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AMENDMENTS TO THE 2011 ESP CODE

Report of the Correspondence Group

Submitted by IACS

SUMMARY

Executive summary:	This document provides the report of the Correspondence Group on Amendments to the 2011 ESP Code to permit the use of remote inspection techniques.
Strategic direction, if applicable:	7
Output:	7.21
Action to be taken:	Paragraph 22
Related documents:	SDC 10/6, SDC 10/6/1 and SDC 10/17

Background

1 SDC 10 established the Correspondence Group on Amendments to the ESP Code to permit the use of remote inspection techniques, under the coordination of IACS to (SDC 10/17, paragraph 6.7).

2 Representatives of the following Member States participated in the Group:

CHINA
GREECE
ITALY
LIBERIA
MARSHALL ISLANDS
PORTUGAL
REPUBLIC OF KOREA
RUSSIAN FEDERATION
SINGAPORE
UNITED ARAB EMIRATES
UNITED STATES

an observer from the following intergovernmental organization:

EUROPEAN COMMISSION (EC)

and observers from the following non-governmental organizations in consultative status:

INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES (IACS)
INTERNATIONAL TRANSPORT WORKERS' FEDERATION (ITF)

3 IACS wishes to express its appreciation for the various constructive contributions made by the members of the Group.

Terms of reference

4 The Correspondence Group was instructed to:

.1 prepare and finalize the draft amendments to the ESP Code, based on document SDC 10/6;

.2 develop draft guidelines for the use of RIT for surveys and approval of firms engaged in surveys using RIT, as an alternative means for close-up survey of the structure of ships;

.3 identify those provisions that would facilitate a holistic approach on the matter, for consideration by other IMO bodies, bearing in mind the ongoing work on existing output 1.18 on "Development of guidance on assessment and applications of remote surveys, ISM Code audits and ISPS Code verifications", and to consider how to facilitate the development of such a holistic approach;

.4 convene virtual meetings using a suitable platform in order to consider any of the terms of reference, as necessary; and

.5 submit a written report to SDC 11.

Prepare and finalize the draft amendments to the ESP Code, based on document SDC 10/6 (ToR 1)

5 The Group engaged in discussions to develop draft amendments to the ESP Code, based on documents SDC 10/6 (IACS) and SDC 10/6/1 (Bahamas et al.), and taking into account the discussions at SDC 10. Discussions took place via correspondence and, as per item 4.4 of the terms of reference (ToR), via two virtual meetings.

6 The Group commenced its work by reviewing and providing comments on document SDC 10/6/1, consulting IACS unified requirement UR Z17/Rev.18/Corr.1 and IACS Recommendation 42/Rev.2 as necessary, with discussion of comments and views taking place via virtual meetings. Using the draft amendments to the ESP Code proposed in the annex to document SDC 10/6, further draft amendments were developed taking into consideration discussions at SDC 10 and the outcomes of the discussions held by the Group. These draft amendments were then discussed by correspondence and further developed, as detailed in annex 1.

7 Each aspect of how to permit the use of remote inspection techniques (RIT) was extensively discussed, with many varying views expressed. Some of the draft amendments were agreed unanimously, whilst others were only agreed by a majority but with a number of views and proposals being put forward. With reference to annex 1, a number of points remain to be agreed, the main ones being the following.

Pending issues

8 Several members of the Group proposed a definition of RIT taken from IACS UR Z7/Rev.29/Corr.1. Another member proposed an alternative definition which was supported by some other members. There was no clear consensus on which definition to be used, thus both are included under paragraph 4 of annex 1.

9 Conditions and requirements for the use of RIT based on the draft amendments proposed by IACS in document SDC 10/6 were discussed by the Group; these are detailed in paragraph 6 of annex 1. A member proposed an alternative text for stipulations for the use of the RIT and suggested to add these in a new section 7a, as detailed in paragraph 12 of annex 1; these alternative proposals were also supported by other members. A clear consensus on which text to use was not achieved; thus, both proposals are shown in annex 1 (paragraphs 6 and 12 of annex 1).

10 There was general support that RIT should not be used as a total replacement for in-person close-up surveys, but rather as a supplemental tool. The draft updates proposed in new paragraphs 2.5.5 and 5.1.6 of annex 1 reflect this view.

11 The Group highlighted that thickness measurements are required to be taken at the same time as the close-up survey, and developed draft amendments with proposal on how this should be undertaken, and for owners to provide corresponding details on how this could be achieved. A member expressed the view that requirements should also be developed for the use of RIT to take thickness measurements and to include these in the draft amendments; whilst this was not supported and was considered to be outside the scope of the terms of reference by the Group. Therefore, the Group agreed that further discussions should be held by the Sub-Committee on this matter.

12 Due to the extensive discussion and varying views expressed, the draft amendments to the ESP Code to permit the use of remote inspection techniques require further development, thus it is recommended that the amendments are further discussed by the Sub-Committee, with a view to continuing their development in a Working Group and/or in a subsequent Correspondence Group.

13 A member proposed that the text be added to the ESP Code and/or to the draft guidelines being developed relating to legal liability covering the use of RIT. The following sentence was proposed for further discussion, both on the content and on the possible right location to do so:

> "The current agreements, authorities and authorizations regulating surveys between flag Administrations, ROs, certified firms engaged in surveys, companies and shipowners remain in force even in the case of the ESP Code surveys using remote inspection techniques (RIT)."

14 Whilst support was not gained to add this wording to the ESP Code and/or to the draft guidelines, other members supported holding further discussion at SDC 11 on this matter, particularly under ToR 3, as it may be deemed that this requires the attention of the Sub-Committee III, with a view to considering implications on other IMO instruments, such as the RO Code.

Development of draft guidelines for the use of RIT for surveys and approval of firms engaged in surveys using RIT, as an alternative means for close-up survey of the structure of ships (ToR 2)

15 A splinter-group consisting four members of the Correspondence Group, agreed to work on preparing the initial draft guidelines for the use of RIT to support the surveyor during close-up survey of the structure of ships. The Group would like to thank this splinter-group for their hard efforts to progress this work.

16 The task to develop the draft guidelines proved to be a demanding and a challenging one, with many detailed contributions being made and views being expressed. In the development of the draft guidelines, reference was made to the ongoing work currently conducted by the III Sub-Committee, under output 1.18 on "Development of guidance on assessment and applications of remote surveys, ISM Code audits and ISPS Code verifications". Significant progress was made and initial draft guidelines were prepared by the Group which contain a main body providing guidelines on the use of RIT, for the ESP Code surveys, and an annex providing for the assessment and certification of unmanned robotic vehicles (URV) and associated digital technologies for detection and sizing of structural defects. There was a consensus in the Group that it shall be ensured that RIT systems can provide information to the same level of assurance as the close-up visual inspection. Several members of the Group proposed that these requirements should include a validation that an RIT system is able to provide information to the same level of assurance as the close-up visual inspection.

17 The Group discussed whether the ESP Code should be amended to refer to the guidelines, and the guidelines be developed as a separate IMO instrument. Alternatively, the Group considered whether the guidelines should, instead, be written as requirements and that these requirements should be included in the ESP Code as a new annex to each part thereof. A clear consensus on this matter was not achieved and further discussion is necessary.

18 Whilst initial draft of the guidelines have been prepared, further time is required to develop them and to complete the work. Due to time constraints, the Group could only give initial consideration to this. It is recommended that the Sub-Committee instruct a working group and/or to a correspondence group to further work on the development of these guidelines. The text, as prepared by the splinter-group, is set out in annex 2.

19 With regards to the terms of reference to develop guidelines for the approval of firms engaged in surveys using the RIT, following detailed discussions, the Group agreed to develop procedures for certification of firms engaged in close-up survey of hull structures using an RIT and that these should be included in the ESP Code itself as a new annex to each part. Draft requirements were prepared making use of:

.1 similar text in the ESP Code for procedures for approval and certification of a firm engaged in thickness measurement of hull structures; and

.2 IACS UR Z17/Rev.18/Corr.1 and requirements contained therein for approval of "Firms engaged in survey using Remote Inspection Techniques (RIT) as an alternative means for close-up survey of the structure of ships and mobile offshore units".

