



GUIDANCE NOTES ON

THE USE OF REMOTE INSPECTION TECHNOLOGIES

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Foreword

Suitable means of access to structures is required for surveys to be carried out safely, effectively, and efficiently. Surveyors use a combination of permanent, temporary (e.g., staging, scaffolding, rafting, and ladder), and alternative (e.g., rope access) means of access in order to conduct class surveys. Remote inspection technologies are considered as additional alternative means of access. These technologies can help to reduce safety risks to the Surveyor (e.g., working at heights as well as working in enclosed and confined spaces). In contrast to Remote Survey, which is for non-attended verification of select surveys, remote inspection techniques are performed in the presence of the Surveyor on site and directed by the attending Surveyor during class-related activities.

There are several different remote inspection technologies (RITs) which can assist the attending Surveyor in evaluating the condition of the structure. Remote Inspection Technologies (RITs) enable a Remote Inspection Vehicle (RIV) to provide access for the inspection of structures. Some common types of RIV include Unmanned Aerial Vehicles (UAVs), Remotely Operated Underwater Vehicles (ROVs), and Robotic Crawlers. These RITs also provide a benefit to the asset Owner/Operator by reducing operational intrusiveness.

These Guidance Notes offer best practices for class surveys and non-class inspections carried out using RITs. These best practices include recommendations and guidance on applications of RITs, qualification and proficiency of the remote inspection Service Providers, Remote Inspection Vehicle (RIV) operation, data handling and data analysis. These best practices are intended to facilitate a safer, more effective and efficient survey. The following IACS Recommendations and Requirements were considered in the development of these Guidance Notes:

- IACS Recommendations No. 42, Guidelines for Use of Remote Inspection Techniques for Surveys
- IACS UR Z7, Hull Classification Surveys 1.6 Remote Inspection Techniques
- IACS UR Z17, Procedural Requirements for Service Suppliers

These Guidance Notes address UAVs, ROVs, and Robotic Crawlers. This document references the relevant industry standards and ABS Guides and Guidance Notes. These Guidance Notes supersede the ABS *Guidance Notes on the Use of Unmanned Aerial Vehicles*, which will be retired upon the publication of this document.

These Guidance Notes become effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of these Guidance Notes is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.

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SECTION 1 Introduction

1 General

Remote Inspection Technologies (RITs) enable a Remote Inspection Vehicle (RIV) with no pilot on board to provide access for the inspection of structures. An RIV is a remotely-controlled vehicle operating in the air, underwater, or on structures (e.g., ship, mobile offshore unit, pipeline, and mooring line/chain). The use of RIVs can reduce risk to Surveyors and inspectors by reducing the need for Surveyors/inspectors to access potentially hazardous locations at height or other hazardous inspection areas. In these Guidance Notes, three RIV types are considered: Unmanned Aerial Vehicles (UAVs), Remotely Operated Underwater Vehicles (ROVs), and Robotic Crawlers. These Guidance Notes provide best practice recommendations on the use of RITs to facilitate safer, more effective, and efficient inspections.

1.1 Unmanned Aerial Vehicles (UAVs)

An unmanned aerial vehicle (UAV), commonly known as a drone, is an aircraft without a human pilot onboard. The UAV can be remotely controlled or programmed to fly a predetermined route using information on a specific asset's condition to target known areas of concern. It can collect visual data (such as still images, live-stream and recorded video) from difficult-to-reach structures and areas.

1.3 Remotely Operated Underwater Vehicles (ROVs)

An ROV is an unmanned unit designed for underwater observation, survey, inspection, construction, intervention or other tasks. Similar to UAVs, an ROV can be remotely controlled or programmed to travel a predetermined route using information on a specific asset's condition to target known areas of concern. It can collect visual data, perform Nondestructive Testing (NDT), and measure plate thickness in difficult-to-reach areas.

1.5 Robotic Crawlers

A Robotic Crawler, commonly referred to as a "crawler", is a tethered or wireless vehicle designed to "crawl" along a structure by means of wheels or tracks. Crawlers are often equipped with magnets which allow them to operate on a vertical surface or hull structures in air or underwater.

3 Scope

The purpose of these Guidance Notes is to provide information to the marine and offshore industries on:

- i) The use of RITs in conjunction with class surveys
- ii) Non-class-related remote inspections using RIVs

If RITs are used in conjunction with class-related activities, it is considered an alternative means of access to assist the attending Surveyor in performing an examination of hard-to-reach structures. The use of RITs should be considered in advance and incorporated into the survey planning phase. Acceptance of the inspection results is at the discretion of the attending Surveyor. The Surveyor may require additional inspections using other alternative or traditional inspection techniques depending on the conditions found and results of inspection.

For non-class-related inspections, recommendations are provided for the selection of a remote inspection Service Provider and on conducting inspection operations, as well as data handling to help provide for a safer, more effective, and efficient inspection.

These Guidance Notes are intended for pilot-operated RIT applications only. Local requirements and regulations for the use of RIVs should be checked and followed.

These Guidance Notes cover:

- Applications of Remote Inspection Technologies (Section 2)
- Guidance for Service Provider Selection (Section 3)
- Survey/Inspection Process (Section 4)

5 Associated Documents

- *ABS Rules for Survey After Construction, Part 7*
- *ABS Rules for Building and Classing Mobile Offshore Units, Part 7, “Surveys”*
- *ABS Guidance Notes on Job Safety Analysis for the Marine and Offshore Industries*
- *ABS Guidance Notes on the Development of Procedures and Technical Manuals*
- *ABS Guidance Notes on Risk Assessment Applications for the Marine and Offshore Oil and Gas Industries*
- *ABS Guidance Notes on the Investigation of Marine Incidents*
- *ABS Guide for Means of Access to Tanks and Holds*
- *ABS Guide for Dropped Object Prevention on Offshore Units and Installations*

7 Terminology and Abbreviations

ABS Recognized External Specialist Program: An ABS program to certify service providers who perform services on behalf of an equipment manufacturer, shipyard, vessel’s owner or other clients in connection with classification and/or statutory services.

Beyond Visual Line of Sight (BVLOS) Operation: Operations where the UAV is not within the visual line of sight of the operator at all times.

Civil Aviation Authority (CAA): The statutory corporation that oversees and regulates all aspects of civil aviation in the United Kingdom. Use of UAVs within the United Kingdom is subject to CAA regulations.

Close-up Survey: A survey where details of structural components are within close visual inspection range of the Surveyor (i.e., normally within hand’s reach), which is defined in the *ABS Rules for Building and Classing Marine Vessels (MVR)*. A Close-up Survey may be referred by the offshore industry as “Close Visual Inspection” (CVI), which is defined in the *ABS Rules for Building and Classing Mobile Offshore Units (MOU Rules)*.

Digital Data: Visual data (e.g., still images, live-stream video, and recorded video), gauging data, and data from other emerging technologies.

ESP: Enhanced Survey Program.

Extended Visual Line of Sight (EVLOS) Operation: Operations that rely on one or more remote observers to keep the UAV in visual sight at all times. These remote observers relay critical flight information via radio and assist the pilot in maintaining a safe separation from other aircraft.

Federal Aviation Administration (FAA): The national aviation authority of the United States, with powers to regulate all aspects of American civil aviation. Use of UAVs within the United States is subject to FAA regulations.

Flight Control Modules: An onboard system that can control a UAV’s direction in flight.

Global Positioning System (GPS): A satellite navigation system used to determine the global position of an object.

Hazardous Areas: Areas where flammable or explosive gases, vapors, or dust are normally present or likely to be present.

Hazardous Area Plan: An arrangement plan clearly indicating the hazardous areas with classification levels. It may be referred to as “Area Classification Plan” by the industry.

High-Definition (HD) Resolution: Video/Image of substantially higher resolution and quality than standard-definition (i.e., 720P, 1080P, 4K).

Job Safety Analysis (JSA): A technique that focuses on job tasks as a way to identify hazards. It focuses on the relationship between workers, tasks, tools, and the work environment. It also includes steps to eliminate or reduce the hazards to an acceptable level. JSAs can be performed formally, with requisite subject matter experts. They may be performed at the job site immediately prior to the beginning of a work activity.

Metadata: Data that provides information about other data. The metadata collected with still imagery and video can include, but is not limited to: time/date stamps, GPS location, camera orientation, focal length, shutter speed, aperture setting, ISO level, camera type, and lens type.

Nondestructive Testing (NDT): A wide group of analysis techniques used in the science, technology and engineering industry to evaluate the properties of a material, component or system without causing damage. NDT is sometimes referred to as nondestructive examination (NDE), nondestructive inspection (NDI), and nondestructive evaluation (NDE).

Notice to Airman: A notice filed with an aviation authority to alert aircraft pilots of potential hazards along a flight route or at a location that could affect the safety of the flight.

Original Equipment Manufacturer (OEM): The original equipment manufacturer of an RIV.

Payload: The carrying capacity of a RIV in terms of weight. It normally refers to the reserved lifting ability of the RIV to perform additional operations excluding the basic systems required for moving (e.g., flying, swimming, or crawling).

