Marine Plant Systems Pty Ltd

Business Case for the Procurement and Installation of an Impressed Current Cathodic Protection System On-Board a Naval Vessel

1. Executive Summary:

This business case presents a compelling justification for the procurement and installation of an impressed current cathodic protection (ICCP) system on-board a naval vessel. The persistent challenge of corrosion in marine environments necessitates a robust and reliable solution to safeguard the vessel's structural integrity and operational capability. This analysis highlights the significant benefits of implementing a high-quality ICCP system, including an extended hull lifespan, substantial reductions in maintenance costs, enhanced safety for personnel and the vessel, and improved operational efficiency through reduced hull drag. While acknowledging the initial investment, this report demonstrates the long-term financial viability and strategic advantages of ICCP over alternative corrosion protection methods. The recommended course of action involves selecting an ICCP manufacturer with a proven track record in the naval sector, specifically those with references including the Royal Australian Navy. Emphasis will be placed on equipment quality and safety, the availability of comprehensive after-sales support within Australia, thorough crew training programs, and the necessity of annual equipment inspections by the original equipment manufacturer or their certified Australian representatives to ensure sustained optimal performance. The failure to implement such a system carries considerable risks, including accelerated corrosion, increased operational expenditure, and potential safety compromises, all of which underscore the urgency and importance of this investment.

2. Introduction and Background:

2.1. The Problem of Corrosion in Marine Environments:

The operational environment of naval vessels presents a formidable challenge in the form of corrosion. Seawater, acting as a highly conductive electrolyte, facilitates electrochemical reactions that degrade metallic structures. This process, driven by differences in electrical potential between various metals or even different areas on the same metal, leads to the gradual deterioration of the vessel's hull and critical underwater components. The corrosivity of seawater is amplified by several factors inherent to the marine environment, including variations in temperature, the concentration of dissolved oxygen, the velocity of water flow against the hull, the presence of corrosive contaminants, and the overall conductivity of the water. This relentless attack by corrosion can result in significant structural weakening, necessitating extensive and costly repairs, increasing hull drag and consequently fuel consumption, and potentially compromising the safety of the vessel and its crew. Therefore, effective corrosion

Perth 3/11 Blackly Row 6164 +61 8 9410 0144
Sydney L57 25 Martin Place 2000 +61 2 9238 2032
sales@marineplantsystems.com | ABN 61 078 997 449 | CAGE CODE ZAC53

prevention is paramount for maintaining the operational readiness and extending the service life of any naval asset.

2.2. Impressed Current Cathodic Protection (ICCP) Systems:

To combat the pervasive threat of corrosion, impressed current cathodic protection (ICCP) systems offer a state-of-the-art solution. Unlike passive methods such as sacrificial anodes, ICCP employs an active approach, utilising an external direct current (DC) power source to mitigate corrosion. The fundamental principle behind ICCP is to apply a controlled amount of DC current to the submerged surfaces of the vessel, effectively forcing an electrochemical reaction that alters any corrosive tendencies. This impressed current ensures that the entire hull surface becomes cathodic, thereby suppressing the anodic reactions that lead to the dissolution of metal and subsequent corrosion. In contrast to sacrificial anode cathodic protection (SACP) systems, which rely on the galvanic corrosion of a more active metal to protect the hull, ICCP offers a more powerful and precisely controlled method of corrosion prevention, particularly advantageous for larger and more complex naval vessels requiring long-term protection.

3. Reasons for the Project:

3.1. Necessity for Enhanced Corrosion Protection:

The current corrosion protection measures in place on the vessel are either approaching the end of their effective lifespan or are proving inadequate to address the long-term threat of corrosion in the demanding operational profile of a naval vessel. This necessitates the adoption of a more robust and enduring solution to minimise the continuous degradation of the hull and associated underwater structures. Implementing an advanced ICCP system represents a proactive investment in extending the vessel's operational lifespan, ensuring its continued availability for critical naval missions. This forward-thinking approach to asset management will contribute significantly to the long-term sustainability and effectiveness of the naval fleet.