The agreed draft requirements are set out in paragraph 21 of annex 1.

Identify those provisions that would facilitate a holistic approach on the matter, for consideration by other IMO bodies, bearing in mind the ongoing work on existing output 1.18 on "Development of guidance on assessment and applications of remote surveys, ISM Code audits and ISPS Code verifications", and to consider how to facilitate the development of such a holistic approach (ToR 3)

20 This matter was discussed and the prevailing view of the Group was that to facilitate a holistic approach, relevant draft guidelines for the use of the RIT for surveys should be developed by IMO. It was noted by the Group that digital technologies are developing very quickly and novel techniques are continuously proposed on the market, therefore a goal-based approach may need to be taken or enabled in order to permit the development and application of the RIT. With regard to scheduled surveys, i.e. periodic surveys, it was also noted that the use of the RIT is currently mainly being deployed to assist with close-up surveys of "ESP" ships.

21 With this in mind, the prevailing view of the Group was that as a priority the guidelines being developed should focus on enabling the use of the RIT to support a surveyor undertaking close-up surveys on "ESP" ships but could be used by flag Administrations for other ships, as they deem appropriate and applicable.

Action requested of the Sub-Committee

22 The Sub-Committee is invited to approve the report in general, and in particular to:

.1 note the discussion of the Group and advances on the draft amendments to the ESP Code to permit the use of remote inspection techniques, as well as the associated draft guidelines (paragraphs 6 to 21, and annexes 1 and 2);

.2 decide on the text for the definition of RIT (paragraph 8; and paragraph 4 of annex 1);

3. consider the discussion on the requirements for the use of RIT and decide on the preferred text and location for them (paragraph 9; and paragraphs 6 and 12 of annex 1);

.4 decide on the need to address the use of RIT for taking thickness measurements by a specific IMO instrument, and if needed, decide whether this should be through provisions of a mandatory (requirements) or non-mandatory (guidelines) nature (paragraph 11);

.5 consider the discussion relating to the legal liability on the use of RIT and decide whether, and where, such a clause is required in the ESP Code and/or in the draft guidelines being developed, and to decide whether this also requires the attention of the III Sub-committee to consider implications on other IMO instruments, such as the RO Code (paragraphs 13 and 14);

.6 consider the draft guidelines on the use of remote inspection techniques for ESP Code surveys, for further development (paragraphs 15 to 18 and annex 2);

.7 agree, in principle, to the draft text for the procedures for certification of a firm engaged in a close-up survey of hull structures using RIT with finalization as part of the continued development of the ESP Code (paragraph 19; and paragraph 21 of annex 1); and

.8 establish the Working Group on Amendments to the ESP Code to permit the use of remote inspection techniques, to continue developing the draft amendments to the ESP Code and the draft guidelines on the use of RIT for the ESP Code surveys (paragraphs 12 and 18).

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ANNEX 1*

DRAFT AMENDMENTS TO THE INTERNATIONAL CODE ON THE ENHANCED PROGRAMME OF INSPECTIONS DURING SURVEYS OF BULK CARRIERS AND OIL TANKERS, 2011 (2011 ESP CODE) RESOLUTION MSC.461(101), AS AMENDED BY RESOLUTIONS MSC.483(103) AND MSC.525(106)

1 Renumber Annexes in the "Contents" section and in the main body:

.1 replace "Annex 5" with "Annex 5A" in part A of annex A and part B of annex A;

.2 replace "Annex 8" with "Annex 8A" in part A of annex B;

.3 replace "Annex 7" with "Annex 7A" in part B of annex B.

2 Insert reference to a new Annex in the "Contents" section:

.1 Annex 5B after existing Annex 5 in part A of annex A and part B of annex A;

"Annex 5B - Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)"

.2 Annex 8B after existing Annex 8 in Part A of annex B;

"Annex 8B - Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)"

.3 Annex 7B after existing Annex 7 in Part B of annex B;

"Annex 7B - Procedures for certification of a firm engaged in close-up survey of hull structures using a Remote Inspection Technique (RIT)"

3 Update definition of "Administration":

.1 in part A of annex A and part B of annex A;

1.2.21 Administration means the Administration or organization recognized by the Administration, unless defined otherwise in this Code.

.2 in Part A of annex B;

1.2.20 Administration means the Administration or organization recognized by the Administration, unless defined otherwise in this Code.

.3 in Part B of annex B;

1.2.17 Administration means the Administration or organization recognized by the Administration, unless defined otherwise in this Code.

* Modifications in grey and this annex is provided in English only.

4 Insert a new definition:

.1 1.2.22 after existing definition 1.2.21 in part A of annex A;

.2 1.2.22 after existing definition 1.2.21 in part B of annex A;

.3 1.2.21 after existing definition 1.2.20 in part A of annex B; and

.4 1.2.18 after existing definition 1.2.17 in part B of annex B, together with the associated footnote to read:

"Remote inspection technique (RIT) is a means of survey of any parts of the structure without the need for direct physical access of the surveyor.*"

Alternative proposal for the definition of RIT:

"Remote Inspection Technique (RIT) – System installed on remote controlled vehicles or robotic arms to support the surveyor during the close-up surveys in providing access to parts of the structure which may not be fully accessed by the permanent means of access with visual livestreaming of video and image providing information to the same level of assurance as the close visual inspection. The system shall include all associated support equipment, ground control station, operators and communication systems.*

* Refer to "Guidelines on the use of remote inspection techniques (RIT) for ESP Code surveys " adopted by the Organization by resolution MSC.…(…), as amended."

5 A new paragraph is added to the existing paragraph 1.5 of all parts, and existing paragraph is renumbered, as follows:

"1.5 Thickness measurements and close-up surveys

1.5.1 In any kind of survey, i.e. renewal, intermediate, annual or other surveys having the scope of the foregoing ones, for structures in areas where close-up surveys are required, thickness measurements, when required by annex 2, shall be carried out simultaneously with close-up surveys.

1.5.2 For periodic surveys after the third Special Survey, the use of RIT is subject to the agreement of the Administration, which may impose additional requirements or limitations; in this case Administration means the Government of the State whose flag the ship is entitled to fly and not the Recognised Organization."

6 Insert new paragraphs 1.6 in part A of annex A, part B of annex A, part A of annex B and part B of annex B, together with the associated footnote, as follows:

"1.6 Remote inspection techniques (RIT)

1.6.1 RIT surveys shall be carried out in accordance with the requirements given herein and the Guidelines for use of remote inspection techniques for surveys*. These considerations shall be included in the proposals for use of an RIT which shall be submitted in advance of the survey and as part of the survey programme in 5.1 so that satisfactory arrangements can be agreed.

1.6.2 The equipment and procedure for observing and reporting the survey using a RIT shall be discussed and agreed with the parties involved prior to the RIT survey, and suitable time shall be allowed to set up, calibrate and test all equipment beforehand.

1.6.3 When using an RIT for close-up survey, if not carried out by the Administration itself, it shall be conducted by a firm approved as a service supplier by the Administration according to the principles stated in annex [5B] [8B] [7B] [part A of annex A and part B of annex A, part A of annex B and part B of annex B respectively] and shall be witnessed by an attending surveyor of the Administration.

1.6.4 The structure to be examined using an RIT shall be sufficiently clean to permit meaningful examination. Visibility shall be sufficient to allow for a meaningful examination. The Administration shall be satisfied with the methods of orientation on the structure.

1.6.5 The surveyor shall be satisfied with the method of data presentation including pictorial representation, and a good two-way communication between the surveyor and RIT operator shall be provided.

1.6.6 If the RIT reveals damage or deterioration that the surveyor judges requires attention or further investigation, the surveyor shall require traditional survey to be undertaken without the use of an RIT; if access for the surveyor cannot be provided during the survey, e.g. the ship is at sea or anchor, then consideration may be given by the surveyor to impose a suitable condition or recommendation with a specific time limit in order to allow access for traditional close-up survey.

1.6.7 Confirmatory surveys/close-up surveys may be carried out by the Surveyor at selected locations to verify the results of the remote inspection technique.

* Refer to "Guidelines on the use of remote inspection techniques (RIT) for ESP Code surveys " adopted by the Organization by resolution MSC.….(…)."