Payload Operator: An operator who only controls the onboard modules of the RIV.

Personal Protection Equipment (PPE): Protective clothing, helmets, goggles, and other garments or equipment designed to protect a person from an injury or hazard.

Pilot: An operator who directly controls the RIV (e.g., UAV, ROV, or robotic crawler).

Quality Management System (QMS): A set of policies, processes and procedures required for planning and execution (production/development/service) in the core business area of an organization.

Receiver Autonomous Integrity Monitoring (RAIM): A technology developed to assess the integrity of Global Positioning System (GPS) signals in a GPS receiver system.

Remote Inspection Technology (RIT): In these Guidance Notes, Remote Inspection Technology (RIT) refers to a technology using a remote inspection vehicle (RIV) to perform an inspection.

Remote Inspection Technology (RIT) System: In these Guidance Notes, a Remote Inspection Technology (RIT) System refers to a system which includes a RIV, a control station, connectivity equipment, a platform to display and replay visual data, and a platform to collect and display NDE data.

Remote Inspection Vehicle (RIV): In these Guidance Notes, Remote Inspection Vehicle (RIV) refers to a remotely-controlled vehicle operating in the air, underwater, or on structures, such as UAVs, ROVs, or robotic crawlers.

Remotely Operated Underwater Vehicle (ROV): An unmanned unit designed for functions such as underwater observation, survey, inspection, construction, intervention or other underwater tasks.

Remote Piloted Aircraft (RPA): A type of UAV that is controlled remotely by a pilot.

Safety Assurance (SA): A key component of the SMS, meant to evaluate the continued effectiveness of applied risk control strategies and supports the identification of new hazards.

Safety Management System (SMS): A systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.

Safety Risk Management (SRM): A key component of the SMS intended to determine the need for, and adequacy of, new or revised risk controls based on the assessment of acceptable risk.

Service Provider: A company which provides specialized inspection services using RITs.

SOLAS: International Convention for the Safety of Life at Sea.

Standard Operation Procedure (SOP): A set of step-by-step instructions created by the organization to assist workers in carrying out routine operations.

Survey Planning Document: A document prepared by the Owner/Operator to support the survey pre-planning requirements for carrying out class-related surveys.

Tether Management System (TMS): Acts as an ROV's "garage". It is a device in which the ROV is contained during launch and recovery for its protection or sits on top of a larger working-class ROV. The purpose of the TMS is to lengthen or shorten the tether to eliminate the drag of the umbilical attached to the ROV.

Unmanned Aerial Vehicle (UAV): An aircraft with no pilot on board that is controlled remotely or able to fly autonomously based on a predefined flight route and/or using dynamic automation systems. Unmanned Aerial Vehicles may be referred to by the industry as "drones" or Remotely Operated Aerial Vehicles (ROAVs). UAVs are also referred to as Unmanned Aircraft Systems (UASs). A UAS is a system comprised of the unmanned aircraft (i.e., UAV) and its associated ground control station, data links, and other support equipment.

Ultra-short Baseline (USBL), also known as Super Short Baseline (SSBL): A method of underwater acoustic positioning. A complete USBL system consists of a transceiver, which is mounted on a pole under a ship, and a transponder or responder on the seafloor or an ROV. A computer is used to calculate a position from the ranges and bearings measured by the trans-receiver.

Visual Line of Sight (VLOS) Operation: Operation that keeps the UAV in the visual line of sight of the pilot at all times. For example; avoiding flying a UAV into clouds, fog, or behind structures.



SECTION 2 Application of Remote Inspection Technologies

1 General

Remote Inspection Technologies (RITs) are typically equipped with a camera and remote control modules capable of collecting visual data in the form of still images, live-stream videos, or recorded videos of difficult-to-reach structures and areas.

Below are a few examples of where RITs can be used to aid/assist in inspection-related activities:

- i) *Working at Heights:* RITs can reduce the need for personnel to work at heights using conventional means of access (e.g., staging, scaffolding, or rafting).
- ii) *Underwater Inspection:* RITs can carry out underwater tasks and reduce or eliminate the need for human divers.
- iii) *Confined Space Entry:* RITs can carry out tasks in areas with limited or restricted means of entry or exit, such as tanks, vessels, and pipelines. This can reduce asset downtime associated with the need for shutting down operations and ventilating the space for continuous human occupancy.
- iv) *Preliminary Condition Assessment:* RITs can be used as a screening tool to quickly collect visual data at specified locations for preliminary condition assessments.
- v) *Known Condition Assessment Monitoring:* RITs can be used to periodically monitor temporary repairs in hard-to-reach areas. Additionally, known damage that does not require immediate repair can be monitored using photographic evidence or other data collected by RITs.
- vi) *Damage Assessment for Rapid Response:* RITs can be used to assist rapid and timely damage assessment following certain situations (e.g., collision or grounding of vessels, structure failure, etc.).

RITs are an evolving technology. Additional applications for RITs may become available in the future.

3 Application to Survey

RITs are tools which may be used to assist the attending Surveyor with survey activities where visual examination of the structure is required. In general, RITs can be used as an alternative means for the close-up survey of marine and offshore structures in compliance with IACS UR Z17. Additional Rule and Regulatory requirements are to be considered and incorporated into Survey Planning Documents for additional inspection methods such as hull gauging and nondestructive testing (NDT). Due to the evolving technology, RIT applications and inspection methods in addition to those discussed in these Guidance Notes may become available in the future. For details on these evolving technologies, the local ABS survey office should be contacted.

If an owner or operator intends to incorporate RITs into an ABS survey, the local ABS office should be advised in advance for consideration. The intended use of the RIT may be incorporated into the Survey Planning Document.

Flag Administrations may have additional requirements or restrictions for the use of RITs during statutory surveys that should be considered during survey planning.

The role of the Owner/Operator, Service Provider, and ABS are outlined in Section 2, Table 1, “Roles and Responsibilities”. For details on survey planning, scheduling and execution, the local ABS survey office should be contacted.

**TABLE 1
Roles and Responsibilities**

<i>Activity</i>	<i>Role of Owner/Operator</i>	<i>Role of Service Provider</i>	<i>Role of ABS</i>
Planning	<p>Determine, in consultation with ABS, if the use of RIT is appropriate</p> <p>Select an ABS Recognized External Specialist as the Service Provider</p> <p>Provide supporting information to the Service Provider about the asset’s condition and drawings related to the work scope</p> <p>Review and accept the remote inspection plan proposed by the Service Provider</p> <p>Provide Survey Planning Documentation, with inspection plan incorporated, to the attending Surveyor</p> <p>Coordinate logistical aspects of the inspection, such as obtaining work/site permits, onboarding crews, inspection preparation, etc.</p>	<p>Develop an inspection plan which includes, but is not limited to:</p> <ul style="list-style-type: none"> • Determining the appropriate type of RIT to be used • Performing a risk assessment and developing the remote inspection plan based on the work scope 	<p>Review the proposed Survey Planning Document to verify the survey plan satisfies the applicable ABS Rules, ABS Guides, and other requirements while employing the RIT as an inspection technique</p> <p>Accept Survey Planning Document</p>
Operation	<p>Initiate the remote inspection</p> <p>Coordinate survey and remote inspection activity with the Surveyor and the Service Provider</p>	<p>Execute the remote inspection in accordance with the agreed Survey Planning Document, RIT operation plan, and to the satisfaction of the ABS Surveyor</p>	<p>Conduct the class survey in compliance with applicable ABS Rules, ABS Guides, and other requirements</p> <p>The inspection will be carried out in the presence of the attending Surveyor or as detailed otherwise in the Survey Planning Document. The Surveyor will direct the RIV operations team, as needed, with regard to the survey requirements</p>
Reporting	<p>Review the inspection results provided by the Service Provider</p>	<p>Provide inspection results and data to the Owner/Operator and ABS, as applicable</p>	<p>Evaluate the results of the remote inspection for credit towards class survey. Determine any additional inspection required to further examine or validate RIT results.</p>

For class surveys, acceptance of the inspection results is at the discretion of the attending Surveyor. The Surveyor may require additional inspections using other alternative or traditional inspection techniques depending on the conditions found and results of inspection.

Additional conditions for using RITs during class-related activities are discussed in Section 4.

5 Owner Self-Inspection

RITs may be used to assist owners with a variety of assessment and self-inspection purposes. Potential applications for owner self-inspection may include, but are not limited to:

Survey and Drydock Preparation: Owners may use RITs to prepare for periodic surveys and drydock related activities. Identifying new damage and checking the condition of any existing damage promotes effective preparation and may increase efficiency by eliminating downtime.

Asset Management/Maintenance Programs: With safer and potentially quicker or less intrusive methods available for accessing heights, enclosed and confined spaces, and other hazardous areas, owners may establish an asset management and/or maintenance programs to regularly perform preventative maintenance.

