INTER-AMERICAN TROPICAL TUNA COMMISSION

WORKSHOP OF AN ELECTRONIC MONITORING SYSTEM (EMS) IN THE EPO: TECHNICAL STANDARDS AND DATA COLLECTION PRIORITIES

4TH MEETING

(by videoconference)
12-14 December 2022

DOCUMENT EMS-04-01

TECHNICAL STANDARDS OF AN EMS

CONTENTS

1. INTRODUCTION AND BACKGROUND

The Inter-American Tropical Tuna Commission has acknowledged and endorsed that electronic monitoring (EM) is a promising tool for monitoring, addressing data gaps, and improving data collection for both purse-seine and longline vessels that do not carry onboard observers, as well as for observed vessel as an instrument to complement observer's data-collection (Resolution C-19-08; Document SAC-07-07f.i ; Gilman et al., 2019). Accordingly, per request of the Scientific Advisory Committee (SAC) during its 10th meeting in 2019, and pursuant to paragraphs 9 and 10 of Resolution C-19-08, the IATTC staff prepared for consideration by the Commission the document SAC-11-10 "*An electronic monitoring system for the tuna fisheries in the eastern Pacific Ocean: objectives and standards*". This document, which received positive feedback from several global experts on the matter, was presented at the SAC 11th meeting in 2020. However, because the meeting was held by videoconference and with time constraints, it was not possible for Members to provide in depth comments and suggestions. Thus, it was proposed that a workshop be held in 2021 to further discuss some of the elements described in SAC-11-10, as well the presentation of a workplan for the implementation of an EM system (EMS) in the eastern Pacific Ocean (EPO), which was provided in EMS-01-02-Rev. The Commission endorsed this concept during its 96th meeting (extraordinary) and agreed that the *1st Workshop on Implementation of an Electronic Monitoring System (EMS)* should be held in April 2021, before the SAC 12th meeting.

Prepared also for the 1st Workshop, the document EMS-01-01 recommended a number of actions for endorsement by the Commission. Among these was a workplan formulated by IATTC staff (EMS-01-02-Rev), which proposed a series of workshops to consider and analyze the EMS components and subcomponents in a hierarchical and chronological order. To provide structure for these workshops and

other activities related to the EMS implementation process, the staff also recommended the adoption of Terms of Reference (ToR) for the EM workshops and a set of working definitions. The associated TORs and a set of definitions were adopted through the Resolutions C-21-02 and C-21-03, respectively, during the 98th Meeting of the IATTC. The workplan was also adopted with a minor modification to show flexibility on a potential starting date for the EMS in the EPO (EMS-01-02-Rev).

Subsequently, during the *2nd Workshop of an Electronic Monitoring System (EMS) in the EPO: Institutional Structure, Goals and Scope of the EMS,* held virtually in December 2021, the IATTC staff addressed a number of organizational issues, rules and procedures relating to the institutional structure (document EMS-02-01) as well as to the goals and the scope of an EMS (document EMS-02-02 Rev) for tuna fisheries in the EPO which are subject for adoption by the Commission. A summary of the discussions from the 2nd Workshop is available here.

A *3rd Workshop of an Electronic Monitoring System (EMS) in the EPO: Management Considerations,* was held by videoconference in April 2022, where the IATTC staff focused on several subcomponents and considerations related to the management of an EMS: i) Coordination and Compatibility, ii) Confidentiality, iii) Compliance, iv) EM equipment, and v) EM coverage and review rate (document EMS-03-01). A summary of the discussions from the 3rd Workshop is available here.

This document was prepared for the 4th workshop of the series planned under the adopted EMS workplan (EMS-02-02 Rev), focusing on the technical standards (Figure 1), an important element of the EMS program infrastructure. Whereas this workshop will consider both technical standards and data collection priorities, aspects that will significantly impact the design and cost of an EMS program (i.e., financial considerations will be addressed in spring 2023), the current document will include the following technical subcomponents: i) cameras, ii) sensors, iii) data storage, iv) compatibility, v) malfunctions/tampering, vi) data encryption, and vii) EM equipment maintenance. The matters related to the data collection priorities are described in document EMS-04-02. Throughout the remainder of this paper, the IATTC staff presents, within a series of outlined text boxes, a number of preliminary recommendations on topics to be considered by the workshop. The preliminary nature of these recommendations deserves special emphasis. One of the primary purposes of this series of workshops on EMS is to facilitate discussions and generate ideas that will inform the formulations of future IATTC staff recommendations on EMS, recommendations from CPCs, and recommendation from other IATTC bodies like the SAC or the newly established *ad hoc* working group on EM (EMWG) (Resolution C-22-07). That is, these preliminary recommendations are intended to serve as starting points for stimulating discussion, and they are not intended to preempt or limit meaningful discussion or alternate approaches.

