

**ANNEX 10**

**RESOLUTION MEPC.282(70)  
(Adopted on 28 October 2016)**

**2016 GUIDELINES FOR THE DEVELOPMENT OF  
A SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP)**

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee (the Committee) conferred upon it by international conventions for the prevention and control of marine pollution from ships,

RECALLING ALSO that it adopted, by resolution MEPC.203(62), Amendments to the annex of the Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (inclusion of regulations on energy efficiency for ships in MARPOL Annex VI),

NOTING that the aforementioned amendments to MARPOL Annex VI, which included a new chapter 4 on regulations on energy efficiency for ships in Annex VI, entered into force on 1 January 2013,

NOTING ALSO that regulation 22 of MARPOL Annex VI, as amended, requires each ship to keep on board a ship specific Ship Energy Efficiency Management Plan, taking into account guidelines developed by the Organization,

NOTING FURTHER that it adopted, by resolution MEPC.278(70), amendments to MARPOL Annex VI related to the data collection system for fuel oil consumption which are expected to enter into force on 1 March 2018 upon their deemed acceptance on 1 September 2017,

RECOGNIZING that the aforementioned amendments to MARPOL Annex VI require the adoption of relevant guidelines for uniform and effective implementation of the regulations and to provide sufficient lead time for industry to prepare,

HAVING CONSIDERED, at its seventieth session, draft 2016 Guidelines for the development of a Ship Energy Efficiency Management Plan (*SEEMP*),

1 ADOPTS the 2016 *Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)* (the 2016 Guidelines), as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed 2016 Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulations 22 and 22A of MARPOL Annex VI, as amended;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed 2016 Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested groups;

4 AGREES to keep the 2016 Guidelines under review in light of the experience gained with their implementation;

5 SUPERSEDES the 2012 *Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)*, adopted by resolution MEPC.213(63).

ANNEX

**2016 GUIDELINES FOR THE DEVELOPMENT OF  
A SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP)**

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## **1 INTRODUCTION**

1.1 The *Guidelines for the development of a Ship Energy Efficiency Management Plan* have been developed to assist with the preparation of the Ship Energy Efficiency Management Plan (SEEMP) required by regulation 22 of MARPOL Annex VI.

1.2 There are two parts to a SEEMP. Part I provides a possible approach for monitoring ship and fleet efficiency performance over time and some options to be considered when seeking to optimize the performance of the ship. Part II provides the methodologies ships of 5,000 gross tonnage and above should use to collect the data required pursuant to regulation 22A of MARPOL Annex VI and the processes that the ship should use to report the data to the ship's Administration or any organization duly authorized by it.

1.3 A sample form of the SEEMP is presented in appendices 1 and 2 for illustrative purposes. A standardized data reporting format for the data collection system is presented in appendix 3.

## **2 DEFINITIONS**

2.1 For the purpose of these Guidelines, the definitions in MARPOL Annex VI apply.

2.2 "Ship fuel oil consumption data" means the data required to be collected on an annual basis and reported as specified in appendix IX to MARPOL Annex VI.

2.3 "Safety management system" means a structured and documented system enabling company personnel to implement effectively the company safety and environmental protection policy, as defined in paragraph 1.1 of International Safety Management Code.

## **PART I OF THE SEEMP: SHIP MANAGEMENT PLAN TO IMPROVE ENERGY EFFICIENCY**

### **3 GENERAL**

3.1 In global terms it should be recognized that operational efficiencies delivered by a large number of ship operators will make an invaluable contribution to reducing global carbon emissions.

3.2 The purpose of part I of the SEEMP is to establish a mechanism for a company and/or a ship to improve the energy efficiency of a ship's operation. Preferably, this aspect of the ship-specific SEEMP is linked to a broader corporate energy management policy for the company that owns, operates or controls the ship, recognizing that no two shipping companies are the same, and that ships operate under a wide range of different conditions.

3.3 Many companies will already have an environmental management system (EMS) in place under ISO 14001 which contains procedures for selecting the best measures for particular vessels and then setting objectives for the measurement of relevant parameters, along with relevant control and feedback features. Monitoring of operational environmental efficiency should therefore be treated as an integral element of broader company management systems.

3.4 In addition, many companies already develop, implement and maintain a Safety Management System. In such case, part I of the SEEMP may form part of the ship's Safety Management System.

3.5 This section provides guidance for the development of part I of the SEEMP that should be adjusted to the characteristics and needs of individual companies and ships. Part I is intended to be a management tool to assist a company in managing the ongoing environmental performance of its vessels and as such, it is recommended that a company develops procedures for implementing the plan in a manner which limits any on-board administrative burden to the minimum necessary.

3.6 Part I of the SEEMP should be developed as a ship-specific plan by the company, and should reflect efforts to improve a ship's energy efficiency through four steps: planning, implementation, monitoring, and self-evaluation and improvement. These components play a critical role in the continuous cycle to improve ship energy efficiency management. With each iteration of the cycle, some elements of part I will necessarily change while others may remain as before.

3.7 At all times safety considerations should be paramount. The trade a ship is engaged in may determine the feasibility of the efficiency measures under consideration. For example, ships that perform services at sea (pipe laying, seismic survey, OSVs, dredgers, etc.) may choose different methods of improving energy efficiency when compared to conventional cargo carriers. The nature of operations and influence of prevailing weather conditions, tides and currents combined with the necessity of maintaining safe operations may require adjustment of general procedures to maintain the efficiency of the operation, for example the ships which are dynamically positioned. The length of voyage may also be an important parameter as may trade specific safety considerations.

## **4 FRAMEWORK AND STRUCTURE OF PART I OF THE SEEMP**

### **4.1 Planning**

4.1.1 Planning is the most crucial stage of part I of the SEEMP, in that it primarily determines both the current status of ship energy usage and the expected improvement of ship energy efficiency. Therefore, it is encouraged to devote sufficient time to planning so that the most appropriate, effective and implementable plan can be developed.

#### ***Ship-specific measures***

4.1.2 Recognizing that there are a variety of options to improve efficiency – speed optimization, weather routing and hull maintenance, for example – and that the best package of measures for a ship to improve efficiency differs to a great extent depending upon ship type, cargoes, routes and other factors, the specific measures for the ship to improve energy efficiency should be identified in the first place. These measures should be listed as a package of measures to be implemented, thus providing the overview of the actions to be taken for that ship.

4.1.3 During this process, therefore, it is important to determine and understand the ship's current status of energy usage. Part I of the SEEMP should identify energy-saving measures that have been undertaken, and should determine how effective these measures are in terms of improving energy efficiency. Part I also should identify what measures can be adopted to further improve the energy efficiency of the ship. It should be noted, however, that not all measures can be applied to all ships, or even to the same ship under different operating conditions and that some of them are mutually exclusive. Ideally, initial measures could yield energy (and cost) saving results that then can be reinvested into more difficult or expensive efficiency upgrades identified by part I.

4.1.4 Guidance on best practices for fuel-efficient operation of ships, set out in chapter 5, can be used to facilitate this part of the planning phase. Also, in the planning process, particular consideration should be given to minimize any on-board administrative burden.

