

Tele. 011-21410495
Fax. 011-21410483
E-mail: dna.ihqmod@navy.gov.in

Integrated Headquarters-MoD(Navy)
Directorate of Naval Architecture
Room No 200, Second Floor
Naval HQ Annexe Building
Talkatora Stadium
New Delhi 110001

NC/0535

06 Aug 21

To,

M/s

**REQUEST FOR INFORMATION (RFI) FOR SUPPLY OF
IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM**

1. The Ministry of Defence, Government of India, intends to procure Impressed Current Cathodic Protection (ICCP) system.
2. This Request for Information (RFI) consists of two parts as indicated below:-
 - (a) **Part I.** The first part of the RFI incorporates technical characteristics and features that should be met by ICCP system.
 - (b) **Part II.** The second part of the RFI states the methodology of seeking response of Vendor.

PART- I

3. **Operational Requirements.** The Technical Requirements of the ICCP system are placed at **Appendix 'A'** of this document.
4. **Important Parameters.** Detailed specifications will be given in the Request for Proposal (RFP) which will be issued to firms after verifying their credentials and capabilities to manufacture the items. Firms responding to this RFI should mandatorily submit the following details:-
 - (a) Feasibility to manufacture and supply ICCP system as per the enclosed specifications (**Appendix 'A'**). All modifications and deviations to the listed

specifications can be suggested by the vendor with suitable justification. Clauses that cannot be complied with are required to be clearly indicated.

- (b) Necessary infrastructure available with the vendor for manufacture of ICCP system needs to be listed.
- (c) Budgetary quotes with breakup of cost including all the elements that needs to be structured into the costing of the complete equipment (including that of comprehensive maintenance schedule) which will serve as guideline to formulate procurement strategy.
- (d) Time required for Manufacture.
- (e) Past installations and past performance of the systems need to be provided.
- (f) Willingness to undertake trials of the system onboard Navy ships.
- (g) Methodology of installation of new ICCP system onboard ships.
- (h) Experience in manufacturing/ supplying similar equipment along with client details.
- (i) MoU with any vendor/agency in India, if any, for service support and maintenance.
- (j) Defence Procurement by Indian Navy are guided by Defence Procurement Manual (DPM). Whether the vendor would be able to comply with all provisions of DPM-09 or not. If not, Para/Clause of DPM-09 that would not be agreed to, with reasons.
- (k) Vendors may consider RFI as advance information to obtain requisite clearances.
- (l) Acceptability to terms of payment as per DPM-09, available for download at Ministry of Defence Website, <https://mod.gov.in/dod>. Shall also be provided on request.

5. **Additional Specifications.** The aim of seeking this RFI is also to review the specifications for the ICCP system with inputs from vendors. The requirements of ICCP system are enclosed herewith and the same can also be provided on request. Following information to be provided by the firm:-

- (a) Additions/ alterations to specifications for the items with details.
- (b) Para wise compliance of **Appendix 'A'**. If not, which Para / clause that would not be agreed to, with reasons.
- (c) Approximate cost estimation in Indian currency only. (Basic equipment cost, without taxes, duties, etc, but inclusive of delivery at place (DAP)). The cost details should be provided under various heads as indicated in **Appendix 'A'**.

6. Shortlisted vendors shall be approached for procurement of the ICCP system for Indian Naval ships. In this regard, the vendor should confirm that the following conditions are acceptable:-

- (a) The solicitation of offers will be as per '**Single Stage-Two Bid System**'. It would imply that a 'Request for Proposal' would be issued soliciting the technical and commercial offers together, but in two separate sealed envelopes. The validity of commercial offers would be at least 12 months from the date of submission of offers.
- (b) The technical offers would be evaluated by a Technical Evaluation Committee (TEC) to check its compliance with RFP.
- (c) Various configurations of the product and consequent cost implication to be highlighted.
- (d) Amongst the Vendors cleared by Staff Evaluation, a Commercial Negotiation Committee would decide the lowest cost bidder (L1) and conclude the appropriate Contract.
- (e) Vendor would be bound to provide product support for time period specified in the RFP, which includes spares and maintenance tools for field and component level repairs.
- (f) The Vendor would be required to accept the general conditions of Contract given in the Standard Contract Document of DPM.
- (g) **Performance-cum-Warranty Bond**. A Performance-cum-Warranty Bond equal to 10% value of the Contract is required to be submitted after signing of the Contract.

PART-II

7. Procedure for Response.

- (a) Vendors must fill the form of response as given in **Appendix 'B' & 'C'** (as applicable). Apart from filling details about the company, details about the exact product meeting our generic technical specifications should also be carefully filled. Additional literature on the equipment and its various components can also be attached with the form.
- (b) The filled form should be dispatched at the under mentioned address. It is mandatory to forward the response in scanned format to the Email address provided below: -

Commodore (NA)
Room No, 200, 2nd Floor
Directorate of Naval Architecture
Naval Headquarters Annex Building

Talkatora Stadium, New Delhi 110001

Tele: 011-21410495

Fax: 011- 21410483

Phone : 8942873535

E-Mail: dna.ihqmod@navy.gov.in

(It is mandatory to forward details to this email id)

(c) Last date of acceptance of filled forms along with details sought is **06 Sep 21**. The vendor short listed for issuance of RFP would be intimated.