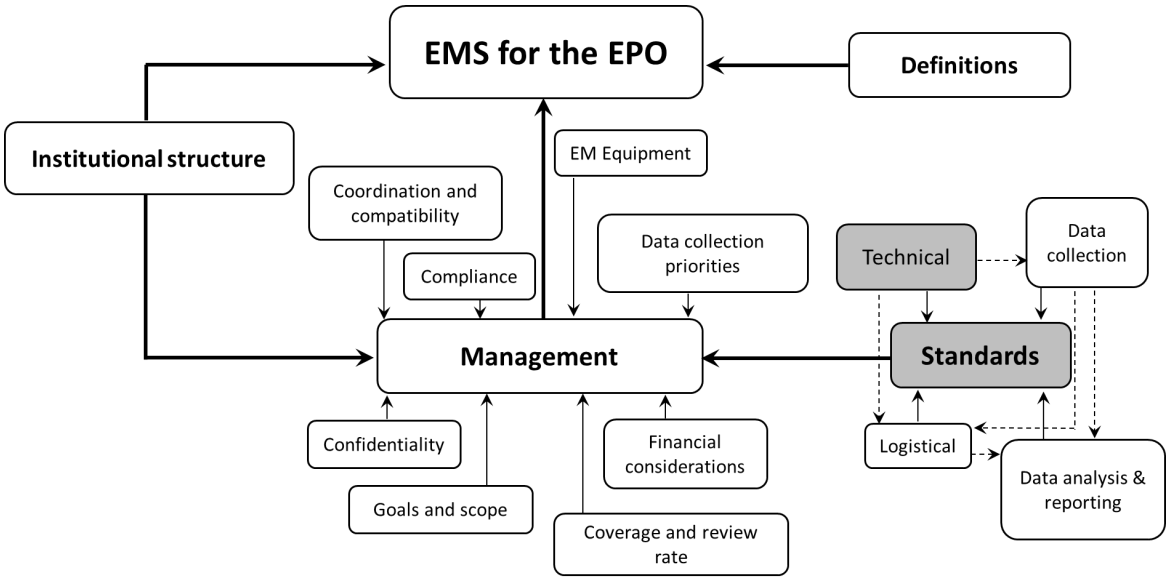

FIGURE 1. Structure of the EMS for the tuna fisheries in the EPO, emphasizing (in gray) the technical standards discussed in this document.

2. TECHNICAL STANDARDS OF AN EMS IN THE EPO

Technical standards cover the specifications for selecting, installing, operating and maintaining EM equipment (cameras, sensors, data storage devices, etc.) and the associated software aboard vessels. The standards need to be clear and specific, but also flexible enough to accommodate technological advances and changes in priorities, as well as the particular requirements of vessels of different sizes, gears, and fishing practices. In addition, and because no common standards have been adopted so far, an EMS would need to be capable of working with all existing hardware and software, and ideally adaptable to future technological developments.

Typically, EM equipment installed on board fishing vessels consists of a central processing control unit connecting sensors, cameras and a GPS receiver. The system software is developed to handle and control sensors and cameras and to store encrypted EM records and sensor data on retrievable hard drives or secured cloud storage. Because of the evolving nature of technology, the associated technical standards should be subject to periodical reviews as their performance depends critically, among others, on how the operating specifications or attributes of the technology are considered (van Helmond et al., 2020). Furthermore, the technical standards should also be flexible enough to ensure the objectives, goals and other components and subcomponents of the structure of the EMS of the EPO are effectively considered and implemented. In fact, some studies consider important that a regulatory strategy of an EMS program should focus on purpose and performance standards, and offer concrete guidance as to how the outcomes of an EMS program should be achieved without prescribing the specific means (e.g., specific technical attributes of EM equipment) of achieving them, so the technical standards can continue evolving, innovating, and merging without confinement to a defined or explicit classification of technology (Garren et al. 2021). Taking these elements into consideration, the first recommendation on technical standards is as follows:

The standards need to be purpose and performance oriented, flexible enough and periodically reviewed by the Commission to accommodate technological advances and changes in priorities, as well as the particular requirements of vessels of different sizes, gears, and fishing practices.