#### ***Company-specific measures***

4.1.5 The improvement of energy efficiency of ship operation does not necessarily depend on single ship management only. Rather, it may depend on many stakeholders including ship repair yards, shipowners, operators, charterers, cargo owners, ports and traffic management services. For example, "Just in time" – as explained in paragraph 5.2.4 – requires good early communication among operators, ports and traffic management service. The better coordination among such stakeholders is, the more improvement can be expected. In most cases, such coordination or total management is better made by a company rather than by a ship. In this sense, it is recommended that a company also establish an energy management plan to manage its fleet (should it not have one in place already) and make necessary coordination among stakeholders.

#### ***Human resource development***

4.1.6 For effective and steady implementation of the adopted measures, raising awareness of and providing necessary training for personnel both on shore and on board are an important element. Such human resource development is encouraged and should be considered as an important component of planning as well as a critical element of implementation.

#### ***Goal setting***

4.1.7 The last part of planning is goal setting. It should be emphasized that the goal setting is voluntary, that there is no need to announce the goal or the result to the public, and that neither a company nor a ship are subject to external inspection. The purpose of goal setting is to serve as a signal which involved people should be conscious of, to create a good incentive for proper implementation, and then to increase commitment to the improvement of energy efficiency. The goal can take any form, such as the annual fuel consumption or a specific target of Energy Efficiency Operational Indicator (EEOI). Whatever the goal is, the goal should be measurable and easy to understand.

### **4.2 Implementation**

#### ***Establishment of implementation system***

4.2.1 After a ship and a company identify the measures to be implemented, it is essential to establish a system for implementation of the identified and selected measures by developing the procedures for energy management, by defining tasks and by assigning them to qualified personnel. Thus, part I of the SEEMP should describe how each measure should be implemented and who the responsible person(s) is. The implementation period (start and end dates) of each selected measure should be indicated. The development of such a system can be considered as a part of planning, and therefore may be completed at the planning stage.

### ***Implementation and record-keeping***

4.2.2 The planned measures should be carried out in accordance with the predetermined implementation system. Record-keeping for the implementation of each measure is beneficial for self-evaluation at a later stage and should be encouraged. If any identified measure cannot be implemented for any reason(s), the reason(s) should be recorded for internal use.

## **4.3 Monitoring**

### ***Monitoring tools***

4.3.1 The energy efficiency of a ship should be monitored quantitatively. This should be done by an established method, preferably by an international standard. The EEOI developed by the Organization is one of the internationally established tools to obtain a quantitative indicator of energy efficiency of a ship and/or fleet in operation, and can be used for this purpose. Therefore, EEOI could be considered as the primary monitoring tool, although other quantitative measures also may be appropriate.

4.3.2 If used, it is recommended that the EEOI is calculated in accordance with the *Guidelines for the development of a Ship Energy Efficiency Management Plan* (MEPC.1/Circ.684) developed by the Organization, adjusted, as necessary, to a specific ship and trade.

4.3.3 In addition to the EEOI, if convenient and/or beneficial for a ship or a company, other measurement tools can be utilized. In the case where other monitoring tools are used, the concept of the tool and the method of monitoring may be determined at the planning stage.

### ***Establishment of monitoring system***

4.3.4 It should be noted that whatever measurement tools are used, continuous and consistent data collection is the foundation of monitoring. To allow for meaningful and consistent monitoring, the monitoring system, including the procedures for collecting data and the assignment of responsible personnel, should be developed. The development of such a system can be considered as a part of planning, and therefore should be completed at the planning stage.

4.3.5 It should be noted that, in order to avoid unnecessary administrative burdens on ships' staff, monitoring should be carried out as far as possible by shore staff, utilizing data obtained from existing required records such as the official and engineering log-books and oil record books, etc. Additional data could be obtained as appropriate.

### ***Search and rescue***

4.3.6 When a ship diverts from its scheduled passage to engage in search and rescue operations, it is recommended that data obtained during such operations is not used in ship energy efficiency monitoring, and that such data may be recorded separately.

## **4.4 Self-evaluation and improvement**

4.4.1 Self-evaluation and improvement is the final phase of the management cycle. This phase should produce meaningful feedback for the coming first stage, i.e. planning stage of the next improvement cycle.

4.4.2 The purpose of self-evaluation is to evaluate the effectiveness of the planned measures and of their implementation, to deepen the understanding on the overall characteristics of the ship's operation such as what types of measures can/cannot function effectively, and how and/or why, to comprehend the trend of the efficiency improvement of that ship and to develop the improved management plan for the next cycle.

4.4.3 For this process, procedures for self-evaluation of ship energy management should be developed. Furthermore, self-evaluation should be implemented periodically by using data collected through monitoring. In addition, it is recommended to invest time in identifying the cause-and-effect of the performance during the evaluated period for improving the next stage of the management plan.

## **5 GUIDANCE ON BEST PRACTICES FOR FUEL-EFFICIENT OPERATION OF SHIPS**

5.1 The search for efficiency across the entire transport chain takes responsibility beyond what can be delivered by the owner/operator alone. A list of all the possible stakeholders in the efficiency of a single voyage is long; obvious parties are designers, shipyards and engine manufacturers for the characteristics of the ship, and charterers, ports and vessel traffic management services, etc., for the specific voyage. All involved parties should consider the inclusion of efficiency measures in their operations both individually and collectively.

### **5.2 Fuel-efficient operations**

#### ***Improved voyage planning***

5.2.1 The optimum route and improved efficiency can be achieved through the careful planning and execution of voyages. Thorough voyage planning needs time, but a number of different software tools are available for planning purposes.

5.2.2 The *Guidelines for voyage planning*, adopted by resolution A.893(21), provide essential guidance for the ship's crew and voyage planners.

#### ***Weather routeing***

5.2.3 Weather routeing has a high potential for efficiency savings on specific routes. It is commercially available for all types of ship and for many trade areas. Significant savings can be achieved, but conversely weather routeing may also increase fuel consumption for a given voyage.

#### ***Just in time***

5.2.4 Good early communication with the next port should be an aim in order to give maximum notice of berth availability and facilitate the use of optimum speed where port operational procedures support this approach.

5.2.5 Optimized port operation could involve a change in procedures involving different handling arrangements in ports. Port authorities should be encouraged to maximize efficiency and minimize delay.

#### ***Speed optimization***

5.2.6 Speed optimization can produce significant savings. However, optimum speed means the speed at which the fuel used per tonne mile is at a minimum level for that voyage. It does not mean minimum speed; in fact, sailing at less than optimum speed will consume more fuel

rather than less. Reference should be made to the engine manufacturer's power/consumption curve and the ship's propeller curve. Possible adverse consequences of slow speed operation may include increased vibration and problems with soot deposits in combustion chambers and exhaust systems. These possible consequences should be taken into account.

5. 2.7 As part of the speed optimization process, due account may need to be taken of the need to coordinate arrival times with the availability of loading/discharge berths, etc. The number of ships engaged in a particular trade route may need to be taken into account when considering speed optimization.

5. 2.8 A gradual increase in speed when leaving a port or estuary whilst keeping the engine load within certain limits may help to reduce fuel consumption.

5. 2.9 It is recognized that under many charter parties the speed of the vessel is determined by the charterer and not the operator. Efforts should be made when agreeing charter party terms to encourage the ship to operate at optimum speed in order to maximize energy efficiency.

### ***Optimized shaft power***

5. 2.10 Operation at constant shaft RPM can be more efficient than continuously adjusting speed through engine power (see paragraph 5.7). The use of automated engine management systems to control speed rather than relying on human intervention may be beneficial.

