EXPRESSION OF INTEREST (EOI) TO DESIGN AND DEVELOP ELECTRIC PATROL CRAFT ("PROJECT")

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1 INTRODUCTION

1.1 Singapore raised its national climate target to achieve "net zero emissions by 2050" as part of the Long-Term Low-Emissions Development Strategy (LEDS). The transition to net zero emissions requires a collective effort from the public and private sectors comprising power generation, industry, transport, buildings, waste and water, and households.

1.2 In support of Singapore's 2050 national target, MPA patrol craft will correspondingly need to achieve net-zero emissions.

2 PURPOSE OF EOI

2.1 The EOI will allow MPA to assess the feasibility of designing and developing best-in-class electric patrol craft (e-PC) according to reference designs, engineered according to common design principles.

2.2 The Project will enable the verification, demonstration, and building up of MPA's electric patrol craft which are able to meet the sector's current operational requirements for relevant harbour craft types from 2027.

2.3 The Project aims to achieve the following desired outcomes:

2.3.1 Design and develop an electric patrol craft which suits MPA's operational needs.

2.3.2 Design and develop suitable charging methods and if required, efficient battery replacement method for extended operational requirements.

2.4 MPA will assess the returns of the EOI and may refine the submitted electric patrol craft design and launch a Request for Proposal (RFP) to implement the Project subsequently. MPA also reserves the right to approach EOI Participant(s) directly after the EOI closes and commence negotiations to award the Project directly without going through an RFP.

3 OVERVIEW OF REQUIREMENTS

3.1 Participants are required to submit their Proposal for the design, mock-up/ scale model (digital and/or physical), and prototype of a best-in-class e-PC with a strong emphasis on safety, good sea keeping, manoeuvrability, energy efficiency, stability and survivability for MPA operations in port waters including rivers and territorial sea. The e-PC shall be designed with excellent seaworthiness, survivability, fuel-efficiency and functionality for organic unmanned (air, surface and sub-surface) vessel/vehicle operations, enforcement patrols, surveillance, personnel transfers, boarding operations, search and rescue, oil/chemical spill control (including chemical plumes), small craft fire-fighting, transfer injured casualties and towing and pushing of small craft.

3.2 The Participant may propose the design and development of the electric patrol craft within the targeted demographics:

3.2.1 Capable of operations at sea state 3 conditions and survivable up to sea state 5 conditions taking into account its sea keeping and manoeuvrability capabilities for MPA operations in port waters (including rivers and territorial seas);

3.2.2 Capable of being remotely operated from a shore-based control centre with appropriate safety measures such as a collision detection and avoidance system [*Note: Semi-autonomous and/or autonomous mode of operations will be a plus.*];

3.2.3 Capable of low latency, high bandwidth, and redundant communications (eg. Maritime 5G) to facilitate two-way transmission of data (including video, imagery and data from MPA sensors/assets);

3.2.4 Carriage of a maximum of 12 pax + crew + Port Inspector at a maximum speed of 25 knots for 2 hours (for proceeding to incident site from a different sector), or equivalent performance, at full load (including 400 litres of oil spill dispersant) without disruption to the routine operations of the electric patrol craft; and maintain operational speed of 10 knots for 10 hours for routine operations (i.e. attending to marine incident, conducting search and rescue missions, patrolling within sectors);

3.2.5 Charging capability (i.e. charging speed for full charge, fast charge), arrangement for battery replacement if required.

3.2.6 Approximate dimensions of the proposed e-PC to be as follows:

a) Length overall: Not exceeding 17m;
b) Moulded Breadth: Not exceeding 7m;
c) Operational Draft: Not exceeding 1.5m.

3.3 The Project is expected to be operational by Q1 2028 or earlier. The Participant shall propose a Project timeline and milestones to be met.

(a) Requirements relating to the design of the electric patrol craft

3.4 The Participant shall design a highly efficient electric patrol craft which is capable of meeting or exceeding the existing operational requirements of its conventional equivalent counterpart. In addition, the proposed electric patrol craft design must be able to meet the following requirements:

3.4.1 The hull type/ form shall be appropriately selected from a proven or derived hull form design with low hull resistance, thus minimising the required power. The material of the hull shall be appropriately selected of high structural strength and integrity.

