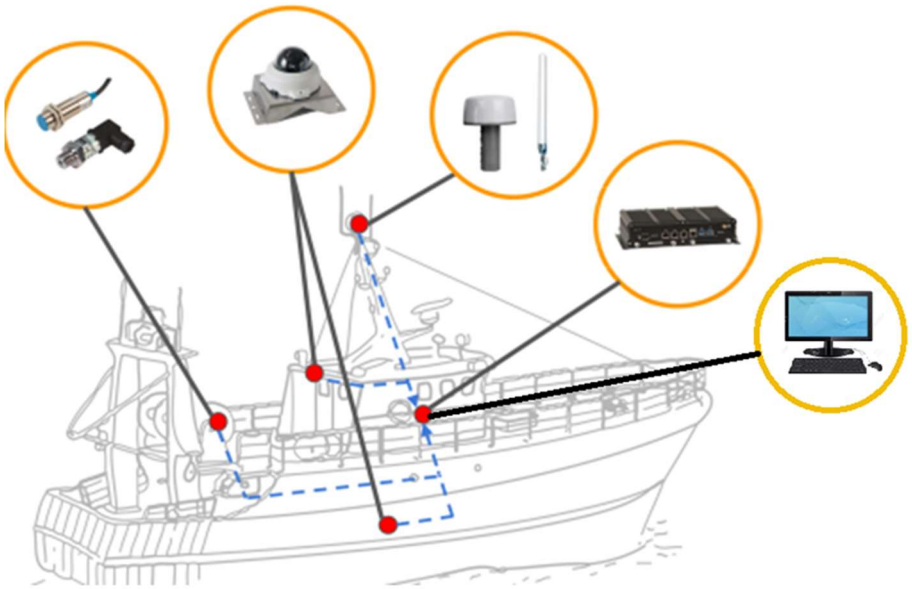
Technical guidelines and specifications for the implementation of Remote Electronic Monitoring (REM) in EU fisheries



European Fisheries Control Agency
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1. Glossary

“4G”: 4G is the fourth generation of broadband cellular network technology / Long-Term Evolution standards.

“CAN”: A Controller Area Network (CAN bus) is a robust vehicle bus standard designed to allow microcontrollers and devices to communicate with each other in applications without a host computer.

“CAT 5e”: Category 5 cable, commonly referred to as Cat 5, is a twisted pair cable for computer networks. The CAT 5 is superseded by the category 5e

“CAT6 SFTP”: Eurocable CAT6 range is for transmitting high bandwidth signals over long distances (typically 300 ft or 90 m). SFTP is extra flexible CAT6 cable

“FTPS”: An extension to the commonly used File Transfer Protocol (FTP) that adds support for the Transport Layer Security (TLS) and, formerly, the Secure Sockets Layer (SSL, which is now prohibited by RFC7568) cryptographic protocols.

“GPS”: Global Positioning System sensor.

“HTTPS”: Hypertext Transfer Protocol Secure (HTTPS) is an extension of the Hypertext Transfer Protocol (HTTP) for secure communication over a computer network, and is widely used on the Internet.

“IP camera”: A type of digital video camera commonly employed for surveillance, and which, unlike analogue closed-circuit television (CCTV) cameras, can send and receive data via a computer network and the Internet.

“MP”: A measure of information e.g. size of a file.

“NMEA 2000”: A plug-and-play communications standard used for connecting marine sensors and display units within ships and boats.

“RS-485”: A standard defining the electrical characteristics of drivers and receivers for use in serial communications systems.

“UPS”: Uninterruptible power supply.

‘’VMP’’: Vessel Monitoring Plan

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2. Introduction

When the reform of the Common Fisheries Policy (CFP)[1] was agreed in 2013, it included measures to reduce the high levels of unwanted catches and to gradually eliminate discards. Therefore, an obligation to land all catches ("the landing obligation") of species which are subject to catch limits and in the Mediterranean Sea also catches of species subject to minimum landing sizes, has been gradually implemented. For the purpose of monitoring compliance with the landing obligation, as specified in article 15 of the CFP, Member States (MS) shall ensure detailed and accurate documentation of all fishing trips and adequate capacity and means of verification, such as observers, closed-circuit television (CCTV) or other methodologies. In doing so, Member States shall respect the principles of efficiency and proportionality.

In many fisheries around the world the use of Remote Electronic Monitoring (REM) systems are being tested and in some countries REM systems are implemented as a tool for management of fisheries. REM data is used as an independent system for documenting fishing activities and catches. The REM system was developed as an alternative to human observers at sea. The use of REM systems is significantly cheaper than observers. Furthermore, an REM system has the advantage of being able to provide observation 24 hours a day, 7 days a week.

An REM system is a system that acquires data and video footage using GPS, sensors and CCTV cameras. Sensor data and video footage are stored on one or two on-board hard drives. Most systems can store data and video footage from several month's fishing and some for a whole year. The data can be accessed by exchanging the hard drives, can be transmitted via mobile data networks, or can be transmitted via Wi-Fi or satellite system. Currently, some systems can run up to 12 cameras at the same time. REM systems include sensor data from for example winch/drum and pump mechanisms and can be set up only to capture video footage when the vessel is starting its first fishing operation on a fishing trip and stops when entering a port, or it can be set up to only capture specific fishing operations as they occur during the fishing trip. The video footage can then be used to obtain information on fishing events; such as catch handling, legal discarding practices and catch composition; and to verify self-reported information when applicable.

The scope of this document is to describe minimum technical requirements and standards for REM systems which could be used as a tool to monitor and document compliance with the CFP landing obligation in EU fisheries. It is meant as a guidance document for MS authorities to be used for the potential implementation of REM on their vessels with the purpose of monitoring and control of the landing obligation and related provisions. The document also seeks to highlight particular issues that require attention when implementing and using a REM system.

[1] REGULATION (EU) No 1380/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC

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This document is written on the assumption that monitoring and controlling compliance with the landing obligation includes both whether (illegal) discarding including slipping takes place and monitoring discarding of catches falling under the applicable exemptions, such as *de minimis*, high survivability, predator damaged fish and those related to technical measures (e.g. gear exemptions).

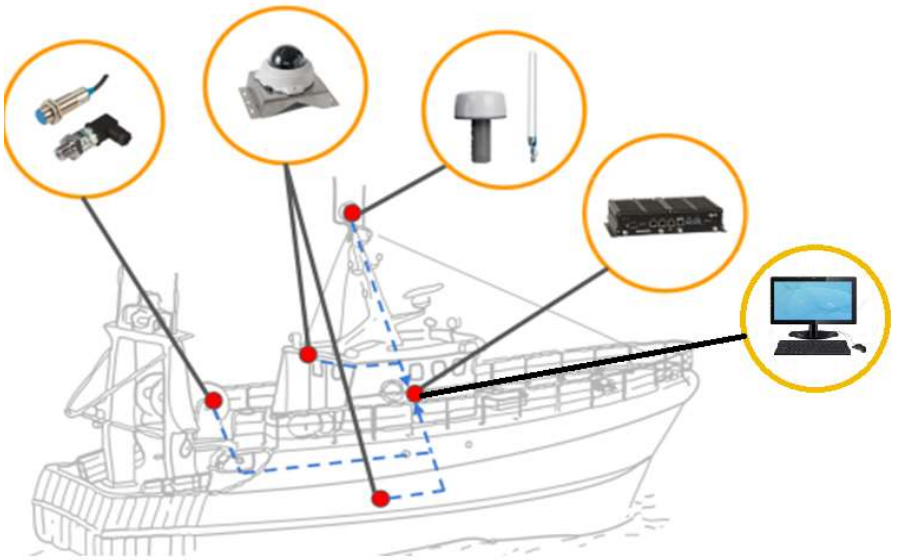
The aim of implementing the use of REM in EU fisheries is to monitor and control compliance with the landing obligation including monitoring any exemptions.

Since the REM system is to be implemented for control of compliance with the landing obligation, the design will focus on implementing REM systems in EU fisheries for these control purposes.