## **5.3 Optimized ship handling**

### ***Optimum trim***

5.3.1 Most ships are designed to carry a designated amount of cargo at a certain speed for a certain fuel consumption. This implies the specification of set trim conditions. Loaded or unloaded, trim has a significant influence on the resistance of the ship through the water and optimizing trim can deliver significant fuel savings. For any given draft there is a trim condition that gives minimum resistance. In some ships, it is possible to assess optimum trim conditions for fuel efficiency continuously throughout the voyage. Design or safety factors may preclude full use of trim optimization.

### ***Optimum ballast***

5.3.2 Ballast should be adjusted taking into consideration the requirements to meet optimum trim and steering conditions and optimum ballast conditions achieved through good cargo planning.

5.3.3 When determining the optimum ballast conditions, the limits, conditions and ballast management arrangements set out in the ship's Ballast Water Management Plan are to be observed for that ship.

5.3.4 Ballast conditions have a significant impact on steering conditions and autopilot settings and it needs to be noted that less ballast water does not necessarily mean the highest efficiency.

### ***Optimum propeller and propeller inflow considerations***

5.3.5 Selection of the propeller is normally determined at the design and construction stage of a ship's life but new developments in propeller design have made it possible for retrofitting of later designs to deliver greater fuel economy. Whilst it is certainly for consideration, the propeller is but one part of the propulsion train and a change of propeller in isolation may have no effect on efficiency and may even increase fuel consumption.

5.3.6 Improvements to the water inflow to the propeller using arrangements such as fins and/or nozzles could increase propulsive efficiency power and hence reduce fuel consumption.

### ***Optimum use of rudder and heading control systems (autopilots)***

5.3.7 There have been large improvements in automated heading and steering control systems technology. Whilst originally developed to make the bridge team more effective, modern autopilots can achieve much more. An integrated Navigation and Command System can achieve significant fuel savings by simply reducing the distance sailed "off track". The principle is simple; better course control through less frequent and smaller corrections will minimize losses due to rudder resistance. Retrofitting of a more efficient autopilot to existing ships could be considered.

5.3.8 During approaches to ports and pilot stations the autopilot cannot always be used efficiently as the rudder has to respond quickly to given commands. Furthermore at certain stages of the voyage it may have to be deactivated or very carefully adjusted, i.e. heavy weather and approaches to ports.

5.3.9 Consideration may be given to the retrofitting of improved rudder blade design (e.g. "twist-flow" rudder).

### ***Hull maintenance***

5.3.10 Docking intervals should be integrated with ship operator's ongoing assessment of ship performance. Hull resistance can be optimized by new technology-coating systems, possibly in combination with cleaning intervals. Regular in-water inspection of the condition of the hull is recommended.

5.3.11 Propeller cleaning and polishing or even appropriate coating may significantly increase fuel efficiency. The need for ships to maintain efficiency through in-water hull cleaning should be recognized and facilitated by port States.

5.3.12 Consideration may be given to the possibility of timely full removal and replacement of underwater paint systems to avoid the increased hull roughness caused by repeated spot blasting and repairs over multiple dockings.

5.3.13 Generally, the smoother the hull, the better the fuel efficiency.

### ***Propulsion system***

5.3.14 Marine diesel engines have a very high thermal efficiency (~50%). This excellent performance is only exceeded by fuel cell technology with an average thermal efficiency of 60%. This is due to the systematic minimization of heat and mechanical loss. In particular, the new breed of electronic controlled engines can provide efficiency gains. However, specific training for relevant staff may need to be considered to maximize the benefits.

### ***Propulsion system maintenance***

5.3.15 Maintenance in accordance with manufacturers' instructions in the company's planned maintenance schedule will also maintain efficiency. The use of engine condition monitoring can be a useful tool to maintain high efficiency.

5.3.16 Additional means to improve engine efficiency might include use of fuel additives; adjustment of cylinder lubrication oil consumption; valve improvements; torque analysis; and automated engine monitoring systems.

### **5.4 Waste heat recovery**

5.4.1 Waste heat recovery is now a commercially available technology for some ships. Waste heat recovery systems use thermal heat losses from the exhaust gas for either electricity generation or additional propulsion with a shaft motor.

5.4.2 It may not be possible to retrofit such systems into existing ships. However, they may be a beneficial option for new ships. Shipbuilders should be encouraged to incorporate new technology into their designs.

### **5.5 Improved fleet management**

5.5.1 Better utilization of fleet capacity can often be achieved by improvements in fleet planning. For example, it may be possible to avoid or reduce long ballast voyages through improved fleet planning. There is opportunity here for charterers to promote efficiency. This can be closely related to the concept of "just in time" arrivals.

5.5.2 Efficiency, reliability and maintenance-oriented data sharing within a company can be used to promote best practice among ships within a company and should be actively encouraged.

### **5.6 Improved cargo handling**

Cargo handling is in most cases under the control of the port and optimum solutions matched to ship and port requirements should be explored.

### **5.7 Energy management**

5.7.1 A review of electrical services on board can reveal the potential for unexpected efficiency gains. However care should be taken to avoid the creation of new safety hazards when turning off electrical services (e.g. lighting). Thermal insulation is an obvious means of saving energy. Also see comment below on shore power.

5.7.2 Optimization of reefer container stowage locations may be beneficial in reducing the effect of heat transfer from compressor units. This might be combined as appropriate with cargo tank heating, ventilation, etc. The use of water-cooled reefer plant with lower energy consumption might also be considered.

### **5.8 Fuel type**

The use of emerging alternative fuels may be considered as a CO<sub>2</sub> reduction method but availability will often determine the applicability.

## **5.9 Other measures**

5.9.1 Development of computer software for the calculation of fuel consumption, for the establishment of an emissions "footprint," to optimize operations, and the establishment of goals for improvement and tracking of progress may be considered.

5.9.2 Renewable energy sources, such as wind, solar (or photovoltaic) cell technology, have improved enormously in the recent years and should be considered for on-board application.

5.9.3 In some ports shore power may be available for some ships but this is generally aimed at improving air quality in the port area. If the shore-based power source is carbon efficient, there may be a net efficiency benefit. Ships may consider using onshore power if available.

5.9.4 Even wind assisted propulsion may be worthy of consideration.

5.9.5 Efforts could be made to source fuel of improved quality in order to minimize the amount of fuel required to provide a given power output.

## **5.10 Compatibility of measures**

5.10.1 These Guidelines indicate a wide variety of possibilities for energy efficiency improvements for the existing fleet. While there are many options available, they are not necessarily cumulative, are often area and trade dependent and likely to require the agreement and support of a number of different stakeholders if they are to be utilized most effectively.

### ***Age and operational service life of a ship***

5.10.2 All measures identified in this document are potentially cost-effective as a result of high oil prices. Measures previously considered unaffordable or commercially unattractive may now be feasible and worthy of fresh consideration. Clearly, this equation is heavily influenced by the remaining service life of a ship and the cost of fuel.

### ***Trade and sailing area***

5.10.3 The feasibility of many of the measures described in this guidance will be dependent on the trade and sailing area of the ship. Sometimes ships will change their trade areas as a result of a change in chartering requirements but this cannot be taken as a general assumption. For example, wind-enhanced power sources might not be feasible for short sea shipping as these ships generally sail in areas with high traffic densities or in restricted waterways. Another aspect is that the world's oceans and seas each have characteristic conditions and so ships designed for specific routes and trades may not obtain the same benefit by adopting the same measures or combination of measures as other ships. It is also likely that some measures will have a greater or lesser effect in different sailing areas.

