IOTC ELECTRONIC MONITORING SYSTEM AND DATA STANDARDS

EM TECHNICAL MINIMUM STANDARDS

The Technical Minimum Standards shall describe the requirements of the EM. CPCs shall ensure all EM equipment installed in their national or subregional programs are consistent with these technical specifications.

Customized to vessel level: there is no standard configuration that will cover all vessels from fleets operating in the Indian Ocean region, therefore each EM equipment installation must be customized at the vessel level. An EM equipment to be installed on board of a fishing vessel should consist of a control system connecting a number of cameras, and optionally to a number of different sensors, to collect and record images to address the objectives of the EM Program. The number of cameras and sensors should be tailored to each vessel through a Vessel Monitoring Plan to meet overall objectives of the program rather than being too prescriptive and should include a sufficient number of cameras. Although it will depend on the configuration of each particular vessel, as a general setup, cameras shall capture the areas and activities provided in Table 1 and 2 and Figure 1 to 3 of Annex 3[3]. Each vessel should develop a "Vessel Monitoring Plan" specifying how many and where the cameras are located, and their settings, to collect the required ROS minimum "mandatory" data fields The collection of some of the required ROS minimum data standards may be complemented by port sampling and/or other data collection methods as described [here[4]]. Within a given EM program, a certain level of harmonisation among vessels may also be necessary (camera placement and settings).

Include sensor/automatic devices: since EM records require large storage capacities, most EMS are not recording vessel activities on a full-time basis. The recording of some cameras may be triggered by the detection of gear usage or fishing activity. EMS may therefore include sensors, and other procedures (Computer Vision, Artificial Intelligence), to detect when fishing or other activities of interest occur on board. This will ensure proper EM record acquisition (e.g. trigger video recording when fishing operation starts) and facilitate EM record reviewing.

Include Global Positioning System (GPS): to monitor vessel position, route, speed and provide information on date/time and location of fishing activities. Fishing vessel position and date/time stamps should be incorporated directly on images or in the metadata of images.

Compatibility: the EMS could ideally be capable of integrating with other Monitoring, Control and Surveillance (MCS) tools (e.g. Vessel Monitoring System).

Robust System: the EM equipment components installed outdoors (such as cameras/camera housing and sensors) should be capable to resist rough conditions at-sea and harsh environment on board the vessels.

Secure System: the EM equipment components and data need to be tamper-resistant and tamper-evident, ideally using encrypted data, such that attempts at unauthorized modifications are not possible.

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[3] Annex 3 should be taken as a general guide since they are examples of existing EMS installations. The EM configuration (number of cameras, position, and monitoring objectives for each) should then be tailored to each fishery/vessel through a Vessel Monitoring Plan.

[4] EM capabilities to collect ROS minimum data requirement fields

(https://iotc.org/documents/ROS/DataStandards) may vary from fleet to fleet if the catch handling and setting/hauling maneuvers differ among fleets. Therefore, these values should be taken as a general guide and subject to constant review.

Cameras: digital, high-resolution, when possible, cameras covering all areas of interest on the vessel according to the vessel and fishing operations are recommended. Camera placement, settings and recording must assure the detection of vessel activities, catch and bycatch species, and enable accurate species identification (at least for all species under the IOTC mandate). The system should be able to record activities in low and very bright natural light conditions (low and high contrasts). The cameras must be water resistant and in a self-contained, weather resistant box.

EM records: EM records shall contain the following information: EM record file name including, at a minimum, the vessel name and vessel ID, camera ID, trip ID, geolocation data (date, time (UTC), latitude and longitude), camera recording status, EM health status(when available), images, and sensor data when used.

Independence: the system needs to be self-governing with the exception of minimal maintenance by the crew (e.g., cleaning sensors and cameras). The system may include remote verification of its functionality in real time to collect all information. A designated person should ensure that the system is working properly before leaving port and at sea, and a protocol (checklist) should exist for that purpose.

No interference: EM equipment should not generate or cause radio frequency interference with other on-board vessel communication, navigation, safety, geolocation devices (e.g. VMS) or fishing equipment.

Autonomy: the EM equipment should have its own uninterruptible power supply or be connected to that of the vessel to ensure that it can work even in the event of a vessel power outage. The EM equipment should include separate, duplicate backup devices to ensure that data are not lost if a storage device fails.

EM Data storage autonomy: the EM equipment should have enough storage capacity to store all EM records for a certain period of time, which should be at minimum a complete trip. The duration will depend on the vessel's operational characteristics that could range from 4 months (in the case of purse seiners) to 12 months or more (in the case of longliners).