One issue to bear in mind is the potential incompatibility of current and future EM equipment from different manufacturers and service providers with some technologies, often developing in parallel (e.g., satellite echo-sounder buoys). In this regard, it is important to design mechanisms for standardization that guarantee the EMS is capable of working with all existing hardware and software, and ideally adaptable to future technological developments. Toward this end, it is recommended that:

> Unless (or until) common standards are adopted, the EM equipment installed should be capable of working with all existing hardware and software and be adaptable to future technological developments.

Cameras

Cameras are the heart of the EMS and the key component of the EM equipment that allows collecting all relevant fishing activities and related data. Although the number, the locations of cameras on the vessel and other settings will vary among vessels according to the vessel structure and design, fishing gear, size, etc., they should be sufficient in number and quality to meet the requirements of the EMS, in terms of both content and quality, and durable enough to withstand conditions at sea. In fact, at sea conditions can be rough and cameras must be resistant to these (e.g., IP66 rating; or IP68 for cameras exposed to rough weather conditions) and protected by a weather-resistant housing capable of being attached to different vessel structures.

> Cameras must be sufficient in number and quality to meet the data requirements of the EMS, with high-resolution images that allow the identification of species, specific fishing activities and the vessel's surroundings, and durable enough to withstand conditions at sea.

Cameras should be capable of recording both video and or still images in high definition (e.g., minimum resolution of 1920 x 1080; 2.1 MP), and with enough frames per second to enable species identification, as suggested by experts in the field. For instance, in the case of video, a minimum frame rate of 15 frames per second has been recommended in other fishery agencies (WCPFC Circ 2022-09; EFCA-Tech guidelines). For still images, Restrepo et al. (2018) found that, the interval between pictures should be no more than two seconds.

> Cameras should be capable of recording both video and still images, with a minimum frame rate of 15 frames per second (15 fps) and a minimum image capture interval of no more than 2 seconds, respectively.

At this time, the staff might not be in a position to make definitive recommendations about specific aspects of the EM equipment and its installation. However, the staff experience with the EM pilot projects, as well as other regional and global initiatives can serve as guidelines to provide rough information on what the cameras should cover, at a minimum. In the pilot study (SAC-10-12), the results of a survey of the operational characteristics of Class 1-5 purse-seine vessels were used to help determine the placement of EM equipment (e.g., size/infrastructure of the vessel, the identification of the key fishing activities, crew traffic or interference areas). Eight cameras were installed on each of the two Class-6 purse-seine vessels, six on the Class-5 vessels, and four on the Class-2 vessels (SAC-10-12) (Figures 2), with promising results. A similar survey could be done for Class-6 vessels, with general specifications for EM equipment and its installation then adapted to individual vessels or groups of vessels with similar operational characteristics (Ruiz et al. 2016). The equipment would need to record all relevant fishing activities aboard the vessel during fishing operations. While the cameras will be aimed at specific areas and activities of the vessel, a panoramic camera mounted on the vessel's mast would be useful for context, and could record events, particularly unexpected ones, that might otherwise pass unseen.

For purse seine vessels, the cameras should cover, at a minimum, the working deck (both port and starboard sides), the net sack and the brailer, the foredeck or amidships, and (if applicable) the well deck and conveyor belt. A first proposal for location of cameras in class 2-6 purse-seiners is provided in Annex 1, based on the experience of the pilot project D.2.a.