7 Insert the new text as paragraphs 2.5 in part A of annex A and part B of annex A and paragraphs 2.4 in part A of annex B and part B of annex B, as follows:

"2.5 Extent of overall and close-up surveys

2.5.5 When using a RIT to assist the close-up survey the following applies:

.1 for areas where means of access are required to enable the surveyor to examine the structure, the surveyor may use RIT to assist the close-up survey when access is not provided by the permanent means of access;

.2 the use of RIT to assist the close-up survey shall not be used after Renewal survey No.3, unless agreed with the Administration (see 1.5.2);

.3 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11 or ballast tanks where a soft or semi-hard coating has been applied, or where a hard protective coating has not been applied from the time of construction;

.4 the RIT shall not be used in ships which have a recorded history of structural defects, damage or deterioration;

.5 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require Thickness Measurements, these shall be carried out simultaneously with the close-up survey, details of how this will be facilitated are to be included in the survey programme."

8 Insert a new text as paragraph 5.1.6 in part A of annex A, part B of annex A, part A of annex B and part B of annex B, as follows:

"5.1.6 If it is proposed to use a RIT, the survey programme shall include relevant information relating to the RIT equipment and its use, and in preparation for the survey programme the following is to be noted:

.1 for areas where means of access are required to enable the surveyor to examine the structure, the surveyor may use RIT to assist the close-up survey when access is not provided by the permanent means of access;

.2 the use of RIT to assist the close-up survey shall not be used after Renewal survey No.3, unless agreed with the Administration (see 1.5.2);

.3 the RIT shall not be used in ballast tanks or any spaces where a hard protective coating is required and it is found to be in less than GOOD condition as defined in 1.2.11 or ballast tanks where a soft or semi-hard coating has been applied, or where a hard protective coating has not been applied from the time of construction;

.4 the RIT shall not be used in ships which have a recorded history of structural defects, damage or deterioration; and

.5 in addition to the requirements of 1.5.1, when the RIT reveals suspected areas that require Thickness Measurements, these shall be carried out simultaneously with the close-up survey, details of how this will be facilitated are to be included in the survey programme."

9 Reference to Annex 5 in existing paragraph 7.2 of part A of annex A and part B of annex A to be updated to Annex 5A, as follows:

"7.2 Certification of thickness measurement firm

The thickness measurements shall be carried out by a qualified firm certified by the Administration according to the principles stated in annex 5A."

10 Reference to Annex 8 in existing paragraph 7.2 of part A of annex B to be updated to Annex 8A, as follows:

"7.2 Certification of thickness measurement firm

The thickness measurements shall be carried out by a qualified firm certified by the Administration according to the principles stated in annex 8A."

11 Reference to Annex 7 in existing paragraph 7.2 of part B of annex B to be updated to Annex 7A, as follows:

"7.2 Certification of thickness measurement firm

The thickness measurements shall be carried out by a qualified firm certified by the Administration according to the principles stated in annex 7A."

12 Insert the new Section 7a in part A of annex A, part B of annex A, part A of annex B and part B of annex B, as follows:

"7a Procedures for use of RIT

7a.1 General

7a.1.1 The proposal for the use of RIT shall be submitted before the survey as part of the survey programme detailed in 5.1 and discussed and approved by the Administration.

7a.1.2 The RIT firm shall be part of the survey planning meeting to be held prior to commencing the survey.

7a.1.3 The use of RIT for surveys shall be carried out under the presence of the surveyor and his/her continuous direction and control.

7a.2 Certification of the RIT firm

7a.2.1 The RIT shall be carried out by a qualified firm certified by the Administration according to the principles stated in annex [5B] [8B] [7B]. [part A of annex A and part B of annex A, part A of annex B and part B of annex B respectively]

7a.3 Use of RIT

7a.3.1 Only certified equipment by a certified firm is to be used.

7a.3.2 Prior to every service onboard, the RIT must be validated with a demonstration under the existing conditions (light, humidity, dust, etc) to confirm that the expected results can be achieved.

7a.3.3 This validation must be done according to an acceptable agreed standard/criteria, in accordance with the provisions in annex [5B] [8B] [7B] [part A of annex A and part B of annex A, part A of annex B and part B of annex B respectively] which will validate and confirm that the livestreaming of video and image of the proposed RIT can provide information to the same level of assurance as the close-up visual inspection. This includes the expected structural defects coating condition, including the acceptable minimum dimensions.

7a.3.4 Confirmatory surveys/close-up surveys shall be carried out by the Surveyor at selected locations to verify the results of the RIT.

7a.3.5 Details of the areas not fully accessed by the permanent means of access and proposed to be covered with the RIT must be detailed in the survey programme and discussed in the survey planning meeting.

7a.3.6 The RIT limitations must be detailed in the survey programme and agreed in the survey planning meeting.

7a.3.7 If the RIT reveals damage or deterioration the surveyor shall require means of access to perform a 'close-up survey' without the use of RIT. These shall be detailed in the programme and agreed in the survey planning meeting.
The surveyor shall apply the requirements of 1.3 'Repairs' and SOLAS, Part B, Regulation 6.

7a.4 Reporting

7a.4.1 Principles for survey reporting shown in annex 6 shall be complied with.

7a.4.2 The RIT report shall include all video and images with a chapter detailing the areas covered and damages found with locations, type, details and dimensions.

7a.4.4 The report shall include the details of: RIT firm, approval certificate, equipment used and operators.

7a.4.5 The report shall have evidence of being reviewed and approved by the attending surveyor(s)"

13 Insert a new paragraph in section 2 of Annex 4B of part A of annex A and part B of annex A and add a new column "RIT" between columns "Ladders" and "Direct access" as follows:

"ANNEX 4B

SURVEY PLANNING QUESTIONNAIRE

2 Information on access provision for close-up surveys and thickness measurement

The owner shall indicate, in the table below, the means of access to the structures subject to close-up survey and thickness measurement. A close-up survey is an examination where the details of structural components are within the close visual inspection range of the attending surveyor, i.e. normally within reach of hand.

When any part of the close-up survey is being undertaken by means of a Remote Inspection Technique (RIT), the means of how thickness measurements are going to be taken are also to be indicated in the table below; the thickness measurements are to be carried out simultaneously with the close-up survey, either when required by the ESP Code or by the surveyor as result of the close-up survey. Note: an RIT to assist the close-up survey may only be used when access is not provided by the permanent means of access. (See 1.5 and 5.1.6)

Hold/Tank No.	Structure	Permanent means of access	Temporary staging	Rafts	Ladders	RIT	Direct access	Other Means (please specify)
F.P.	Fore peak							
…								

"

14 Annex 6, part A of annex A and part B of annex A are amended as follows:

.1 the new paragraphs 1.4 and 1.5 are added:

1 General

1.4 When RIT have been used then:

.1 the RIT report shall include all videos and images with a chapter detailing the areas covered and damages found with locations, type, details and dimensions;

.2 the report shall include the details of: RIT firm, approval certificate, equipment used and operators.

1.5 The report shall have evidence of being reviewed and approved by the attending surveyor(s).

.2 paragraph 3.2.2 is amended, as follows:

"3 Result of the survey

3.2 Structural condition of each compartment with information on the following, as relevant:

.2 identification of compartments where no structural damages/defects are found. The report may be supplemented by sketches/photographs/videos; and"

15 Annex 5 of part A of annex A and part B of annex A to be renumbered as Annex 5A, as follows:

"ANNEX 5A

PROCEDURES FOR APPROVAL AND CERTIFICATION OF A FIRM ENGAGED IN THICKNESS MEASUREMENT OF HULL STRUCTURES"

16 Annex 8 of part A of annex B to be renumbered as Annex 8A as follows:

"ANNEX 8A

PROCEDURES FOR APPROVAL AND CERTIFICATION OF A FIRM ENGAGED IN THICKNESS MEASUREMENT OF HULL STRUCTURES"

17 Annex 7 of part B of annex B to be renumbered as Annex 7A as follows:

"ANNEX 7A

PROCEDURES FOR APPROVAL AND CERTIFICATION OF A FIRM ENGAGED IN THICKNESS MEASUREMENT OF HULL STRUCTURES"

18 Insert a new paragraph in section 2 of Annex 7B of part A of annex B and add a new column "RIT" between columns "Ladders" and "Direct access" as follows:

"ANNEX 7B
SURVEY PLANNING QUESTIONNAIRE

2 Information on access provision for close-up surveys and thickness measurement

The owner shall indicate, in the table below, the means of access to the structures subject to close-up survey and thickness measurement. A close-up survey is an examination where the details of structural components are within the close visual inspection range of the attending surveyor, i.e. normally within reach of hand.