3.4.2 The electric patrol craft design shall be weight optimised to enable high operational efficiency and structural integrity. Appropriate selection of light-weight materials (e.g. hull, furniture, deck) shall contribute to a lower vessel weight of the electric patrol craft. Where possible, the use of advanced manufacturing techniques such as additive manufacturing should be considered.

3.4.3 The propulsion system and its interaction with the hull and engine shall be optimised to require low power/ energy to deliver highly efficient optimal cruising speeds.

3.4.4 The material of the superstructure shall be appropriately selected with attention to minimizing noise, vibration, crew comfort and functionality.

3.4.5 The design of the electric patrol craft shall be based on the following principles:

i. Safety;
ii. Reliability and;
iii. Availability of spare parts and maintenance services.

3.4.6 The design of the electric patrol craft shall fulfil the different levels of autonomy/remote control as provided by IMO (MSC 100/20 / Add.1 Annex 2)

i. Degree one: Ship with automated processed and decision support;
ii. Degree two: Remotely controlled ship with seafarers on board;
iii. Degree three: Remotely controlled ship without seafarers on board;
iv. Degree four: Fully autonomous ship.

3.4.7 The electric patrol craft shall be equipped with navigational aids such as:

i. Radar
ii. Automatic Identification System (AIS);
iii. Differential Global Positioning System (DGPS);
iv. Echosounder;
v. Wind Direction and Speed Sensor
vi. Magnetic Compass
vii. Integrated Multifunction Displays (to show navigation system software data to the operator)
viii. Electronic Chart Display Information System (ECDIS)

3.4.8 The electric patrol craft shall be equipped with dispersant spraying, chemical plume dilution, and firefighting capabilities, as well as a shallow

water rescue craft with mechanical means of launching permanently fitted onboard.

3.4.9 The wheelhouse/accommodation area of the electric patrol craft to be positively pressurised or have means to enable positive pressure function when needed.

3.4.10 The electric patrol craft shall have an unobstructed deck space of either at least 5.0m x 5.0m for up to three unmanned aerial vehicles (UAVs) heavy payload (up to 95kg) operations or at least one unmanned surface or sub-surface vessel (USV/UUV). Electrical power sockets for charging the UAVs to be provided. A DC to AC inverter with a capacity of 4000W to be provided for the charging of the UAVs. This operational space shall have a clear line-of-sight from the helmsman position.

3.4.11 The onboard systems (e.g. Sensor Suite (SS) systems, Navigational system, energy management systems, etc) shall allow remote monitoring and data exchange via the Connectivity Suite (CS). The Participant shall provide the details on the remote monitoring capabilities in their proposal.

3.4.12 Sensor Suite (SS). The electric patrol craft shall be optimally fitted with a Sensor Suite (SS) comprising the following:

a) CCTV system that includes stabilized camera(s) with functionalities such as pan-tilt zoom, fixed, thermal, daylight/low-light sensing, with video recording and real-time transmission to shore-based operations centres.

b) External chemical detector system for real-time detection, identification, measurement and monitoring of the concentration of volatile organic compounds (VOC), such as ammonia, methanol and hydrogen gas in the air in real-time, as well as external environmental sensors (i.e., wind, wave and temperature). The results are to be uploaded to MPA's digital system(s) as well as MPA's Cyber Assurance and Operations Centre for real-time monitoring.

3.4.13 Connectivity Suite (CS). The electric patrol craft shall be optimally fitted with a Connectivity Suite (CS) that includes satellite connectivity, cellular connectivity and onboard connectivity. This could include SATCOM terminals (e.g. Starlink), multi-SIM 5G network routers (e.g., Cradlepoint) and wireless/wired Local Area Network (LAN) devices to facilitate 24/7 and load-balanced access to the Internet as well as data exchanges between the on-board systems and with shore-based operations centre. The design of electric patrol craft shall ensure that all RF antennas can be optimally positioned onboard the electric patrol craft to maximise data rate and minimise latency and interference.

3.4.14 Maintainability.

3.4.14.1 The CS and SS shall be installed in a manner to facilitate easy and non-obstructed access for ad-hoc repairs and routine maintenance works.

3.4.14.2 For the installation of CS and SS, spare infrastructure cables (e.g. power supply and data signals) that connect outdoor equipment to indoor spaces shall be laid in parallel to provision for redundancy and reduction of repair turn-around time.

3.4.15 Environmental Survivability. All equipment installed outdoor shall be specified to survive the marine environment with appropriate IP ratings.