This document should be considered a living document to account for technical developments as well as changing requirements following the adoption of new or amended management measures.

3. Minimum requirements for a standard REM system - Technical specification

A REM system to be installed on board fishing vessels consists of a control box (a modified computer with possibilities for connecting a number of different sensors and a number of cameras). The system software is developed to handle and control sensors and cameras, store sensor data and video footage on embedded storage, and to display all information on a screen in the wheelhouse. The typical system set up on a given vessel is shown in the figure below.



Technical specification of the minimum requirements for a standard REM system is given in the Annex. A precondition for the REM system is that it can communicate with the land based competent authority.

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3.1 Control box

The control box is the on board computer that acquires and stores all sensor data and video footage. It is recommended that the unit is based as a minimum on the following technical specifications:

The below listed specifications do not physically have to be inside the unit, but may be connected to/integrated in it.

A. Fan-less passive cooling – with high temperature cut out.
B. 12-24V DC isolated power input.
C. Max. power 60W.
D. GPS sensor or equivalent.
E. 4G/LTE or faster (upload), mobile data connection.
F. Wired interconnection of the components of the system on board.
G. Capability for wireless (e.g. WiFi (802.11ac or faster)/Bluetooth) connections.
H. Utilization of existing on-board satellite data connection for sensor data transmission. For vessels only fishing within in cell phone range 4G can be used for sensor data transmission.
I. Automatic prioritisation of best suitable connection for data transfer and remote access.
J. Data storage capability for storing sensor data and video footage. Minimum data storage capacity depends on the vessel activity (days at sea), the number of cameras and the data storage duration.
K. At least one removable/swappable back-up data storage of variable sizes.
L. Support at least the required number cameras, including spare camera capacity.
M. On board screen connection for verification including keyboard (and mouse) or touch screen.
N. Supports remote access/configuration.
O. UPS (Uninterruptible power supply) of controlled shutdown, logging in case of power loss. If possible, UPS should also enable continuation of recording for relevant timespan (for e.g. 10 minutes). Information on any power failure should automatically be recorded for subsequent notification to the FMC.
P. Sensor data and video footage needs to be properly encrypted and compressed.
Q. Digital signature (date and time stamp, vessel name, vessel registration and GPS co-ordinates).
R. If data transmission is temporarily not possible, the request shall be stored on the control box and the requested data shall be secured to prevent possible deletion or tampering. The requested data shall be automatically transmitted when data transmission again is feasible.

<u>Furthermore, the following system capabilities need to be considered:</u>

S. The system should be able to upload all or if required parts of recorded data automatically at specific intervals or when connectivity prioritisation allows. All data being transmitted, stored for backup on the control box should be securely encrypted.

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T. Transmission of encrypted data should be done using secure communication protocols (FTPS, HTTPS).
U. Build-in remote access should be possible, for system configuration and verification of system health if required.
V. Remote access should include access to health checks of the camera and configuration (e.g. frame rate). A common format for analysis is needed to allow access to configurations (see 6.2).
W. Possibility for remote access to support transmission requests of all or parts of recorded sensor data and video footage, from any camera, should be made.
X. Possibility to have a wireless option (e.g. via WiFi/Bluetooth) to interconnect the parts of the system.
Y. Possibility to have a wireless option (e.g. via WiFi) for uploading the data from vessel to land-based system.

Recommendation:
For standardisation reasons it should be considered whether a standard control box should be able to support the number of cameras and sensors needed (in excess of the minimum requirement) to provide assurance that the landing obligation is being complied with. The standard control box should be able to support the required number of cameras and sensors needed to provide assurance that the LO is being complied with.

3.2 Cameras

The cameras and the camera housing need to be constructed of material that can resist the harsh environment on board the vessels and that can resist tampering. Using smaller cameras should be prioritized. Camera closure fittings need to be robust and durable. It is recommended that the cameras should fulfil the following minimum technical specifications:

A. Type: Digital IP Cameras (IP = Internet Protocol).

B. Ingress Protection: IP66 Rating. A higher IP (e.g. IP68) for cameras regularly exposed to heavy weather conditions is recommended.

C. Cabling: Minimum CAT 5e Ethernet cable preferably CAT 6 SFTP cable.

D. Resolution: Minimum 2MP (1080P), depending on the purpose of each camera.

E. Lens: Specified range of fixed and zoom lens option cameras, with replaceable lenses.

F. Housing: Replaceable camera dome / housing glass.

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G. Video:

- Compression: Supports standard video compression formats. Minimum H.264.
- Remote configuration: Capability to configure the following parameters both remotely and on board (on board configuration needs to be secured and any changes should be logged):
  - FPS - Frames per second (adjustable depending on camera purpose)
  - Image Resolution
  - Image Quality (Bitrate)
  - Digital/optical zoom level.

H. Measuring capability: Capability to measure fish length for relevant cameras (lens dependable).

I. Masking capability: Possibility to blank out parts of images to protect persons and to select region of interest, with higher quality than rest of image (background/foreground).

J. The system should be capable of functioning in the environmental conditions (e.g. temperature) where the vessel will be operating.

The minimum requirements for the cameras to be used depend on the location of the camera and what the camera is intended to capture. As a general setup, cameras should capture the following views, requiring one or more cameras for each view depending on the vessel

1. the fishing deck;
2. the general view for providing a wide angle view of the fish handling/processing area;
3. the sorting belt/sorting table;
4. the discard area/areas.
5. An area of the sea sufficient to observe the entire net being hauled on board

For determining which type of camera and number of cameras is needed, a number of parameters will apply:

- The distance of the camera from its object / focus area
- The aperture and focal length of the lens
- The required resolution needed for the purpose of the camera

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A segmentation of the EU fishing fleet for the purpose of REM requirements has been proposed (see section 4), and a draft is included as Appendix 1. According to Appendix 1 the indicative minimum number of cameras for each fleet segments is listed.

For fleet segments with a minimum of two cameras capturing:

Camera 1: the fishing deck + the general view for providing a wide angle view of the fishing handling/processing area + the sorting belt/sorting table

Camera 2: the designated discard area.

For fleet segments with a minimum of four cameras capturing:

Camera 1: the fishing deck.

Camera 2: the general view for providing a wide-angle view of the fishing handling/processing area.

Camera 3: the sorting belt/sorting table.

Camera 4: the designated discard area.

In cases where more cameras are needed these cameras are most likely for needed for capturing the general view of the fishing handling/processing area and the sorting belt/sorting table.

In most of these cases, a camera of minimum 2 MP (1080P) would be sufficient to ensure the needed resolution/quality of the video footage, incl. digitally zooming in the footage during the analysing process. In some areas like e.g. the discard area, a minimum of 3 MP camera is required. The standard setting and the range of the lens of a camera depends on the area to capture. It is important that the resolution, quality and frame rate is easy configurable, since these parameters have a high influence on the data size, and that the goal is to get the needed quality of data at the lowest possible size. For cameras positioned on a distance from their target, either an optical zoom lens should be used or a higher resolution (e.g. 5 MP) camera, using digital zoom to obtain the wanted field of view at the required resolution. The frame rate setting should be set according to the size of objects and the speed in which they pass the cameras view. In general, deck and overview cameras should be set to 1-5 fps (frames per second), and on more active areas like sorting belt and discard chute cameras should be set to 5-15 fps.

For the deck overview and the designated discard area, the set-up should facilitate to identify the legality of the discard activity, including in darkness. This can be achieved by both infrared lighting and white-light. The competent authority has to consider these needs at the VMP preparation stage.

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Recommendation:
Cameras/camera housings should be constructed of material that can resist harsh environment on board the vessels, that can resist tampering, and that camera closure fittings are robust and durable. High-resolution cameras should be prioritised – the higher the better. Lower resolution on the cameras can be set if needed. The system set-up will need to be able to record activities in low natural light conditions.

3.3 Sensors

The minimum requirements for sensors are based on a generic vessel type (in accordance with Appendix 1). Some sensors should be based on a common requirement irrespective of vessel type (e.g. GPS) and other sensors will be vessel type specific. The control box system specified in 3.1 should support both digital and analogue sensor input options.