When any part of the close-up survey is being undertaken by means of a Remote Inspection Technique (RIT), the means of how thickness measurements are going to be taken are also to be indicated in the table below; the thickness measurements are to be carried out simultaneously with the close-up survey, either when required by the ESP Code or by the surveyor as result of the close-up survey. Note: an RIT to assist the close-up survey may only be used when access is not provided by the permanent means of access. (See 1.5 and 5.1.6).

Hold/Tank No.	**Structure**	**Permanent means of access**	**Temporary staging**	**Rafts**	**Ladders**	**RIT**	**Direct access**	**Other Means (please specify)**
F.P.	Fore peak							
…								

"

19 Insert a new paragraph in section 2 of Annex 6B of part B of annex B and add a new column "RIT" between columns "Ladders" and "Direct access" as follows:

"ANNEX 6B

SURVEY PLANNING QUESTIONNAIRE

2 Information on access provision for close-up surveys and thickness measurement

The owner shall indicate, in the table below, the means of access to the structures subject to close-up survey and thickness measurement. A close-up survey is an examination where the details of structural components are within the close visual inspection range of the attending surveyor, i.e. normally within reach of hand.

When any part of the close-up survey is being undertaken by means of a Remote Inspection Technique (RIT), the means of how thickness measurements are going to be taken are also to be indicated in the table below; the thickness measurements are to be carried out simultaneously with the close-up survey, either when required by the ESP Code or by the surveyor as result of the close-up survey. Note: an RIT to assist the close-up survey may only be used when access is not provided by the permanent means of access. (See 1.5 and 5.1.6).

Hold/Tank No.	**Structure**	**Permanent means of access**	**Temporary staging**	**Rafts**	**Ladders**	**RIT**	**Direct access**	**Other Means (please specify)**
F.P.	Fore peak							
…								

"

20. Annex 9, part A of annex B and Annex 8, part B of annex B are amended, as follows:

.1 A new paragraphs 1.4 and 1.5 are added:

"1 General

1.4 When RIT have been used then:

.1 the RIT report shall include all video and images with a chapter detailing the areas covered and damages found with locations, type, details and dimensions;

.2 the report shall include the details of: RIT firm, approval certificate, equipment used and operators.

1.5 The report shall have evidence of being reviewed and approved by the attending surveyor(s)."

.2 Paragraph 3.2.2 is amended, as follows:

"3 Result of the survey

3.2 Structural condition of each compartment with information on the following, as relevant:

.2 identification of compartments where no structural damages/defects are found. The report may be supplemented by sketches/photographs/videos; and"

21 Insert a new annex 5B in part A of annex A and part B of annex A; 8B in part A of annex B; and 7B in part B of annex B, as follows, containing the same text:

"[ANNEX 5B] [ANNEX 8B] [ANNEX 7B]

PROCEDURES FOR CERTIFICATION OF A FIRM ENGAGED IN CLOSE-UP SURVEY OF HULL STRUCTURES USING A REMOTE INSPECTION TECHNIQUE (RIT)

1 Application

1.1 This procedure applies to remote inspection technique (RIT) firms providing visual livestreaming of video and images to support close-up surveys.

2 General Requirements

Supervisor and operators

2.1 The firm shall designate a supervisor who shall be certified according to the recognized national requirements or an equivalent industrial standard and shall have a minimum of two years' experience in the inspection of ship's structure.

2.2 Operators of the RIT shall be certified according to the recognized national requirements or an equivalent industrial standard and have had at least one year's experience as an assistant carrying out inspections of ship's structure (including participation in a minimum of five different assignments). The operators of those RIT which require, according to the international and national legislations, to be licensed for their use shall hold valid documentation issued by the appropriate Bodies (e.g. Unmanned Aerial Vehicles (UAV) Pilots are to be qualified and licensed in accordance with applicable national requirements).

Training and qualification of operators

2.3 The firm is responsible for the training and qualification of its operators. UAV Pilots are to be qualified and licensed in accordance with applicable national requirements or an equivalent industrial standard acceptable to the Administration.

2.4 The firm is to maintain a documented training plan for RIT equipment operators. The plan shall include requirements for training in the Special Survey requirements for the structure as specified in this Code, the recognition of structural deterioration (including corrosion, buckling, cracking and deteriorated coatings) and the reporting requirements of this Code.

2.5 Knowledge of the following shall be documented:

.1 *guidelines on the use of Remote Inspection Techniques (RIT) for ESP Code surveys* (MSC.1/Circ…)

.2 marine and/or offshore nomenclatures;

.3 the structural configuration of relevant ships types, including internal structure;

.4 the remote inspection equipment and its operation; and

.5 survey plans for examination of hull spaces of various configurations, including appropriate flight plans if using a UAV;

RIT equipment

2.6 The following equipment shall be available:

.1 remotely operated platform with data capture devices capable of operation within an enclosed space;

.2 means of powering the platforms with sufficient capacity to complete the required inspections, including spare batteries if applicable;

.3 data collection devices which may include cameras capable of capturing in high definition both video images and still images;

.4 illumination equipment;

.5 high-definition display screen with live high-definition feed from inspection cameras;

.6 means of communication, as applicable; and

.7 data recording devices;

2.7 The RIT equipment shall be provided with a URV Statement of Capability issued by the Administration, in accordance with Annex 1 of *Guidelines on the use of Remote Inspection Techniques (RIT) for ESP Code surveys* (MSC.1/Circ…).

Firm Procedures and Guidelines

2.8 The firm shall have documented operational procedures and guidelines for how to plan, carry out and report inspections; how to handle/operate the equipment; collection and storage of data. These shall include:

.1 requirements for preparation of inspection plans when UAV are part of the equipment flight plans shall be included;

.2 operation of the remotely operated platforms;

.3 operation of lighting;

.4 calibration of the data collection equipment;

.5 operation of the data collection equipment;

.6 two-way communication between the operator, platform, Surveyor, other personnel such as support staff and ships officers and crew;

.7 guidance of the operator to provide complete coverage of the structure to be inspected;

.8 guidance for the maintenance of the remotely operated platforms, data capture and storage devices and display screens, as applicable;

.9 requirements for the collection and validation of data;

.10 if data is to be stored, then requirements for location attribution (geo-tagging), validation and storage of data;

.11 requirements for the reporting of inspections, including the recording of damages and defects found during inspection and repair work; and

.12 if capable of undertaking cleaning/surface preparation, then procedures for undertaking this work.

Documents and records

2.9 The firm shall maintain the following:

.1 records of training;

.2 operator statutory and regulatory certificates and licenses;

.3 equipment register for RIT equipment, including delivery device (e.g. UAVs, Robots), data collection devices, data analysis devices and any associated equipment necessary to perform inspections;

.4 equipment maintenance manuals and records / logbook;

.5 records of calibration; and

.6 RIT equipment operation logbook;

3 Procedures for certification

Submission of documents

3.1 The following documents shall be submitted to the Administration for approval, together with a list of the documents submitted:

.1 outline of the firm, e.g. organization and management structure;

.2 experience of the firm on RIT of hull structures of ships;

.3 technicians' careers, i.e. experience of technicians as RIT operators, technical knowledge and experience of hull structure, etc;

.4 equipment used, including capturing devices (i.e. drones, cameras, etc), streaming devices (i.e. screens) and other supporting equipment (i.e illumination), and their maintenance/calibration procedures;

.5 operational procedures and instructions on how to carry out the servicing of the equipment and/or system. These are to either contain or make reference to the Manufacturer's servicing manuals, servicing bulletins, instructions and training manuals, as appropriate, and to relevant international requirements;

.6 training programmes for RIT Operators; and

.7 report format in accordance with recommendations of *Guidelines on the use of Remote Inspection Techniques (RIT) for ESP Code surveys of ship structures* (MSC.1/Circ…)

Auditing of the firm

3.2 Upon reviewing the documents submitted with satisfactory results, the firm shall be audited in order to ascertain that the firm is duly organized and managed in accordance with the documents submitted, and eventually is capable of conducting close-up surveys of the hull structure of ships using RIT.