Interoperability: EMS ideally should generate EM records that are interoperable between different EM service and review providers and, where possible, integrate with other data collection and monitoring tools.

Maintenance: a designated person on board (and/or on land) should be designated to maintain the equipment (e.g., clean of lenses, etc.) and report to the EM equipment provider and the competent authority (e.g., IOTC or flag state) when the system is malfunctioning at port or at sea so the system is fixed as soon as possible, and should record any failure of the EM equipment in a dedicated form.

EM LOGISTICAL MINIMUM STANDARDS

EM records retrieval: the EM records should be transmitted via mobile networks, Wi-Fi, or satellite, or storage device (i.e., SSD or HDD) exchange. For the latter, a protocol to recover and send the storage devices to the designated EM review center should also be implemented.

EM record storage: EM records should be stored by the vessel/company/EM service provider/EM review provider/EM program administrator for at least 1 year or for the period established in the national/regional EM programs.

EM records backup: if EM records are automatically transmitted electronically, operational procedures for their receipt and backup should be implemented taking into account any necessary chain of custody arrangements.

Storage device chain of custody: the EMS must ensure traceability of every storage device and EM records. The chain of custody of the EMS storage devices should be assured.

Frequency: EM programs should include requirements on the method and frequency (e.g. after each trip) of EM records transmission to EM review centers, that should be consistent with the minimum standards established by the CPC or IOTC.

EM DATA REVIEW MINIMUM STANDARDS

EM review software: EMS should include software to facilitate the review of EM records and to produce EM data that will allow compiling and reporting in an IOTC common output format for exchange/submission to IOTC. Ideally, EM review software can be used to review EM records collected from different EM equipment providers.

EM review and EM data reporting: EM records reviewing and EM data reporting should be done by institutions, organizations and independent companies with proven expertise and experience (e.g., work experience with onboard observers). These tasks can be centralized in a "regional EM review center" when implementing a regional program and/or can be carried out by national or independent organizations.

EM records and EM data quality check: the reviewing process of EM records should include quality controls through EM records quality check, EM data entry checks, possible automatic error identification in EM data (e.g. incorrect fishing set positions on land, etc), debriefing of EM observers. The produced EM data should be checked prior to reporting to the IOTC Secretariat.

EM data: EMS should allow collecting and reporting, at a minimum, the ROS Minimum Standard Data Fields. EM data will be submitted to the IOTC Secretariat using IOTC standard forms according to the time frame specified in Resolution 22/04, or any superseding Resolution. Data confidentiality requirements outlined in Resolution 12/02, Data Confidentiality Policy and Procedures, or any superseding Resolution, shall apply to all EM data submitted to the IOTC Secretariat.

EM observers' training: EM observers must have specific qualifications related to EM record review which should be integrated into the regional or national EM program standards. The EM observer should participate in specialised training courses that should be updated upon modification of the EM review protocol to ensure EM data high-quality standards.

EM observer's qualifications: EM observers must have the ability to review EM records and produce EM data according to IOTC requirements. EM observers should be familiar with fishing activities and be capable of identifying (i) IOTC species and species of special interest, (ii) IOTC fishing methods, and (iii) IOTC mitigation methods.

Compatibility with ongoing standardized data flow and databases: EM data should have compatible output format (including usage of standardized, well-established code lists) to exchange collected information with current IOTC data reporting format and standards, and should be consistent with IOTC data rules. EM data will be submitted in an approved electronic data reporting format to the IOTC Secretariat, using IOTC standard codes and units.

Data storage and retention: legal provisions on data protection, storage, and retention by IOTC should be developed and agreed upon whether it is a REMP or EM National Programs.

EM records ownership: EM records ownership is of the vessel owner/flag state but should provide IOTC with the EM data outputs to incorporate in the IOTC database for use, analysis, and disposal as required by the IOTC observers Resolution on Regional Observer Scheme.

Hardware/software ownership: irrespective of the scope of the EM program, it is recommended that hardware and software license ownership (and maintenance) is of the vessel owner/flag state.