5.10.4 The trade a ship is engaged in may determine the feasibility of the efficiency measures under consideration. For example, ships that perform services at sea (pipe laying, seismic survey, OSVs, dredgers, etc.) may choose different methods of improving energy efficiency when compared to conventional cargo carriers. The length of voyage may also be an important parameter as may trade specific safety considerations. The pathway to the most efficient combination of measures will be unique to each vessel within each shipping company.

## **PART II OF THE SEEMP: SHIP FUEL OIL CONSUMPTION DATA COLLECTION PLAN**

### **6 GENERAL**

6.1 Regulation 22.2 of MARPOL Annex VI specifies that, "On or before 31 December 2018, in the case of a ship of 5,000 gross tonnage and above, the SEEMP shall include a description of the methodology that will be used to collect the data required by regulation 22A.1 of this Annex and the processes that will be used to report the data to the ship's Administration." Part II of the SEEMP, the Ship Fuel Oil Consumption Data Collection Plan (hereinafter referred to as "Data Collection Plan") contains such methodology and processes.

6.2 With respect to part II of the SEEMP, these Guidelines provide guidance for developing a ship-specific method to collect, aggregate, and report ship data with regard to annual fuel oil consumption, distance travelled, hours underway and other data required by regulation 22A of MARPOL Annex VI to be reported to the Administration.

6.3 Pursuant to regulation 5.4.5 of MARPOL Annex VI, the Administration should ensure that each ship's SEEMP complies with regulation 22.2 of MARPOL Annex VI prior to collecting any data.

### **7 GUIDANCE ON METHODOLOGY FOR COLLECTING DATA ON FUEL OIL CONSUMPTION, DISTANCE TRAVELLED AND HOURS UNDERWAY**

#### ***Fuel oil<sup>1</sup> consumption***

7.1 Fuel oil consumption should include all the fuel oil consumed on board including but not limited to the fuel oil consumed by the main engines, auxiliary engines, gas turbines, boilers and inert gas generator, for each type of fuel oil consumed, regardless of whether a ship is underway or not. Methods for collecting data on annual fuel oil consumption in metric tonnes include (in no particular order):

- .1 method using bunker delivery notes (BDNs):

This method determines the annual total amount of fuel oil used based on BDNs, which are required for fuel oil for combustion purposes delivered to and used on board a ship in accordance with regulation 18 of MARPOL Annex VI; BDNs are required to be retained on board for three years after the fuel oil has been delivered. The Data Collection Plan should set out how the ship will operationalize the summation of BDN information and conduct tank readings. The main components of this approach are as follows:

- .1 annual fuel oil consumption would be the total mass of fuel oil used on board the vessel as reflected in the BDNs. In this method, the BDN fuel oil quantities would be used to determine the annual total mass of fuel oil consumption, plus the amount of fuel oil left over from the last calendar year period and less the amount of fuel oil carried over to the next calendar year period;

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<sup>1</sup> Regulation 2.9 of MARPOL Annex VI defines "fuel oil" as "fuel oil means any fuel delivered to and intended for combustion purposes for propulsion or operation on board a ship, including gas, distillate and residual fuels."

- .2 to determine the difference between the amount of remaining tank oil before and after the period, the tank reading should be carried out at the beginning and the end of the period;
- .3 in the case of a voyage that extends across the data reporting period, the tank reading should occur by tank monitoring at the ports of departure and arrival of the voyage and by statistical methods such as rolling average using voyage days;
- .4 fuel oil tank readings should be carried out by appropriate methods such as automated systems, soundings and dip tapes. The method for tank readings should be specified in the Data Collection Plan;
- .5 the amount of any fuel oil offloaded should be subtracted from the fuel oil consumption of that reporting period. This amount should be based on the records of the ship's oil record book; and
- .6 any supplemental data used for closing identified difference in bunker quantity should be supported with documentary evidence;

.2 method using flow meters:

This method determines the annual total amount of fuel oil consumption by measuring fuel oil flows on board by using flow meters. In case of the breakdown of flow meters, manual tank readings or other alternative methods will be conducted instead. The Data Collection Plan should set out information about the ship's flow meters and how the data will be collected and summarized, as well as how necessary tank readings should be conducted:

- .1 annual fuel oil consumption may be the sum of daily fuel oil consumption data of all relevant fuel oil consuming processes on board measured by flow meters;
- .2 the flow meters applied to monitoring should be located so as to measure all fuel oil consumption on board. The flow meters and their link to specific fuel oil consumers should be described in the Data Collection Plan;
- .3 note that it should not be necessary to correct this fuel oil measurement method for sludge if the flow meter is installed after the daily tank as sludge will be removed from the fuel oil prior to the daily tank;
- .4 the flow meters applied to monitoring fuel oil flow should be identified in the Data Collection Plan. Any consumer not monitored with a flow meter should be clearly identified, and an alternative fuel oil consumption measurement method should be included; and
- .5 calibration of the flow meters should be specified. Calibration and maintenance records should be available on board;

- .3 method using bunker fuel oil tank monitoring on board:
  - .1 to determine the annual fuel oil consumption, the amount of daily fuel oil consumption data measured by tank readings which are carried out by appropriate methods such as automated systems, soundings and dip tapes will be aggregated. The tank readings will normally occur daily when the ship is at sea and each time the ship is bunkering or de-bunkering; and
  - .2 the summary of monitoring data containing records of measured fuel oil consumption should be available on board.

7.2 Any corrections, e.g. density, temperature, if applied, should be documented<sup>2</sup>.

### **Conversion factor $C_F$**

7.3 If fuel oils are used that do not fall into one of the categories as described in the *2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.245(66)), as amended, and have no  $C_F$ -factor assigned (e.g. some "hybrid fuel oils"), the fuel oil supplier should provide a  $C_F$ -factor for the respective product supported by documentary evidence.

### **Distance travelled**

7.4 Appendix IX of MARPOL Annex VI specifies that distance travelled should be submitted to the Administration and:

- .1 distance travelled over ground in nautical miles should be recorded in the log-book in accordance with SOLAS regulation V/28.1<sup>3</sup>;
- .2 the distance travelled while the ship is underway under its own propulsion should be included into the aggregated data of distance travelled for the calendar year; and
- .3 other methods to measure distance travelled accepted by the Administration may be applied. In any case, the method applied should be described in detail in the Data Collection Plan.

### **Hours underway**

7.5 Appendix IX of MARPOL Annex VI specifies that hours underway should be submitted to the Administration. Hours underway should be an aggregated duration while the ship is underway under its own propulsion.

### **Data quality**

7.6 The Data Collection Plan should include data quality control measures which should be incorporated into the existing shipboard safety management system. Additional measures to be considered could include:

- .1 the procedure for identification of data gaps and correction thereof; and

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<sup>2</sup> For example, ISO 8217 provides a method for liquid fuel.

<sup>3</sup> Distance travelled measured using satellite data is distance travelled over the ground.

- .2 the procedure to address data gaps if monitoring data is missing, for example, flow meter malfunctions.

### ***A standardized data reporting format***

7.7 Regulation 22A.3 of MARPOL Annex VI states that the data specified in appendix IX of the Annex are to be communicated electronically using a standardized form developed by the Organization. The collected data should be reported to the Administration in the standardized format shown in appendix 3.