3.3 Certification is conditional upon a demonstration (on-board or in a test environment) of a close-up survey using the RIT, as well as satisfactory reporting.

4 Certification

4.1 Upon satisfactory results of both the audit of the firm referred to in 3.2 and the demonstration tests referred to in 3.3, the Administration shall issue a certificate of approval stating that the firm's operation system has been found to be satisfactory and that the results of services performed in accordance with that system may be accepted and utilised by the Administration in making decisions affecting certification. The certificate shall clearly state the type and scope of services, type of equipment and/or names of Manufacturers of equipment where this is a limiting restraint and any limitations or restrictions imposed and include a statement that the RIT is to support the close-up survey for the areas which may not be not fully accessed by use of the permanent means of access.

4.2 Renewal/endorsement of the certificate shall be made at intervals not exceeding three years by verification that original conditions are maintained.

5 Report of any alteration to the certified RIT operation system

In cases where any alteration to the certified RIT operation system of the firm is made, such an alteration should be immediately reported to the Administration. Re-audit should be made where deemed necessary by the Administration.

6 Withdrawal of the certification

The certification may be withdrawn in the following cases:

.1 where the RIT were improperly carried out or the results were improperly reported;

.2 where the surveyor found any deficiencies in the RIT operation systems of the firm; and

.3 where the firm failed to report any alteration referred to in 5 to the Administration as required.

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ANNEX 2*

DRAFT GUIDELINES ON THE USE OF REMOTE INSPECTION TECHNIQUES (RIT) FOR ESP CODE SURVEYS

1 Introduction

1.1 These Guidelines are intended to provide guidance on technical aspects to be considered when the using remote inspection techniques (RIT) as an alternative means of access for close-up survey and thickness measurement, in accordance with the ESP Code requirements. In annex the technical requirements and an assessment framework to determine the capabilities and limitations of unmanned robotic vehicles (URV) are provided.

1.2 The ESP Code (International Code on the Enhanced Programme of Inspections During Surveys of Bulk Carriers and Oil Tankers) defines close-up surveys (i.e. normally at hands reach) requirements for bulk carriers and oil tankers that require significant planning, preparation and execution. Means of access to enable close-up surveys are required by SOLAS II-1/3 and the Technical Provisions for Means of Access for Inspections. "Permanent means of access" (resolution MSC.133(76), as amended) are the primary enabler for close-up surveys, but it is recognised that these will not give access to all the areas required to be inspected and gauged. Therefore, it is essential that all areas outside of reach of the "permanent means of access" (i.e. normally beyond hand's reach) are accessed by "alternative means" in combination with the "permanent means of access". With proper consideration, remote inspection techniques (RIT) may replace some of the traditional "alternative means of access", such as scaffolding or rafting, as long as it can provide an equivalent performance level of the survey.

1.3 Rope access inspection techniques (manned) are already used since several years, but recently, unmanned robotic vehicles (URV) have also been introduced, presenting greater benefits but also some challenges when compared with manned techniques.

1.4 In both manned and unmanned remote inspection techniques, the visual livestreaming of an image from a camera is a common element, but other technologies may be used to provide supplementary information that is not normally readily available when using conventional visual inspection techniques. These technologies may include sensor driven data, such as infrared/thermal cameras, stereoscopic (3D) cameras, RGB-D cameras, laser scanning or UT probes, but also digital technologies that process and analyse the information obtained from sensors, (e.g. Machine Learning and AI).

1.5 The development of different digital technologies and combinations of multiple sensors may lead to different capabilities. It is therefore essential that the RIT capabilities and limitations are properly known, in order to identify the situations that require a conventional close-up survey and/or thickness measurement techniques to be applied.

2 General requirements

2.1 The methods applied when using remote inspection techniques (RIT) are to provide the same survey results obtained by the Surveyor performing close-up survey, *i.e. normally within reach of hand.*

* This annex is provided in English only.

2.2 Visual livestreaming technology should be used as the primary means of inspection. The visual livestreaming should have sufficient quality to provide the same level of assurance as conventional close-up visual inspection. *i.e. normally withing reach of hand*. Whilst other technologies may be used as supplementary information, these should not be considered as a replacement of visual livestreaming or a downgrade of its quality.

2.3 When considering the use of unmanned robotic vehicles (URV), the selected equipment should be provided with a *URV Statement of Capability* issued by the Administration, detailing the equipment, capabilities, and limitations. *Annex – Technical Requirements, Assessment and Certification of Unmanned Robotic Vehicles* provides a standard to assess these systems.

2.4 An inspection plan for the use of remote inspection techniques (RIT) should be submitted together with the 'Survey planning questionnaire' required by the ESP Code Annex A and Annex B as appropriate for review and acceptance in advance of the survey. The inspection plan should also form part of the ESP 'Survey Programme' documentation.

2.5 The inspection plan should be prepared in accordance with '6. Planning and Preparation'.

2.6 Items to be examined using a RIT are to be sufficiently clean to permit meaningful examination. Visibility is to be sufficient to allow for a meaningful examination, complemented by illumination as required.

3 Certification of Firms engaged in survey using Remote Inspection Techniques (RIT) as an alternative means of access for Close-up Survey

3.1 Remote Inspection Techniques

The inspection should be carried out by a Firm certified by the Administration or Recognised Organisation, in accordance with the ESP Code 'Procedures for Certification of Remote Inspection Techniques (RIT) Firms' applicable annexes.

3.2 Thickness Measurement using RIT

When it is intended to take thickness measurements using RIT, the Firm should also be certified by the Administration or Recognised Organisation, in accordance with the ESP Code ‘Procedures for Approval and Certification of a Firm Engaged in Thickness Measurement of Hull Structures’ applicable annexes.

4 Training requirements

4.1 General Knowledge Requirements

4.1.1 The training requirements are to be reviewed by the Administration as part of the Firm Certification, refer to *3. Certification of Firms engaged in survey using Remote Inspection Techniques (RIT) as an alternative means of access for Close-up Survey.*

4.1.2 Personnel involved in remote inspection techniques (i.e. rope climbers, URV Operators, UT Technicians, etc.) should have appropriate knowledge of the following:

.1 marine and/or offshore nomenclatures;

.2 the structural configuration of relevant ships types, including internal structure;

.3 the remote inspection equipment and its operation; and

.4 survey plans for examination of hull spaces of various configurations, including appropriate flight plans if using an Unmanned Aerial Vehicle (UAV) or path plans if using crawlers, legged robots or other RIT technologies.

4.2 Additional Training Requirements for URV Operators

URV operators are to be qualified and licensed in accordance with applicable national requirements or an equivalent industrial standard acceptable to the Administration.

4.3 Additional Training Requirements for UT Operators

In addition to the operator training requirements, personnel performing thickness measurement should be certified in accordance with a national or international NDT standard (e.g. EN 473 level II). This applies to both manned and unmanned techniques.

5 Conditions and Limitations on the use of RIT

5.1 General

5.1.1 For vessels up to and including the third Special Survey, consideration may be given by the attending surveyor to allow the use of remote inspection techniques (RIT) in achieving the objectives of a close-up survey. For periodic surveys after the third Special Survey, the agreement and requirements of the Administration§ to use a RIT to undertake close-up surveys is to be obtained prior to undertaking the survey.

5.1.2 Surveys conducted using RIT should be completed in any case to the satisfaction of the attending surveyor. When RIT is used for a close-up survey, means of taking the corresponding thickness measurements as specified in this part should be provided unless such RIT is also able to carry out the required thickness measurements.

§ In the context of this paragraph, Administration means the Government of the State whose flag the ship is entitled to fly and not the Recognised Organization.

5.1.3 Additionally, the below listed considerations should be taken into account when deciding on permitting the use of a RIT on a vessel:

.1 structural condition of the vessel;

.2 survey history of the vessel;

.3 PSC/FSC history of the vessel; and

.4 record of owner/manager.