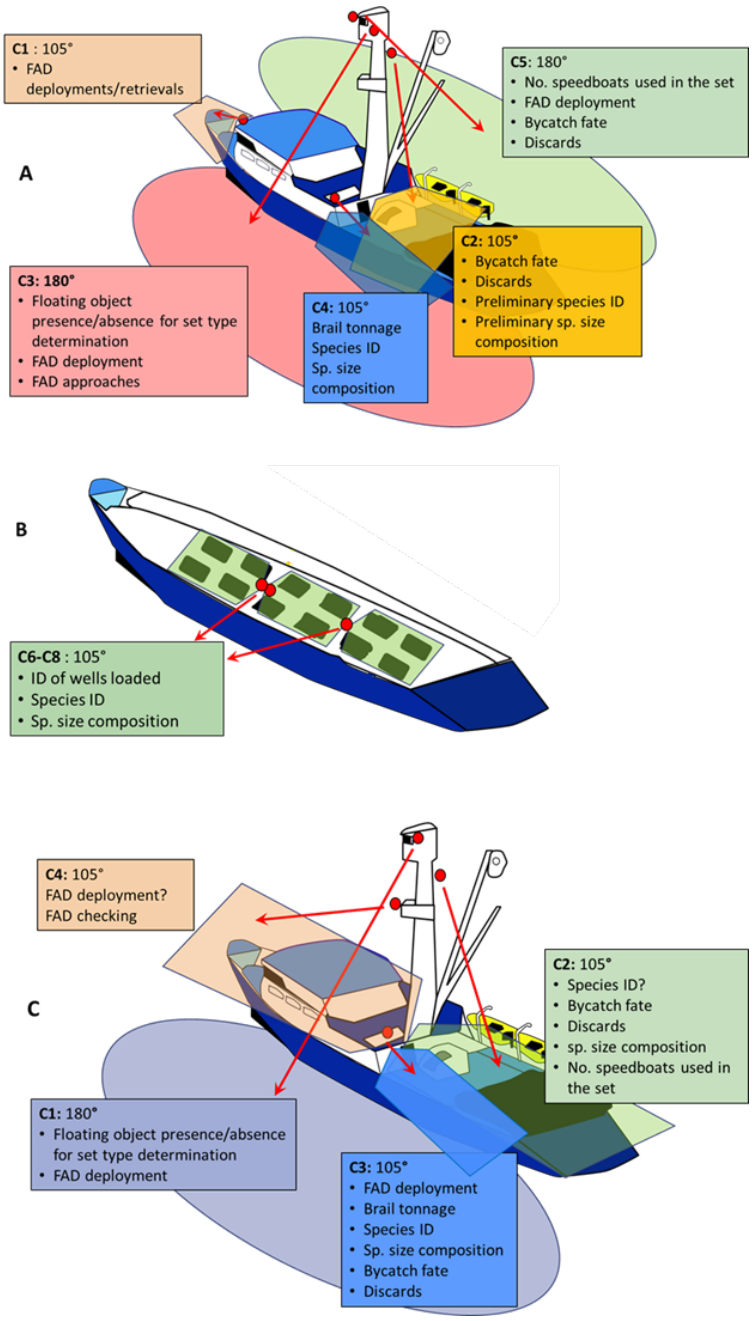

FIGURE 2. Cameras' configuration and fishing activities to record on the main deck (A) and the well deck (B) of the Class-6 tuna purse-seine vessels, and on the Class-2 vessel (C), as defined in the project D.2.a.

Similar approaches could be applied to longline vessels to identify different vessel structure and designs and fleet segments. The ongoing pilot project C.2.b attempts to consider these differences to set up and

install the EM equipment onboard longline vessels (Figure 3), along with information from EM service providers and initiatives implemented in other oceans (e.g., Hawaii longline vessels; Carnes et al, 2019).

On longliners, the cameras should provide, at a minimum, a view of all hooked fauna, both those brought aboard the vessel and those discarded or released without landing them on the vessel. A first proposal for the location of cameras on longliners is provided in Annex 2, based on information provided by the pilot project C.2.b, EM service providers and other international initiatives.