8. The Government of India invites responses to this request only from Original Equipment Manufacturers (OEM)/ Authorized Vendors/ Government Sponsored Export Agencies. Vendor qualification criteria is specified in **Appendix 'D'**. The end user of the ICCP system is the Indian Navy.

9. This information is being issued with no financial commitment and the Ministry of Defence reserves the right to change or vary any part thereof at any stage. The Government of India also reserves the right to withdraw RFI, should it be so necessary, at any stage.



(S Thiagarajan)
Commander
Cdr(NA)-Equip-I

TECHNICAL SPECIFICATIONS FOR
IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM FOR INDIAN
NAVAL SHIPS

<u>1. Technical Requirements</u>	(a) Technical Requirements of ICCP system are placed at Annexure 1 to this Appendix.
<u>2. Past Performance</u>	(a) High emphasis shall be accorded to analyze the long term performance of the ICCP system supplied. In this regard, the vendor is requested to provide list of past installations and performance report of these systems. (b) Vendor can also share details of the clientele in order to ascertain ICCP performance from the User perspective.
<u>3. Manufacturing Facilities</u>	(a) The firm should provide details of manufacturing facilities available and certification of such facilities. (b) The vendor/ manufacturer shall provide details of plant size, no of employees, yearly production capacity etc. Any certification available for the production facilities can be provided.
<u>4. Quality Control</u>	(a) Vendor shall provide the Quality Assurance Plan (QAP) followed during manufacture of the system and components. (b) Details of internal Quality Control Department and external QC agencies (viz, Class Societies) etc, may also be indicated.
<u>5. Service Life and Warranty</u>	(a) The items shall be provided with a warranty period of 02 years from the date of supply. The warranty shall cover defects arising from inappropriate material, quality control issues, production issues and non-conformance to specifications. The expected fair service life of the items shall be mentioned.
<u>6. Product Support</u>	(a) Product Support modalities need to be indicated by the vendor. Product support shall include installation, Setting-To-Work, onboard Trials, Sea Trials, spares supply, post installation service support etc.

	<p>(b) Willingness for Annual Maintenance Contract and PBL (Performance Based Logistics) Contract during service life of ICCP systems.</p> <p>(c) Availability of Indian office or authorised Indian Rep for spares supply and service support in India to be indicated. Spares are required</p>
<p>7. <u>Compliance</u></p>	<p>(a) Para-wise compliance to be provided.</p> <p>(b) In case of non-compliance reasons for the same should be provided.</p> <p>(c) Vendor is welcome to provide any additions/ alterations to the specifications.</p>
<p>8. <u>Costing</u></p>	<p>(a) Detailed costing of the ICCP system to be forwarded by the supplier. The cost can be broken down, but not limited to following heads:-</p> <p>(i) <u>Cost of equipment per ship.</u> Should include all system components including anodes, REs, cofferdams, ACUs, cabling, mounts etc. A typical configuration of 04 anodes and 04 REs can be considered. Additionally, breakdown of cost of each components should also be indicated. Equipment which the OEM expects to be supplied by Yard needs to be indicated.</p> <p>(ii) <u>Cost of Installation.</u> The cost of installation of the system onboard ship to be indicated separately. Yard support required for installation and time required for installation to be specified.</p> <p>(iii) <u>Cost of Service Support.</u> The service support shall be conducted by one of the four models provided below:-</p> <ul style="list-style-type: none"> ➤ <u>Supply of spares for the system.</u> Maintenance and repairs carried out by Naval Maintenance Agencies. ➤ <u>Annual Maintenance Contract.</u> Routine maintenance activities (Weekly, Monthly) carried out by Naval agencies. Quarterly, Half-yearly and Annual Maintenance to be conducted by OEM/ OEM reps. Cost of AMC per ship/ per year to be indicated. ➤ <u>Performance Based Logistics Model.</u> PBL contracts are based on performance

	<p>of the system. OEM has to guarantee the performance of the system in terms of Operational availability and Minimum Specified Down Time (MSDT). Stage payment shall be linked to equipment performance with penalties on downtime.</p>
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INFORMATION PROFORMA
(INDIAN VENDORS)

1. **Name, Address and Unique ID (if any) of the Vendor/ Company/ Firm.**
_____ (Company profile, in brief, to be attached. In the eventuality of the firm emerging as L1, Contract will be concluded in the **name and address** of the firm, as indicated here). Vendors are to submit an undertaking that any subsequent proposal for change in name of firm or address, will be intimated to IHQ MoD (N) at the first available opportunity and supporting documents be furnished within five working days of approval by relevant competent authority.