## **8 DIRECT CO<sub>2</sub> EMISSIONS MEASUREMENT**

8.1 Direct CO<sub>2</sub> emission measurement is not required by regulation 22A of MARPOL Annex VI.

8.2 Direct CO<sub>2</sub> emissions measurement, if used, should be carried out as follows:

- .1 this method is based on the determination of CO<sub>2</sub> emission flows in exhaust gas stacks by multiplying the CO<sub>2</sub> concentration of the exhaust gas with the exhaust gas flow. In case of the absence or/and breakdown of direct CO<sub>2</sub> emissions measurement equipment, manual tank readings will be conducted instead;
- .2 the direct CO<sub>2</sub> emissions measurement equipment applied to monitoring is located exhaustively so as to measure all CO<sub>2</sub> emissions in the ship. The locations of all equipment applied are described in this monitoring plan; and
- .3 calibration of the CO<sub>2</sub> emissions measurement equipment should be specified. Calibration and maintenance records should be available on board.

APPENDIX 1

**SAMPLE FORM OF SHIP MANAGEMENT PLAN TO  
IMPROVE ENERGY EFFICIENCY  
(PART I OF THE SEEMP)**

Name of ship:		Gross tonnage:	
Ship type:		Capacity:	

Date of development:		Developed by:	
Implementation period:	From: Until:	Implemented by:	
Planned date of next evaluation:			

**1 MEASURES**

<b>Energy efficiency measures</b>	<b>Implementation (including the starting date)</b>	<b>Responsible personnel</b>
Weather routing	<Example> Contracted with (Service providers) to use their weather routing system and start using on trial basis as of 1 July 2012.	<Example> The master is responsible for selecting the optimum route based on the information provided by (Service providers).
Speed optimization	While the design speed (85% MCR) is 19.0 kt, the maximum speed is set at 17.0 kt as of 1 July 2012.	The master is responsible for keeping the ship's speed. The log-book entry should be checked every day.

**2 MONITORING**

Description of monitoring tools

**3 GOAL**

Measurable goals

**4 EVALUATION**

Procedures of evaluation

## APPENDIX 2

**SAMPLE FORM OF SHIP FUEL OIL CONSUMPTION DATA COLLECTION PLAN  
(PART II OF THE SEEMP)****1 Ship particulars**

Name of ship	
IMO number	
Company	
Flag	
Ship type	
Gross tonnage	
NT	
DWT	
EEDI (if applicable)	
Ice class	

**2 Record of revision of Fuel Oil Consumption Data Collection Plan**

Date of revision	Revised provision

**3 Ship engines and other fuel oil consumers and fuel oil types used**

	Engines or other fuel oil consumers	Power	Fuel oil types
1	Type/model of main engine	(kW)	
2	Type/model of auxiliary engine	(kW)	
3	Boiler	(...)	
4	Inert gas generator	(...)	

**4 Emission factor**

$C_F$  is a non-dimensional conversion factor between fuel oil consumption and CO<sub>2</sub> emission in the 2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships (resolution MEPC.245(66)), as amended. The annual total amount of CO<sub>2</sub> is calculated by multiplying annual fuel oil consumption and  $C_F$  for the type of fuel.

Fuel oil Type	$C_F$ (t-CO <sub>2</sub> / t-Fuel)
Diesel/Gas oil (e.g. ISO 8217 grades DMX through DMB)	3.206
Light fuel oil (LFO) (e.g. ISO 8217 grades RMA through RMD)	3.151
Heavy fuel oil (HFO) (e.g. ISO 8217 grades RME through RMK)	3.114
Liquefied petroleum gas (LPG) (Propane)	3.000
Liquefied petroleum gas (LPG) (Butane)	3.030
Liquefied natural gas (LNG)	2.750

Fuel oil Type	$C_F$ (t-CO <sub>2</sub> / t-Fuel)
Methanol	1.375
Ethanol	1.913
Other (.....)	

**5 Method to measure fuel oil consumption**

The applied method for measurement for this ship is given below. The description explains the procedure for measuring data and calculating annual values, measurement equipment involved, etc.

Method	Description

**6 Method to measure distance travelled**

Description

**7 Method to measure hours underway**

Description

**8 Processes that will be used to report the data to the Administration**

Description

**9 Data quality**

Description





**ANNEX 11**

**ROADMAP FOR DEVELOPING A COMPREHENSIVE IMO STRATEGY ON  
REDUCTION OF GHG EMISSIONS FROM SHIPS**

In order to build upon, and bring together, the various streams of activity that have already been taking place in IMO in relation to the reduction of GHG emissions from international shipping, including the technical and operational measures (EEDI and SEEMP) in force since 2013, the adoption of the data collection system at MEPC 70 and various technical cooperation activities and major projects, the MEPC approved the *Roadmap for developing a comprehensive IMO strategy on reduction of GHG emissions from ships*, set out below.

October 2016 (MEPC 70)	- Adoption of Data Collection System (DCS) - Voluntary data collection and submission begins - Approval of Roadmap
Week before MEPC 71	- Intersessional meeting to start discussions on a comprehensive IMO strategy on reduction of GHG emissions from ships, taking into account inputs such as: (1) Third IMO GHG Study; (2) submissions on the elements below and on existing activities related to GHG emissions reductions by States and stakeholders; and (3) a technical paper by the Secretariat compiling a list of existing IMO activity related to reducing GHG emissions in the shipping sector. The discussions should include but not be limited to the elements below: <ul style="list-style-type: none"> <li>• Levels of ambition and guiding principles for the strategy;</li> <li>• Emissions scenarios;</li> <li>• Assessment of the projected future demand for shipping;</li> <li>• Parameters/indicators on energy efficiency of ships (current status and long-term potential);</li> <li>• Emission reduction opportunities (near-, mid- and long-term actions), including alternative fuels;</li> <li>• Costs and benefits;</li> <li>• Capacity building and technical cooperation;</li> <li>• Barriers to emissions reductions and how to overcome them;</li> <li>• Priority areas for R&amp;D, including in relation to technology;</li> <li>• Impact of EEDI;</li> <li>• Impacts on States, taking into account the HLAP (resolution A.1098(29)); and</li> <li>• Impacts of other regulations on GHG emissions</li> </ul>
May 2017 (MEPC 71)	- Discussion continues <sup>1</sup>
September 2017	- Intersessional meeting
Week before MEPC 72	- Intersessional meeting
Spring 2018 (MEPC 72)	- Adoption of initial IMO Strategy <sup>2</sup> , including, inter alia, a list of candidate short-, mid- and long term further measures with possible timelines, to be revised as appropriate as additional information becomes available
January 2019	- Start of Phase 1: Data collection (Ships to collect data)

<sup>1</sup> Modality of further intersessional work after MEPC 71 to be considered based on written submissions.

<sup>2</sup> Initial IMO Strategy is subject to revision based on DCS data during 2019-2021 and does not prejudice any specific further measures that may be implemented in phase 3 of the 3-step approach.