Emergency Response: Owners may use RITs to respond to emergencies (e.g., ship grounding, man overboard, structural failure) in a safe and efficient manner.

Section 2 Application of Unmanned Aerial Vehicles

Platform for Emerging Technologies: RITs may be used as a platform for piloting emerging technologies (e.g., image comparison, gaugings, lasers for coating assessment). This promotes collaboration among owners, service providers, vendors, and class societies to explore safer, more efficient inspection technologies.

The owner may own the platform or perform the inspection through a Service Provider. All inspections should be carried out by qualified personnel.



SECTION 3 Guidance for Service Provider Selection

1 General

When RIT is used for an inspection, the asset Owner/Operator is responsible for:

- i) Selecting a remote inspection Service Provider whose qualifications and capabilities are appropriate for the intended application
- ii) Verifying the inspection can be conducted safely, effectively, and efficiently

If the RIT is used for close-up inspections associated with class surveys, the remote inspection Service Provider is to be an ABS Recognized External Specialist in compliance with IACS UR Z17.

The following recommendations can be used as guidance for the Owner/Operator to assess the qualifications of the remote inspection Service Provider.

3 Regulations

For UAVs, the remote inspection Service Provider should obtain all applicable certificates of authorization from recognized national/local authorities or according to an equivalent industrial standard where the inspection is to be performed. Where no national/local requirement is applicable for UAVs, it is recommended to follow the requirements implemented by recognized aviation authorities such as the FAA's Title 14 Code of Federal Regulations (CFR), Part 107 requirements, and the CAA's CAP 722 guidance.

5 Quality Management System

A Quality Management System (QMS) is a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives. A QMS helps coordinate and direct an organization's activities to meet customer and regulatory requirements and improve effectiveness and efficiency on a continual basis. The Service Provider should have an internal QMS that:

- i) Demonstrates the ability to consistently provide services that meet customer and applicable statutory and regulatory requirements
- ii) Enhances customer satisfaction through the effective application of a management system, including processes for continual improvement of the system and conformity to customer and applicable statutory and regulatory requirements

It is recommended that the remote inspection Service Provider obtain ISO 9001 certification or equivalent third-party vetting credentials. At a minimum, the following should be included as part of the QMS:

- Operating instructions, maintenance logs, and reference calibration of all equipment
- Training program to provide relevant training based on job description and individual qualifications
- Policies and procedures regarding the recording and reporting of information
- Policies and procedures regarding operating preparations
- Process for reviewing procedures, complaints, corrective actions, and issuance, maintenance, and control of documentation
- Code of conduct for the use of RITs for inspection

7 Safety Management System

A Safety Management System (SMS) provides a systematic approach to manage safety. The SMS should emphasize safety management as a fundamental business process to be considered in the same manner as other aspects of business management. For example, in the United States, the US FAA/Coast Guard suggests that the SMS for product/service providers integrate modern safety risk management and safety assurance concepts into repeatable, proactive systems.

The SMS of the Service Provider should be evaluated for its fitness-for-service based on the aspects of the following paragraphs.

7.1 Safety Policy

The remote inspection Service Provider should establish their senior management's commitment to continually improve safety and define the methods, processes, and organizational structure required to meet safety goals. The Service Provider should have written policies, processes, and procedures to address:

- i) Safety commitment
- ii) Safety objectives

7.3 Safety Risk Management

Safety Risk Management (SRM) determines the need for and adequacy of new or revised risk controls based on the assessment of acceptable risks. The Service Provider should incorporate system descriptions, risk assessment, and risk controls as part of their service planning documents.

7.5 Safety Assurance

Safety Assurance (SA) evaluates the continued effectiveness of implemented risk control strategies and supports the identification of new hazards. It is recommended that the Service Provider maintain organizational procedures that address compliance with SMS requirements and standards, policies, directives, and any requirements applicable to the technology being used, such as aviation orders. Actions to demonstrate safety assurance include, but are not limited to:

- i) Internal audits and evaluations
- ii) Reporting culture and incident reporting system, including near miss reporting
- iii) Safety data analysis and assessment
- iv) Safety oversight and improvement

7.7 Safety Promotion

The Service Provider should promote a positive safety culture through training, communications, and other actions within all levels of the workforce in the company. Further guidance on positive safety culture can be found in the *ABS Guidance Notes on Safety Culture and Leading Indicators of Safety*.

9 Management of Change

If modifications to equipment, operational policies, and organization's or personnel are necessary, then an effective Management of Change (MoC) system is critical. A MoC system is a combination of policies and procedures used to evaluate the potential impacts of a proposed change so that it does not result in the introduction of new hazards or increase the risk of existing hazards. Developing an effective MoC strategy requires establishing, documenting, and successfully implementing formal policies to evaluate and manage both temporary and permanent modifications. Whenever a change is made, the potential consequences of that change should be assessed before implementation. It is recommended that the Service Provider have a MoC strategy in place as part of their quality and/or safety management system. Further guidance on MoC can be found in the *ABS Guidance Notes on Management of Change for the Marine and Offshore Industries*.

11 Recommendations for Service Provider Selection

When selecting a remote inspection Service Provider, it is recommended that the asset Owner/Operator review the QMS (Subsection 3/5) and SMS (Subsection 3/7) of the Service Provider for the aspects provided in the following Paragraphs.

11.1 Equipment

The remote inspection Service Provider can be an Original Equipment Manufacturer (OEM) of the RIV that is capable of providing inspection services to the asset Owner/Operator. The remote inspection Service Provider can also be an inspection service firm that utilizes RIVs manufactured by others. In either case, the quality standards of the equipment, including hardware and software, should be maintained through equipment selection and maintenance.

11.1.1 Equipment Selection

Based on the intended application of the RIT (e.g., external offshore structure inspection, internal marine vessel cargo tank/hold/ballast/void inspections, wind turbine inspection, dropped objects inspection, Underwater Inspections in Lieu of Drydocking (UWILD)), the specifications and capabilities of the hardware and software equipment may be different. The following should be considered when selecting a remote inspection Service Provider, RIV and associated equipment.

i) Safety:

- a)* The RIV and any onboard inspection modules should be rated for their intended operational environment (e.g., intrinsically safe in hazardous areas, operational wind speed, temperature, humidity, etc.).
- b)* The materials of the RIV and onboard inspection modules should be non-hazardous to the structure and the operational environment during normal operations or in the instance of a malfunction or failure.
- c)* For internal structure inspections, it is recommended that the RIV possess a protection component to minimize damage to the structure and coatings (e.g., propeller guards).
- d)* The RIV should have critical component redundancy in the case of a malfunction or failure (e.g., motor, battery, controller, etc.).
- e)* The RIV should have multiple operational modes (e.g., GPS mode, height mode and manual mode) in the case of a malfunction or failure.
- f)* For UAVs, the propeller mounting method should prevent accidental detachment.
- g)* The UAV should have capabilities for emergency landing, returning to its recovery zone, and keeping the same location after losing communication link.
- h)* The remote inspection Service Provider should have a fatigue management program for its pilots. It is recommended that the daily operating time for each pilot be limited to eight hours, and the continuous operating time for each task be limited to three hours.

ii) Operability:

- a)* The RIT system should have a control station that allows the pilot to easily operate the RIV.
- b)* The RIV should have onboard localization and navigation modules (e.g., GPS for external inspection).
- c)* The RIV should provide sufficient lighting, especially for internal tank inspection and/or during night time operation.
- d)* The RIV should operate for an amount of time adequate enough to conduct the inspection (e.g., sufficient battery life).

- e) The maximum operating range of the RIV should be accurately defined (e.g., in terms of flight height/tether length/depth rating, distance from the pilot).
 - f) The functionality of the selected RIV type should have been tested by the OEM.
 - g) Dimensions of the RIV allow for access and navigation within the intended space (e.g., manhole, opening to small confined spaces, size of the openings, and structural limitations within the space, etc.).
 - h) The RIT system should provide and maintain an interference-resistant communication channel.
 - i) The RIT system should include reliable connectivity to equipment to maintain constant communication among team members during operations.
 - j) The UAV has onboard flight control modules that allow for the maintenance of stable and accurate positions.
- iii) *Acquisition, Review and Security of Remote Inspection Technology Data:*
- a) Integrity of the raw data should be maintained during the data storage process.
 - b) Related metadata of the raw data should be captured and stored properly.
 - c) The raw data and related metadata should be stored separately from any post-processed data.
 - d) The RIV should have an onboard camera that provides adequate visual quality of still images, live-stream videos, and recorded videos. It is recommended the camera possess High-Definition (HD) resolution (e.g., 4K resolution for still images).
 - e) If applicable, the RIV may have onboard sensors that can provide additional information such as geo-tag information, anomaly measurement (e.g., crack length measurement and corrosion area measurement), thermal imaging, and 2D/3D modeling.
 - f) The RIT system should include an appropriate platform to display and replay visual data on location for the owner/Surveyor, including still images, live-stream videos, and recorded videos.
 - g) All frequencies used to support safety-critical functionality should be coordinated and licensed in accordance with the appropriate licensing regime, as applicable.
 - h) The remote inspection Service Provider should have data security policies and procedures in place to verify that the data collected during the inspection and any data analyses are captured, transmitted, and stored in a secure way that has minimum vulnerability to unauthorized manipulation and distribution.