3.2. Alignment with Naval Standards and Best Practices:

Impressed current cathodic protection systems are widely recognised within the naval sector as a superior alternative to traditional sacrificial anode systems, especially for larger vessels that require sustained and adaptable corrosion protection. The ability of ICCP systems to provide a controlled and monitored level of protection aligns with the stringent performance requirements of naval assets. Furthermore, the implementation of an ICCP system may facilitate compliance with specific naval engineering standards, such as NES 704, which outlines requirements for cathodic protection systems. Adhering to such established standards and embracing best practices in corrosion prevention underscores the commitment to maintaining a high level of operational readiness and safety within the naval fleet.

3.3. Addressing Potential Risks of Inadequate Protection:

The failure to implement a robust ICCP system on-board the vessel exposes it to a multitude of significant risks associated with unchecked corrosion. These risks include the potential for accelerated structural weakening of the hull, which can compromise the vessel's seaworthiness and safety. Increased hull roughness due to corrosion can lead to greater drag, resulting in higher fuel consumption and reduced operational efficiency.

Furthermore, critical underwater components and systems may be susceptible to corrosion-related failures, potentially impacting mission capabilities and necessitating unscheduled and costly repairs. Addressing these potential risks through the implementation of a high-quality ICCP system is a crucial step in safeguarding the vessel's long-term operational effectiveness and minimising unforeseen expenditures.

4. Business Options:

4.1. Option 1: Do Nothing (Continue with existing corrosion protection measures):

The "do nothing" option entails continuing with the current corrosion protection methods already in place on the vessel. However, given the limitations and potential obsolescence of these existing measures, this approach carries significant risks. The ongoing process of corrosion will inevitably lead to increased maintenance costs as repairs become more frequent and extensive. The vessel's operational lifespan will likely be reduced due to the cumulative effects of corrosion on its structural integrity. Moreover, the potential for structural failures or system malfunctions due to corrosion poses a direct threat to the safety of the vessel and its crew. Therefore, while this option avoids immediate capital expenditure, it presents a high-risk scenario with potentially substantial long-term costs and safety implications.

4.2. Option 2: Implement a Sacrificial Anode Cathodic Protection (SACP) System:

Implementing a sacrificial anode cathodic protection (SACP) system involves attaching anodes made of a more electrochemically active metal (such as zinc or aluminum) to the vessel's hull. These anodes corrode preferentially, thus protecting the hull. SACP systems offer the advantages of simpler installation and not requiring an external power source. However, they also have notable disadvantages. Sacrificial anodes have a limited lifespan, typically requiring replacement every 3 to 5 years, leading to increased maintenance and dry docking costs over the vessel's life. The presence of these anodes can also increase hull resistance, potentially impacting fuel efficiency. Furthermore, it is often difficult to accurately monitor the effectiveness of an SACP system, and it may not provide the level of protection required for larger naval vessels with complex hull designs and demanding operational profiles requiring long-term corrosion prevention.

4.3. Option 3: Implement an Impressed Current Cathodic Protection (ICCP) System (Recommended):

The recommended option is to implement a high-quality impressed current cathodic protection (ICCP) system. As previously described, ICCP systems utilise an external power source to apply a controlled DC current, providing a robust and adaptable method of corrosion prevention. The advantages of ICCP are numerous. These systems offer long-term protection, with a potential lifespan exceeding 20 years, significantly reducing the frequency of major interventions. The automated and adjustable current output ensures optimal protection levels are maintained, even as seawater resistivity or hull coating conditions change. A smoother hull surface, often maintained with ICCP, can lead to reduced hull resistance and improved fuel efficiency. ICCP systems also provide real-time monitoring capabilities, allowing for proactive management and ensuring continuous effectiveness. Moreover, ICCP is particularly well-suited for the corrosion protection needs of large and complex naval vessels. While there are potential dis-benefits associated with ICCP, as will be discussed later, the overall advantages make it the most suitable option for this requirement.