2. **Type (Tick the relevant category).**

Original Equipment Manufacturer (OEM) - Yes/ No

Authorised Representatives of foreign Firm - Yes/ No (attach details, if yes)

Others (give specific details) _____

3. **Contact Details.**

Postal Address: _____

City : _____ State : _____

Pin Code : _____ Tele : _____

Fax : _____ URL/Web Site: _____

Email : _____

4. **Local Branch/ Liaison Office in Delhi (if any).**

Name & Address _____

Pin Code: _____ Tele: _____ Fax: _____ Email: _____

5. **Financial Details .**

(a) Category of Industry (Large/ Medium/ Small Scale): _____

(b) Annual Turnover : _____ (in INR)

(c) Number of employees in firm : _____

(d) Details of manufacturing infrastructure : _____

(e) Earlier contracts with Indian Ministry of Defence/ Government agencies:

Contract Number	Equipment	Quantity	Cost

6. **Certification by Quality Assurance Organisation.**

Name of Agency	Certification	Applicable from (Date & Year)	Valid till (Date & Year)

7. **Details of Registration.**

Agency	Registration Number	Validity (Date)	Equipment
DGS&D			
DGQA/ DGAQA/ DGNAI			
OFB			
DRDO			
Any other Government Agency			
Any other non-governmental agency			

8. **Membership of FICCI/ ASSOCHAM/ CII or other Industrial Associations.**

Name of Organisation: _____

Membership Number: _____

9. **Equipment/ Product Profile (to be submitted for each product separately).**

(a) Name of Product : _____

(Should be given category wise for e.g. all products under night vision devices to be mentioned together)

(b) Description (attach technical literature): _____

(c) Whether OEM or Integrator : _____

(d) Name and address of Foreign collaborator (if any): _____

(e) Industrial License Number: _____

- (f) Indigenous component of the product (in percentage): _____
- (g) Status (in service/design & development stage): _____
- (h) Production capacity per annum: _____
- (j) Countries/agencies where equipment supplied earlier (give details of quantity supplied): _____
- (k) Estimated price of the equipment. _____
10. Alternatives for meeting the objectives of the equipment set forth in the RFI.
11. Any other relevant information: _____
12. **Declaration.**
- (a) It is certified that the above information is true and any changes will be intimated within five (05) working days of occurrence.
- (b) It is certified that design and development is indigenous and belongs to the _____ (Vendor) and/ or _____ (its Indian Sub Vendor). The Indigenous Content in the said equipment is _____% as on date and is likely to be raised to _____% by _____ (date). The clarification for the same is enclosed.
- (c) It is certified that the complete set of design and production drawing are available and source code for all software applications/ programmes are also available with the _____ Vendor and that these would be produced for verification when required.
- (d) It is certified that in the past that _____ (name of firm) has never been banned/ debarred for doing business dealings with MoD/ GoI/ any other Government organisation and that there is no inquiry going on by CBI/ ED/ any other Government agency against the firm.

(Authorised Signatory)

INFORMATION PROFORMA
(NON-INDIAN VENDORS)

1. **Name, Address and Unique ID (if any) of the Vendor/ Company/ Firm**

_____ (Company profile, in brief, to be attached. In the eventuality of the firm emerging as L1, Contract will be concluded in the **name and address** of the firm, as indicated here). Vendors are to submit an undertaking that any subsequent proposal for change in name of firm or address, will be intimated to IHQ MoD (N) at the first available opportunity and supporting documents be furnished within five working days of approval by relevant competent authority.

2. **Type (Tick the relevant category).**

Original Equipment Manufacturer (OEM) Yes/No
Government sponsored Export Agency Yes/No (Details of registration
to be provided)
Authorised Vendor of OEM Yes/No (attach details)
Others (give specific details) _____

3. **Contact Details.**

Postal Address: _____
City : _____ Province : _____
Country: _____ Pin/ Zip Code : _____
Tele : _____ Fax : _____
URL/Web Site : _____ Email : _____

4. **Local Branch/Liaison Office/Authorised Representatives, in India (if any).**

Name & Address: _____
City : _____ Province : _____
Pin code : _____ Tel : _____ Fax : _____
Email. _____

5. **Financial Details.**

- (a) Annual turn over : _____ USD
- (b) Number of Employees in firm _____.
- (c) Details of manufacturing infrastructure available _____.

(d) Earlier contracts with Indian Ministry of Defence/Government agencies:

Agency	Contract Number	Equipment	Quantity	Cost

6. **Certification by Quality Assurance Organisation (If Applicable).**

Name of Agency	Certification	Applicable from (date & Year)	Valid till (date & year)

7. **Equipment/ Product Profile (to be submitted for each product separately).**

- (a) Name of Product: _____
- (b) Description (attach technical literature): _____
- (c) Whether OEM or Integrator: _____
- (d) Status (in service /Design development stage): _____
- (e) Production capacity per annum: _____
- (f) Countries where equipment is in service: _____
- (g) Whether export clearance is required from respective Government: ____
- (h) Any collaboration/joint venture/co production/ authorised dealer with Indian Industry (give details):

Name & Address: _____

Tel : _____ Fax : _____

8. Alternatives for meeting the objectives of the equipment set forth in the RFI.

9. Any other relevant information. _____

10. **Declaration.** It is certified that:-

(a) It is certified that the above information is true and any changes will be intimated within five (05) working days of occurrence.

