.2 When the scanning is done with laser tape measure/handheld laser rangefinder, scanning only one side of the ship hull is permitted. At that, if the hull is positioned with heel/trim on the scanning site, heel/trim values should be accurately measured to make appropriate corrections to the position of the coordinates of cross-sections points in space, relative to the reference surface. If the ship has a hull that is asymmetrical with respect to the centerline plane, scanning shall be performed from both sides.

7.3 Requirements for scanning site

7.3.1 Reference surface of the scanning site shall be cleaned of foreign objects (equipment, building materials, waste, etc.) capable of distorting the readings of measuring instruments or preventing their correct installation or free handling.

7.3.2 Reference surface of the scanning site shall be still to avoid distortion of the scan results due to possible vibrations of a measuring instrument.

7.4 Requirements for external conditions during scanning

7.4.1 The ship hull scanning procedure may be performed both indoors and outdoors.

7.4.2 If the scanning site is located outdoors, scanning procedure in raining, snowing strong wind, foggy or flooding, as well as other weather conditions capable of distorting the readings of measuring instruments, impeding their reliable placement or causing damage to them is not permitted.

7.4.3 For scanning sites located both outdoors and indoors, carrying out the scanning procedure simultaneously with the repair works associated with release of dust, aerosols, and sparking that create smoke or bright light flashes is not permitted.

7.4.4 At nighttime or in insufficient natural lighting conditions during the scanning process, the operator shall ensure that such conditions do not adversely affect the results of measurements, or shall provide sufficient artificial lighting for the purposes of the procedure.

7.4.5 Temperature conditions during the scanning process shall be within the operating temperature range of the measuring instruments.

7.5 Requirements for the hull scanned

7.5.1 During the scanning procedure, no plates of the hull plating shall be dismantled.

7.5.2 If some repair or modernization works of the ship hull are planned concerning hull reshaping, scanning shall be done only after application of the changes and completion of the hull painting procedure.

7.5.3 During the scanning procedure, the outside surface of the ship hull shall be dry so that no inclusions can distort the readings of measuring instruments.

7.5.4 The ship hull shall be thoroughly cleaned from biofouling capable of distorting the hull shape lines.

7.5.5 The outside part of the ship hull shall be free from any repair equipment: scaffolding, cradles, ropes, cables, etc.

7.5.6 Anchor chains and anchors shall either be located in their proper place in the anchor hawse pipes/recesses or shall be completely dismantled.

8 PROCESSING OF RESULTS AND QUALITY ASSESSMENT

8.1 Presentation of results

8.1.1 Scanning results obtained shall be presented as follows:

.1 for lidar scanning, a cloud of points in specialized software that forms a 3-D model of the ship;

.2 for laser tape measure/handheld laser rangefinder scanning, a list of coordinates of hull cross-sections with data on the location of each section along the length of the ship;

.3 when applying photogrammetry, a 3-D model of the ship hull surface obtained after converting in specialized software.

8.1.2 Clouds of points or coordinates of plane sections received after the scanning shall be converted into a computational 3-D model.

8.1.3 As soon as the scanning procedure is finished, a scanning report shall be drawn up containing the following information:

.1 information on organizations and people responsible for scanning and quality assessment procedures;

.2 ship type, her name and yard building number;

.3 date and location of ship hull scanning procedure;

.4 external conditions of scanning process, including the data on the scanning site (outdoor/indoor area), hydro meteorological conditions, and ambient temperature;

.5 information on the position of the scanned hull (heel, trim);

.6 applied scanning technique, or several technique and parts of the ship hull in relation to which they were applied, if the scanning was performed with the use of several techniques;

.7 technical passports of measuring instruments used in the scanning procedure, containing the information on their accuracy, as well as on calibration of the instruments, if applicable;

.8 a copy of the Recognition Certificate (form 7.1.4.2) of the firm performing scanning procedure.

Recommended form of the scanning report is given in Appendix 1.

9 SCANNING QUALITY ASSESSMENT

9.1 Quality assessment of results

9.1.1 Quality assessment of scanning results shall be performed on the basis of the ship hull computational 3-D model developed in accordance wherewith.