ANNEX 3

VESSEL MONITORING PLANS (GUIDE)

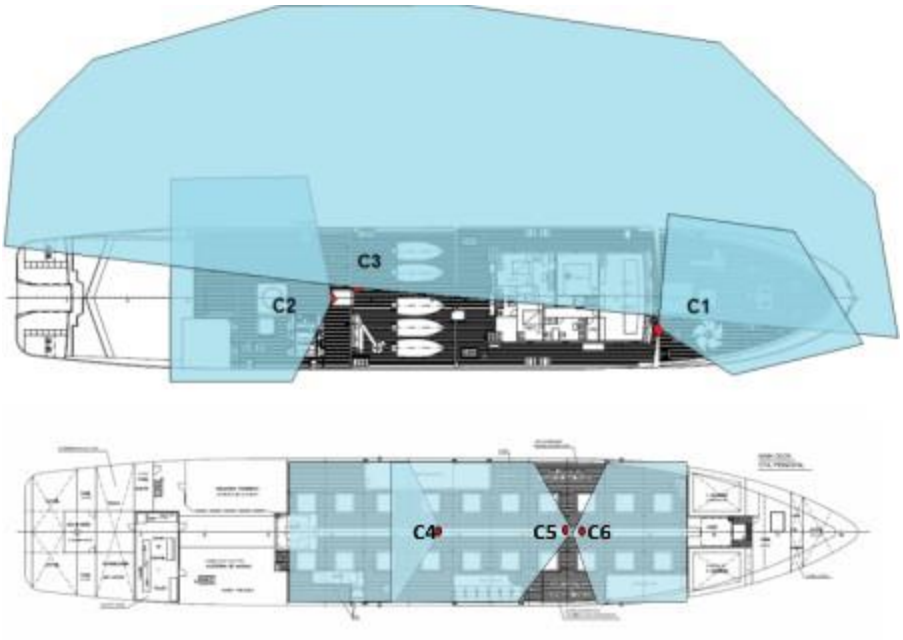
Each vessel should develop a "Vessel Monitoring Plan" so as to define how many and where cameras are located to collect the required ROS minimum data fields. Vessel Monitoring Plans should be reviewed by the CPCs fishery management agency and presented to the WGEMS/WPDCS to ensure it meets IOTC REMP Program and EM System and Data Standards.

On purse seine vessels, the minimum areas that cameras are recommended to cover:

- the working deck (both port and starboard sides),
- the net sack and the brailer,
- the foredeck or amidships (e.g., FAD activity),
- and the well deck and conveyor belt (Murua et al., 2022; Restrepo et al., 2018): for the conveyor belt, in more than one place (e.g. at the beginning and at the end of the conveyour belt as a minimum). If a discard conveyor belt exists, it should also be covered.
- Cameras must cover the following actions: fishing set, brailing, net hauling, FAD activities, total catch, catch well sorting (process of putting the catch in the hold or wells), bycatch handling and release, and tuna discards (Figure 1 and Table 1).
- In large purse seines, at least 6 cameras are needed to cover fishing and fish-handling operations; however, less fewer cameras (e.g. 4 cameras) could cover the activity to collect the data required of smaller purse seines (e.g. 300-400 tonnes capacity).

The preferred EM equipment configuration would be the one that allows a greater number of images (frames) of higher quality/resolution. Digital video is generally preferred, but still images can also be a viable option to capture information during the various phases of the vessel activity. However, considering that storage capacity is limited, an optimal configuration may have video on certain areas/cameras/moments, while still photos on others. In the case of photographs, the minimum requirement should be that a picture is taken by the camera with viewing angle fully covering the fish management areas at least every 2 seconds when fishing action occurs (Restrepo et al., 2018). Image quality should also be adequate enough to allow accurate collection of all required data field, such as species ID, FAD materials and design, or bait used and, hence, achieve the monitoring objectives.

A


C3
C2
C1
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C6

B


Panoramic camera:
Surrounding activity
Crows nest camera:
Fishing deck
Starboard camera:
Bycatch and discards
Bow camera:
Crane activity.
Partial view of seine
Brailing camera:
Brailing and purse.

Figure 1. (A) An example of a 6-cameras EM system installed in a purse seine covering main areas of fishing and fish handling operations (from Murua et al., 2020b) and (B) 7-cameras EM system (4 in the upper deck and 3 in the well deck) installed in a purse seine covering main areas of fishing and fishing handling operations including 1 more camera in the conveyor belt: (B1) 360˚ Panoramic view camera (e.g port side view), (B2) Crows nest stern view camera, (B3) Working deck crane camera view , (B4) Foredeck view camera, (B5) Conveyor belt stern camera view, (B6) Conveyor belt middle camera, and (B7) Conveyor belt bow camera (source: Digital Observer Services).