(b) The _____ (name of firm) has never been banned/ debarred for doing business dealings with MoD/ GoI/ any other Government organisation and that there is no inquiry going on by CBI/ ED/ any other Government agency against the firm.

(Authorised Signatory)

CRITERIA FOR VENDOR SELECTION/ PRE QUALIFICATION

1. **Technical Parameters.**

- (a) Number of years of experience in ICCP systems.
- (b) Product performance
- (b) Manufacturing infrastructure.
- (c) Quality plan maintained by vendor.
- (d) Details of certification by Quality Assurance Agencies.
- (e) Industrial License details at the time of submission of bid.
- (f) Annual production capacity and capability to increase the production capacity to meet the delivery schedule requirements of Services.

2. **Financial Parameters.**

- (a) **Turnover.** Turnover of Rs. _____ Crs in last three years.
- (b) **Capital Assets.** Capital Assets of _____.
- (c) **Profit.** Profit/ Loss in last three years _____.
- (d) **Tax Return.** Copy of Income Tax Return filed during last three years.

3. **Additional Parameters.**

- (a) Projects/ supply orders successfully executed in last five years.
- (b) Annual reports of last five years.
- (c) Shareholder information.
- (d) Details of Promoters, associated, allied and JV companies.
- (e) Details of vigilance action viz ongoing investigation and suspension/ debarment/ blacklisting actions against the company, if any.

4. **Undertaking.** Prospective Vendors must submit an undertaking that information provided by them is correct.

TECHNICAL REQUIREMENTS
IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM
FOR INDIAN NAVAL SHIPS

1. INTRODUCTION

1.1. Impressed Current Cathodic Protection (ICCP) systems are a means of actively mitigating corrosion i.e., the amount of current employed may be varied depending on the protection needs of the vessel. ICCP consists of one or more (active) anodes, one or more reference electrodes and a control mechanism to determine current output.

1.2. In ICCP systems, the current is supplied to the protection surface using power supplies internal to the vessel. Current flows from the power supplies into the seawater by means of a number of inert (i.e. they are not consumed in the process) anodes positioned on the hull. The amount of current output by the power supplies is calculated by a controller which may be a simple analogue feedback circuit or a more complex computer controlled digital feedback system. The controller establishes the required current from a series of external monitoring points which take the form of external reference cells. It is the responsibility of the CP designer to ensure that there are the correct numbers of anodes to ensure an even distribution of current over the hull; there are sufficient reference cells to adequately characterize the state of the hull and that the control system is stable taking into account the possible alterations to the system parameters caused by hull damage and external environment changes.

1.3. The expected requirements on ICCP system from the vendor is enumerated below. Any deviations in the requirement and recommended additions and alterations can be brought out by the vendor.

2. System Components

2.1. The ICCP System supply is to comprise of the Anodes (Platinum Titanium or other appropriate material), Reference Electrodes (Ag-AgCl, Zinc or other material), installation accessories, all types of cables and end connectors , junction boxes, hull penetrations, cofferdams, onboard spares, multi-test equipment((portable test equipment capable to measure all the input/output parameters of the system, conforming to international measuring instrumentation standards), Data logger, bonding material for mounting of anodes, REs on hull, power and control units (ACUs). Shock mounts and other relevant fitting may also be included.

2.2. The ICCP System is to be of multi zone type, implying that current can be pumped and controlled into each zone independently from an ACU, forming a local zone near the vicinity of the electrode. The system construction should be modular in design, each DC power supply unit should be dedicated to feed individual anode. The DC units should be plug-in type and repairs should be feasible by replacement of the DC unit.

2.3. The system is to be designed to ensure adequate and effective corrosion protection and suppression of corrosion related electric and electromagnetic signatures under the full range of operating conditions, salinity (Sea Water conductivity expected from 15 Ohm cm to 40 ohm cm), temperature of sea water (in Indian tropical conditions) and the condition of underwater paint as well as speed of the Ship. The system should be designed for reduced maintenance requirements under tropical environmental conditions. Additionally the system components

must be chosen to avoid bimetallic corrosion with steel. The system design is to be optimized to ensure effective corrosion protection and reduced signatures under all operating conditions (in harbour and at sea).

2.4. The design of the system has to be carried out for optimum corrosion protection and signature management through computer simulation/analysis using well established and proven software. Details of software modelling results to be shared.

3. DESIGN CALCULATIONS

3.1. Design of ICCP system current requirements are to be undertaken by the OEM. A typical design calculations that are used by Navy is given below, only for reference. The vendor is requested to provide details of their design methodology and suggest recommendations. Currents for various seaway and environmental conditions given in section 3.3 is to be followed. For surface vessels the hull potential should be no more positive than -750mV and no more negative than -1200mV.