5.2 Limitations related to previous findings and condition

5.2.1 Use of remote inspection techniques (RIT) should be restricted or limited where there is a record of abnormal deterioration or damage to structure to be inspected. Remote inspection techniques should not be used in the following cases:

.1 for close-up survey and thickness measurement of areas where substantial corrosion was previously identified (e.g. during previous special or intermediate surveys);

.2 for close-up survey of areas where the coating was previously graded as less than good (i.e fair or poor); and

.3 for areas already subjected to a "Condition" requiring repair.

5.2.2 The above limitations are applicable to the affected area and Surveyors may consider the use of remote inspections techniques to the space under consideration, subjected to the results of the overall survey.

6 Planning and Preparation

6.1 Inspection Plan

6.1.1 The inspection plan, is to be submitted together with the 'Survey planning questionnaire' for review and acceptance in advance of the survey, and is to include:

.1 type and extent of survey;

.2 asset type, operational details, and other asset general information;

.3 location and the anticipated timeframe for the survey and the operational status of the asset (*e.g., shipyard, repair facility or lay-by berth, etc.*);

.4 logistics details, including permissions from local authorities, site permissions and work permits, as applicable;

.5 proposed RIT firm, including approval details;

.6 details of RIT equipment, recording facilities and associated *'URV statement of capability'* (when using unmanned robotic vehicles);

.7 proposed structural locations where the RIT will be used, with details of possible hot spots;

.8 arrangements for the attending surveyor to perform confirmatory inspections by conventional means (*e.g., safe access cleaning/descaling, illumination, ventilation, etc.*);

.9 procedure and criteria to validate the use of RIT for specific structure and conditions (light, humidity, cleanliness) at the start of inspection;

.10 details on how to deal with identified deficiencies; and

.11 methods for thickness measuring (simultaneously with RIT). additionally, when an RIT is able to take thickness measurements, supplementary details are also to be submitted, including TM Firm approval, TM equipment, measuring capabilities (e.g. direction limitations) and operator(s) details as per ESP Code requirements.

6.2 Risk Assessment

6.2.1 A risk assessment should be carried out by the approved RIT firm before survey commences to identify hazards and ensure appropriate risk controls are in place.

6.2.2 The risk assessment should include as a minimum:

.1 URV minor failure (*e.g. URV emergency landing/deployment*);

.2 URV catastrophic failure (*e.g. URV crashing and falling*);

.3 battery depletion;

.4 loss of communication and signal interference issues;

.5 URV and ship damages due to collisions;

.6 risks related to tethered and untethered systems;

.7 interference with other works occurring simultaneously in the space or vicinity;

.8 operator(s) and surveyors (s) location during inspection; and

.9 operation next to hazardous areas.

6.3 Survey Planning Meeting

6.3.1 Prior to the commencement of surveys, a survey planning meeting should be held between the RIT Firm Supervisor(s), the Owner's Representative(s) and the attending Surveyor(s) to ascertain that all the arrangements detailed in the inspection plan are in place, so as to ensure the safe and efficient conduct of the survey work to be carried out.

6.3.2 The inspection plan (included as part of the approved survey programme) should be reviewed to reiterate conditions and limitations on the use of RIT. Additionally, when unmanned robotic vehicles (URV) are used, the *'URV Statement of Capability'* is also to be reviewed during the survey planning meeting, to:

.1 confirm the URV is suitable for the intended works;

.2 review URV access limitations and determined alternatives (e.g. provision of access means to perform conventional close-up survey); and

.3 review URV capabilities related to defect quantification/measuring and determine whether further arrangements may be required (e.g. provision of access means to quantify/measure/NDT new defects).

6.4 Pre-Inspection Validation

6.4.1 Prior to commencing of inspections, the systems must be checked on-site to verify that they can perform to the required standard under the existing conditions (i.e. light, humidity, structure cleanliness) as reported in the *URV Statement of Capability* issued by the Administration. This verification must be done according to an acceptable agreed procedure and criteria which will confirm that the livestreaming of video and image as well as the other offered data of the proposed RIT can provide information to the same level of accuracy as the close-up visual inspection carried out using traditional permanent or temporary means of access. If a URV is able to take thickness measurements, this capability should also be verified as well and calibration of the gauging device(s) demonstrated to the Surveyor.

7 Conduct of Survey

7.1 General

7.1.1 The results of the inspections using a RIT, when being used towards the crediting of surveys, are to be acceptable to the attending Surveyor. Confirmatory verifications are to be carried out by the Surveyor at selected locations to verify the results of the RIT inspection.

7.1.2 When the RIT identifies damage or deterioration, the Surveyor should normally require conventional close-up survey techniques to enable a more detailed assessment and decide whether further action is required, unless the Surveyor considers the information and data obtained using the RIT is sufficient to make a decision on the course of action (*e.g. repairs, periodical re-examination*). If traditional means of access for close-up survey, e.g. scaffolding, cannot be provided immediately then a suitable period would need to be agreed by the Surveyor to allow specific time limit for access to be provided; this will be dependent on individual circumstances *e.g. nature and seriousness of the damage or deterioration or vessel's geographic location.*

7.2 Data Capture and Recording

7.2.1 Video capturing requirements are to be agreed with the Surveyor prior to commencing of the survey. As a minimum, representative video recordings are to be made, to:

.1 demonstrate the video quality of the RIT survey; and

.2 record defects found during the RIT survey.

7.2.2 When recording, the vessel, location onboard and items being looked at should be identified. These can be done by audio or visual means as well as by markers/labelling suitably placed onto the surfaces of the structures to improve orienteering capabilities of the URV. The latter should be reported in the *URV Statement of Capability* issued by the Administration.

7.2.3 The above guidelines may also be applied to other data formats, as applicable, e.g. *photographs*.

7.3 Dealing with Findings and Deficiencies

7.3.1 Whenever a finding is identified, it should be appropriately assessed and categorised by the Surveyor to determine the course of action. Course of action would normally be:

.1 immediate repair;

.2 imposing a condition or recommendation; and

.3 noting as a minor defect that does not require action.

7.3.2 If the RIT reveals damage or deterioration that requires attention, the Surveyor may require traditional survey to be undertaken without the use of a RIT. The Surveyor will determine this by taking into account:

.1 the data provided by the RIT;

.2 the type and severity of the defect; and

.3 the ability and need to quantify/size the defect without direct access.

8 Survey Reporting

8.1 General

8.1.1 The ESP Code requirements are to be complied with. When thickness measurement is taken by remote inspection techniques, the results are to be reported in accordance with ESP Code requirements and appropriate ESP TM Forms.

8.1.2 After completion of the survey, the RIT Firm should provide a comprehensive survey report complemented by any relevant video recordings, as agreed with the Surveyor.

8.2 RIT Firm Report

The Firm report should include the following:

.1 copy of the firm certificate of approval;

.2 copy of the 'URV Statement of Capability' (when applicable);

.3 general survey details, e.g. Close-up survey for SS I, survey dates, etc;

.4 details of the equipment used, e.g. cameras, drone maker, type, S/N, etc;

.5 details of the spaces and areas examined;

.6 general condition results;

.7 method used for thickness measurements (if applicable);

.8 details of Findings and defects, including categorization, size; and

.9 index of the video recordings.

8.3 Data, Video Recordings and Photographs

Whenever data capturing, including video recordings or photographs are required, these should be submitted in appropriate format and properly labelled, including space details, area under inspection and other relevant details.

ANNEX 1

TECHNICAL REQUIREMENTS, ASSESSMENT AND CERTIFICATION OF UNMANNED ROBOTIC VEHICLES (URV) AND ASSOCIATED DIGITAL TECHNOLOGIES FOR DETECTION AND SIZING OF STRUCTURAL DEFECTS

1 General

1.1 Unmanned Robotic Vehicles (URV) are significantly different from manned remote inspection techniques, such as rope access climbers and require appropriate consideration of its capabilities and limitations to achieve equivalent results to manned techniques.

1.2 New URV technologies should be assessed by the Administration to validate its performance against the intended application and identify its capabilities and limitations.

1.3 The assessment should include a review of documentation including the intended use, equipment data, types of sensors, automation and conditions as listed in 2) below, followed by performance testing to the satisfaction of the Administration.