3.4.16 The design of the electric patrol craft shall comply with existing regulatory requirements for harbour craft, including the Maritime and Port Authority of Singapore (Harbour Craft) Regulations, the Merchant Shipping Act[1], and Prevention of Pollution of the Sea Act. In addition to the above, the electric patrol craft would have to be registered and maintain her registration with the Singapore flag administration. Furthermore, the electric patrol craft hull and machinery construction, energy storage system and battery management system, autonomous system, etc including plans/drawings shall be appraised and approved by the recognised organisations[2] (ROs) reference to its relevant class rule(s).

3.4.17 Designed to be future ready for addition of future systems, sensors, machineries and/or equipment with data transmission to MPA's Cyber Assurance and Operations Centre. (additional 30% I/O spare capacity for future expansion)

(b) Requirements relating to the design of the energy storage and management systems of the e-PC

3.5 The Participant shall design highly integrated and optimised energy storage and management systems to enable the electric patrol craft to meet or exceed existing operational requirements of its conventional equivalent counterpart. In addition, the proposed design must be able to meet the following requirements:

3.5.1 The energy storage system shall be optimised to deliver the appropriate battery capacity to support high endurance operations (maximum range at an optimal speed).

3.5.2 Adopt a regulated e-waste management system (i.e. solar photovoltaic panels, batteries, electronic equipment) in its design and business model

for electric patrol craft, which takes into account the circular flow of regulated consumer e-waste.

3.5.3 The energy storage system shall be able to react to emergency/ redundancy power for “back-to-shore” contingency without the use of fossil fuel-based dual systems (e.g. battery swaps or backup vessels that can be activated as part of the overall fleet operating model).

3.5.4 The battery management system (BMS) and battery charging devices shall conform to all regulatory requirements and/or be in accordance with existing charging communication standards and be interoperable with various relevant charging systems.

3.5.5 The BMS shall be optimised and equipped with intelligent decision making capabilities with appropriate selection of battery charging control strategies and ability to send data ashore via the Connectivity Suite (CS).

1 E.g. Merchant Shipping (Non-Convention Ships) Safety Regulations and Merchant Shipping (Load Line) Regulations

2 ABS, BV, CCS, DNV, KR, LR, NK and RINA

3.5.6 Battery charging and alternatives to battery charging (e.g. battery replacement, battery swapping) shall be ergonomic and seamless in transition during operations. The system shall be provisioned to facilitate battery upgrading (e.g. overhaul and replacement for maintenance, extension of battery capacity and/or higher energy-density batteries when technology readiness is higher).

3.5.7 The hotel load (auxiliary load e.g. lighting, heating, ventilation and air conditioning (HVAC)) shall be highly energy efficient to reduce unnecessary energy demands. The design should reduce thermal load to reduce cooling requirements.

3.5.8 Renewable energy (e.g. solar, wind, tidal, regenerative, etc.) generated onboard shall be considered to supplement energy supply to the energy storage system and/or as emergency/ redundancy power for “back-to-shore” contingency.

3.5.9 The integration of the energy storage and management systems shall be based on safety, reliability, and maintainability principles.

3.6 In designing the highly integrated and optimised energy storage and management systems of the electric patrol craft, the Participant shall take into consideration the operational requirements of the electric patrol craft and the technical requirements of the energy storage system which include but are not limited to the following:

3.6.1 Type(s) of battery chemistry (e.g. Li-ion (e.g. nickel manganese cobalt, lithium iron phosphate, lithium titanate), Na-ion) or working in concert with other energy systems (e.g. supercapacitors).

3.6.2 Type(s) of battery cells (e.g. cylindrical, prismatic, pouch)

3.6.3 Type(s) of battery system design (e.g. module, tray, rack, block)

3.6.4 Primary requirements (e.g. minimum required usable energy, maximum discharge power, maximum charge power, number of cycles per year, time per (dis)charge period, root mean squared value (dis)charge power)

3.6.5 Operation profile of electric patrol craft

3.6.6 Battery sizing (i.e. total installed capacity)

3.6.7 Battery lifetime

3.6.8 Charging approach (e.g. types of connectors, manual/ automated plugin, battery swapping)

3.6.9 Location of battery bank (e.g. for battery swapping, battery should be housed where it is easily retrievable without heavy machinery)