11.1.2 Battery Handling

If the RIV is powered by a battery, the remote inspection Service Provider should have procedures in place for the proper handling of RIV batteries, including the following:

- Battery tracking system identifying the use, replacement, and performance of the batteries.
- Battery transportation and storage including safe charging and safe disposal.

11.1.3 Tether Handling

If the RIV is powered by a tether/cable, the remote inspection Service Provider should have procedures in place for the proper handling of tethers/cables, including the following:

- It is recommended that there is an additional camera for monitoring tethers/cables.
- An alternative plan should be in place to address tangled tethers/cables.

11.1.4 Maintenance

It is recommended that the Service Provider provides maintenance training to their designated personnel. Adequate knowledge of pre-operation assembly and checkup, post-operation disassembly, handling, transport, and storage are essential to deliver safe, effective, and efficient service.

It is recommended that the Service Provider follows the maintenance processes and procedures provided by the OEMs. Where no maintenance guidance is available from the OEMs, the following criteria should be considered:

- i) *Calibration:* Equipment should be calibrated on a regular basis for its fitness-for-service.
- ii) *Hardware Check:* Blades, motors, wires, and other fixed components should be checked, cleaned, and renewed/replaced if needed.
- iii) *Software Check:* Any software updates or changes should be documented as part of the maintenance procedures.
- iv) *Swappable Payload Check:* Swappable modules should be checked for loose connections. Module functions should be checked and calibrated.
- v) *Battery:* Inspections for capacity and thermal runaway should be conducted regularly.

A logbook (or log entries) should be maintained for each type of maintenance activity. It is recommended the logbook include all pre-operation and post-operation inspection records, and a record of any malfunctions (e.g., loss of link), anomalies, and parts needing replacement.

11.3 Personnel

The remote inspection Service Provider should utilize competent personnel to perform remote inspection related services.

Depending on the nature of the job, different training programs should be provided by the remote inspection Service Provider to their operators. If recognized national/local authorities have qualification and training requirements, these should be considered as minimum standards. In addition to the applicable statutory and regulatory requirements, the remote inspection Service Provider is recommended to have mandatory standard requirements for the qualification and training/re-training of its personnel.

When the RIV is equipped with a Nondestructive Examination (NDE) tool, the operator should be qualified and certified in accordance with the *ABS Guide for Nondestructive Inspection for Hull Welds*.

11.3.1 Safety Awareness

Safety awareness training should be part of the Service Provider's SMS. The objective of this training should be to confirm that the personnel in the field can execute the inspection safely, not only in regard to themselves but also to the asset and the environment, and should also include any national, local, or industry recognized requirements (e.g., Safety and Environmental Management Systems (SEMS) from Bureau of Safety and Environmental Enforcement (BSEE)). Where no such requirements are applicable, the Service Provider should provide safety training to the designated personnel including, as applicable:

- i) Personal protective equipment (PPE) training
- ii) Dropped object awareness training
- iii) Confined space entry and safety practice
- iv) Hazardous area identification and safety practice
- v) Maritime emergency response and evacuation training
- vi) Basic Offshore Safety Induction and Emergency Training (BOSIET)

11.3.2 Supervisor Proficiency

A supervisor is the person who oversees the pilot, who controls the RIV. The supervisor is certified according to the recognized national requirements or an equivalent standard and has a minimum of two years' experience in the inspection of marine and/or offshore structures.

11.3.3 Pilot Proficiency

A pilot is the person in direct control of the RIV. Pilot proficiency in remote inspection operations can affect the safety of onsite personnel and the asset that is being inspected. If applicable, the pilot should meet statutory and regulatory operation training requirements to maintain their pilot license.

In addition to the statutory and regulatory requirements, the Service Provider should place a high level of emphasis on pilot proficiency through training. The following are recommended:

- i) The pilot should have formal training in the minimum Rule requirements for the structure of relevant ships or asset types, the recognition of structural deterioration (including corrosion, buckling, and deteriorated coatings), and use of the reporting system.
- ii) The pilot should have sufficient flight/ground/underwater experience so that expected or observed extreme scenarios (i.e., weather condition changes, functional loss, operation with extra PPE, etc.) can be foreseen and accounted for.
- iii) The pilot is qualified and licensed in accordance with applicable national requirements or an equivalent industrial standard and has at least one year's experience as an assistant in the inspection of marine and/or offshore structure (including participation in a minimum of five different assignments).

11.3.4 Inspection Knowledge

If the remote inspection Service Provider's personnel are not sufficiently familiar with basic maritime and/or offshore asset designs, training should be provided. This training should include maritime and/or offshore nomenclatures in order to communicate effectively with the asset Owner/Operator and/or the attending Surveyor during the inspection.

Personnel should have working knowledge of applicable Rules, Guides, and guidelines (such as the *ABS Rules for Survey After Construction (Part 7)*, Part 7 of the *ABS Rules for Building and Classing Mobile Offshore Units*, the *ABS Guide for Means of Access to Tanks and Holds for Inspection*, and IACS Recommendation No. 42, UR Z7, and UR Z17).

11.3.5 Fatigue Management

It is recommended that the Service Provider have a Fatigue Management System in place to help prevent work incidents related to fatigue. The Fatigue Management System should aim to:

- Increase the personnel's understanding of the need to be fit for duty.
- Create safe working environments and operations by eliminating or minimizing hazards associated with fatigue.
- Utilize fatigue avoidance and mitigation strategies or countermeasures for identified hazards which are to be implemented, where possible, to help manage fatigue risk and related issues.
- Incorporate fatigue management in the Service Provider's ongoing risk assessment and hazard monitoring processes.

11.5 Documentation

The remote inspection Service Provider should have an organized documentation system to confirm that service-related records are well maintained. It should include, but is not limited to:

- i) Documentation of the organizational and management structure.
- ii) *Statutory and Regulatory Certificates*: Required certificate of authorization from recognized national/local authorities or according to an equivalent industrial standard.
- iii) *Equipment Registry*: The Service Provider should obtain a registry of each operational device with OEM specifications, serial number, technical bulletins, software versions, and hardware alteration and customization history.
- iv) *Training/Retraining Record*: The training/retraining record should include all applicable information of personnel in terms of personal portfolio, training hours, dates, scores, and other company-specified categories.

- v) *Operations Logbook*: The Service Provider should maintain a logbook to record all applicable operational information such as operation date, time, duration, malfunction incident, accident, etc.
- vi) *Operations Manual*: The Service Provider should have operations manuals for each RIV detailing the operating environments, inspection planning and procedures, as well as pre-operation checks and operational procedures.
- vii) *Maintenance Logbook*: The Service Provider should maintain a logbook to record maintenance activities, calibration certificates, and software revision for each device and payload module.
- viii) *Safety Assessment Plan*: The remote inspection Service Provider should have a documented plan in place that details how to assess potential risks and hazards, corresponding mitigation plans, and emergency procedures for response, escape and evacuation.

13 Liability

It is recommended that the remote inspection Service Provider maintain a third-party liability insurance in case of any accidents or incidents.

15 ABS Recognized External Specialist Program

ABS Recognized External Specialists are approved Service Providers that perform services on behalf of an equipment manufacturer, shipyard, asset owner, or other client in connection with classification/statutory surveys. The inspection results provide supporting information regarding classification and/or statutory survey decisions.

The best practices related to management systems (e.g., QMS, SMS, MoC) in this section (Section 3) are based on ABS' experience and are considered recommendations and not necessarily requirements to become an ABS Recognized External Specialist.

For more information, refer to the ABS website www.eagle.org or contact Corporate ABS Programs at externalspecialist@eagle.org.



SECTION 4 Survey/Inspection Process

1 General

This Section provides guidance on the survey process when an RIT is employed during class-related activities for close-up survey (see Subsection 2/3). Similar guidance should also be used as a reference during owner self-inspection activities.

3 Operational Limitations

There are several potential limitations to using RIT as a sole means of inspection. During remote inspection operations, various conditions may be identified that could require the use of different inspection techniques or methodologies. These conditions include, but are not limited to:

- i) The inspection reveals damage that requires immediate attention.
- ii) The inspection reveals deterioration that requires immediate attention.
- iii) The review of the data captured does not allow for a meaningful examination (e.g., condition or color of tank coatings).
- iv) The inspection area/tank surface is not clean and covered by mud, grime, or marine growth.

If any of the above conditions are found to exist, additional surveys or inspections using conventional techniques may be required for a proper assessment.

Additionally, there are instances where remote inspections are not appropriate, such as when historical records indicate abnormal levels of deterioration or damage to the areas of interest.