1.4 On satisfactory completion of the assessment, the Administration should issue a '*URV Statement of Capability*', it should include:

.1 URV basic details (Maker, type, version no., etc);

.2 inspection types;

.3 areas unable to be accessed on those inspections – exclusions;

.4 data capture/collection associated with the sensors;

.5 data review/analytics methods associated with the URV;

.6 lighting type;

.7 condition of structure/space;

.8 defect type detection/identification capability;

.9 defect type quantification/sizing capability; and

.10 automation capabilities relating to navigation, data collection and analysis.

as further specified in the following.

1.5 The 'URV Statement of Capability' is only valid for the assessed design type, although a single Statement may cover design variations of the same platform (e.g. version with a visual light range camera, version with other sensors, etc.).

1.6 Any change in the design and capability of the URV, which impacts on the performance criteria against which the URV has been tested, may invalidate the ‘Statement of Capability’ and retesting may be required. URV Suppliers (e.g. the URV manufacturer or a RIT Firm intending to certify their equipment) are to notify the Administration whenever changes are made. The Administration should review the changes to decide on whether retesting of the URV is required.

2 Design Specification and Intended Use

2.1 Initial Specifications and Intended Use

2.1.1 When applying for the assessment of a new technology, the URV Supplier should initially specify:

.1 the inspection types for which the URV has been designed to perform;

.2 any areas of the specified inspections that the URV has not been designed to examine;

.3 the defect types for which the URV has been designed to detect/identify;

.4 the defect types for which the URV has been designed to quantify/size;

.5 the lighting requirements;

.6 the required structural condition for performing the specified inspections;

.7 the level of automation for navigation; and

.8 the level of automation for data collection/analytics.

2.1.2 The URV Supplier should specify its intended use during ship surveys, which may be:

.1 close-up survey of cargo holds – hatch covers open;

.2 close-up survey of enclosed spaces;

.3 close-up survey of wide spaces (e.g. cargo spaces);

.4 close-up survey of narrow spaces (e.g. double skin, double bottom);

.5 thickness measurement of enclosed spaces; and

.6 thickness measurement of non-enclosed spaces.

2.2 Design Specifications

2.2.1 The URV Supplier should specify the data collection sensors and their technical features, examples being:

.1 mandatory visual light range camera (with/without optical zooming);

.2 infrared/thermal camera;

.3 stereoscopic (3D) camera;

.4 RGB-D camera;

.5 laser scanning; and

.6 UTM probe.

2.2.2 The URV Supplier should specify the lighting conditions and illumination minimum requirements for the intended inspection use(s), which may be:

.1 daylight, e.g. external or in a cargo hold with hatch covers open;

.2 lit by artificial light separate to the URV; and

.3 using only URV mounted lighting,

2.2.3 The URV Supplier should specify the condition of the structure that the URV is able to deal with, which may be:

.1 clean;

.2 coated/uncoated and/or surface conditions;

.3 dirty, such as corrosion scale debris or mud;

.4 adhered scale corrosion;

.5 corrosion deposits, such as sulphur-reducing bacteria deposits covering pits;

.6 cargo residue;

.7 water/liquid; and

.8 coverings, such as linings or ceilings.

2.2.4 The URV Supplier should specify the levels of navigation automation, which may be:

.1 manual control; and

.2 semi-autonomous control (e.g. position hold and collision avoidance).

2.2.5 The URV Supplier should specify the levels of sensor automation, which may be:

.1 sensor operation manual; and

.2 sensor operation semi-autonomous.

2.2.6 The URV Supplier should specify the levels of data analytics, including specification of recording means (e.g. if all acquired data are recorded onboard URV, all acquired data are transmitted and recorded remotely, elaborated data are recorded onboard URV, elaborated data are transmitted and recorded remotely and how data are acquired/transmitted/recorded). Levels of data analytics may be:

.1 manual review of data post inspection;

.2 manual live review of data during inspection;

.3 automated data analytics post inspection; and

.4 automated data analytics during inspection.

3 Technical Requirements and Performance Goals

3.1 General

3.1.1 Any equipment used to perform remote inspection techniques should be appropriate for the intended environment (e.g. cargo holds, enclosed spaces, marine environment, hazardous area, wind limitations, etc.). Any equipment used should not interfere with the normal operation of electrical and electronical equipment on board.

3.1.2 It is recommended that URV intended to be used in internal or restricted environment (i.e. enclosed spaces) are provided with protection of moving parts to safeguard persons, ship's structure and the equipment itself. The vehicle movement and any securing features should not damage ship structure and coating.

3.1.3 For battery powered equipment (e.g. drones, screens, remote controllers, etc.), a power management plan should be provided for each job, including job total time expectations, number of required batteries, individual battery capacity, recharging means and segregation of charged batteries from depleted batteries, position of charging facility during inspection, etc. The number of batteries and charging facilities should be sufficient to ensure the total charging ratio is higher than the consumption ratio. Whilst interruptions for battery replacement are expected, the goal should be to ensure continuous operation as far as possible, and that any inspection is not prematurely interrupted due to lack of power. For wireless equipment, the battery status should be available to the operator at any time.

3.1.4 Power and communications failure (including low battery) should be mitigated by appropriate technical measures. This may include emergency landing capabilities (for UAVs), fall arrestors or safe return systems (for robot crawlers) and/or any other technical solution adequate for the captioned URV.

3.2 Navigation – General Requirements

3.2.1 For each specified inspection type as given in 2.2 above, the URV is to be able to access for inspection the specified structural areas. If there are any areas the URV is unable to access for the specified inspection, then these areas will be listed as exclusions in the 'URV Statement of Capability' issued by the Administration or Recognised Organisation on completion of testing *(e.g. unable to pass through manholes below 800 x 600 mm in size, unable to examine under a suction bellmouth, unable to examine back of faceplates of stiffening members, etc.)*.

3.2.2 For a full examination of structure, a URV is to be able to access for examination all of the structural areas required for each specified inspection type equivalently to a traditional manned inspection. For each structural element, i.e. plating and stiffening elements, this means the capability to examine from all required sides within that space.

3.2.3 A full inspection of a tank will normally include:

.1 overhead structure *(e.g. deck transverse, underside of a stringer, underside of a horizontal bracket and relevant supported shell plating)*;

.2 tank bottom plate and associated structure *(e.g. bottom shell plating, floors, girders, frames, longitudinals, other stiffening and connecting elements)*;

.3 side shell, longitudinal and transverse bulkheads *(e.g. bulkhead plating and stiffening members, corrugated plating, hopper and topside tank sides plating and stiffening members, lower and bottom stools plating and stiffening members)*;

.4 stringers and cross ties;

.5 behind structure *(e.g. behind the face plate of a stringer, cross tie or other stiffening members)*;

.6 sounding pipe and its striking plate;

.7 under suction bellmouth;

.8 cross connection tunnels/ducts; and

.9 outfitting *(e.g. any extended spindles, valves, sea connections, penetrations, piping, ladders)*.

Reference is also made to the ESP Code and relevant inspection standards.

3.3 Navigation – Additional Requirements for Unmanned Aerial Vehicles (UAV)

3.3.1 UAVs should have flight stabilization and hovering capabilities, allowing steady access to hull structure. Equipment stabilization should be sufficient to address the environmental and working conditions, such as wind or force ventilation air drafts, humidity, etc.

3.3.2 In addition to 3.2 requirements, UAVs design should consider collision avoidance, which may include automatic collision prevention, collision shielding or any other measures to mitigate collision risks.

3.3.3 UAVs are to be equipped with signal lights, displaying equipment status.

3.4 Navigation – Additional Requirements for Robotic Crawlers

3.4.1 Robotic crawlers should have sufficient manoeuvring characteristics to permit inspections on structures with stiffening elements., including braking and fall avoidance functions.

3.4.2 Robotic crawlers are to be equipped with signal lights, displaying equipment status.

3.4.3 Additional requirements for URV other than UAVs and robotic crawlers should be to the satisfaction of the Administration.

3.5 Lighting, Video Capturing and Livestreaming

3.5.1 URV should be able to operate in low-lighting environments. The equipment should be provided with floodlighting system to offer sufficient brightness to enable examination of structural details at the minimum required accuracy level, but not in excess that to produce reflections or image white spots impairing the detection and sizing of inspection results.