Spring 2019 (MEPC 74)	- Discussion continues - Initiation of Fourth IMO GHG Study using data from 2012-2018
Summer 2020	- Data for 2019 to be reported to IMO
Autumn 2020 (MEPC 76)	- Start of Phase 2: data analysis (no later than autumn 2020) - Discussion continues - Publication of Fourth IMO GHG Study for consideration by MEPC 76 <sup>3</sup>
Spring 2021 (MEPC 77)	- Initiation of work for adjustments on Initial IMO Strategy, based on DCS data - Secretariat report summarizing the 2019 data pursuant to regulation 22A.10
Summer 2021	- Data for 2020 to be reported to IMO
Spring 2022 (MEPC 78)	- Phase 3: Decision step - Discussion continues - Secretariat report summarizing the 2020 data pursuant to regulation 22A.10
Summer 2022	- Data for 2021 to be reported to IMO
Spring 2023 (MEPC 80)	- Adoption of Revised IMO Strategy, including short-, mid- and long-term further measure(s), as required, with implementation schedules - Secretariat report summarizing the 2021 data pursuant to regulation 22A.10

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<sup>3</sup> Every five (5) years, to publish updated IMO GHG study, as to be decided by the Committee, and to review Strategy (including further measures).

**ANNEX 12**

**RESOLUTION MEPC.283(70)  
(Adopted on 28 October 2016)**

**DESIGNATION OF THE JOMARD ENTRANCE  
AS A PARTICULARLY SENSITIVE SEA AREA**

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by international conventions for the prevention and control of marine pollution from ships,

BEING AWARE of the ecological criteria, in particular the criteria relating to uniqueness or rarity, critical habitat, and diversity, and the social, economic, cultural and scientific attributes of the region surrounding the Jomard Entrance<sup>1</sup> as well as its vulnerability to damage by international shipping activities and the steps taken by Papua New Guinea to address that vulnerability,

NOTING the *Revised Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas*, adopted by resolution A.982(24), as amended by resolution MEPC.267(68), (Revised PSSA Guidelines), and the *Revised Guidance Document for Submission of PSSA Proposals to IMO* set forth in MEPC.1/Circ.510,

HAVING AGREED that the criteria for the identification and designation of a PSSA provided in the revised PSSA Guidelines are fulfilled for the Jomard Entrance,

HAVING NOTED that the Jomard Entrance includes newly established routing systems (four two-way routes and a precautionary area), adopted by the Maritime Safety Committee at its ninety-fourth session, as the Associated Protective Measures to improve the safety of navigation and the protection of the marine environment, and that these routing systems entered into force on 1 June 2015,

1 DESIGNATES the region surrounding Jomard Entrance as defined in annex 1 to the present resolution as a Particularly Sensitive Sea Area;

2 INVITES Member Governments to recognize the ecological, social, cultural, economic and scientific attributes of the Jomard Entrance area, set forth in annex 2 to the present resolution, as well as its vulnerability to damage by international shipping activities, as described in annex 3 to the present resolution;

3 FURTHER INVITES Member Governments to note the associated protective measures established to address the area's vulnerability, the details of which are set out in annex 4 to the present resolution.

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<sup>1</sup> Part of the Louisiade Archipelago at the south eastern extent of Milne Bay Province, Papua New Guinea.

ANNEX 1

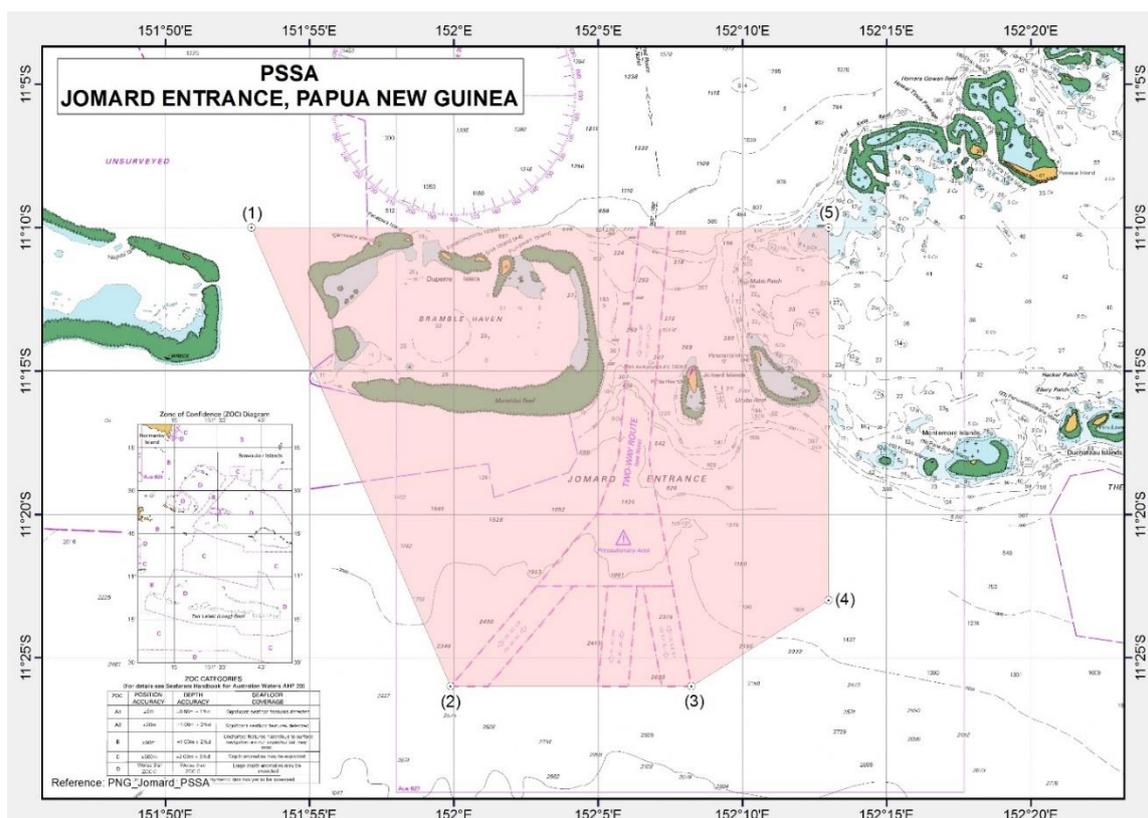
**DESCRIPTION OF JOMARD ENTRANCE PARTICULARLY SENSITIVE SEA AREA\***

**Description of the Particularly Sensitive Sea Area**

To minimize the risk of damage from ship groundings and pollution damage by international shipping activities and to protect the area's unique and threatened species as well as to preserve as far as practicable its critical habitat and diversity, mariners should exercise extreme care when navigating in the area bounded by the geographical coordinates of the Particularly Sensitive Sea Area, provided below, and adhere to the Associated Protective Measures set out in annex 4.

All geographical positions are based on WGS 84. Listed number refer to figure 1.

No.	Latitude	Longitude
1	11°10.00'S	151°53.00'E
2	11°26.00'S	151°59.90'E
3	11°26.00'S	152°08.24'E
4	11°23.00'S	152°13.00'E
5	11°10.00'S	152°13.00'E



**Figure 1 – Map showing the PSSA and newly established IMO routing systems**

\* The text in this annex is drawn from Papua New Guinea's submission contained in document MEPC 70/8. All references in this resolution are from annex 2 of MEPC 70/8.

## ANNEX 2

### **ECOLOGICAL, SOCIO-ECONOMIC, AND SCIENTIFIC CRITERIA OF THE JOMARD ENTRANCE PARTICULARLY SENSITIVE SEA AREA\***

#### **1 INTRODUCTION – THE JOMARD ENTRANCE ECOSYSTEM**

1.1 The Jomard Islands consist of two small uninhabited coral cay islands – Jomard Island (also called the Panuwaiyayapuna Island, meaning "long island") and Panarairai Island (also called Panadaludalu, meaning "island of dolphins"). The islands are located on raised reef flats and are fringed by coral reefs of significant size. The morphology of the fringing reef varies from site to site due to the different physical processes that take place on different parts of the island (e.g. wind and wave action). Without the current protection provided by the fringing reefs, the physical processes evident would ultimately erode the islands away. The fringing reef of Jomard Island also provides a significant habitat for marine species such as fish, crustaceans, corals, bivalves and other marine organisms. The marine life surrounding Jomard Island is extremely diverse in nature.