3.2. Densities of Current Required for Corrosion Protection of Under Water Hull.

3.2.1. For simple corrosion protection calculation, the following data may be used. The current densities shown below in Table 1 and, unless otherwise stated, elsewhere in this NCD, are based on providing a protection voltage of approximately -800mV ref Ag/AgCl:

All values are in mA/m ²					
Tropical > 20°C			Sub Tropical 12 - > 20°C		
<i>i</i> _{Initial}	<i>i</i> _{Final}	<i>i</i> _{Mean}	<i>i</i> _{Initial}	<i>i</i> _{Final}	<i>i</i> _{Mean}
147.5	100	72.5	167.5	115	82.5
Temperate 7 - 11°C			Arctic < 7°C		
<i>i</i> _{Initial}	<i>i</i> _{Final}	<i>i</i> _{Mean}	<i>i</i> _{Initial}	<i>i</i> _{Final}	<i>i</i> _{Mean}
195	137.5	95	222.5	160	110

Note:

1. In the Table above, the following definitions are used:
 - *i*_{Initial} : **Short** term current required to initially polarize bare material (on first wetting and newly damaged bare material) and develop the calcareous deposition layer.
 - *i*_{Mean} : **Long** term current required to maintain protection during 'steady state' period with fully formed calcareous deposit layer. This is sometimes known as the maintenance current.
 - *i*_{Final} : **Maintenance** current above with an allowance for re-polarization of metal where calcareous deposit layer is partly or wholly removed.
2. The design is to be based on the temperature range specified in at Para 3.7 of this NCD.

3.2.2. Steel that has been fully coated with anti-corrosion paint is generally considered an insulator with no current passing through the coating. For the calculation of cathodic protection currents, however, it may be prudent to assume that all coatings have an initial level of damage or porosity and that this will become worse over time.

3.2.3. For tanks and free flood spaces where an initial value for damage may be difficult to assess, it is advisable to allow for a protection current value of 7mA/m² over the whole (coated) protection surface. Where the suitability of the applied coating cannot be verified an increased figure of 15mA/m² is advised.

3.2.4. For current calculations in areas external to tanks/free-flood spaces a further multiplier should be applied to the values in Table 1 to account for increased protection requirements under various flow conditions as indicated in Table 2 below.

Protection of Bare Steel All Values in mA/m ² @ 20knots			
Tropical > 20°C	Sub Tropical 12 - > 20°C	Temperate 7 - 11°C	Arctic < 7°C
330	375	430	500

3.2.5. For Propeller and materials such as NAB (Nickel Aluminium Bronze), Monel, and others, the current for protection varies considerably. NAB type materials can, initially, require high protection current densities and the maintenance levels for long-term exposure NAB are similar to those quoted for steel above. For propellers where the build-up of calcareous deposits is more problematic and prone to removal, current densities may remain high. For design purposes protection currents for NAB should be used as given in Table 3 below (If actual polarisation data is available, the same should be used):

Propellers at all times and Initial Current Densities for All Fittings	1000 mA/m ²
External Fittings (Static) Maintenance Current Density	250 mA/m ²
Ballast Tank Maintenance Current Density	150 mA/m ²

3.3. **Coating Damage (Coating Breakdown Factors)**

3.3.1. The protection current densities above apply to unprotected (bare) materials. Coatings applied in accordance with the requirements promulgated by Indian Navy will reduce the current required for protection to almost zero. As the effectiveness of the coating is decreased due to loss or damage, the current required for protection increases.

3.3.2. Each separate base material (Steel, NAB, etc) or separate coating area will be assigned its own coating level of coating damage.

3.3.3. Each coating area will be assigned damage as a percentage for:

- (a) **CD_{initial}** Initial Coating Damage – anticipated coating loss at start of life.
- (b) **CD_{mean}** Average Coating Damage – mean damage over life of system/vessel.
- (c) **CD_{final}** Final Coating Damage – coating damage and end of system life (t_{final}).

Note:

1. System life applies to period over which a CP system is designed to provide protection. This may be the period between dry-docking and hull coating replacement for ICCP systems.
2. Vessel Life is defined as time between major coating replacements.
3. Coating loss will be based on existing experience where available.
4. For CP systems to be designed effectively, the assessment of coating loss must be made as accurately as possible.

3.3.4. Vessel life is defined as time between coating replacements.

3.3.5. Coating loss will be based on existing experience available.

3.4. **Preliminary Design of ICCP System**

3.4.1. **Current Capacity**

The designer should provide evidence that the ICCP system meets the design intent of the system. The following rules should be observed for preliminary estimate of ICCP system:-

3.4.1.1 Identify all significant wetted coated areas, σ_m , for each different material m ;

3.4.1.2 Establish initial coating loss. If this is unknown a conservative estimate is to assume an initial loss of 0.5% of the wetted surface area;

3.4.1.3 Establish maximum coating loss for the coated surface. Assume maximum coating loss as 10%.

3.4.1.4 Obtain protection current densities, j_m for all bare materials as per Para 3.3. Some coated surfaces may be assumed to require zero protection current and may be ignored. The current density used should reflect the condition of the material and environment of operation;

3.4.1.5 Calculate initial life current capacity, with initial coating loss. This is given by $I_s = \sum j_m \sigma_m$

3.4.1.6 Calculate the final current capacity based on the above coating loss and non-coated surfaces

3.5 The protection current densities in 3.3.5 above will depend on the location and vessel velocity. It is recommended that the above procedure is carried out for a variety of locations and vessel speeds.