For operational limitations specific to each RIV, see Section 4, Table 1 below:

**TABLE 1
Operational Limitations of RIV**

	<i>UAVs</i>	<i>ROVs</i>	<i>Robotic Crawlers</i>
Operational environment	In air	Underwater	In air and underwater
Operational limitations	<ul style="list-style-type: none"> • The ability and accuracy of thickness gauging requires additional development of UAV technology. • For external inspections, high wind speed, insufficient ambient light, rain and snow conditions, as well as inspection in shadow areas should be considered. • For internal inspections, the temperature inside the tank should be monitored to avoid overheating of the UAV equipment • Non-intrinsically safe UAVs should not be operated in hazardous locations. 	<ul style="list-style-type: none"> • The in-water visibility and the cleanliness of the hull below the waterline is to be clear and clean enough to permit a meaningful examination. For example, enclosed spaces may have sediments, which are easily stirred up by the ROV, reducing visibility. • For external inspection, the sea environment (e.g., strong ocean current, severe wave) should be monitored to avoid the loss of the ROV • The return route of the ROV should follow the entering route to avoid entanglement of the ROV's tether. 	<ul style="list-style-type: none"> • The in-water visibility and the cleanliness of the hull below the waterline is to be clear and clean enough to permit a meaningful examination. • The height limits of crawlers should take into consideration the weight of the tether. • Most crawlers have difficulty overcoming obstacles, marine growth or complicated structures over 5 cm (2 in.). • Non-intrinsically safe crawlers should not be operated in hazardous locations.

5 Survey/Inspection Planning

Proper preplanning, preparation and close cooperation between the attending Surveyor, asset owner/shipyard representatives, and the remote inspection Service Provider is an essential part of the survey/inspection process. For details about the roles and responsibilities of different groups, refer to Section 2, Table 1, “Roles and Responsibilities”.

Prior to the commencement of the survey, a survey planning meeting should be held between all parties to verify that the arrangements envisioned in the survey process are in place. A Survey Planning Document prepared by the asset Owner/Operator, with the inspection plan incorporated, should be provided to the attending Surveyor for review and agreement.

The following topics should be addressed during the meeting and included in the Survey Planning Document.

5.1 Scope

The following information should be considered in the Survey/Inspection Planning scope:

- i) Type and extent of survey (i.e., close-up survey/CVI, Annual Survey, Intermediate Survey, Special Periodical Survey, damage survey, etc.).
- ii) Asset type, operational details, and other asset general information
- iii) Arrangements for the attending Surveyor and third-party specialist to perform confirmatory inspections by conventional means and thickness measurements (i.e., safe access, cleaning/de-scaling, illumination, ventilation, etc.).
- iv) Location and anticipated timeframe for the survey, as well as operational status of the asset (i.e., shipyard, repair facility or lay berth, etc.).
- v) Logistics, including permissions from local authorities, site permissions, work permits, transportation, accommodations, etc.
- vi) Risk assessment (4/5.3), RIV operations plan (4/5.5), and Classification External Specialist certificate number of Service Provider.

5.3 Risk Assessment

A case-specific risk assessment should be carried out to identify any hazards related to any planned remote operations and the need for risk control measures. It is recommended that this risk assessment be finalized during the survey planning meeting and incorporated in the Survey Planning Document. Each party should acknowledge the risks associated with the remote inspection activities and agree to the mitigation plan associated with those risks.

Risk assessment should include, but is not limited to:

- i) *Explosion Risks in Hazardous Areas:* If the remote operation is proposed within a hazardous area, the RIT system should be rated for the intended classification level or the area should be made safe for the equipment. The remote inspection Service Provider should refer to the asset’s Hazardous Area Plan for area identification and follow the Owner/Operator company-specified safe operation requirements if applicable. Typical factors to consider include, but are not limited to:
 - *Payload:* Risks associated with the motor, camera, or other onboard modules
 - *Battery:* Risks associated with battery storage, usage, change out, and recharge
 - *Operations:* Risks associated with operational incidents/accidents
- ii) *Dropped Object Risks:* In the event the RIV fails or malfunctions, it can become a dropped object hazard and become a danger to onsite personnel or the asset. Example dropped object factors to consider include, but are not limited to those in Section 4, Table 2:

TABLE 2
Example Dropped Object Risks for Each RIT Type

<i>UAVs</i>	<i>ROVs</i>	<i>Robotic Crawlers</i>
<ul style="list-style-type: none"> • Launch/recovery zones • Fly-by or inspection areas occupied by people • Fly-by or inspection areas occupied by safety critical equipment or systems 	<ul style="list-style-type: none"> • Launch/recovery zones • Launch and recovery system (LARS) components (e.g., crane, winch, wires) • ROV shackle or hooks • Disconnection of tether(s) 	<ul style="list-style-type: none"> • Launch/recovery zones • Areas where the asset is climbing structures • Inability to overcome obstacles • Disconnection of tether(s)

For consequence severity to personnel safety caused by a potential dropped object (in this case, the RIV or its payload), please refer to the DROPS calculator in the *ABS Guide for Dropped Object Prevention on Offshore Units and Installations*.

- iii) *Collision Risks:* Collisions may occur due to unexpected change in the inspection environment, RIV malfunction(s), and/or human errors, including:
- Collisions with other RIVs in operation, asset structures, operating machinery, or animals (e.g., birds, fish).
 - Collisions due to device communication interference or unexpected malfunction of the RIT system.
 - Collisions of UAV where visual line of sight (VLOS) is not maintained or upon unexpected interruption of pilot operation.
- iv) *Lost Link Risks:* Communication control links could be lost when a UAV is operated in an unreliable radio frequency (RF) environment or if nearby systems interfere with the UAV's RF. It is recommended to consider a spectrum or Receiver Autonomous Integrity Monitoring (RAIM) analysis to determine frequency strength, integrity and areas of possible interference. Typical factors to consider include, but are not limited to:
- Sources of possible radio frequency (RF) interference such as microwave antennas and high voltage lines
 - Sources of possible electromagnetic disturbances of a GPS signal such as large steel structures in close proximity to each other
- v) *Other Risks:* Other risks should be identified in terms of personnel health and safety, including:
- High-risk working areas that may contain high voltage, toxic gases, or hazardous contents
 - Risk associated with other ongoing operations in the area during RIV operations
 - Emergency scenarios requiring evacuation from the asset

For further guidance on risk assessment techniques, refer to the *ABS Guidance Notes on Risk Assessment Application for the Marine and Offshore Oil and Gas Industries*.

5.5 RIV Operations Plan

An RIV operations plan should be developed and agreed upon by all parties at the planning stage. It is recommended that the RIV operations plan be prepared by the remote inspection Service Provider and the owner/operator/shipyard. The plan should be developed based on the survey work scope and requirements as well as the asset's Hazardous Area Plan.

The Service Provider should check with national/local authorities for any required RIV operations plan submissions or approvals needed prior to any RIV operations.

It is essential to the survey process to establish a video replay/image reviewing protocol. Experience has shown that recorded image quality (including stability and clarity) can be significantly better than the live-stream video displayed during operation. In addition to the Surveyor's real-time monitoring of RIT activities, a protocol should be established and agreed upon by all parties to determine when and where the video/pictures should be reviewed and when the results of the survey will be determined.

In addition to the video replay/pictures reviewing protocol, a typical RIV operations plan scope should contain at least the following information:

- i) *RIV Operations Team:* It is recommended that the RIV operations team consist of at least three persons:
 - *Pilot:* Responsible for direct control of the RIV to maintain operation stability and accuracy.
 - *Camera/Payload Operator:* Responsible for direct control of the onboard camera and other intended modules to collect the data and coordination with the Surveyor.
 - *Designated Safety Watch:* Responsible for monitoring any potential safety hazards that may arise, and is empowered to abort the operation in the event of perceived or actual safety hazards.

- ii) *Equipment Selection and RIT Method:*
 - *Planned RIV Type and Specifications for the Intended Survey:* Verify the capabilities of the selected RIV(s) are appropriate for the survey being conducted.
 - *Planned RIV Limits:* Identify the selected RIV operating limitations and restrictions.
 - *Planned Procedure for Bringing RIV(s) and Equipment into the Survey Site/Country:* Identify the national/local authorities' requirements to bring RIV(s) and equipment into/out of the survey site/country.
 - *Planned Launch/Recovery Zones:* Select potential locations for launch/recovery based on the supporting information provided by the asset Owner/Operator.
 - *RIV Operation Routes, Maps, or Diagram:* RIV operation routes, maps, or diagram should be developed to maximize the effectiveness and efficiency of the remote inspection for the intended structure based on the work scope and requirements.
 - *Planned Distances from the Structure:* Altitudes, depths, and distances should be determined based on local regulatory requirements and safety consideration.
 - An emergency RIV operation plan should be in place in case of an environmental change, malfunction of the RIV system, loss of link incident, or total loss of the RIV.
 - An incident response checklist should be in place which should be followed after an incident or accident.
 - Night operations may be considered if the operator provides a safety case and sufficient risk mitigation to avoid collision hazards at night (e.g., provide proper lighting to assist external operations at night).
 - Distraction Management Strategies should be developed to reduce the communication sources during the operation to keep RIV pilots' attention focused. It is also recommended that all information be filtered or prioritized, and only essential/accurate messages pass to RIV pilots.
 - Before external inspection using a UAV, a Notice to Airman (NOTAM) should be filed by the Service Provider for any potential affected airspace, as necessary.