1.2 The beaches at Jomard Island are made up of fine sands and coral rubble. Ground vegetation lines the upper limits of the beach providing stability and protection from eroding processes, while the littoral zone (intertidal zone) is home to corals that have adapted to withstand intense ultraviolet radiation, desiccation and high salinities. The reefs surrounding Jomard Island provides very good shelter for foraging and mating activities for turtles. Furthermore, these diverse reef systems support other marine species like fish, rays, clam and sea cucumber which seek food, refuge and thrive in this healthy ecosystem. The beaches of Jomard Island and its fringing reefs accommodate a number of globally endangered species.

1.3 The terrestrial environment provides shelter for various species of birds like pigeons, crows and sea eagles. Jomard Island has been identified to have the largest turtle-nesting rookery in the southern part of Milne Bay Province. All six species of turtles that may be found in the region are currently listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as species threatened with extinction, and are also listed in Appendix I and/or Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals. The IUCN Red List of Threatened Species currently lists the Loggerhead, Leatherback and Olive Ridley turtles as Vulnerable; the Green turtle as Endangered; and the Hawksbill turtle as Critically Endangered.

1.4 Bramble Haven lies to the north-west of the Jomard Islands and consists of a total of five coral cay islands namely, Punawan, Siva, Pananimunimu, Panapwa and Awanagamwana Islands. These islands are important habitat to marine fauna and flora and lie on a reef platform of approximate depth range of 2 metres to 25 meters. The southern part of this group of islands consists of moderately exposed fringing and lagoonal reefs with sand and coral bommies in the shallows and coral ridges running horizontally across the slope. These drop off into deep water. The islands harbour marine species of turtles, giant clam, bumphead parrotfish (*Bolbometopon muricatum*) and humphead (maori) wrasse (*Cheilinus undulates*) that are on the IUCN Red list of threatened species. Green and hawksbill turtles often utilize these areas for nesting, mating and foraging, while loggerhead turtles transit through the region. This area is commercially exploited at a very low level. Factors that contributes toward this include the location of these islands in relation to human settlement.

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\* The text in this annex is drawn from Papua New Guinea's submission contained in document MEPC 70/8.

1.5 As the PSSA is part of the Louisiade Archipelago, Milne Bay Province, and is also within the Coral Triangle, the critical habitat, diversity and biogeographic importance criteria are applicable throughout the PSSA. The uniqueness or rarity and fragility criteria apply particularly in the vicinity of the Jomard Islands, with the naturalness criteria particularly applicable around Bramble Haven. The social or economic dependency and human dependency criteria are also applicable in both the Bramble Haven and Jomard Islands. Further details are provided below.

## 2 ECOLOGICAL CRITERIA

### Uniqueness or rarity

2.1 Six of the world's seven marine turtle species can be found in the waters off PNG. These include Hawksbill, Green Turtle, Leatherback, Flatback, Loggerhead and Olive Ridley. (Kinch, J., 2003). Of these, the first three are commonly found in the vicinity of Jomard Entrance. Scientific surveys and anecdotal evidence suggest that PNG has some of the largest remaining populations of these three turtle species in the world today. There is an informal tagging programme for turtle management and conservation at Jomard Islands, as the turtles have been nesting there annually for generations.

2.2 In terms of rarity, all six species of turtles that may be found in the region are currently listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as species threatened with extinction, and are also listed in Appendix I and/or Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals. The IUCN Red List of Threatened Species (<http://iucn-mltsg.org/>) currently lists the Loggerhead, Leatherback and Olive Ridley turtles as Vulnerable; the Green turtle as Endangered; and the Hawksbill as Critically Endangered (see below).

Turtle Type	IUCN Status List
Loggerhead Turtle ( <i>Caretta caretta</i> )	Vulnerable
Green turtle ( <i>Chelonia mydas</i> )	Endangered
Leatherback turtle ( <i>Dermochelys coriacea</i> )	Vulnerable
Hawksbill turtle ( <i>Eretmochelys imbricata</i> )	Critically Endangered
Flatback turtle ( <i>Natator depressus</i> )	Data Deficient
Olive ridley turtle ( <i>Lepidochelys olivacea</i> )	Vulnerable

### Critical habitat

2.3 Fifteen marine sub-regions were identified within the Milne Bay Province by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Ocean Flagships, the Louisiade Archipelago has the largest area of reef or reef associated (deep lagoon) habitat, with approximately 800,000 ha, representing 58% of the Archipelago (Skewes et al., 2003 and Skewes et al., 2011).

2.4 As noted above, the area provides a critical habitat for the Hawksbill, Green and Leatherback turtles. According to the IUCN, the overall global decline of the Hawksbill in particular has been in excess of 80% (Mortimer and Donnelly, 2008). In addition to these turtle species, both Bramble Haven and Jomard Island provide habitats for migratory marine and shore birds nesting sites, as well as for all giant clam species (Allen et al., 2003).

2.5 The fringing reef of Jomard Island provides a significant habitat for marine species such as fish, crustaceans, corals, bivalves and other marine organisms (UNESCO, 2016). The marine life surrounding Jomard Island is extremely diverse in nature. These habitats are sensitive to any shipping impact (e.g. oil spills, introduction of harmful marine species, marine debris and physical harm caused by groundings). Jomard Island has been identified to have the largest turtle-nesting rookery in the southern part of Milne Bay Province (UNESCO, 2016).

### **Representativeness**

2.6 The Jomard Entrance ecosystem include pristine reefs with high species endemism that are relatively undisturbed or only commercially exploited at a very low level (see Reef Condition Index value in paragraph 16 below).

### **Diversity**

2.7 Papua New Guinea (PNG) is located in the "Coral Triangle", an epicentre of rich marine biodiversity, see figure 1, and is home to 76% of all know coral species, 37% of all known coral-reef fish species, and 53% of the world's coral reefs. The area is of ecological and scientific significance and has great natural beauty and diversity, as seen in its pristine islands and reefs. Its waters host over 500 species of hard coral, 44 species of mangroves and 14 species of seagrass. PNG's Fourth National Report to the Convention on Biological Diversity (UNEP GEF 2016) notes that:

"PNG provides one of the last opportunities for the conservation of significant areas of coral reefs in the western Pacific region of maximum marine biodiversity. Few other locations offer the combination of large areas of high diversity reefs mostly undamaged by human activity; relatively low population size in most coastal areas; a scientific and management community that is committed to sustainable use of marine resources, and a customary land tenure system that can be used to enhance conservation efforts."

2.8 The Conservation International 2000 Rapid Marine Biodiversity Assessment (Allen et al. 2003) of the Milne Bay Province listed Punawan Island at Bramble Haven as the fifth most coral diverse of the 57 sites surveyed, with 107 coral species observed. The assessment also listed both Punawan and Jomard Islands as among the best sites in Milne Bay with a rich combination of coral and fish diversity, as well as being relatively free of damage and disease.