3.5.2 URV cameras should be able to adjust to low lighting environments, and sufficiently protected from expected vibrations (e.g. provided with image stabilization).

3.5.3 The livestreamed image should be clear and free of distortion. The colours should report a meaningful representation the structural details.

3.5.4 The system should be able take high-resolution still images simultaneously with the video livestreaming.

3.6 Visual Defect Detection

3.6.1 For the specified structural conditions and lighting conditions a URV is to be capable of being used to find/identify the specified defects in the steel structure of ships and in addition, if specified, is to be capable of being used to quantify/measure those identified defects.

3.6.2 *Cracking (fractures)* can occur in structure as a result of fatigue at structural connections, structural overload and impact or from latent defects in parent material or welds. When specified, a URV is to be able to be used to identify cracks in any part of the structure being examined and in addition, if specified, is to be capable of being used to quantify/measure those identified cracks. Identification and measuring can either be performed manually or by autonomous means. The minimum detectable crack size of the URV should be specified.

3.6.3 *Deformation (mechanical damages)* may be present in the structure from new build. Permanent structural deformation can be caused on ships in service by impacts, or from overload by compressive forces or shear forces causing buckling phenomena.

3.6.4 When specified, a URV is to be able to be used to identify deformation in any part of the structure being examined and in addition, if specified, is to be capable of being used to quantify/size the deformation. Identification and sizing can either be performed manually (from remote) or by autonomous means (e.g. digital technologies analysing images). The minimum detectable deformation of the URV should be specified in terms of length and depth.

3.6.5 The *coating condition* in tanks is required to be assessed and graded in as either good, fair or poor (refer to *4. URV Performance Tests* section). When specified, a URV is to be able to be used to identify coating degradation/wastage/breakdown on any part of the structure being examined and to assess its condition against the defined criteria. Coating condition assessment can either be performed manually (from remote) or by autonomous means (e.g. digital technologies analysing images).

3.6.6 *Corrosion* can normally manifest in steel structure in the form of general wastage, edge wastage (knife-edging), grooving and pitting. When specified, a URV is to be able to be used to identify corrosion in any part of the structure being examined and in addition, if specified, is to be capable of being used to measure the thickness of each structural element at any required point/location. Identification of corrosion type and thickness measuring can either be performed manually (from remote) or by autonomous means (e.g. digital technologies analysing images). The accuracy in thickness measurements and the capability of distinguish different corrosion types of the URV should be specified in the URV Statement of Capabilities.

3.7 Additional requirements for thickness measurement using Unmanned Robotic Vehicles

3.7.1 When it is intended to take thickness measurement using the unmanned robotic vehicle by adding an ultrasonic testing (UT) equipment as part of its payload, the integration requirements in this section apply*.

3.7.2 The URV should be able to maintain a steady position against the structural element whilst the UT equipment is taking a reading.

3.7.3 The equipment should be able to take measurements in different directions, using equipment manoeuvring characteristics and probe arm dynamics. The applicable measuring directions may be defined:

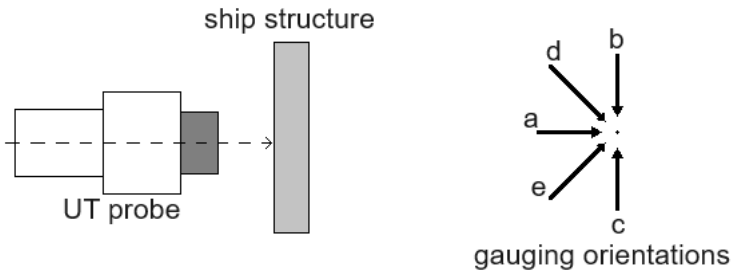
.1 horizontal *(e.g. TM gauging of e.g. bulkheads, deck transverse, web frames and relevant plating);*

.2 downward *(e.g. TM gauging of e.g. stringers, horizontal stiffeners and relevant plating);*

.3 upward *(e.g. TM gauging of e.g. underdeck, deck transverse web and relevant plating);*

.4 inclined downward *(e.g. TM gauging of e.g. hopper plating);* and

.5 inclined upward *(e.g. TM gauging of e.g. topside plating).*



3.7.4 The UT equipment able to take readings through coating on coated surfaces (e.g. using pulsed echo technique).

3.7.5 The equipment should be able to operate continuously, allowing a reasonable number of measurements to be taken before retrieval of the URV (e.g. power source, built-in supply of gel).

3.7.6 The gauging results should be streamed in real-time to the operator. The operator should clearly distinguish consecutive measurement results.

3.7.7 Means to assess gauging accuracy and calibration should be available during surveys. Thickness measurement calibration should be carried out before work commencing, and accuracy of measurements should be demonstrated to Surveyor's satisfaction.

** These requirements only cover integration of the UT equipment in the robotic vehicle and do not cover the UT equipment itself, which should comply with the appropriate NDT standards.*

3.8 Data

3.8.1 The sensors deployed by the URV are to be:

.1 capable of calibration for the detection/identification of the specified defects; and

.2 when specified, capable of calibration for the quantification/sizing of defects.

3.8.2 The design requirements for data geolocation and data formatting will depend on the level of automation for data collection and data analytics. When data is stored for review post inspection:

.1 it is to be geolocated;

.2 it is to be presented in a format acceptable to the surveyor; and

.3 it is to be of a quality that enables the Surveyor to discern any defects present.

4 URV Performance Tests

4.1 General Requirements

4.1.1 Tests are to be performed, as specified in this section, in order to demonstrate that the URV is capable of performing the specified inspection types and is capable of being used to detect/identify the specified defects, and if applicable, is capable of quantifying/sizing those identified defects equivalently to a surveyor carrying out a traditional survey using permanent or temporary means of access to reach the item to be surveyed.

4.1.2 The testing is to be carried out in an environment that replicates the environment of the specified survey type(s) for which the URV is to be certified to conduct inspections; this includes the lighting conditions and the condition of the space/structure. Alternatively, the testing may be carried out on site/on location. The test environment, whether actual or replicated, is to contain the specified defects and those defects should be duly characterized (i.e. information about defect detection/identification/quantification/sizing is available to interested parties but not to the URV pilots and surveyors to be performance-tested) by traditional inspection means (e.g. manned inspections) for subsequently validating the URV capabilities. Testing may be undertaken over a series of tests.

4.1.3 Prior to testing, a test plan is to be submitted to the Administration or Recognised Organisation for review and acceptance. The test plan is to include the location at which the tests are to be held (i.e. a test facility or ship’s name), a test programme adequate to the intended capabilities of the URV and it is to specify the 'design specification and intended use’ (see section 2 above) against which the URV is to be assessed.

4.1.4 The tests are to be witnessed and conducted to the satisfaction of the attending Surveyor of the Administration issuing the *URV Statement of Capability* (or RO acting on behalf of the Administration).

4.1.5 The testing is to demonstrate that the URV is able to access and illuminate the specified areas/structure in order that adequate and meaningful examination may be performed.

4.1.6 The URV is to be tested to demonstrate that it can be used to detect/identify the specified defects.

4.1.7 When specified, the URV is to be tested to demonstrate that it can be used to quantify/size those defects.

4.1.8 Testing is to fully demonstrate to the satisfaction of the Administration, the autonomous capabilities of the URV being requested to be assessed, if any. This should include the manual and autonomous navigation to be tested, as applicable.

4.2 Sensor calibration

Testing is to demonstrate that the sensors deployed by the URV are:

.1 capable of calibration for the detection/identification of defects;

.2 when specified, capable of calibration for the quantification/sizing of defects; and

.3 capable of calibration prior to each inspection.

4.3 Data collection and analytics

4.3.1 On a URV where a surveyor views data in a live format, the tests carried out are to demonstrate that the presentation of data is of a quality that enables the attending Surveyor to detect and identify any present defects equivalently to traditional close-up surveys.

4.3.2 On a URV where data is stored, tests are to be carried out to demonstrate that the data collected by the URV can be correctly geolocated, are presented in a format acceptable to the Surveyor and is of a quality that enables the attending Surveyor to detect/identify present defects and their location.