Depending on vessel type according to Appendix 1, the system should support the following sensor data as a minimum:

A. GPS.
B. Winch rotation with direction detection.
C. Hydraulic pressure.
D. Electric current.
E. Fish hatch/door open/close.
F. Temperature (in fish-hold tanks).
G. Power block.
H. Fish pump.
I. Knife valve.
J. [Estimate of catch in the net.]

The sensors A, B and C are already in use. For sensor D the electrical power should be measured. Sensor E records whether the fish hatch is open or closed. Sensor F records the temperature in the fish-hold tanks – this is already standard installation at the vessels and output from these systems can most likely be made easily. Sensor G records the power block activity and sensor H is for fish pump activity. Sensor I records when the knife valve is opened and closed. Data from sensor J still needs to be defined.

Final specifications, protocols and output for each of the other sensors needs to be defined in cooperation with the REM technology providers.

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Additionally, a data-bus connection should be available for future expansions and for integration with general sensors and instruments already on-board the vessels. (e.g. CAN, RS485 and NMEA2000).

Estimate of catch in the net sensors have not been fully developed in REM. It is recommended that these sensors are tested/developed in more trials ahead of implementation. An estimate of the catch in the net could help monitoring slipping practices.

Recommendation:
The REM systems should be able to support all types of sensors needed and a data-bus connection for efficient use of the system**.**

3.4 System diagnostics

The REM system should be able to deliver to the master and the competent authority via a data request automatically created system health messages, including:

A. Position fix accuracy.
B. System temperature.
C. Memory usage.
D. Camera image check.
E. Sensor operation check.
F. Warnings for missing data (sensors and/or video) these should display both on the on board system and via the analysing software.
G. Tamper events.

It could be considered to develop image recognition approach that could give automatic warning, on which the master should be obliged to act upon in case the focus area of the camera had been changed. A picture of the camera shot for each camera should be inserted in the Vessel Monitoring Plan (see Appendix 2).

The system should be able to accommodate new technologies on automatic detection of failures.

The master should be obliged to report to the flag state competent authority (Fisheries Monitoring Centre) if the system fails to operate properly at sea or critical warnings have been displayed.

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Recommendation:
The system should allow the master to test it and ensure it is fully functional and meets the requirements at all times in order to verify all activities. A self-test function should be incorporated and the master should ensure that the system is fully functional before leaving port. The system test should include at least position check, memory status check, camera image check, and sensor operation check. The system should record the self-test data. The system should give alerts to the master when it is non-functional.

The master should be obliged to report to the flag state competent authority when in port or at sea if the system diagnostic fails or if warnings that affect the capture of the data and the video footage as specified in the VMP have been displayed. The master should be obliged to report any system or power failures in the logbook.

Rules need to be established on the vessel having to stay in port, or what to do at sea, when the system fails.

The master may repair/replace a part, e.g. a camera or winch sensor, while at sea in view of camera. If the VMP requirements continue to be met then fishing could resume without returning to port.

4 Segmentation of the EU fishing fleet

The EU fishing fleet consists of numerous fishing vessels types and sizes. The vessels target different species or groups of target species depending on fishing area, seasonality, quotas availability and fishing gears used. The minimum requirements for REM vary depending on type of fishing gear to be used, vessel characterisation, vessel configuration, vessel length and target species or group of target species. In order to ensure that the REM system required is not too onerous a fleet segmentation approach is recommended. A draft segmentation of the EU fishing fleet for the purpose of REM requirements is included in Appendix 1.

Recommendation:
A fleet segmentation approach is recommended when implementing REM on board EU fishing vessels, to accommodate for the variety of installation needs for different vessel types, and also for the purpose to support the phasing-in of REM and risk assessment.

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5 Vessel Monitoring Plan

Due to the variety of fishing vessels types and configurations, even within the same segment, a REM Vessel Monitoring Plan (VMP) is necessary for each individual vessel in order to cover all monitoring needs and to optimize the quality of data and especially the video footage. The VMP should be made in cooperation between the vessel owner or master and the flag state competent authorities. After the installation and any agreed repositioning of equipment is completed following initial trials, the flag state competent authority shall approve the REM system before the vessel is authorised to start its fishing activities.

In order to optimize the video footage capture on-board a vessel, several factors have to be considered such as positioning of cameras and the camera settings. A layout of camera positions should be based on a survey of the vessel prior to installation of the REM system. The main purpose of such a vessel survey is to be able to secure optimal camera layout solution, which will allow monitoring for ensuring compliance with the landing obligation. When installing cameras, a balance will be required between optimal views of catch handling and practical issues such as space and minimisation of interference with crew operations. Optimal view should be prioritised and more than one camera may be necessary.

Recommendation:
A REM Vessel Monitoring Plan (VMP) shall be made for each vessel in order to adapt the installation to the vessel characteristics and optimize the quality of data and especially the video footage.

At least one camera and, if possible or required, additional cameras, should be positioned around the designated discard area in order to cover the area and give the optimal video data for identification and quantification of discards.

In order to allow a visual verification of fishing operations at least one camera or as many as required should be placed on locations so a full overview of the processing line and fishing deck can be made. Cameras should be positioned to allow an assessment of retained catch quantities as this is fundamental to monitoring compliance of the landing obligation.

Some cameras will need to be recording during the entire fishing trip from the start of the first fishing operation and some cameras will only need to initiate recording during certain processes taking place on the vessel (such as hauling the gear) to ensure no illegal slipping or discarding are taking place outside the designated discarding area.

Areas where discarding could take place and identified risk areas should be monitored by cameras 24/7.

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When a VMP has to be established, the vessel owner is obliged to provide some basic initial information including a general plan of the vessel to the flag state competent authority. A predefined template is provided (see Appendix 2 part A).

Based on the information provided in the VMP part A, the flag state competent authority establishes an installation plan with layout schematics. A predefined template is provided (see Appendix 2 part B).

The flag state competent authority shall establish a VMP for each vessel for guidance during the installation and monitoring. Key risk areas where discarding can take place and where species identification of catch discarded can be made shall be prioritised at each individual vessel. This will be an integrated part of the VMP. When preparing VMPs, it should be taken into account that the flag state competent authority can require adjustments to the plans, which may require a change in the REM set-up including additional parts.

The initial phase of operation of the vessel after the installation should be considered a testing stage. Changes to the VMP may be proposed to the authorities during this stage.

The VMP should be signed off by the vessel owner and finally approved by the flag state competent authority.

Any physical changes on a vessel, changes in its fishery, changes in the categorisation of the vessel in relation to the fleet segmentation, changes to the catch handling deck or the fishing deck, including the designated discard area should be reported to the flag state competent authorities. The VMP should be updated and approved again by the competent authority before the next fishing trip can take place. It shall not be possible to make changes to the VMP while at sea.

6 Rules of operation

6.1 Logbook recording

Logbook recording of catch (both retained and discarded) should be done per fishing operation in order to maximise the effectiveness of REM system's sensor data and video footage. The logbook reporting (submission) frequency can remain once a day, if the recording is done by fishing operation (haul by haul). Furthermore, detailed information recorded in the logbooks is needed for automation of the analysis processes and to maximise time-efficiency for the analysis. Unless detailed recordings in the logbook per fishing operation is prescribed the full advantages of the REM information will not be obtained.

For all fisheries, slipping events should also be recorded in the logbook.

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The future of electronic monitoring is a transition from post-analysis to live-analysis of the catches. The aim is to be able to do a total catch quantification and species recognition, using image analysis and AI (artificial intelligence) on the vessel while the catch is being processed. This would reduce the need for manual video review and drastically minimize the amount of data needed to be transferred. At the same time, this would make the data very valuable to the individual vessel owners, who would have an instant overview of their catches, and the ability to make better planning or adjustment of their fishery and calls on e.g. a landing port. The use of artificial intelligence is not considered for the current guidelines.

Recommendation:
In order to facilitate automated REM analysis and to maximise the effectiveness of REM system's sensor data and video footage all fishing operations (haul by haul) should be recorded in the logbook, including events inhibiting taking the catch on board.