3.6 Under flow conditions of 20knots, 10ms^{-1} , if the designer is not supplying their own polarisation data validated by trials data then the current densities for bare steel should be used.

Although coatings are not perfect, the current needed to protect them is, in general, very much smaller than the current needed to protect the expected end of life coating loss. Thus any current demand calculated for the imperfections in the initial application of the coatings can be regarded as insignificant compared to the final system current demand.

Consider the case of a vessel with coated steel hull wetted surface area of 2400m^2 , bare NAB propellers of 80m^2 including shafts and it is expected that a 10% coating loss will occur at the end of service or before the next refit.

For underway conditions we might expect a conservative estimate of 500mA/m^2 for the protection needs of bare steel and 1000mA/m^2 in for the protection needs of the propellers in Mediterranean operating environment.

For the initial current demand we assume that we have 0.5% coating loss,

$$i_{Hull} = 0.005 \times 2400 \times 0.50 = 6 \text{ Amps}$$

$$i_{Prop} = 80 \times 1 = 80 \text{ Amps}$$

$$I_{Total} = 86 \text{ Amps}$$

For the final end of service current demand we have,

$$i_{Hull} = 0.1 \times 2400 \times 0.50 = 120 \text{ Amps}$$

$$i_{Prop} = 80 \times 1 = 80 \text{ Amps}$$

$$I_{Total} = 200 \text{ Amps (which is to be used for design of the system)}$$

4. **DESIGN CONSIDERATIONS**

4.1. The system should be provided with system malfunction indicators to indicate the fault in the system. The operations of indicators should be automatic with a provision to identify the nature of the defects. The system should not interfere with the functioning of other systems, like antifouling protection system for sea chests. The vendor should also take into account the degaussing system, if fitted, on the ship. In case the details of such systems are required to be considered while designing the ICCP system, the same may be intimated by the vendor.

4.2. The system should be designed such that only minimum human intervention is required during the entire operation. The routine maintenance and periodic checks for proper operation of equipment needs to be clearly specified and supplied along with the equipment. The maintenance technicians should be able to quickly isolate the fault and repair the equipment by module replacement. Meters and indicating lamps are to be provided to display system operation status.

4.3. Underwater Electric Potential (UEP) signature is to be reduced by proper design of ICCP system and suitably positioning ICCP anodes and electrodes. In order to minimize Power Frequency ELFE (PF ELFE) signature due to the presence of ripple content (AC component) in the electric supply to the ICCP anodes, ripple content in the ICCP control panel to be as low as possible, and not exceeding 0.03 %.

4.4. The ICCP System is to be designed to suppress the corrosion by imposition of external current. This regulated DC current within the specified tolerances has to be provided by the Auto Control Unit of the ICCP system to anodes mounted on the hull. The electronic circuitry is to be designed to produce smooth low level ripple output voltage by using standard filter circuit and to maintain the predetermined and preferred reference within the tolerances. The system design should offer less than 0.03% ripple peak to peak. The control unit shall be designed to meet input / output supply characteristics and duty cycle. The design is to cater for the most adverse environmental and electrical conditions.

4.5. The reference electrode/anodes with the cofferdam housing should be located in easily accessible location for maintenance. Locating the cofferdams inside the tanks is not permitted.

4.6. **Anode, Reference Electrodes and Dielectric Shield.** Anodes of requisite amperage capacity (as applicable) capable of functioning satisfactorily in marine/ river/ estuary waters and reference electrodes are to be used. The anodes are to be sited clear of the SONAR and EM log (as applicable) by at least by 9 meters). The electrode and anode should have a low electrical

noise level. The dielectric shields are to be designed to protect the area of the hull near the anodes and this area is to be calculated. A service life of at least 15 years for the reference electrode and anode is to be guaranteed. Specification for anodes and Reference Electrodes are to be provided for evaluation.

4.7. In case of malfunction, the anodes and reference electrodes and other underwater components are to be replaceable by divers, without need for drydocking.

4.8. The design shall cater to losses, if any, in cabling and ensure that the maximum rated current is available to the anode.

4.9. The system is to be designed for the following seaway and environmental conditions:-

4.9.1 **Seaway Conditions.** The system shall be capable of efficient and unrestricted operation without any deviation from its normal operating parameters under the following seaway conditions:

- (a) Roll : max $\pm 30^\circ$
- (b) Pitch : max $\pm 7^\circ$

Note: The exact limit or roll/pitch and the corresponding time period will differ from ship to ship, the supplier to obtain these values from IHQ on receipt of TE.

4.9.2 **Static Tilt.**

4.9.3 The system should operate at design performance with a tilt of 20° in any direction.

4.9.4 Survive, without leakage of fluids or other degradation, a permanent tilt of 30° in any direction and be capable of design performance when conditions return to the condition mentioned at 3.2.1.1 or normal.