2.9 The 2000 Assessment also assessed reef condition at 57 sites in Milne Bay Province. Reef condition is a term pertaining to the general "health" of a particular site as determined by assessment of key variables including natural and human-induced environmental damage and general biodiversity as defined by major indicator groups (corals and fishes). A Reef Condition Index (RCI) value – derived from three components: coral diversity, fish diversity, and relative damage from human and natural causes – as calculated for each site. The results of this analysis indicated that the Louisiade Archipelago is included in the geographical area with the highest ranking Reef Condition Index. Overall, the RCI for the Milne Bay Province was significantly greater than the values obtained at previously surveyed reefs in other parts of the Coral Triangle.

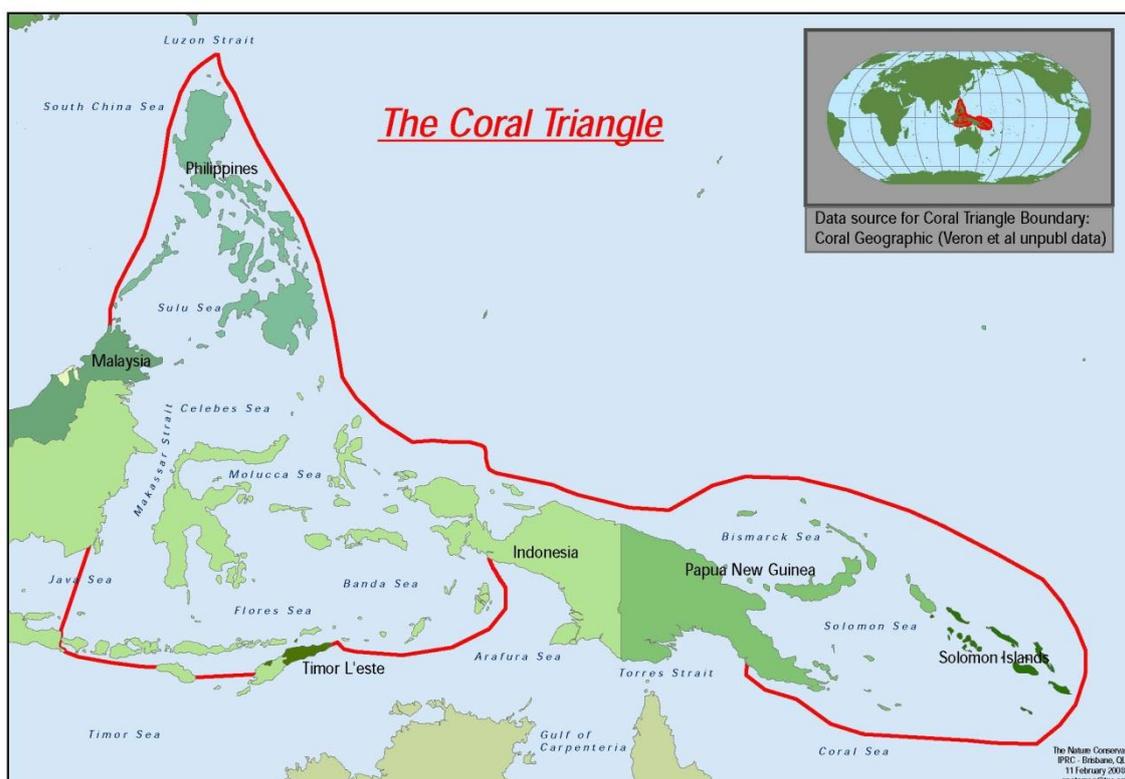


Figure 1 – Map showing Coral Triangle

### Naturalness

2.10 The 2000 Rapid Marine Biodiversity Assessment of Milne Pay Province (Allen et al. 2003) concluded that Punawan Island at Bramble Haven was one of the six sites in the Province (from a total of 57 sites surveyed) that rated highly from an aesthetic point of view (good diversity, pristine condition, extensive cover, and good visibility). Most indicators show that Milne Bay's reefs are in remarkably good condition, especially compared to other areas in the Coral Triangle. While coral bleaching has occurred several times in limited areas of Milne Bay, this has mostly been limited to the northern areas of less than 10 degrees south.

### Fragility

2.11 Jomard Island is a small coral cay island constructed on reef platforms, which have reached sea level during the Holocene. The island is fringed by a coral reef of significant size. The morphology of the fringing reef varies from site to site due to the different physical processes that take place on different parts of the island (e.g. wind and wave action). Without the current protection provided by the fringing reef, the physical processes evident will ultimately erode the island away (UNESCO, 2016).

2.12 A 2011 assessment of the coastal and marine ecosystem assets of Milne Bay found that the Louisiade Archipelago would be one of the subregions most impacted, taking into account sensitivity, exposure and weighting of ecosystem assets, climate change and human pressures (Skewes et al., 2001).

### **Bio-geographic importance**

2.13 Milne Bay by nature of being a series of variable island chains in close proximity to the large island of New Guinea has led to very high levels of endemism across virtually all taxa. These islands are a part of the Woodlark and Pocklington Rises that are separated by active seabed floor spreading. The islands range from mountainous volcanic chains through to coralline, makateas, atolls and sand cays, and their associated sea mounts and shelf; sunken, fringing and barrier reefs. Milne Bay has disproportionate biodiversity richness and endemism for its size (Andréfouët et al., 2006).

## **3 SOCIAL, CULTURAL AND ECONOMIC CRITERIA**

### **Social or economic dependency**

3.1 PNG's human population (~10 million inhabitants, 2016) has strong economic, social and cultural ties with the sea. PNG's marine resources are an important source of economic livelihood in the extensive rural portions of the country's islands and coastal areas. They support a private sector fishing industry that is a significant source of government revenue. (Asian Development Bank, 2016).

3.2 Tuna and shrimp are the major commodities comprising PNG's commercial fisheries. The 2010 tuna catch totalled 799,000 tons, while the shrimp catch has averaged about US\$10.5 million in recent years. Within the PSSA Panuwaiyayapuna and Panarairai Islands are both important sites for subsistence artisanal fishing and diving for commercially valuable resources, while Punaman Island is an important site of sea cucumbers for beche-de-mer and trochus harvesting.

### **Human dependency**

3.3 PNG's waters are vital to the subsistence of its inhabitants and the nation's economy, with the sea acting as a "supermarket" for coastal community residents. Fish is a major source of dietary protein, particularly in island and coastal areas, evident in the relatively high annual per capita fish consumption of coastal community residents, which is estimated at 53.3 kilograms (Asian Development Bank, 2016).

3.4 Marine resource use in the Louisiade Islands is artisanal in nature, providing for subsistence needs as well as limited small-scale commercial production. Because of a lack of regularly scheduled cargo transport and the absence of refrigeration facilities, commercial harvesting primarily targets non-perishable, high-value invertebrate products. Residents of some of the smaller islands are especially dependent on income from harvesting resources such as sea cucumbers for beche-de-mer.

### **Cultural heritage**

3.5 Traditional shell "money", locally known as "bagi" made from *Spondylus* shell is also extensively extracted and manufactured in the Louisiade Islands. These bagi flow along the Louisiade Archipelago and are eventually modified and fed into Kula Ring.

3.6 With the importance of the marine resources for islanders' wellbeing, many traditional legends, dances and hymns are linked to it. Many still ply the waters to these islands in either traditional sailing canoes or dinghies maintaining their seamanship and navigational skills in doing so (Smaalders and Kinch, 2003).