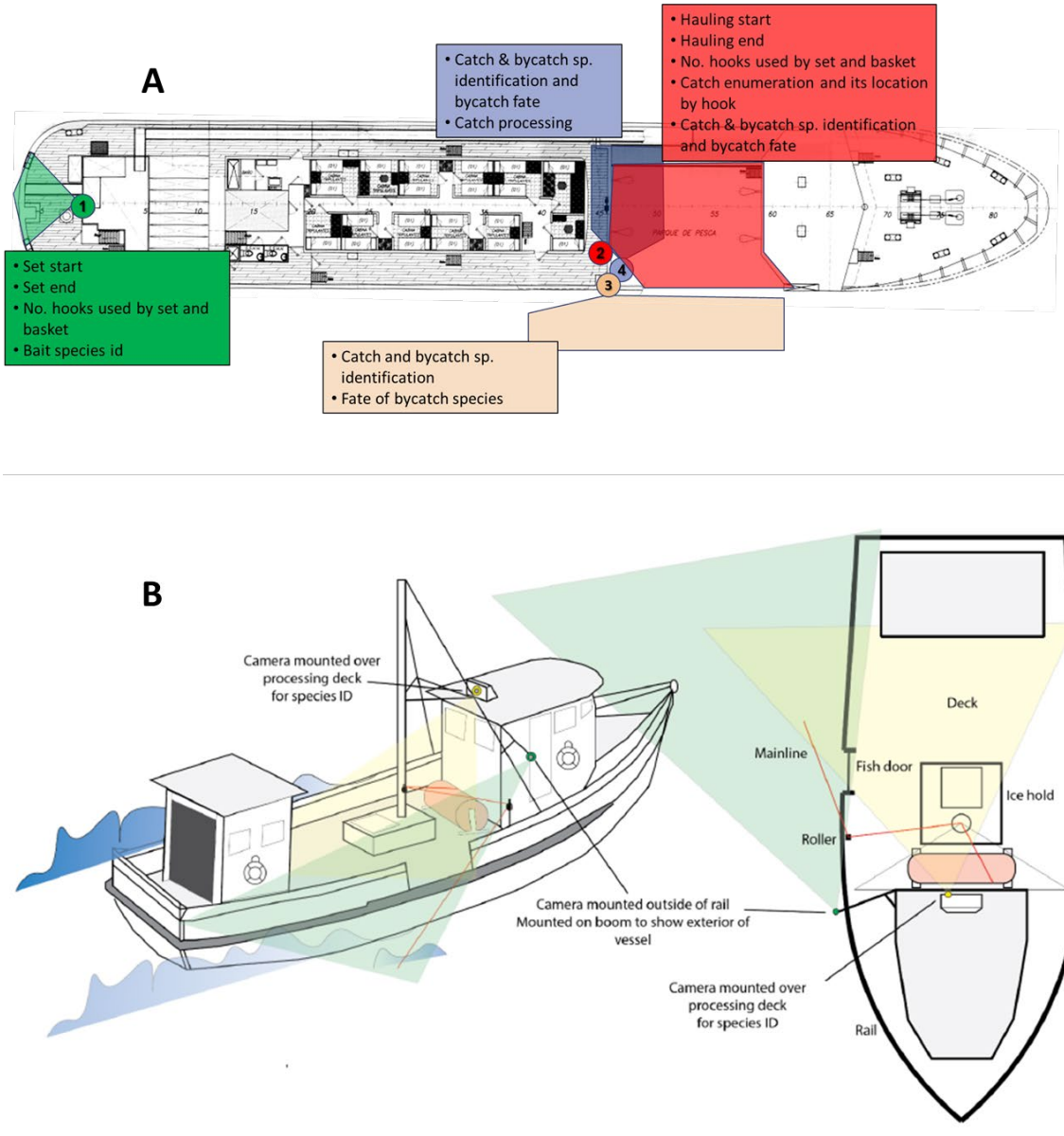

FIGURE 3. Cameras' configuration and fishing activities to record on board a large longline vessel (A) as defined in the project C.2.b, and (B) on a small longline vessel EM camera configuration for Hawaii longline vessels. Bottom picture taken from Carnes et al. (2019).

IATTC staff also believe that the Commission should consider application of EMS to help with monitoring of catches transshipped to carrier vessels. However, IATTC staff has not yet conducted any pilot studies of EM in transshipments and is not in a position to recommend camera and other sensor configurations at this time. The IATTC staff is monitoring the progress being made by others and are hopeful that results available in the near future may help inform the development of recommended equipment configurations for transshipment vessels, which can in turn provide context for further consideration by the IATTC *Ad Hoc* Working group on electronic monitoring.

Installing, maintaining, and repairing EM equipment will not be a trivial matter and may require active coordination and cooperation between different actors involved in the process. The installation of the equipment, tailored to each type of fishing vessel, could take several days (e.g., 1-3) and vessels would need to test their equipment before departing and ensure the equipment is maintained and repaired as needed after installation. Therefore, the scientific staff highlights the importance of the cooperation of the fleet with the EM providers and the EM programs to facilitate and coordinate the logistics and other aspects of the installation, maintenance and repair, to ensure the EM equipment performs according to the desired EMS standards. Toward this end, the following recommendation:

> CPCs will require their vessels to cooperate with and facilitate the installation, maintenance and repair of cameras and other EM equipment according to the device placement design plan for their vessel or vessel type.