4.10 **Environmental Conditions.** The complete system offered shall achieve specified output and function smoothly under tropical conditions. It shall withstand air contamination through oil, salt and other contaminants associated with the marine environment. The equipment shall operate under the following environmental conditions:

CONDITION	NORMAL	CLOSED DOWN
Temperature Ambient air Engine room Sea water	5 to 45°C upto 55°C 2 to 35°C	Upto 55°C
Relative Humidity at 38°C	Upto 100%	Up to 100%
Time	Continuous	Up to 48 hrs.

5. **COMPUTER MODELING/ANALYSIS FOR DESIGN OF THE ICCP SYSTEM**

5.1 The aim of computer modeling in general is to describe the physical system using mathematics and to extract meaningful information about the system. Computer modeling shall be undertaken using proven software. The software used by the OEM for computer modelling is required to be indicated. A typical software generated data may be forwarded for better evaluation of the system.

6. ICCP AUTO CONTROL UNIT

6.1 **Functional Requirements of ICCP Auto Control Unit.** The Control Unit should be capable of operation both in Auto mode as well as in Manual mode of operation. The desired mode to be selectable by using a Selector Switch. SMPS based power supplies with EMI/EMC control to be used. Anodized metallic circuit diagram is to be provided in the panel. Mechanical locking arrangement is to be provided in the control panel when the front door is to be kept in the open condition. Only MIL grade components/ PCB's are to be used in the control panel. However in case of non-availability and difficulty in sourcing the components, industrial and commercial grade may be used.

6.1.1 **Auto Mode Operation.** The auto-mode of operation should regulate the hull potential by automatic variation in the DC output, so that the hull potential is always maintained at the desired level of protection. The ICCP system should be based on microcontroller having programming logic for ACU and a spare controller card (as OBS, *if the PLC itself contains the controller card then the complete PLC is to be supplied as OBS*) which could be replaced with minimum time duration, in case of controller failure. Manual override provision should be provided to take control of the ICCP system. The PLC logic should be such that it receives all RE signals and feeds appropriate currents to the different anodes to ensure that the RE's are controlled within $\pm 10\text{mV}$ of their set or target potential with minimal oscillations. The PLC should also sense and report RE errors and have in built logic for ignoring defective REs and still ensuring current feed. The firm should submit the programmable logic to IHQ-MoD(N) for approval. The system should have an inbuilt power supply unit, catering to all secondary supplies required for system operation.

6.1.2 **Manual.** Provision of display of all relevant parameters like current, voltage, hull potential etc are to be provided and the current feed to each anode should be manually controllable.

6.1.3 Following Controls are to be provided and the same can be provided as soft switches:-

- (a) Auto/Manual/Standby Selection Switch
- (b) Ability to set target potentials for each RE
- (c) In manual mode ability to feed current to each anode individually

6.1.4 These controllers are to be provided on the top front side of the control unit for easy operation. A Perspex / glass door is to be provided to gain access to the controls. The control section must house the following meters and indications, which can be read without opening the front door.

6.1.5 **Meters.** Accuracy class of meters is to be mentioned Class-I meters of reputed make are only to be used for AC input voltage. Latest calibration certificates are to be provided with the equipment. The following digital displays are to be available and the least count of all meters shall be in consonance with the readings of the system or provided as part of the LCD display of Micro Controller:

- (a) AC Input voltage
- (b) DC Output voltage for each anode
- (c) DC Output current for each anode
- (d) Reference electrode reading for each RE

6.1.6 **Indications.** The following indications are to be provided by lamps;

- (a) Input supply "ON"/ Output supply "ON".
- (b) **Auto/ Manual LED (L1)**. This is a dual colour LED, which glows green when the control unit is in manual mode and red when it is in auto mode.
- (c) **Over Temperature LED (L2)**. This LED glows when the temperature inside the cabinet exceeds 65°C.
- (d) **Over Current LED (L3)**. This LED glows when the total output DC current in the module exceeds the set limits for any reason.
- (e) **Electrical Protection**. The controller is also to be protected by fuses in the input as well as output, in addition to the circuit breaker.
- (f) **Thermal Protection**. Inside the cabinet of the control unit at least two fans to be provided for cooling. The fans should operate automatically when temperature goes above 45°C and turn off when temperature goes below 35°C.

6.1.7 **Ripple Content**. System shall be tested and proved at the factory to check the ripple. The specific features of the design to meet this requirement must be clearly stated with the proposed method. The ACU must be designed to ensure constant monitoring of the ripple content and have the feature of a sound and visual alarm to indicate ripple content beyond the limiting value. The operator must have the choice (in case the ripple content is beyond limits) to shut down the system or overrule the alarm with a system warning.

6.1.8 **Computerized Data Logging of Hull Potentials**. The PLC/microprocessor based ACU should be interfaced with computer through user friendly software for data collection of individual anode current and voltage and individual RE readings at user-defined frequency for online data monitoring, logging file storage and recall facility. An industrial monitor should be installed on the ACU so that the ICCP data can be read on the ACU. Also provision should be made to access all the ICCP data with external PC/Laptop in case the monitor on the ACU is malfunctioning. Colour printer is to be provided to print out the data.