- iii) *Communication Method:*
 - Means for reliable and constant communication should be provided and maintained between all the RIV operations team members throughout the operation.
 - A communications protocol between the attending Surveyor and RIV operations team should be established (e.g., RF setup).
 - An understanding of the survey procedural process and terminology between the attending Surveyor and RIV operations team should be maintained.
 - An intermediary (e.g., camera/payload operator) between the attending Surveyor and the pilot should be present.

- iv) *Data Viewing Capability:*
 - Means for real-time data display.
 - Means for video data replay/pictures reviewing.
- v) *RIV Operations – Modifications:* Any changes to the RIV operations methodology should be agreed upon by all parties, such as:
 - The appropriate time for proposing a change to any RIV operations methods (e.g., during the operation, between operations or after data review).
 - The intermediary (e.g., camera/payload operator) on the RIV operation team to whom changes will be proposed.

7 Remote Inspection Vehicle (RIV) Operational Considerations

7.1 Pre-operations

On the date of field operations, but before the commencement of the RIV operations, it is recommended that a short briefing session and job safety analysis (JSA) be held for all participating personnel addressing, at a minimum, the following items:

- i) Confirm the work scope of the intended RIV operations and survey/inspection plans.
- ii) Assess the field condition and determine if any amendments to the RIV operations plan are necessary.
- iii) Verify the responsibilities of all personnel, including the representatives from Owner/Operator, ABS Surveyor and RIV operations team.
- iv) Review identified risks and associated mitigation plans.
- v) Review the emergency escape/evacuation plan.
- vi) Review permit to work requirements.
- vii) Review RIV maintenance records to verify that pre-operations and periodic inspections are up-to-date and the RIV is seaworthy/airworthy in all respects.
- viii) Review weather forecast to determine the meteorological conditions (e.g., wind speed, waves, ocean current, rain, etc.) for external inspections.
- ix) Verify proper personal protective equipment (PPE).
- x) Confirm the inspection area/tank surface is clean and devoid of mud, grime, and marine growth.
- xi) For ROV, confirm the enclosed space free of sediments which may be easily stirred by the ROV to reduce the visibility.

Any party should have the authority to immediately abort the operation at any time if deemed necessary.

Further guidance on JSA can be found in the *ABS Guidance Notes on Job Safety Analysis for the Marine and Offshore Industries*.

7.3 In-operation

The remote inspection Service Provider should possess an organizational Standard Operation Procedure (SOP) for each RIV operation. The following action items are recommended to be included in the SOP, at a minimum:

- i) *Checklist Clearance:* The checklist should contain relevant system checks, inspection condition checks, personnel readiness checks, communication equipment checks, and testing RIV operation checks (e.g., flight for UAV, magnetic capability for crawler, underwater operation for ROV).
- ii) *RIV Launch and Recovery Zones:* For typical restrictions of launch and recovery zones to be considered, see Section 4, Table 3, below:

TABLE 3
RIV Launch and Recovery Zones

<i>UAVs</i>	<i>ROVs</i>	<i>Robotic Crawlers</i>
Launch and recovery zones should be identified, and access should be restricted. It is recommended that the designated landing zone(s) remain clear of any personnel and obstacles during the inspection process in case of any unexpected lost-link incidents.	Launch and recovery zones should be identified, and access should be restricted. It is recommended that the designated launch and recovery zones remain clear of any personnel during the inspection process to avoid tripping hazards of tethers.	Launch and recovery zones should be identified, and access should be restricted. It is recommended that the designated launch and recovery zones remain clear of any personnel during the inspection process in case of any unexpected dropped crawlers and modules.

- iii) *Communication:* If the communication signal is lost or experiences significant interference, the operation should be aborted immediately. The time and duration of each lost-link event should be recorded by the RIV operations team and reported through the incident reporting system in Safety Assurance.
- iv) *Documentation:* Whenever conditions that do or may affect Classare found during operations, reference data (i.e., still image capture, location and orientation in relation the vessel, etc.) should be properly documented for final reporting and be documented in the operations and maintenance logbooks.
- v) *Visual Line of Sight (VLOS) for UAVs:* Some aviation authorities require human direct and unaided VLOS be maintained throughout the operation. It is recommended that VLOS be maintained even if no regulatory requirement applies. Extended VLOS (EVLOS) or beyond VLOS (BVLOS) can be accepted upon agreement by all parties when no regulatory requirements apply.
- vi) *De-confliction for UAV:* Procedures should be in place so that adequate de-confliction with helicopters or surface vessels servicing the asset is achieved (e.g., There should be no UAV operations for external inspection within 30 minutes prior to scheduled helicopter activities).

The attending Surveyor should be present and direct the RIV operations team, as needed, with regard to the survey requirements.

7.5 Post-operation

- i) *Logging:*
 - RIV operational details should be logged, including time of launch, duration of the operation, time of recovery, and the type of work completed.
 - Maintenance or technical adjustments conducted during the operation should be documented.
 - Any accidents or near misses observed during the operation should be documented and reported to all parties so that the decision to abort the work or other adjustments can be made in a timely manner. If it is required by local laws and requirements (e.g., USA FAA, UK CAA, etc.), the incident or near miss may also need to be reported to local regulatory authorities.
- ii) *Maintenance:*
 - Post-operation maintenance may be required according to the OEM instructions and should be completed immediately after RIV operations, as applicable.
 - Maintenance should be performed safely and efficiently to minimize the impact to onsite personnel and the asset.
- iii) *On-site Battery Handling:*
 - Battery checks should be conducted and documented to confirm the reliability of the battery’s safety and endurance for the next operation.
 - Batteries should be clearly marked for maintenance and recharged.

- Batteries should be stored and recharged in fire proof containers.
- Transportation of the batteries should comply with applicable regulations and work site requirements.
- Damaged or underperforming batteries should be removed from service.

9 Data Review

Digital data is to be reviewed in real-time and/or submitted to the attending Surveyor as agreed in the survey planning stage. The following criteria should be considered to evaluate the visual data collected by a RIT system:

- i)* Image (picture and video) quality should be adequate to make a meaningful assessment of the structure condition and to identify possible anomalies which may affect Class or the crediting of a Class Survey. Potential factors affecting image quality include:
 - Poor image resolution (see 3/11.1.1)
 - Image out of focus
 - Occluded camera lens (e.g., rain, snow, dust, on lens)
 - Inadequate lighting (see 3/11.1.1 and 4/5.5)
 - Unstable RIV (see 3/11.1.1 and 4/5.5)
 - Dark or shadowy areas (see Section 4, Table 1)
 - Glare from strong lights or the sun
 - Grime, mud, or marine growth on tank surface (see 4/7.1)
 - Reduced visibility from sediments inside enclosed space stirred up by ROV (see 4/7.1)
 - Lost connectivity between RIV and on-site video monitors (e.g., stuttering frame rate or inconsistent stream speed)
- ii)* If an anomaly is suspected or determined to affect Class or the crediting of a Class Survey, the image quality should enable the Surveyor/Inspector to further identify the nature, severity level, and approximate dimension (if applicable).
- iii)* Video footage, live-streaming and recorded data, should be uninterrupted. In the case of any breaks, gaps, or interruptions in the data, the Surveyor and owner/operator should be notified. The date and time are recommended to be stamped on images (picture and video)
- iv)* Structural member identification data should be collected, especially associated with anomalies affecting Class, in a way that such data can be tracked afterwards.

As agreed upon by all parties during the planning stage, recorded data is to be available for Surveyor review:

- i)* On-site so that additional RIV operations can be made if necessary, or
- ii)* Off-site within a specified time period so that additional RIV operations or other alternative inspection methods can be arranged if necessary.

Proper equipment should be arranged by the asset Owner/Operator and the Service Provider to enable the attending Surveyor to review the data. The Surveyor may require additional inspections using other alternative or traditional inspection techniques depending on the conditions found and results of inspection.

11 Data Post-Processing

Some remote inspection Service Providers offer post-processing of data for further evaluation after the remote inspection. Advanced post-processing techniques may include:

- i)* Advanced image processing to perform anomaly measurement (e.g., crack dimension measurement, corrosion area measurement, or space volumetric measurement)
- ii)* Artificial intelligence for pattern recognition of cracks, fractures, or corrosion
- iii)* Data analytics for anomaly trending and prediction
- iv)* 3D model generation for data integration and reporting

These enhanced post-processing techniques can be particularly beneficial for an asset where life expectancy is important, such as those engaged in site-specific operations. The use of the post-processing of data is at the discretion of the Owner/Operator. However, if such post-processing data reveals conditions which can or do have an immediate impact on Class and were not identified during the survey, ABS is to be notified.