Sensors

The EM equipment must consist of and be able to record data from different sensors. These should be able to collect additional information about the vessel (course, speed, hydraulic pressure, winch rotation, etc.) as well as environmental data (water temperature, wind speed, etc.), regardless of whether the cameras are operating. Sensor data must integrate time and geolocation information from the GPS receiver regardless of the vessel type and fishing gear.

Unless the cameras are left continuously recording regardless of the vessel's activities, their operation will need to be triggered by sensors monitoring for specific events corresponding with activities of interest, such as letting the skiff go on purse seiners to start a set, the activation of the hydraulic equipment, or a change in vessels speed or course that indicates a particular activity, such as a visit to a floating object, chasing marine mammals, or assessing fishing ground. For longline vessels, sensors such as a trigger in the drum-rotation to record the setting or hauling activities, or fish hatch/door open/close should be considered.

In addition, the EM equipment must be capable of integrating with general sensors and existing vessel instrumentation, as well as being able to incorporate, activate and record data from technological expansions currently in development (e.g., sensors that could remotely identify satellite buoys attached to FADs, scale in the brail). Based on the above, the staff recommendation about sensors is as follows:

> EM equipment may also include sensors for recording non-visual data (e.g. vessel movement, hydraulic pressure, environmental information), and also possibly mechanisms for activating/disactivating cameras so as to focus visual data collection during activities of interest.

Data storage

The EM equipment should include sufficient storage capacity to securely archive all required imagery and sensor information (i.e., EM records) for a certain period, which will depend on the vessel's size and operational characteristics, but could be several months.

EM equipment should include sufficient capacity to store all required EM records, at a minimum, for the duration of a fishing trip.

Currently, EM on a vessel with 4 and 8 cameras continuously recording generates between about 40 and 70 GB of data per day at sea, or about 1.2 to 2.1 TB/month, respectively. Large vessels carry eight data drives of 8 TB each, but small vessels, whose trips are shorter, have fewer (typically four). To safeguard the integrity of EM records stored in devices under rough weather and transport conditions, it is recommendable using solid state storage drives (SSD). Unlike large purse-seine and longline vessels for which storing and transmitting the data through the cloud would be cost-prohibitive, smaller vessels typically making shorter trips may consider this alternative. Provision should be made for vessels exhausting their data storage capacity.

Vessels should have onboard enough blank data storage devices (preferable solid-state drives) in case these must be replaced at sea. A specially trained crew member may need to replace the devices during a fishing trip if the data storage capacity is exhausted, always in coordination with the EM service provider.

It should also include separate duplicate backup devices, to ensure that data are not lost if one device fails.

EM equipment should include separate duplicate backup devices, to ensure that data are not lost if one device fails.

Compatibility

Since their implementation, IATTC databases have received and processed records and information of different nature for the EPO tuna fisheries. In order to adjust to the constantly evolving fishery and associated data needs and requirements, IATTC databases have been conveniently designed and structured to incorporate and relate information coming from different sources, such as logbooks, observer data, tuna tracking information, etc., as well as to allow the possibility to accommodate further data needs or modifications (e.g., new data fields required by a Resolution, new data sources such as EM). However, for its incorporation, the information needs to be compatible with the formats and protocols used by the IATTC data processing and storing tools. In this regard, the staff recommendation is as follows:

EM equipment should use and generate records and/or data in a format compatible with IATTC databases and IT resources.

Malfunctions/tampering

Although some recommendations for cases of malfunction and tampering were proposed in section 2 of document EMS-03-01 (EMS management considerations), these provided management-like guidelines and procedures for cases where a malfunction or tampering events may occur (e.g., policies and procedures for installation, use and repair). The recommendation below is oriented to provide hardware and software requirements for the EM equipment and EM records to minimize potential equipment malfunctions or tampering events.

EM equipment should be tamper-evident/resistant and send automatic alerts in real time to the appropriate EM program in cases of malfunctions, manual activation/shutdown, manual data input, external data manipulation, or attempts to tamper with the equipment or EM records. It should also be possible for data recording to be controlled manually, but only in case the EM equipment fails to start or stops automatically, and any manual activation should trigger an automatic alert. Manual shutdown should not be permitted.