6.1.9 **Interfacing with Ship's IPMS**. Facilities should be provided in the control panel for Interfacing with Ship's IPMS (if fitted). The following should be catered for in the ICCP system for interfacing with IPMS:

- (a) Indication of hull potential reading.
- (b) Indication of preset potential.
- (c) Malfunctions of the ICCP system as indicated at ACU should be made available at IPMS in audio-visual mode as one common alarm.

6.1.10 This information should be transmitted to IPMS through standard communication links. Details of protocol is to be finalized by the supplier on interaction with Indian Navy/ nominated IPMS vendor

6.2 **Technical Specifications of ICCP Auto Control Unit**

Mode of control	Microprocessor Logic controlled system. The system can be set to manual and auto of operation.
Output Voltage of each power supply unit	0-10V
Sensitivity	The microprocessor control should ensure that in auto-mode the potential reading of each reference electrode is within $\pm 10\text{mV}$ of the set potential
Type of Mounting	Bulkhead and deck mounted
Current limit setting	10% greater than the maximum rated current
Control range of impressed current	0 to maximum rated current
Limiting Overall Dimension	To be kept minimum
Limiting Weight	To be kept minimum
Ripple content of voltage	Less than 0.03% (peak to peak) of rated output voltage
Supply Voltage of the Ships	To be specified by the tendering agency.

7 **CONSTRUCTION**

7.1 **Enclosure**

7.1.1 The cabinet of control units are to be totally enclosed front door open type construction conforming to IP 56/IP 54 Protection. It should be of SS material of minimum 14 SWG thicknesses conforming to AISI-316. Door should be provided with locking arrangements. Shock mounts/ vibration isolators are to be supplied along with units.

7.1.2 Passing of all incoming and outgoing cables should be from the bottom only. On the front side there should be at least three tallies made of either of aluminum anodized plate or of brass plate affixed showing following details:

- (a) Brief operating instructions.

- (b) Manufacturers name
- (c) Danger warning

7.1.3 Anodized metallic circuit diagram of system to be affixed in the rear side of door.

7.2 **Insulation**. Class F or higher.

7.3 **Enclosure Protection**. Enclosure protection to be defined as per IP 54 for the ACU and IP 56 for ASG control unit

7.4 **Equipment Internal Wiring**. LFH (Limited Fire Hazard) cables are to be used for internal wiring except for certain internal wiring like communication cables, flat wires, computer cables where LFH cables may not be available.

7.5 **Cable Entry Glands**. Cable entry glands of mild steel for body and naval brass for nut and their sizes shall conform for incoming and outgoing cables. The details of cables/gland size are to be obtained from shipyard/dockyard. Cable glands to be fitted on removable gland plate and the cable entry glands are not to be predrilled.

7.6 **Mounting**. The control unit shall be suitable for bulkhead and deck mounting for the ICCP system. The shock mounts are to be supplied along with equipment. The equipment must be provided with suitable lifting arrangements.

7.7 **Cabling**. Adequate space is to be provided inside control unit for bunching, bending & termination of incoming cables.

7.8 **Painting**. Powder Coating, Paint Scheme as per IS 5, colour code 632. SS Panels need not be painted.

7.9 **Earthing**. Earthing and Bonding is to be undertaken as per standard practices. An external earthing terminal is to be provided at both sides of the item.

7.10 **EMI/EMC**. The control unit shall be designed to conform to EMI/EMC Standard MIL-STD-461E/F or its latest version.

7.11 **Shock Mounts**. The shock mounts are to be supplied along with control panel.

7.12 **Vibration**. The design of the control unit should withstand structural borne and propeller induced vibrations and its own vibration levels are to be specified in the technical offer.

7.13 **Spares**. The On Board spares (OBS), Base & Depot (B&D) spares and test equipment are to be recommended by the supplier. Such recommendations are to be commensurate with the reliability of critical components and component use in the system. Special tools and test equipment are to be supplied for on board maintenance.

7.14 **On Board Spares**. An itemized list of OBS, special tool and special test equipment, which shall be supplied with the main equipment are to be furnished. The OBS are to cater for all on-board maintenance routines and possible repair requirements. The OBS should include the following:

7.14.1 All spares required for exploitation upto 2 years.

7.14.2 One set of general-purpose maintenance tools along with each plant.

7.14.3 One set of special tools required for disassembling/ assembling of

components for repair by replacement.

7.14.4 OBS list is to be furnished in ILMS format placed at Appendix 'A'.

7.15 **Five Year Base & Depot Spares/Comprehensive Part Lists**. Base spares recommendation is to cover maintenance/ overhaul requirements for 5 years including two refits. Itemized cost of B&D spares are to be forwarded with the main offer.

8 **Warranty**. The system with its associated components and controls/instrumentation is to be guaranteed for stipulated performance for 2 years after commissioning of the system onboard the ship.