3.6.10 End of use information for the recycling of battery systems

3.7 The Participant shall in its Proposal provide the Government with technical and operational information which is capable of demonstrating that the design for the energy storage and management systems is able to meet the requirements set out at paragraph 3.5 and 3.6. This may include:

3.7.1 Engineering, technical, design/ schematics/ drawings, calculations, and modelling where applicable;

3.7.2 Information related to operations and maintenance of the energy storage and management systems; and

3.7.3 Any other information which is to be mutually agreed by all parties.

(c) <u>Requirements for battery storage compartment and battery racks</u>

3.8 To ensure safe operation of the electric patrol craft, the Participant shall include battery storage compartment in the Proposal, which shall comply with the following requirements:

3.8.1 The battery storage compartment shall be located at the aft of the collision bulkhead [if built with] of a ship and outside of accommodation spaces and control stations.

3.8.2 Electric harbour crafts of 20 metres in length (L) and above shall be provided with at least two independent battery systems and stored in two separated dedicated compartments.

3.8.3 Only equipment or system associated with the battery system or ESS should be in the battery storage compartment, except for fully welded drainage pipes from spaces above the battery compartment which must have a minimum thickness of SCH160 and are self-draining.

3.8.4 The battery compartment boundaries shall maintain the fire, gastight and watertight integrity of the space.

3.8.5 The battery compartment shall be located away from the craft's bottom or side shell plating. It should not locate directly above or below a flammable oil tank.

3.8.6 non-conducting gratings or mats are to be provided in the battery compartment unless the battery system or ESS is installed on an electrically insulated floor.

3.8.7 High bilge level sensor is to be provided in the battery compartment. The sensor is to give an alarm at a continuously manned location.

3.8.8 Access to the battery compartment shall be through normally closed gas-tight doors with alarm at a normally manned location or self-closing gas-tight doors with no holdback arrangement.

3.8.9 The battery compartment shall house individual battery racks, which comprise of individual battery modules / cells installed. Each battery rack should be individually compartmentalised to protect against thermal runaway propagation from rack to rack.

3.8.10 Each battery rack should be integrated with cooling distribution unit and rack manifolds to distribute and manage liquid to the batteries for liquid cooling. The liquid cooling solution should also consider design variables including, but not limited to the overall heat load from the batteries, the cooling liquid flow rates and pressure.

3.8.11 For immersion cooling, a thermally conductive dielectric liquid or fluid should be used to maximise the thermal transfer properties of liquid and ensure the most energy-efficient form of liquid cooling.

3.8.12 Each battery rack shall be installed with adequate switching and protection devices as well as auxiliary and communication circuits. This should also include integrated ventilation and vents. Refer to 3.9.4.

(d) Requirements for general ventilation of the battery compartment

3.9 To ensure safe operation of the electric patrol craft, the ventilation of the battery compartment shall comply with the following requirements:

3.9.1 Battery compartment shall be mechanically ventilated and discharges from the exhaust fans to maintain negative pressure and to be monitored. The ventilation of battery compartment shall have sufficient capacity to minimise the possibility of accumulation of flammable or toxic vapours and control of room temperature.

3.9.2 Ventilation fans shall be non-sparking and explosion proof type and shall be at least six (6) air changes per hour. Inlet and exhaust ventilation ducts for the battery compartment are to be from and to a safe location on open deck.

3.9.3 The ventilation duct of battery compartment shall be separate from ventilation systems serving other spaces. Ducts shall be of fully welded construction and duct materials are to be resistant of the gases produced in a thermal runaway condition.

3.9.4 Ventilation duct for battery compartment shall not pass through accommodation spaces, service spaces and control stations. Vice versa, ventilation ducts for accommodation spaces, service spaces and control stations shall not to pass through battery compartment, unless the following requirements are complied.

a. The ventilation ducts are made of materials that resistant with the gases produced in a thermal runaway condition; and
b. The ventilation ducts are fully welded construction; and
c. The ventilation ducts are insulated to A-60 standard; and
d. Ventilation duct fire dampers are to be provided on the bulkheads and capable of operating outside of battery compartment.

3.9.5 The ventilation system of the battery compartment shall be interlocked with the battery chargers to prevent battery charging when the ventilation is not operating.

3.9.6 The power supplied to the ventilation fan of the battery compartment shall be provided from both main power source and emergency source.