6.2 Catch handling

Due to the variability in catch handling on board fishing vessels, and in order to be able to capture the whole catch handling process on camera, some work processes might need to be adjusted if a technical solution cannot be found. If a sorting table or conveyer belt is used it needs to be ensured that the discard monitoring cameras are able to capture every fish discarded. For vessels where a technical solution cannot be found through the VMP to monitor the catch handling on the REM system, the vessel owner will be required to either change some handling processes or if a fully satisfactory position/angle for data/video capture cannot be achieved then the use of alternative monitoring methods, e.g. to take observers on board and bear the related costs.

There is a need to designate an agreed discard area where legal discarding can take place (defined in the VMP) in order to ensure that the discarding can be captured on the dedicated camera. Any discarding outside this designated area should be regarded as illegal discarding regardless of the species in question.

For vessels using pumps special requirements may be needed. For instance, there will need to be camera/s or sensors in place to view the gear and pump operating during the pumping of fish on board.

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Recommendation:
In order to capture the whole catch handling process on camera, some work processes might need to be adjusted if a technical solution cannot be found. Discarding outside a designated discardarea, included in the VMP, where legal discarding can take place should be prohibited. Any discarding outside this designated discard area should be regarded as illegal discarding regardless of the species.

7 Data storage and data handling by the competent authority

7.1 Data retrieval

Until now different methods of retrieving information and video footage acquired by the REM systems have been used. Simply collecting hard drives from all vessels at fixed intervals does not seem a sustainable solution. An approach is recommended where all sensor data is automatically transmitted over mobile networks, Wi-Fi, or satellite and video footage is only transferred on request by the flag state competent authority. This request should be based on a manual or semi-automatic pre-analysis of the sensor data made on land. In most cases, using this methodology would allow keeping the quantities of transmitted video footage at a minimum, and thus reducing the transmission costs significantly. Further, it is important to futureproof these requirements as retrieval of data and video footage using satellite communication may be more economically viable in the near future, allowing the possibility to request images or video via satellite, as decided by the competent authority.

If large amounts of data/all data and video footage stored is required, the data may be retrieved on board the vessel by the competent authority. Adapting such an approach would fit very well with the rapidly growing possibilities of image analysis and machine learning algorithms. The requirement for data transferred and manual video review would significantly decrease, the better the algorithms would get.

The sensor data will need to be pushed at regular intervals (e.g. daily, to be decided) during the fishing trip, including a push of data at the end of the fishing trip.

Recording should continue until after discharge of the catch ashore has finished.

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Recommendation:
An approach is recommended where all sensor data is automatically transmitted over mobile networks, Wi-Fi, or satellite and video footage is only transferred on request by the competent authority.

7.2 Data analysis software

REM systems on board the vessels should be able to deliver the sensor data and video footage in a specified common format for exchange (output). The land based analysing software (REM analyser) should be able to analyse the data and video footage delivered in this format.

The current advantage for providers is that they control both the software on board the vessel and the analysing software, which gives them the possibility to innovate and develop. In order to be more effective on the land part, there need to be more development on the ship part. You cannot develop it, when you do not control it. The future is species recognition. To develop this you need access and control over both parts.

There are many ways in which this exchange format could be established and different designs are possible. The setting-up of a dedicated working group could probably facilitate this development. There are also different options on how to organise the exchange, some technically more complicated, others less (pros and cons). A competent authority may need to analyse data coming from different systems even without considering exchanging. To facilitate this, there are several options:

1) A common format for exchange (requires development by providers, in cooperation with MS)
2) Competent authority to use different analysis software packages for each REM system
3) A single national procurement for one system
4) A single EU procurement for one single system

Recommendation:
A competent authority may need to analyse data coming from different systems. Therefore, it is recommended to develop a common format for exchange (output). This requires development by providers in cooperation with MS.

For this solution, it is required that the data received from the different REM systems, can be processed using a REM data and video footage analyser from one provider even though the data to review stem from a REM system of another provider. All sensor data and video footage should be able to be analysed using any REM analyser software. This will also accommodate data sharing.

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Required minimum functionalities:

A. Sensor data must automatically be linked to video footage to facilitate easy analysis.
B. Graphic presentation of sensor data.
C. Input of speed and pressure sensor to pinpoint an activity and indicate individual reviewing;
D. Zoom function of the video footage, while playing.
E. Analyst should be able to annotate observations at the date/time of the fishing trip that observations relate to.
F. Capability to export a subset of sensor data and related video footage.
G. Capability to connect REM data and video footage to ERS data to facilitate quicker analysis when comparing logbook reporting per fishing operation.
H. Capability to properly encrypt and compress data;
I. Capability to geo-fence areas of activity.
J. Capability to indicate where data is missing in order to analyse events around that time.
K. Capability to measure fish species on the belt by the system (regardless of direction of fish on belt).
L. Capability of automatic measurement if possible should be able to take place without any major sorting of the fish.
M. Capability for the analyst to grade the quality of the data (ideally the system should recognise this in future).

Recommendation:
A solution is required for the data gathered from the different REM systems, so the analyser software from any provider could be used to review sensor data and video footage from any other REM provider. This could be an issue within a MS, where the fleet is using different systems and for the exchange between MS.

7.3 Data storage and retention

The estimated size of video footage for one year of fishing would mean for a less active smaller vessel approximately 250 GB and for a larger more active vessel around 6 TB. For an 8-camera vessel the needed storage capacity is approximately 1 TB per month (depending on the length and frequency of the fishing trips). Storing large volumes of data and especially video footage by the competent authority is not considered manageable. Furthermore, stricter privacy and data protection legislation would be required for video footage to comply with the EU General Data Protection Regulation (GDPR) standards.

The magnitude of the sensor data is more manageable and could therefore easily be stored. A minimum and a maximum period for the storage of sensor data should be specified in the Control Regulation.

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Similarly, a minimum and a maximum period for the storage of the transmitted video footage should be established. These retention periods can be extended for example for video footage necessary to allow the follow up of a complaint, an infringement, an inspection, a verification, an audit, or on-going judicial or administrative proceedings. In these cases, video footage could be stored for as long is necessary.

The general applicable rules on data protection of the control regulation apply also to REM data under the CFP. It is recommended that the rules on data protection in the Control Regulation are amended to cater for the protection of REM data.

Recommendation:
Legal provisions on data protection, storage and retention in Member States may currently vary. It is recommended that the rules on data protection in the Control Regulation are amended to cater for the protection of REM data. These legal provisions on data are considered outside the specific area of expertise of the technical group drafting these guidelines.

7.4 Risk based analysis

Selection of vessel data and video footage to be reviewed should be based on risk-analysis of the vessels/trips/fishing operations. In order to achieve an overall picture of compliance with the landing obligation and to be able to estimate total catches by species, a random selection of fishing operations need to be reviewed.

The percentage (e.g. minimum 5%) to be defined for analysis could be:

- A percentage of all fishing operations of specific vessel segment.
- A percentage of fishing operations during a trip
- A combination of the previous

A risk based viewing indicator could also include missing data, data quality issues, tamper event, abnormal fishing or landing pattern, risk of non-compliance with the LO, risk indicator, quota availability or date of last inspection.

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Recommendation:
Selection of vessel data and video footage to be reviewed should be based on risk-analysis and in order to achieve an overall picture of compliance with the landing obligation a random selection of fishing operations should in addition be made.
Risk based viewing indicator could also include missing data, data quality issue, tamper events, abnormal fishing or landing pattern, risk of non-compliance with the LO, or date of last inspection.

Missing data could be difficult to detect. In order to detect missing data, a big data analysis can help indicate.

Data viewing (the analysis) needs to be done by competent trained staff. It could be done by non-inspector staff, but potential infringements need to be confirmed by a fishery inspector.

The viewers need to participate in specialised and regularly updated training. To ensure level playing field, these trainings should focus on exchanging experiences and standardising these reviews at the maximum extent. The minimal requirements for the viewers should be independence of the industry and having competent knowledge of:

- The legal framework relevant to the data analysis.
- catch handling processes on board fishing vessel (what is normal and what is abnormal)
- Fish species identification (could include REM nuances).
- Risk indicators for the fishing trip.
- How to use the REM analyser software.