13 Reporting

The remote inspection Service Provider should prepare a report which identifies the asset and structure inspected. Any descriptive information associated with the class survey should be factual and objective. If the asset Owner/Operator has contracted the remote inspection Service Provider to provide additional data, technical support or recommendations outside the scope of the class survey, such information should be provided in a separate report.

The report submitted to ABS is to include:

- i)* General particulars of the asset, including asset name, Classification identification number, port of registry, and year of build.
- ii)* Survey information, including survey type and cycle number, locations of the structure or space that was surveyed, and inspection results (satisfactory, further inspection required, or repair required). The recorded inspection result is at the discretion of the Surveyor. The specific inspection areas identified in the Survey Planning Document should be detailed in the report.
- iii)* Remote inspection Service Provider's information, including company name, Classification External Specialist certificate number, RIV operation team members' names, the RIV model name used during the survey, and dates of inspection.
- iv)* Details of the RIV operation record, including launch time, operation period, and recovery time.
 - a)* Any digital data (e.g., pictures and videos) supporting the crediting of class-related activities.
 - b)* Each inspection report is to be endorsed by the Service Provider technician, Owner and Surveyor.
 - c)* Video should be uninterrupted. Any breaks, gaps, or interruptions in the video, should be documented in the report.

A sample of inspection report using RIT is shown in Appendix 4.

If the review of the data reveals any condition that is not identified at the time of the survey and affects or may affect classification, the Owner/Operator should advise ABS as required by the ABS Rules.



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20. *ABS Guide for Means of Access to Tanks and Holds*, Houston, TX, United States, 2016
21. *ABS Guide for Dropped Object Prevention on Offshore Units and Installations*, Houston, TX, United States, 2017
22. *ABS Guide for Building and Classing Floating Offshore Wind Turbine Installations*, Houston, TX, United States, 2015
23. *ABS Guide for Building and Classing Bottom-founded Offshore Wind Turbine Installations*, Houston, TX, United States, 2015
24. *Unmanned Aircraft Systems (UAS) Operations Management Standards and Guidelines*, Oil & Gas UK, London, United Kingdom, 2017
25. *Unmanned Aerial Systems Guidelines, Helicopter Safety Advisory Conference (HSAC), HSAC RP UASRP 15-1*, United States, 2015



APPENDIX 2 Remote Inspection Vehicle (RIV) Standards

1. ASTM Standard F2910-14: Standard Specification for Design and Construction of a Small Unmanned Aircraft System (sUAS)
2. ASTM Standard F2911-14: Standard Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS)
3. ASTM Standard F3002-14a: Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)
4. ASTM Standard F3178-16: Standard Practice for Operational Assessment of Small Unmanned Aircraft System (sUAS)
5. API Recommended Practice 17H: Remotely Operated Tools and Interfaces on Subsea Production Systems



APPENDIX 3 Checklist for Asset Owners/Operators

This Appendix contains a checklist providing suggestions and recommendations for the Asset Owners/Operators in decision-making during different stages of the RIT inspection process. The four stages include: 1. Inspection Objective, 2. RIV Selection, 3. Inspection Plan & Operation, and 4. Post-Processing.

Note that some of the capabilities contained in the checklist have not been covered in the Guidance Notes, as they are either:

1. Out of scope of the current Guidance Notes (e.g., not class-related), or
2. The Technology is still in the testing and evaluation stage and not available for use in the marine/offshore industry at this time.

Stage 1: Inspection Objective				
General Description				
Inspection Type	Owner Self-Inspection		<input type="checkbox"/>	
	Class-related Inspection		<input type="checkbox"/>	
ABS Recognized External Specialist	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
Local Requirements and Regulations:				
Purpose of the Inspection:				
	Gross General Inspection	<input type="checkbox"/>	Detailed Inspection	<input type="checkbox"/>
Type of Data Needed				
Data Type	Y/N	Required Resolution		
a. Still Image	<input type="checkbox"/>			
b. Full Motion Video	<input type="checkbox"/>			
c. Recorded Video	<input type="checkbox"/>			
d. Real-Time Video	<input type="checkbox"/>			
e. Ortho-photomap	<input type="checkbox"/>			
f. 3D Model Scanning	<input type="checkbox"/>			
g. Material Property	<input type="checkbox"/>			
h. Meteorology Data	<input type="checkbox"/>			

Stage 2: RIV Selection					
Type of Sensor/Payload					
In Situ Sensing		Y/N	Comments		
a. Thickness Gauging		<input type="checkbox"/>			
b. NDE Detector		<input type="checkbox"/>			
c. Meteorological Sensors		<input type="checkbox"/>			
d. Chemical Sensors		<input type="checkbox"/>			
e. Biological Sensors		<input type="checkbox"/>			
f. Microphones		<input type="checkbox"/>			
Remote Sensing					
a. High Definition (HD) Cameras		<input type="checkbox"/>			
b. Visible Spectrum Cameras		<input type="checkbox"/>			
c. Near-Infrared Cameras		<input type="checkbox"/>			
d. Long-Wave Infrared Cameras		<input type="checkbox"/>			
e. Multispectral/Hyperspectral Cameras		<input type="checkbox"/>			
f. Light Detection and Ranging (LiDAR)		<input type="checkbox"/>			
g. Synthetic Aperture Radar (SAR)		<input type="checkbox"/>			
Tools on Vehicles					
a. Cleaning		<input type="checkbox"/>			
b. Object Retrieval		<input type="checkbox"/>			
c. Measurement on mooring chain dimensions (ROV)		<input type="checkbox"/>			
d. Paint & Coating		<input type="checkbox"/>			
Type of ROV					
1. ROV Categorization (<i>ABS Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities</i>)					
a. Class I (Pure Observation)	<input type="checkbox"/>	b. Class II (Observation with Payload Option)	<input type="checkbox"/>	c. Class III (Work Class Vehicles)	<input type="checkbox"/>
d. Class IV (Seabed-working Vehicles)	<input type="checkbox"/>	e. Class V (Prototype or Development Vehicles)	<input type="checkbox"/>		
2. ROV Parameters					
Hardware		Input	Comments		
a. Model					
b. Manufacture					
c. Serial Number					
d. Year Built					
e. Dimension (cm × cm × cm)					
f. Weight (kg)					
g. Design Operation Depth (m)					
h. Maximum Operation Depth (m)					
i. Maximum Allowable Working Pressures (MPa)					
j. Maximum Allowable Working Temperatures (°C)					
k. Hydrostatic Test Pressure (MPa)					
l. Maximum Tether Length (m)					
m. Tether Management System		<input type="checkbox"/>			
n. Emergency Recovery Features		<input type="checkbox"/>			
o. Emergency Locating Devices		<input type="checkbox"/>			

Appendix 3 Checklist for Asset Owners/Operators

p. Corrosion Protection	<input type="checkbox"/>				
q. Mechanical Protection	<input type="checkbox"/>				
r. Frames	<input type="checkbox"/>				
s. Lifting Lugs/Attachments	<input type="checkbox"/>				
t. Towing Attachments	<input type="checkbox"/>				
u. Variable Ballast Systems	<input type="checkbox"/>				
v. ROV Properly Protected in Storage	<input type="checkbox"/>				
w. Maintenances Record Checked	<input type="checkbox"/>				
Software	Input	Comments			
a. ROV Control Stations	<input type="checkbox"/>				
b. ROV Control Box	<input type="checkbox"/>				
c. Handling System	<input type="checkbox"/>				
d. System Testing Procedures	<input type="checkbox"/>				
Type of UAV					
1. Propulsion Types					
a. Fixed-Wing	<input type="checkbox"/>	b. Rotary-Wing <input type="checkbox"/>	c. Hybrid <input type="checkbox"/>		
2. UAV Size					
a. Mini UAV (≤ 5 kg)	<input type="checkbox"/>	b. Small UAV (5-25 kg)	<input type="checkbox"/>	c. Large UAV (>25 kg)	<input type="checkbox"/>
3. Energy Source					
a. Internal Combustion	<input type="checkbox"/>	b. Battery Cells	<input type="checkbox"/>	c. Fuel Cells	<input type="checkbox"/>
d. Solar Cells	<input type="checkbox"/>	e. Others	<input type="checkbox"/>		
4. Control Methods					
a. Manual Control	<input type="checkbox"/>	b. Stabilized Control	<input type="checkbox"/>	c. Automated Control	<input type="checkbox"/>
5. UAV Parameters					
Hardware	Input	Comments			
a. Model					
b. Manufacture					
c. Registration Number					
d. Dimension (mm × mm × mm)					
e. Weight (kg)					
f. Flight Endurance (min)					
g. Wind Tolerances (m/s)					
h. Top Speed (miles/hr)					
i. Visibility Limit (m)					
j. Telemetry Range (m)					
k. Maximum Flight Altitude (m)					
l. Control Frequency (Hz)					
m. Vertical Take-off Landing (VTOL)	<input type="checkbox"/>				
n. Contact Protection Cage	<input type="checkbox"/>				
o. Maintenances Record Checked	<input type="checkbox"/>				
p. Energy Source Maintenance Control Plan Available	<input type="checkbox"/>				
q. Airframe Maintenance Control Plan Available	<input type="checkbox"/>				
r. Avionics Maintenance Control Plan Available	<input type="checkbox"/>				
s. UAV Properly Protected in Storage	<input type="checkbox"/>				