3.9.7 The ventilation fans starters cabinet(s) shall be located outside of the battery compartment.

(e) Requirements relating to battery safety and fire protection

3.10 To ensure the compliance with the fire protection requirements, the Participant shall include the following in its Proposal:

Electrolyte Gas and Smoke Detection

3.10.1 The battery compartment shall be fitted with heat and smoke detection to detect presence of heat or smoke.

3.10.2 For lithium-type batteries, an integrated gas and smoke detection is to be installed in the battery compartment, which continuously samples the air for presence of gas or smoke particles within the battery compartment, based on the electrolyte gas composition recommended by the battery manufacturer. A minimum of two detectors are to be fitted in the battery compartment with one located at the ceiling and one close to the floor.

3.10.3 For enhanced lithium battery fire protection, there should be localized electrolyte off-gas detection and temperature measurements and reporting within individual lithium-ion battery racks. The release of off-gas is the first stage of a battery failure which can self-propagate until the battery begins to smoke and go into fully developed thermal runaway. This would provide early warning of lithium-ion battery failures and prevention of thermal runaway.

3.10.4 Each individual lithium-ion battery rack shall come with integrated ventilation to remove any heated air generated or any gases produced from thermal runaway. The vents from the individual battery pack should come equipped with sensors continuously sampling the air for presence of electrolyte gas or smoke particles or minimally be installed with sensors at the outlet vent of the battery compartment to provide early warning and detection of lithium-ion battery failures and prevention of thermal runaway.

3.10.5 The power supplied to the heat / gas / smoke detection system shall be provided from both main power source and emergency power source.

3.10.6 Failure of the heat / gas / smoke detection system is to give an alarm at a continuously manned location.

3.10.7 The BMS shall be able to receive data of a complete temperature profile of the battery in real time and therefore, detect the malfunctioning battery before it reaches thermal runaway.

Fire Extinguishing and Suppression

3.10.8 When a heat or gas anomaly is detected, a de-ionised liquid or foam fire extinguishing system will be activated to suppress the thermal runaway by absorbing the exothermic heat produced from thermal runaway, reducing the temperatures for battery cells.

3.10.9 The de-ionised liquid or foam will fully submerge the battery cells and absorb the intense exothermic heat without breaking down or boiling off.

3.10.10 The de-ionised liquid or foam should not be electrically conductive, in order not to result in any inadvertent shorting of battery cells.

3.10.11 At least two portable extinguishers of a type suitable for extinguishing fires involving electrical system shall be provided for each battery compartment. Each power extinguisher shall have a capacity of at least 5kg and each foam extinguisher shall have a capacity of at least 9 litres. The portable fire extinguishers shall be stowed outside of EES compartment near the battery compartment entrance door.

(f) Requirements relating to the safety of the electric patrol craft

3.11 To ensure the safe operation of the electric patrol craft, the Participant shall include the following in its Proposal:

3.11.1 Infrastructure or systems to enhance safe boarding practices for shore-ship and ship-ship movement;

3.11.2 Appropriate thermal runaway (TR) propagation insulation (e.g. cell/ module level), TR propagation control (e.g. passive/ active), TR gas exhaust system (e.g. open/ closed) and location of ventilation exhaust, and TR response plans;

3.11.3 Appropriate provision and placement of gas detection sensors and gas detection response plans;

3.11.4 Appropriate external fire monitoring, early warning systems, and detection (e.g. heat sensors, smoke sensors, thermal cameras) and firefighting systems (e.g. gas, aerosol, foam, water mist/ sprinkler); and

3.11.5 Routine inspections of battery spaces and incident risk assessments and response plans.

3.12 The electric patrol craft design proposed by the Participant must be able to meet the following safety-related requirements.

3.12.1 Ship steering and manoeuvrability shall be controllable from the primary source of power or emergency/ backup power (auto-switching feature when primary source of power fails) with an ergonomic design layout from the wheelhouse (e.g. remote operation).

3.12.2 Advanced navigational equipment shall constantly monitor craft position, course, speed, surroundings (e.g. automatically acquires other vessel in its vicinity), operational from primary source of power or emergency/ backup power (auto-switching feature when primary source of power fails)

3.12.3 Cybersecurity requirements, including preventive and monitoring measures of shipboard systems against cyber threats, taking reference from industry best practices (e.g. NIST 800-53, ISO 27000, IEC 62443, IACS UR E26 and E27, etc.) for the cyber safety of the electric patrol craft.