Recommendation:
Data viewing (the analysis) needs to be done by competent trained staff and the viewers need to participate in specialised and regularly updated training to ensure level playing field. Minimal requirements for the viewers should be independence of the industry and that they have the required competent knowledge.

8 REM system ownership

Experiences gained during the last 10 years of trials in European fisheries as well as in the first trials carried out in other parts of the world have shown that ownership of the systems has an effect on instances of tampering.

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If the REM system does not work properly, the workload of analysing the data and video footage will increase and the quality of the analysis will decrease. Therefore, while the vessel will be obliged to have an REM system, the REM system should be the property of the vessel owner. The master of the vessel should be obliged to ensure the system is running in accordance with the rules of operations. This may include the allowance to replace parts of the system that had ceased to function whether at sea or in port, because it would enable the system to be operational again.

Recommendation:
REM system should be property of the vessel owner. The master of the vessel should be obliged to ensure that the system is running in accordance with the rules of operation.

9 Cost issues

9.1 REM systems on board

The price for a REM system varies depending on the vendor. For a typical system consisting of a control box, 4 cameras, sensors cables and 1-year software license the price per system is € 6,000 - € 9,000. A REM system software license is around € 250 annually. There are additional requirements in the document, from what is available now, which could have impact on the expenses.

Installation of a system on board a vessel varies depending how complicated the installation and especially the cabling is. For a smaller vessel (less than 12 m) the installation can be done in half a day for around € 500 and € 1000. This in contrast to a medium size vessel (15 – 40 m) where the price varies between € 2,500 and € 3,500 and for a larger vessel (more than 40 m) could be around € 4,000.

Maintenance cost of a REM system is very dependent on the activity of a vessel and on the conditions in which it is fishing. An estimate is € 400 - € 1,000 annually. If the system is of good quality the maintenance costs may be significantly lower.

Costs given in this analysis for the REM systems on board are based on currently known prices, and are estimated in the table in Appendix 1 of the Annex per type and size of vessel. The costs of these technologies could of course change significantly in a relative short period.

9.2 Land based organisation

It is difficult to estimate the cost for the land-based organisation as the setup may be different between MS. For a rough estimate, the following has to be taken into account:

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- Purchase of servers (price depending on storage capacity) or purchase of hosting externally. As an example where data storage hosting is purchased externally, the annual cost for 5 TB is € 1,340 (€ 268 per TB). The cost per TB is cheaper when purchasing 25 TB or more storage. [Add indication of cloud storage and buying a server]

- Costs of the analysis software (licenses). For a single user the price is app. € 2,700 per year and for site license (unlimited number of users) the price is app. € 20,000 per year.

The cost for analysing the sensor data and video footage and compare this information with e.g. logbook data for a vessel/trip/haul is very dependent on the analyser (software). The more user friendly, the merging of the various data sources and the quality especially of the video footage, the cheaper.

Some MS might consider developing their own software (analyser) to prevent license costs. Based on the experiences on the development cost for other fisheries related databases and other related software, this is not recommended. Some of the REM vendors have over 10 – 15 years developed and constantly improved the analyser software and at present, this software is already fully functional software. Such software needs continuous improvement based on input from the users. If each MS develop its own software, the development cost will likely exceed far more than € 300,000. In addition, an annual cost of maintenance and further development can easily amount to € 100,000 - € 150,000 annually.

9.3 Transmission cost

Several different methods of retrieving sensor data and video footage acquired by the REM systems can be used. It is recommended that all sensor data are automatically transmitted over mobile networks or satellite. The heavier video footage may only be transferred on request by the flag state competent authority using mobile networks, satellite or in port by Wi-Fi.

As an example, the following cost may be expected if assuming a vessel being at sea for 200 days a year, using 4 cameras and 4 sensors and all sensor data and video footage from 5% of 600 hauls (30 hauls) is transmitted to land (competent authority).

Sensor data

4 sensors (GPS, Winch, Hatch, Temperature) recorded every 10 sec ~ 500KB per day
200 days at sea * 500 KB = 100MB per year

Cost for transmission of sensor data

Mobile data (3G/4G): Almost nothing.

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Satellite data: Depending on subscription: 0.5 € per MB - €50 - €400 per year. This depends on whether you already have a subscription for satellite connection (added data space to existing subscription, should not be high). If you need a subscription just for this, the costs will be higher. Usually, a combination of the two will be used where the mobile network also will be used for transmission of video footage and live-view. Cost for sensor data will therefore be negligible.

Video data

4 cameras (average configuration)
200 days at sea * 3 hauls per day * 5% = 30 hauls
1.5 hours' video footage per haul (catch processing) * 30 hauls * 4 cameras = 180 hours
1-hour video footage = 400 MB on average → 180 hours * 0.4 GB = 72 GB

Cost for transmission of video data

Mobile data (3G/4G): 15GB per month = €15 per month = €180 per year (sufficient to cover review of 60 hauls)

Estimated time for uploading: 15-25 GB per hour (4G).

Satellite data: The cost for an unlimited 4MB/1MB connection is at present €800 per month = €9,600 per year

There is some uncertainty on the SAT cost as it will probably be cheaper if a vessel is having a connection and this is upgraded. Just to use satellite connection for transmission of all requested video footage with the present prices would be too expensive.

Wi-Fi in ports is another option for transmission of video footage. This solution requires installation of multiple access points and a good fibre connection. As the mobile data prices constantly are reduced and the upcoming 5G network will be installed within the next years, a mobile data transmission solution would be preferable.

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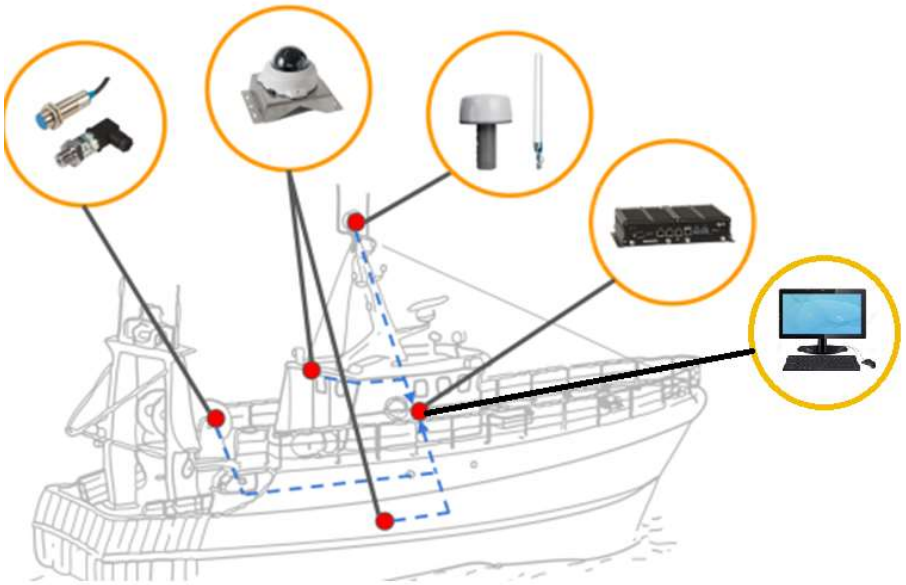
Annex. Summarised technical specifications of Remote Electronic Monitoring system (REM) in EU fisheries

A REM system to be installed on board fishing vessels consist of a control box (a modified computer with possibilities for connecting a number of different sensor and a number of cameras). The system software is developed to handle and control sensors and cameras and to store sensor data and video footage on embedded solid hard drives and to display all information on a screen in the wheelhouse. The system set up on a vessel is shown in the figure below.



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Control box

The control box is the on board computer that acquires and stores all sensor data and video footage. It is recommended that the unit be based as a minimum on the following technical specifications:

The below listed specification do not need to be physically in the unit, but connected to/integrated in it.