Appendix 3 Checklist for Asset Owners/Operators

Software	Input	Comments
e. Measuring Tool	<input type="checkbox"/>	
f. Autopilot System	<input type="checkbox"/>	
g. Attitude Stabilization System	<input type="checkbox"/>	
h. GPS System	<input type="checkbox"/>	
i. Waypoint Flight Planning	<input type="checkbox"/>	
j. Collision Avoidance Sensor	<input type="checkbox"/>	
k. Backup Manual Controls	<input type="checkbox"/>	
l. Real-time Data Telemetry	<input type="checkbox"/>	
m. Operate Without Payload	<input type="checkbox"/>	
n. Cyber Security System	<input type="checkbox"/>	
o. Software System Testing Procedures	<input type="checkbox"/>	
Type of Crawler		
1. Propulsion Type		
a. Tracks	<input type="checkbox"/>	b. Wheels
		<input type="checkbox"/>
c. Others		
		<input type="checkbox"/>
2. Power Source / Communication Method		
a. Tether/Wired	<input type="checkbox"/>	b. Battery/Wireless
		<input type="checkbox"/>
c. Others		
		<input type="checkbox"/>
3. Crawler Parameters		
Hardware	Input	Comments
a. Model		
b. Manufacture		
c. Serial Number		
d. Year Built		
e. Dimension (cm × cm × cm)		
f. Weight (kg)		
g. Design Underwater Operation Depth (m)		
h. Maximum Underwater Operation Depth (m)		
i. Design Operation Height (m)		
j. Maximum Operation Height (m)		
k. Maximum Allowable Underwater Working Pressures (MPa)		
l. Maximum Allowable Underwater Working Temperatures (°C)		
m. Hydrostatic Test Pressure (MPa)		
n. Maximum Tether Length (m)		
o. Tether Management System	<input type="checkbox"/>	
p. Emergency Recovery Features	<input type="checkbox"/>	
q. Telemetry Range (m) for Wireless Communication		
r. Control Frequency (Hz) for Wireless Communication		
s. Maintenances Record Checked	<input type="checkbox"/>	
Software	Input	Comments
a. Crawler Control Stations	<input type="checkbox"/>	
b. Handling System	<input type="checkbox"/>	
c. Real-time Data Telemetry for Wireless Communication	<input type="checkbox"/>	
d. System Testing Procedures	<input type="checkbox"/>	

Stage 3: Inspection Plan & Operation			
Inspection Environment			
Inspection Location:			
Maximum Elevation from Waterline/Ground (m):		Maximum Inspection Distance (m):	
Number of RIV Operation Team Members		Expected Number of RIV Operations	
Marine Asset	<input type="checkbox"/>	Offshore Asset	<input type="checkbox"/>
Wind Turbine	<input type="checkbox"/>	Dropped Object Inspection	<input type="checkbox"/>
Internal Inspection	<input type="checkbox"/>	External Inspection	<input type="checkbox"/>
Hazard Identification & Risk Control			
Common	Y/N	Comments	
a. Clear Operation Space	<input type="checkbox"/>		
b. Open Launch & Recovery Space	<input type="checkbox"/>		
c. Sufficient Light	<input type="checkbox"/>		
d. Reachable Distance	<input type="checkbox"/>		
e. Hot Work Permit	<input type="checkbox"/>		
Potential Risk Environment			
a. Electro-Magnetic Interference	<input type="checkbox"/>		
b. Loss of Link	<input type="checkbox"/>		
c. Operation Location Access Controlled	<input type="checkbox"/>		
d. Operation Over People	<input type="checkbox"/>		
e. Confined Space	<input type="checkbox"/>		
f. Soft Coating	<input type="checkbox"/>		
g. Dusty Environment	<input type="checkbox"/>		
h. Windy Environment	<input type="checkbox"/>		
i. Foggy Environment	<input type="checkbox"/>		
j. Sunny Environment	<input type="checkbox"/>		
k. Raining Environment	<input type="checkbox"/>		
l. Wave Environment	<input type="checkbox"/>		
m. Current Environment	<input type="checkbox"/>		
Operator & Ground Crew			
a. Pilot Certificate	<input type="checkbox"/>		
b. Training/Re-training Records Available	<input type="checkbox"/>		
c. Familiarization with selected RIV Operation System	<input type="checkbox"/>		
d. Familiarization with Inspection Environment	<input type="checkbox"/>		
e. Previous Operation Experience	<input type="checkbox"/>		
Operation Procedures			
a. Survey Documentation Prepared	<input type="checkbox"/>		
b. Short Briefing Session and JSA Held	<input type="checkbox"/>		
c. RIV Operation Readiness Review Process	<input type="checkbox"/>		
d. Data Reviewing Protocol Established	<input type="checkbox"/>		
e. Communication Equipment Checked	<input type="checkbox"/>		
f. Loss of Link Procedures Available	<input type="checkbox"/>		
g. Landing/Recovery Procedures Available	<input type="checkbox"/>		
h. Emergency RIV Operation Plan Available	<input type="checkbox"/>		

Appendix 3 Checklist for Asset Owners/Operators

i. Distraction Management Program Available	<input type="checkbox"/>	
j. RIV Operation Management Program Available	<input type="checkbox"/>	
Stage 4: Post-Processing		
Post-Operations		
a. Post-Operation Inspection Completed	<input type="checkbox"/>	
b. RIV Operation Information Logged	<input type="checkbox"/>	
c. Hardware Adjustment Conducted during Operation Documented	<input type="checkbox"/>	
d. Software Adjustment Conducted during Operation Documented	<input type="checkbox"/>	
e. Incident/Near-miss during Operation Documented	<input type="checkbox"/>	
f. Accident/Near-miss during Operation Reported	<input type="checkbox"/>	
g. Data Analysis Procedures Available	<input type="checkbox"/>	
h. Data Validation Procedures Available	<input type="checkbox"/>	
i. The Purpose of Inspection Achieved	<input type="checkbox"/>	
j. Additional RIT Inspection Needed	<input type="checkbox"/>	
k. Additional Inspection Using Alternative/Traditional Inspection Needed	<input type="checkbox"/>	



APPENDIX 4 Sample of Inspection Report using RIT

This Appendix is a sample of inspection report using RIT. It illustrates the report-writing principles and practices discussed in Subsection 4/13.

INTERMEDIATE HULL SURVEY 3 – REMOTE INSPECTION

Remote Inspection Technology – Reporting details for use in close-up survey

General Particulars

1. Ship name: TANKER
2. IMO number: xxxxxxxx
3. ABS identification number: xxxxxxxx
4. Date of build: DD-MM-YYYY
5. Survey task and cycle number: Intermediate Hull Survey No.3
6. ABS report number: xxxxxxxxxx
7. Name of company providing remote inspection service: xxxxxxxxxx
8. ABS External Specialist Certificate No: xx-xxxxxxxxxx-x
9. Certificate valid from DD-MM-YYYY to DD-MM-YYYY
10. Place of inspection: xxxxxxxxxx
11. First date of inspection: DD-MM-YYYY
12. Last date of inspection: DD-MM-YYYY
13. Details of RIV and associated equipment:
 - RIV type and brand name / Serial No.: xxxxxxxxxxxxxxxxxxxx
 - RIV type and brand name / Serial No.: xxxxxx
14. Details of operator:
 - First Name Last Name / Pilot
 - First Name Last Name / Co-Pilot
 - First Name Last Name / Safety Watch
15. Name of operator, signature – First Name Last Name, DD-MM-YYYY
16. Name of surveyor, signature – First Name Last Name, DD-MM-YYYY
17. Name of owner's representative, signature – First Name Last Name, DD-MM-YYYY

Remote Inspection Areas

1. Details of areas inspected for survey credit and considered satisfactory
2. Details of areas identified requiring further inspection (traditional means of inspection)
3. Details of areas identified requiring repair

Space/Tank /Hold	Survey Plan Reference	Area (STBD, Center, Port)	Location (Frame, Strake, etc.)	Result – Satisfactory (SAT), Further inspection required (FIR), Requires repair (REP)
No. 1 COT	xxxxxxxx	STBD	Fr. 107, 108, 109, 112,114	SAT
No. 2 COT	xxxxxxxx	STBD	Fr. 99, 100, 101, 105,107	SAT
No. 3 COT	xxxxxxxx	STBD	Fr. 91, 92, 93, 97,99	SAT

Note:

The selection of any suspect areas or areas for inspection in addition to the Survey Plan is at the option of the Surveyor.

Videos and still images may be provided in a separate report for Owner. Videos or still images of any specific location are to be provided to the Surveyor on request for internal reporting.