9.1.2 When the quality of results is assessed, parameter values obtained based on the computational model shall be compared with those specified in the ship stability documentation.

9.1.3 The main parameters monitored during the assessment of scanning results are the following:

.1 *d* — draught, in m;

.2 *tr* — trim, in m;

.3 *LCB* — longitudinal center of buoyancy, in m;

.4 KMT — metacenter z-coordinate, in m.

.5 KN curve, in m.

9.1.4 Parameters given in 9.1.3 shall be compared in the context of equal values of mass displacement (provided that water density values are equal).

9.1.5 Difference in the parameters obtained on the basis of the computational model and those specified in the ship stability documentation shall not exceed the smaller of the values given in Table 9.1.5.

Table 9.1.5

Parameter	Permissible difference
d, in m	± 50 mm / 1 % of ship draught
tr, in m	± 100 mm / 2 % of ship draught
LCB, in m	± 100 mm / 1 % of *LCB* value, measured from aft perpendicular
KMT	± 50 mm / 1 % of *KMT* value
KN curve	± 50 mm / 5 %
Note. It is permitted to take draught as an input parameter and mass displacement as an output parameter for quality assessment. In this case, the permissible difference in mass displacement should not exceed ± 1%.	

9.2 Documents to be submitted to the Register

9.2.1 Prior to application of the computational model of the ship, a report containing the following information shall be submitted to the Register:

.1 information on organizations and people responsible for scanning and quality assessment procedures;

.2 ship type, its name and yard building number;

.3 date and place of ship hull scanning procedure;

.4 external conditions of scanning process, including the data on the scanning site (outdoor/indoor area), hydro meteorological conditions, and ambient temperature;

.5 information on the position of the scanned hull (heel, trim);

.6 applied scanning technique, or several techniques and parts of the ship hull to which they were applied, if the scanning was performed with the use of several techniques;

.7 technical passports of measuring instruments used in the scanning procedure, containing the information on their accuracy, as well as on calibration of the instruments, if applicable;

.8 information on software used for quality assessment procedure, information on the availability of the Register Type Approval Certificate;

.9 quality assessment results in a form of comparison of tables of hydrostatic characteristics and KN curves values from the ship stability documentation with hydrostatic characteristics KN curves values calculated on the basis of 3-D model of the ship hull obtained by scanning;

.10 comparison of obtained results with values permitted by the Register, as well as conclusions of the quality assessment procedure;

.11 scanning report form signed by participants of the scanning procedure and stamped with a seal of the firm performing scanning.

9.3 In case of positive results of the consideration of the submitted documentation, the Register approves the use of the computational 3-D model obtained by scanning for calculations.

APPENDIX 1

FORM OF SCANNING REPORT

Place of scanning:
Date of scanning:

1 SHIP

Name	
Project	
Type and purpose	
Yard, year of building	
Building number	
Shipowner, port of registry	
The Register number	
IMO number	
Length overall *LOA*, in m	
Length between perpendiculars *LBP*, in m	
Breadth *B*, in m	
Hull height *H*, in m	
Design draught *D*, in m	

2 SCANNING OPERATOR

Name of operator		
The Register certificate number		
	Position	Name
Scanning manager		
Participant		
…		

3 SCANNING CONDITIONS

Time of scanning:	start:	end:
Site:	outdoor / indoor / partially covered	
Ambient temperature	°C	
Atmospheric precipitation	no / drizzle / rain / snow / hail	
Position of the ship hull		trim, in deg.
		heel, in deg.

4 SCANNING INSTRUMENTS

Scanning technique	Laser scanning / photogrammetry / other
Measuring instrument type	lidar / laser tape measure / photo camera / other
Measuring instrument brand and model	
Measurement accuracy	
Certificate for the measuring instrument	

5 ADDITIONAL INFORMATION

6 SIGNATURES OF PARTICIPANTS

	Signature	Name
Scanning manager		
Participant		

Russian Maritime Register of Shipping

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