A. Fan-less passive cooling – with high temperature cut out.
B. 12-24V DC isolated power input.
C. Max. power 60W.
D. GPS sensor or equivalent.
E. 4G/LTE or faster (upload), mobile data connection.
F. Wired interconnection of the components of the system on board.
G. Capability for wireless (e.g. WiFi (802.11ac or faster)/Bluetooth) connections.
H. Utilization of existing on-board satellite data connection for sensor data transmission. For vessels only fishing within in cell phone range 4G can be used for sensor data transmission.
I. Automatic prioritisation of best suitable connection for data transfer and remote access.
J. Data storage capability for storing sensor data and video footage. Minimum data storage capacity depends on the vessel activity (days at sea), the number of cameras and the data storage duration.
K. At least one removable/swappable back-up data storage of variable sizes.
L. Support the required number cameras.
M. On board screen connection for verification including keyboard (and mouse) or touch screen.
N. Supports remote access/configuration.
O. UPS (Uninterruptible power supply) of controlled shutdown, logging in case of power loss. If possible, UPS should also enable continuation of recording for relevant timespan (for e.g. 10 minutes). Information on any power failure should automatically be recorded for subsequent notification to the FMC.
P. Sensor data and video footage needs to be properly encrypted and compressed.
Q. Digital signature (date and time stamp, vessel name, vessel registration and GPS co-ordinates).
R. If data transmission is temporarily not possible, the request shall be stored on the control box and the requested data shall be secured to prevent possible deletion or tampering. The requested data shall be automatically transmitted when data transmission again is feasible.

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Furthermore, the following system capabilities need to be considered:

S. The system should be able to upload all or if required parts of recorded data automatically at specific intervals or when connectivity prioritisation allows. All data being transmitted, stored for backup on the control box should be securely encrypted.

T. Transmission of encrypted data should be done using secure communication protocols (FTPS, HTTPS).

U. Build-in remote access should be possible, for system configuration and verification of system health if required.

V. Remote access should include access to health checks of the camera and configuration (e.g. frame rate). A common format for analysis is needed to allow access to configurations (see 6.2).

W. Possibility for remote access to support transmission requests of all or parts of recorded sensor data and video footage should be made.

X. Possibility to have a wireless option (e.g. via WiFi/Bluetooth) to interconnect the parts of the system.

Y. Possibility to have a wireless option (e.g. via WiFi) for uploading the data from vessel to land-based system.

Cameras

The cameras and the camera housing need to be produced of material that can resist harsh environment on board the vessels and that can resist tampering. Using smaller cameras should be prioritized. Camera closure fittings need to be robust and durable. The cameras should fulfil the following minimum technical specifications:

A. Type: Digital IP Cameras (IP = Internet Protocol).

B. Ingress Protection: IP66 Rating. A higher IP (e.g. IP68) for cameras regularly exposed to heavy weather conditions is recommended.

C. Cabling: Minimum CAT 5e Ethernet cable preferably CAT 6 SFTP cable.

D. Resolution: Minimum 2MP (1080P), depending on the purpose of each camera.

E. Lens: Specified range of fixed and zoom lens option cameras, ideally replaceable lenses.

F. Housing: Replaceable camera dome / housing glass.

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G. Video:
    - Compression: Supports standard video compression formats. Minimum H.264 preferably H.265.
    - Remote configuration: Capability to configure the following parameters both remotely and on board(on board configuration needs to be secured and any changes should be logged):FPS - Frames per second (adjustable depending on camera purpose)
        - Image Resolution
        - Image Quality (Bitrate)
        - Digital/optical zoom level.

H. Measuring capability: Capability to measure fish length for relevant cameras (lens dependable).

I. Masking capability: Possibility to blank out parts of images to protect persons and to select region of interest, with higher quality than rest of image (background/foreground).

J. The system should be capable of functioning in the environmental conditions (e.g. temperature) where the vessel will be operating.

Sensors

The minimum requirements for sensors are based on a generic vessel type. Some sensors should be based on a common requirement irrespective of vessel types (e.g. GPS) and other sensors will be vessel type specific. The control box system should support both digital and analogue sensor input options.

Depending on vessel type as per appendix 1 as a minimum the system should support the following sensor data:

A. GPS.

B. Winch rotation with direction detection.

C. Hydraulic pressure.

D. Electric current.

E. Fish hatch/door open/close.

F. Temperature (in the fish-hold tanks).

G. Power block.

H. Fish pump.

I. Knife valve.

J. [Estimate of catch in the net.]

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Estimate of catch in the net sensors have not been fully developed in REM. It is recommended that these sensors are tested/developed in more trials ahead of implementation

Additionally, a data-bus connection available for future expansions and for integration with general sensors and instruments already on-board the vessels. (e.g. CAN, RS485 and NMEA2000).

System diagnostics

The REM system should be able to deliver to the master and the competent authority via a data request automatically created system health messages, including:

A. Position fix accuracy.
B. System temperature.
C. Memory usage.
D. Camera image check.
E. Sensor operation check.
F. Warnings for missing data (sensors and/or video) these should display both on the on board system and via the analysing software.
G. Tamper events.

The system should be able to accommodate new technologies on automatic detection of failures.

Segmentation of the EU fishing fleet

The EU fishing fleet consists of numerous fishing vessels types and vessel sizes. The minimum requirements for REM vary depending on fishing gear type to be used, vessel characterisation, vessel configuration, vessel length and target species or group of target species. A draft segmentation of the EU fishing fleet for the purpose of REM requirements is included in Appendix 2.

Vessel Monitoring Plan

Due to the variety of fishing vessels types and configurations, even within the same segment, a REM Vessel Monitoring Plan (VMP) is necessary for each individual vessel in order to cover all monitoring needs and to optimize the quality of data and especially the video footage. The VMP should be made in cooperation between the vessel owner, or master and the flag state competent authorities. After the installation the flag state competent authority has to approve the REM system before the vessel starts with its fishing operations.

When a VMP has to be made the vessel owner is obliged to provide some basic initial information including a general plan of the vessel to the flag state competent authority. A predefined template is made (see Appendix 2 part A).

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Based on the information given in VMP part A, an installation plan with layout schematics is made by the flag state competent authority. A predefined template is made (see Appendix 2, part B).

VMP should be signed off by the vessel owner and finally approved by the flag state competent authority.

Any physical changes on a vessel, changes in its fishery, changes in categorisation of the vessel in relation to the fleet segmentation, changes the catch handling deck or the fishing deck, including the designated discard area should be reported to the flag state competent authorities. The VMP should be updated and approved again by the competent authority before the next fishing trip can take place.

Data retrieval

All sensor data should be automatically transmitted over mobile networks, Wi-Fi, or satellite and video footage is only transferred on request by the flag state competent authority. This demand should be based on a manual or semi-automatic pre-analysis of the sensor data made on land. Using this methodology, it would in most cases be possible to keep the quantities of transmitted video footage at a minimum and also reduce the transmission costs significantly. Further, it is important to futureproof these requirements as retrieval of data and video footage using satellite communication may be more economically viable in the near future, allowing the possibility to request images or video via satellite, as decided by the competent authority.

Data analysis software

REM systems on board the vessels should be able to deliver the sensor data and video footage in a specified common format. The land based analysing software (REM analyser) should be able to analyse the data and video footage delivered in this format.

A solution is required for the data gathered from the different systems, so an analyser from one provider could be used to review data from another provider. All sensor data and video footage should be able to be analysed using any REM analyser software. This will also accommodate data sharing.

Required minimum functionalities:

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E. Analyst should be able to annotate observations at the date/time of fishing trip which observations relate to.

F. Capability to export a subset of sensor data and related video footage.

G. Capability to connect REM data and video footage to ERS data to facilitate quicker analysis when comparing logbook reporting per fishing operation.