Table 1. Minimum areas and actions that should be monitored (adapted from Murua et al., 2022; Ruiz et al., 2017).

Area covered	Action covered	Purpose	Minimum data requirements to be monitored
Work deck (port side)	Brailing	Total catch by set Species composition	Number of brails & fullness by brail. Weight, size and species of retained tuna
	Tuna discards	Total tuna discards by set	Weight, size and species of discarded tuna
	Bycatch handling	Bycatch estimation	number of individuals handling mode Species ID
Work deck (starboard side)	Bycatch handling	Bycatch estimation	Handling mode
	Bycatch release	Total bycatch by set	Number of individuals and species ID
In-water purse seine area	Brailing	Total catch by set	Number of brails & fullness by brail
	Bycatch handling and safe-release of individual animals (whale sharks, manta rays…)	Total bycatch by set . Application of handling and safe-release best practices	Handling mode
	Bycatch release of big species (whale sharks, manta rays…)	Total bycatch by set Application of handling and safe-release best practices.	Number of individuals and species ID
Foredeck or amidships	FAD activity (deploying, replacement, reparation…)	Total number of FAD deployments, FAD design and FAD activities by trip	Number, material (natural or artificial), and FAD characteristics (entangling or no entangling)
Well deck and conveyor belt	Catch well sorting	Species composition	Weight, size and species of retained tuna.
	Bycatch handling	Best practices	Handling mode
	Estimation of bycatch discards, releases or retention	Total bycatch by set Species composition Application of handling and safe-release best practices.	Number, size or weight of individuals, species ID and fate

On longline vessels, the minimum areas and activities that cameras are recommended to cover (Table, 2, Figure 2):

- The area of setting the longline (usually vessel stern site camera),
- the area of hauling the longline,
- the working deck where catch is handled,
- and the surrounding water area for those discarded species not brought onboard

- Cameras must cover the following actions: setting of the longline, bait type information, whether mitigation techniques are being used (e.g. tori lines for seabirds), hauling of the longline, all hooked species (both retained and discarded), the fate of the catch, and the size of the specimens.

- On most tuna longlines, at least 3 cameras are needed to cover fishing activities and fish handling operations: one capturing images when setting the longline, one to record the hauling and boarding of the catch, and other mounted over the processing deck to record species, size of specimens and fate (Murua et al., 2020a). And additional camera to cover the surrounding
  water area for those discarded species not brought onboard is also recommended.

Figure 2. An example of a 3-cameras EM equipment installed on a longline covering main areas of fishing and fish handling operations. View of the 3 cameras: (left panel) Stern camera - setting longline providing information on hooks, floats, mitigation techniques and bait; (middle panel) Fishing deck 1 - hauling information, captures and discards, species ID, size and fate; and (right panel) Fishing deck 2 - fate of the species, size, species ID (source: Digital Observer Services).

Table 2 – General configuration and areas/activities covered by the EM system onboard tropical tuna longline vessels

Area covered	Action covered	Minimum data requirements to be monitored
Stern camera of the boat	Start and end setting operation	Position, date, and time
		Total number of hooks set and between floats
		Total number of floats set
		Bait type
		Bait species
		Bait ratio (%)
		Mitigation measures/marine pollution
Work deck	Catch onboard	Length and weight[5] by capture
		Condition
		Fate
		Predator observed
	Bycatch discarded, released, or retained	Total bycatch by set and species composition
Processing area	Catch	Total catch by set
		Length and weight1 by capture
		Sex
		Fate
Surrounding water area	Start and end hauling operation	Position, time and date
	Estimation of bycatch discards, releases or retention	Total bycatch by set and species composition
		Species condition and fate

[5] Estimated through length-weight relationships.

On pole and line vessels, the minimum areas that cameras are recommended to cover are the area of bait fishing activity, the area of the fishing set and pole and line fishing activity (vessel stern site camera) and the working deck where catch is handled. On a typical Indian Ocean pole and line vessels, this will require at least 2 or 3 cameras to cover main fishing activity areas, fish handling operations and bait fishing (Figure 3).

Figure 3. An example of a 3-cameras EM equipment installed on a Bay of Biscay (Atlantic Ocean) pole and line vessel covering main areas of fishing activity and fish handling operations. View of the 3 cameras: (left panel) Vessel bridge camera stern view – pole and line activity; (middle panel) Fish handling - catch storage; (right panel) Vessel bridge camera bow view - bait and pole and line fishing activity (source: Marine Instrument.)