Data encryption

EM Records and data produced by digital platforms and tool can often be read and processed by compatible software. In the case of confidential data, data with proprietary rights or other types of secured data, these can be protected by encryption. In such cases, only specific software using specific permits and plug ins can transfer, read and translate the data into readable files and information. In order to ensure confidentiality of the EM records and data collected by the EM equipment, they will need to be encrypted accordingly.

EM equipment should be capable of transmitting EM records in encrypted form.

EM equipment maintenance

As other digital tools and devices, EM equipment is susceptible to deterioration or becoming outdated. Therefore, provisions that ensure the correct servicing, maintenance, and replacement of the EM equipment will need to be implemented before reaching its specified life-span limits or when affected during normal fishing activities. These provisions will need to take place when vessels are in port or at sea, and they should also always be addressed in coordination with EM service providers to ensure the EM equipment are manipulated, maintained, replaced or repaired consistent with the agreed technical standards.

At sea, all maintenance, repairs and replacement activities of EM equipment should be conducted by a specially trained vessel crew member, only in coordination and when instructed to do so remotely by the EM service provider.

On land, all maintenance, repairs and replacement activities of EM equipment should be conducted by an official technician, in coordination with EM service provider.

Each vessel must have a designated crew member responsible for routine camera lenses cleansing, per a specific protocol, to ensure the clarity of EM records. The protocol should include the following instructions: i) the lenses of cameras operating within 10 meters of any fishing activity must be wiped clean before every set; ii) the lenses of all other cameras must be wiped clean once every week. Appropriate cleaning materials must be used to avoid lenses damage and should always be available onboard.

3. REFERENCES

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4. ANNEXES

Annex 1. A first proposal for location of cameras in class 2-6 purse seine vessels.

Pilot project D.2.a, demonstrated that the number of cameras to be installed on purse-seines should not follow a standardized plan, rather it should be customized to the vessel structural design and fishing operativities. The following number and locations of cameras are recommended to generate acceptable EM records and EM data for class 2-6 purse-seine vessel fishing activities, given the experience acquired in project D.2.a:

1) Class-6 vessels with 6 or more rows of wells:
    - Two panoramic cameras (e.g., 180°), on crow's nest, covering port side (floating object presence/absence for set type determination and FAD interactions, set times) and starboard side (No. speedboats used in the set, FAD deployment, large-sized bycatch identification, discards, set times).
    - One camera (e.g., 105°), on back of crow's nest, covering the main deck and sack area (catch and bycatch species identification, discards).
    - One camera (e.g., 105°) on bridge roof, covering the bow (FAD deployments, retrievals).
    - One camera (e.g., 105°) on boom controls roof, covering the brailing area (total catch estimation, bycatch identification, discards).
    - Three cameras (e.g., 105°), each covering equal numbers of well rows (catch and bycatch identification and estimation by species, discards).
2) Class-5 vessels with less than 6 rows of wells:
    - Two panoramic cameras (e.g., 180°), on crow's nest, covering starboard and port sides.
    - One camera (e.g., 105°), on back of crow's nest, covering the main deck and sack area (FAD deployments, retrievals).
    - One camera (e.g., 105°) on boom controls roof, covering the brailing area.
    - Two cameras (e.g., 105°) covering equal numbers of well rows.
3) Class-2 vessels with no wet deck access:
    - One panoramic camera (e.g., 180°), on crow's nest, covering the port side.
    - One camera (e.g., 105°), on back of crow's nest, covering the main deck.
    - One camera (e.g., 105°) on bridge roof, covering the bow.
    - One camera (e.g., 105°) on boom controls roof, covering the brailing area.

Annex 2. A first proposal for location of cameras on longliners.

On longline vessels, cameras should provide a view of all hooked fauna, both those brought aboard the vessel and those discarded. The following preliminary camera installation design, which is based on information gathered from EM service providers and international initiatives (e.g. Carnes *et al.* 2019), may be updated at a later time with results of pilot project C.2.b:

1) For small-sized longline vessels (< 20m LOA):
    - One camera on the work deck to identify species
    - One camera mounted outside the side rail to cover the fish door, where the catch is brought aboard.
2) For medium large-sized longline vessels (> 20m LOA):
    - One camera at the stern, to record the number of floats, hooks and bait used on the setting.
    - One camera located amidships, covering the total catch and discards by species, size and fate.
    - One camera located at the bow, covering the retained catch, by species, size and fate, during the hauling.
    - One camera mounted on boom, outside the rail where the line is hauled, to record catch evasion, line cutting, etc.