H. Capability to properly encrypt and compress data;

I. Capability to geo-fence areas of activity.

J. Capability to indicate where data is missing in order to analyse events around that time.

K. Capability to measure fish species on the belt by the system (regardless of direction of fish on belt).

L. Capability of automatic measurement if possible should be able to take place without any major sorting of the fish.

M. Capability for the analyst to grade the quality of the data (ideally the system should recognise this in future).

Data storage and retention

The estimated size of video footage for one year of fishing would mean for a less active smaller vessel approximately 250 GB and for a larger more active vessel around 6 TB. For an 8 camera vessel the needed storage capacity is app. 1 TB per month (depending on the length and frequency of the fishing trips). Storing large volumes of data and especially video footage by the flag state competent authority is not considered manageable. Furthermore, stricter privacy and data protection legislation would be required for video footage to comply with the EU General Data Protection Regulation (GDPR) standards.

The magnitude of the sensor data is more manageable and could therefore easily be stored. A minimum and a maximum period for the storage of sensor data should be specified in the Control Regulation.

Similarly, a minimum and a maximum period for the storage of the transmitted video footage should be established. These retention periods can be extended for example for video footage necessary to allow the follow up of a complaint, an infringement, an inspection, a verification, an audit, or on-going judicial or administrative proceedings. In these cases, video footage could be stored for as long is necessary.

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Appendix 1. Vessel segmentation and summarized minimum requirements[2]

To facilitate a possible phasing in and risk assessment this segmentation is recommended. This does not prejudice future decisions on which segments could be obliged to be equipped with REM.

Segment	Fishing type	Vessel length	Gear type	Vessel type	Indicative minimum number of cameras[3]	Sensors								Estimated system cost[4]	Estimated installation cost	Annual running cost[5]
						GPS	Net drum activity	Winch activity	RSW tank temperature	Power block	Fish pump	Knive valve	Catch in net[6]			
REM01	Demersal Passive	< 12 m	Set nets, lines		2		X							€ 6,000	€ 1,000	€ 500
REM02		12 – 18m			4		X							€ 6,500	€ 2,000	€ 1,000
REM03		> 18 m			4		X							€ 6,500	€ 2,000	€ 1,000
REM04	Demersal Active	< 12 m	Trawls		4			X						€ 6,500	€ 2,000	€ 1,000
REM05		12 – 18m			4			X						€ 6,500	€ 2,000	€ 1,000
REM06		18 – 24 m			5			X					X	€ 6,800	€ 2,500	€ 1,000
REM07		> 24 m			5			X					X	€ 6,800	€ 2,500	€ 1,000
REM08	Pelagic Active	< 12 m			2			X			X			€ 6,300	€ 1,000	€ 750
REM09		12 – 24m			4	X		X			X		X	€ 6,800	€ 2,000	€ 1,500
REM10		> 24 m			4			X			X		X	€ 8,000	€ 2,500	€ 1,500
REM11		12 – 24m		RSW	4			X	X		X	X	X	€ 8,000	€ 2,000	€ 1,500
REM12		> 24 m		RSW	4			X	X		X	X	X	€ 8,000	€ 3,000	€ 1,500
REM13		> 24 m		Freezers	8			X	X		X		X	€ 9,000	€ 3,000	€ 2,500
REM14		12 – 24m	Purse seine	RSW	4				X	X	X	X		€ 8,000	€ 2,500	€ 1,500
REM15		> 24 m		RSW	4				X	X	X	X		€ 8,000	€ 3,000	€ 1,500
REM16	Pelagic Passive	All	Long liner		3		X							€ 6,500	€ 2,000	€ 1,000

[2] Total number of cameras and (type of) sensors should be defined in the Vessel Monitoring Plan (VMP), depending on specific vessel configuration.

[3] See section 3.2 for a description of the types of cameras.

[4] System costs covered considering cameras covering the following areas: i) the fishing deck; ii) the general view for providing a wide angle view of the fishing processing area; iii) the sorting belt/sorting table; iv) the discard area/areas. (minimal 3 MP).

[5] Costs include the annual REM system software license fee (app. € 250) and an estimation of the annual maintenance cost. Transmission cost not included.

[6] This sensor could be a minimum requirement for monitoring slipping, where considered relevant by the competent authority on the basis of risk assessment.

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Vessel Monitoring Plan

Remote Electronic Monitoring (REM)

Part A

Information to be provided by the vessel owner

External registration:	
Vessel Name:	
EU Fleet Register number:	
IRCS:	
Home port:	
Vessel Length:	
Vessel type:	
Main fishery (demersal/pelagic):	
Gear Type(s):	
Crew Size:	
May carry an observer:	
Name of the owner or owner's representative:	
Phone no:	
E-mail:	

Description of crew fish handling and any other useful details

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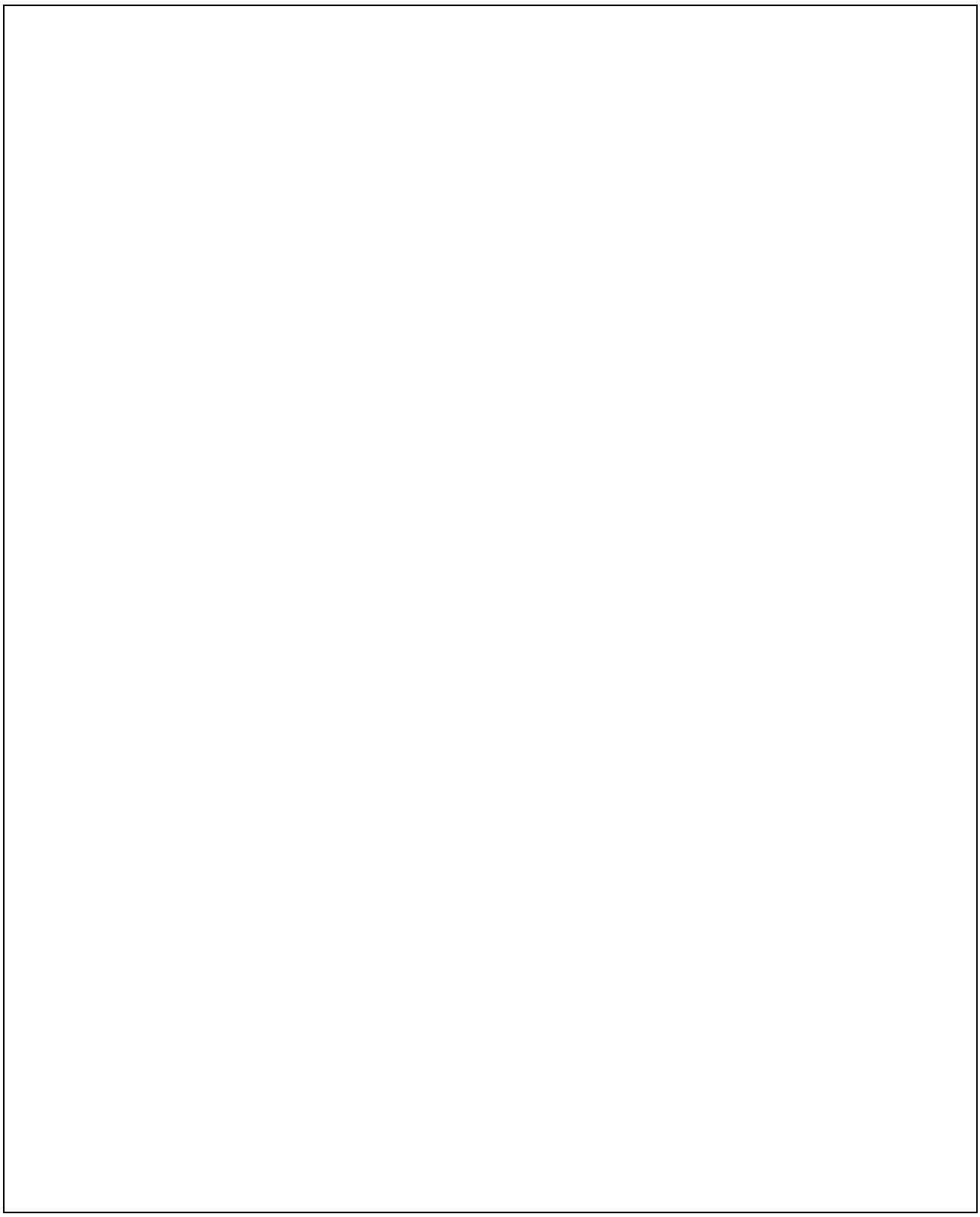
If available copy or image of vessel general arrangement plan