3.12.4 Provisions for the monitoring of onboard computer/system vulnerability and/or detection of abnormal cyber events on the networks, sensors, systems and equipment of onboard systems, etc and to transmit the information to MPA for real-time cyber detection and monitoring.

(g) Requirements relating to <u>data monitoring and transfer</u>

3.13 The BMS shall be capable to monitor and protect the battery system from the following faults:

a. Cell over-voltage
b. Cell Under-voltage
c. Cell over-current
d. Cell over-temperature
e. Failure of communication
f. Ground fault

3.14 The Energy Management System (EMS) shall be independent of the BMS and provided with remote monitoring at the continuously manned location to the satisfaction of the Authority.

3.15 The EMS shall be capable of monitoring the following parameters:

a. available energy of the EES systems
b. available power of the EES systems
c. battery state of charge (SOC)
d. alarm for minimum capacity reached
e. battery state of health (SOH)

3.16 Data acquisition and monitoring shall be continued even after the charging sequence has ceased.

(h) <u>Requirements relating to the manpower requirements of the electric patrol craft</u>

3.17 The Participant shall ensure the design and development of electric patrol craft support human-centric and lean operations to achieve minimum manning requirements. The design shall incorporate advanced functions to enable remote monitoring, support remote control and autonomous navigation including but not limited to: vision enhancement under adverse weather and environmental conditions (i.e. rains, storms, etc), remote monitoring of system and equipment health status (i.e., battery power and propulsion system, etc), situational awareness, voyage optimization (i.e., route planning and speed optimization), grounding warning, collision warning and avoidance, sensor information fusion for transmission via the Connectivity Suite to and

remotely controlled from a shore-based station, autonomous navigation in open water and fail-safe functions (i.e., onboard personnel to take over the control at any time where necessary).

3.18 The Participant shall propose requirements for crew training including but not limited to:

a. Required enhancements to existing Certificate of Competency (COC) courses
b. Battery management and safety
c. Fire safety and training
d. Maintenance regime

(i) Requirements relating to the economic viability of the e-PC

3.19 The Participant shall demonstrate in its Proposal the value-proposition of the e-PC design with a focus on weight reduction while maintaining seaworthiness, emissions intensity, energy efficiency, and ability to meet or exceed operational requirements of its conventional equivalent counterpart or propose ways in which the existing operational requirements can be better met through higher utilisation of a fleet of vessels. The number of vessels for the same operational requirements as a fleet should be less than the number of existing conventional equivalent counterpart.

3.20 To demonstrate economic viability of its Proposal, the Participant shall provide the following financial information in their Proposal. Amongst others, this may include:

3.20.1 Financial breakdown and projections related to capital costs for the design, build, testing, and delivery of one unit(s) of e-PC, fully equipped and outfitted as specified with consideration of value engineering. The Participant may perform a similar financial breakdown and projections for multiple units of e-PC with aggregated demand (e.g. 2, 4, 6 units) and clearly indicate capacity and cost projections at different stages of the scale-up.

3.20.2 Financial breakdown and projections related to operational costs for the insurance, consumables (e.g. cost of electricity), maintenance, repair, overhaul, disposal costs, and residual value (including battery recycling) over the lifecycle of the e-PC (i.e. hull, propulsion system, battery management system, and electrical equipment, etc.)

3.20.3 The total cost of ownership (TCO) shall be calculated over its estimated lifecycle, assuming 5, 8, and 10 years of operations. This should take the lifespan of the battery into consideration, assuming 5, 8, and 10 years of operations.

3.20.4 The cost of electricity where the TCO of the e-PC matches or is lower than the TCO of its conventional equivalent counterpart.

3.21 In providing the information stated at paragraph 3.20.2, the Participant shall specify the scope of preventive and scheduled maintenance requirements and frequency for the e-PC outboard, propulsion system, energy storage system and battery management system, and electrical components, etc.

3.22 In submitting its proposal, the Participant shall assess the financial viability of the e-PC design. The assessment shall be based on: (a) the TOC of the e-PC design; (b) the TOC of the e-conventional equivalent counterpart of the e-PC; and (c) the projected price of electricity and marine gas oil price. The Participant shall provide the said assessment to the Government.

4 FORM OF EOI

4.1 The Participant shall submit the EOI using the format set out in **Appendix A.**

4.2 The Participant should provide supporting reasons if there are deviations to the requirements set out in this EOI or if it is unable to furnish any of the commercial and technical details in **Appendix A.**

5 ASSESSMENT CRITERIA

5.1 Proposals will be assessed based on:

5.1.1 Quality and strength of Participant's technical and commercial proposals including but not limited to: energy efficiency optimisation, reference design that allows for potential scale-up and further demand aggregation in the future, delivery timeline, TCO, and Participant's compliance to the requirements of the EOI summarised in Section 3 and detailed in **Appendix A**.

5.1.2 Robustness and completeness of safety and training requirements.

5.1.3 Proven financial strength, experience track record, and capability of the Participant in value-chain development.

5.2 Only proposals submitted before the closing date will be considered.

6 ADMINISTRATIVE DETAILS

6.1 Please submit your EOI in **Microsoft Word** and/or **PDF** formats[3] via email to:

Andrew_leong@mpa.gov.sg; Divakar_nadarajan@mpa.gov.sg;
Magesh_sivakumar@mpa.gov.sg

6.2 The closing date for submissions is 14 December 2024 Singapore time.

6.3 MPA will acknowledge receipt of each submission via email. If you do not receive an acknowledgement of your submission within two business days, please contact Capt Magesh Sivakumar (magesh_sivakumar@mpa.gov.sg).

6.4 MPA reserves the right to share any information submitted by Participants in their EOI for the purpose of assessing the Participant's Proposal. Any part of the submission that is considered by Participants to be confidential should be clearly marked. MPA reserves the right to aggregate/anonymise the information before sharing on a need-to basis. All EOIs submitted shall be on a non-binding basis and MPA shall not be bound or under any obligation to accept any proposal submitted.

* * *

3 The Participant shall validate its assumptions and calculations as requested by MPA, using digital software and models as required. These files shall be presented and shared with MPA during further clarifications.

Appendix A

FORM OF EOI

Instructions: Please use this form to submit your EOI and include any supporting documents, justifications or key assumptions where applicable.

1. Participant's name, registered business address, contact person's name, designation, email and contact number.

2. Profile of Participant and its partners, if any, in the Project consortium, and details of relevant experience. If the Participant consists of a consortium of companies, the Participant shall also list the key personnel from each company.

3. Most recent 3 years' financial information in respect of the Participant and its partners in the consortium, if any.

4. Technical Details

4.1 The Participant shall provide the following specific details on technical specifications of the proposed reference design for e-HC, which include but are not limited to the following:

(If the proposal includes plans for scale-up through demand aggregation, the participant shall also include the following details for the scale-up phase as separate line items within.)

1. General	
a. Basic function (Type 1 Craft/ Type 2 Craft)	
b. Hull type	
c. Hull material	
d. Superstructure material	
2. Dimensions	
a. Length moulded	
b. Beam moulded	
c. Draught (max)	
d. Gross tonnage	
3. Performances	
a. Maximum speed (kts)	
b. Operating/ service speed (kts)	
c. Range (nm)	

4. Propulsion system	
a. Type of propulsion system	
b. Make of propulsion system	
c. Propulsion power	
5. Energy management systems	
a. Battery capacity (kWh)	
b. Battery weight (kg)	
c. Type of battery chemistry	
d. Type of battery cells	
e. Type of battery system design	
f. Battery lifetime	
g. Charging current (i.e. AC, DC)	
h. Charging connections	
i. Charging duration to meet operational needs	

4.2 The Participant shall provide a detailed Proposal as set out in Section 3 of this EOI.

5. The Participant shall provide details on the overall Project timeline, management, and risk details. These include but are not limited to the following:

5.1 Project Timeline. Key Project tasks and milestones, including but not limited to technical studies, regulatory and permitting approvals.

5.2 Project Management. Engineering, Procurement and Construction (EPC) date and Commercial Operational Date (COD). Phased or future expansion, if any, and associated timeline.

5.3 Project Risk Assessment. Identification of potential show-stoppers that may impact the technical and commercial viability of the Project and their associated mitigation measures, if any.

5.4 Technical and Commercial Non-Compliance. Participant shall state clearly any non-compliance to the technical and commercial requirements stated in the EOI. For all non-compliance, Participant shall explain the extent and reason of the deviation and provide mitigation measures if possible.

5.5 Regulatory Non-Compliance. To state clearly any regulatory requirements or standards that could not be met, or are at risks breaching through the construction and operational lifetime of the project. Participants are to provide the amount of deviation, and explanations for such non-compliance.

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