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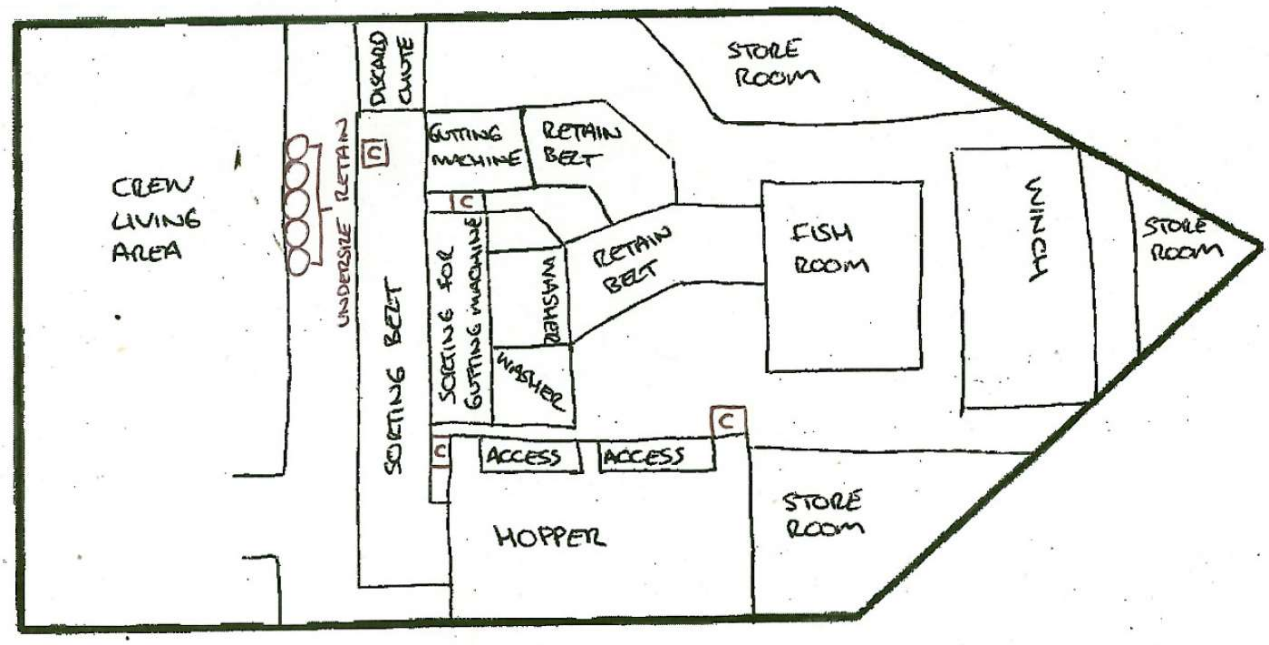
General layout and handling (NOT TO SCALE).

Example



Position of the crew during fish processing should be marked.

General remarks

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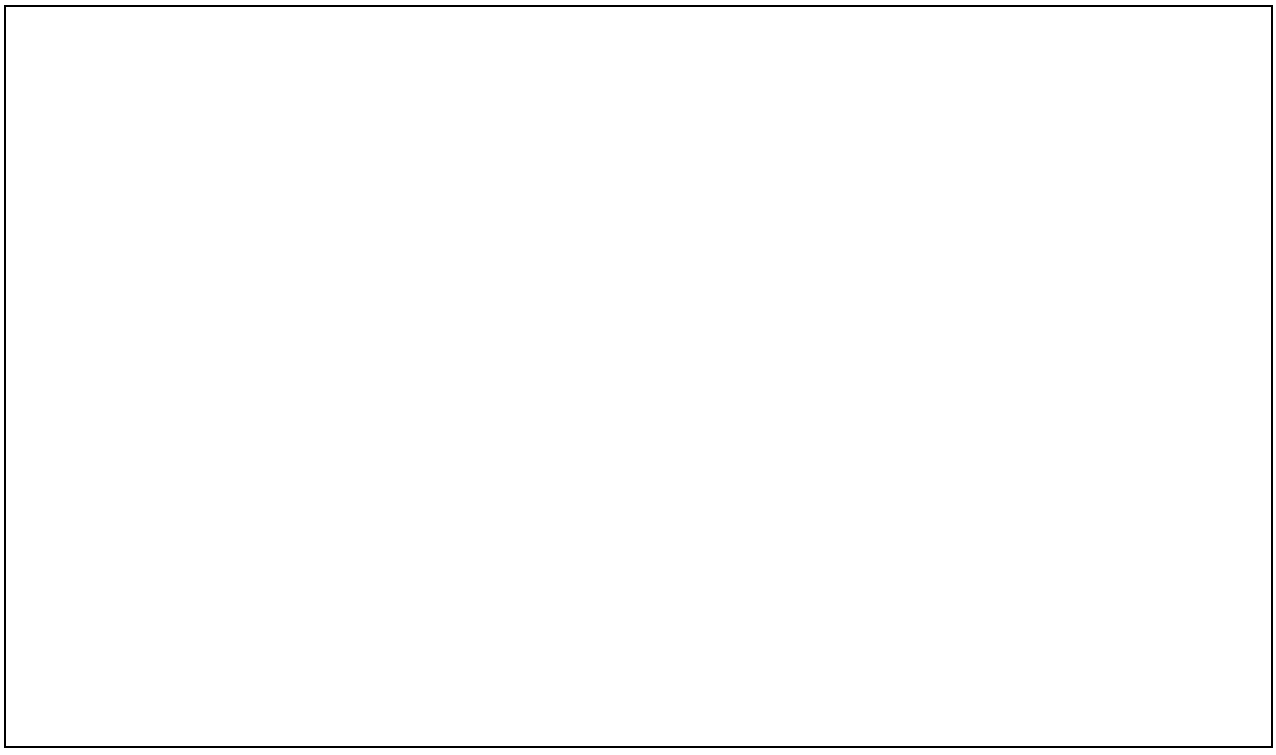
Vessel Monitoring Plan

Remote Electronic Monitoring (REM)

Part B

Responsibility of the competent authority and to be validated by the competent authority

VESSEL IMAGE



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System Configuration

System Operation - General Description

Sensor Recording:	Description of the settings
Video Recording:	Description of the settings

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System Components Location

Control Box Image of location of the control box	User Interface
GPS Image of location of the GPS	GPS Details
Drum Rotation Sensor Image of location of the GPS	Drum Rotation Senor Details
Hydraulic Pressure Sensor Image of location of the Hydraulic Pressure Sensor	Hydraulic Pressure Sensor Details

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Sensor xx Image of location of the xx sensor	XX Sensor Details
Sensor xx Image of location of the xx sensor	XX Sensor Details
Sensor xx Image of location of the xx sensor	XX Sensor Details
Sensor xx Image of location of the xx sensor	XX Sensor Details

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Camera 1 – Deck camera	
Image of location of camera 1	View and objectives
Image deck camera	Camera settings
Camera 2 – Retain/General View Camera	
Image of location of camera 2	View and objectives
Image retain/General View Camera	Camera settings
Camera 3 – Sorting belt camera	
Image of location of camera 3	View and objectives
Image sorting belt camera	Camera settings
Camera 4 – Discard Camera	
Image of location of camera 4	View and objectives
Image discard Camera	Camera settings

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Camera XX – XX camera	
Image of location of camera XX	View and objectives
Image XX camera	Camera settings
Camera XX – XX camera	
Image of location of camera XX	View and objectives
Image XX camera	Camera settings
Camera XX – XX camera	
Image of location of camera XX	View and objectives
Image XX camera	Camera settings
Camera XX – XX camera	
Image of location of camera XX	View and objectives
Image XX camera	Camera settings

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Control Box Setting Summary	Camera Settings Summary
Main Configuration Screen	

Sorting Area Measurements/Details

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General remarks

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