4.4. Comparative Analysis of Options:

The following table provides a comparative overview of the three corrosion protection options based on key criteria:

Criteria	Option 1: Do Nothing	Option 2: SACP	Option 3: ICCP
Initial Cost	Low	Medium	High
Lifespan	Limited	Short (3-5 years)	Long (20+ years)
Maintenance	Increasing	Medium (frequent replacement)	Low
Effectiveness	Low	Medium	High
Monitoring Capability	None	Limited	High
Naval Suitability	Low	Medium	High
Overall Risk	High	Medium	Low

This comparison clearly indicates that while Option 1 has the lowest initial cost, it carries the highest long-term risks and lowest effectiveness. Option 2 offers a moderate solution but falls short in lifespan and monitoring capabilities, making it less ideal for a large naval vessel. Option 3, despite a higher initial investment, provides the most comprehensive and long-term solution with high effectiveness and monitoring capabilities, making it the most suitable choice for ensuring the vessel's longevity and operational readiness.

5. Expected Benefits:

5.1. Extended Hull Lifespan:

The implementation of an ICCP system is projected to significantly extend the operational life of the vessel's hull. By actively preventing corrosion, the rate of hull degradation will be substantially reduced, potentially adding decades to the vessel's service life. This extended lifespan translates directly into a greater return on the initial investment in the vessel itself and can defer the need for costly hull replacement or major structural repairs. Furthermore, the consistent protection offered by ICCP can contribute to longer intervals between scheduled drydockings, minimising vessel downtime and maximising its availability for operational duties.

5.2. Reduced Maintenance Costs:

A primary benefit of utilising an ICCP system is the significant reduction in maintenance costs associated with hull corrosion. By proactively preventing corrosion, the need for frequent and extensive hull repairs, such as welding corroded sections or replacing large areas of plating, will be minimised. The extended dry dock intervals resulting from effective corrosion prevention also contribute to substantial cost savings, as dry docking is a significant expenditure in vessel maintenance budgets. The automated nature of ICCP systems generally requires less routine maintenance compared to constantly monitoring and replacing sacrificial anodes, further contributing to reduced operational expenses.

5.3. Improved Operational Efficiency:

Maintaining a smooth, corrosion-free hull surface through the use of an ICCP system can lead to notable improvements in the vessel's operational efficiency. Corrosion and the accumulation of marine growth on a hull create increased drag as the vessel moves through the water. By preventing corrosion and minimising marine growth, ICCP helps to maintain a smoother hull profile, reducing frictional resistance. This reduction in drag translates directly into improved fuel efficiency, allowing the vessel to travel the same distance on less fuel, resulting in significant cost savings over time and a reduced environmental footprint. In some cases, the reduced drag may also allow the vessel to achieve slightly higher speeds with the same power output.

5.4. Enhanced Safety:

The prevention of structural weakening caused by corrosion is a critical safety benefit of implementing an ICCP system. Corrosion can compromise the integrity of the vessel's hull, potentially leading to breaches or structural failures, especially under the stresses of naval operations. By actively mitigating corrosion, ICCP ensures that the hull maintains its designed strength and integrity, enhancing the safety of both the vessel and the personnel on board. Reducing the risk of corrosion-related system failures in critical areas further contributes to a safer operational environment.

5.5. Increased Life of Underwater Fittings:

Beyond the hull itself, an ICCP system also provides protection to other vital underwater fittings and components, such as rudders, propeller shafts, struts, and propellers. These components are often made of different metals, making them susceptible to galvanic corrosion. By controlling the electrochemical environment around these fittings, ICCP extends their operational lifespan, reducing the frequency of their replacement and the associated costs. This contributes to the overall reliability and longevity of the vessel's propulsion and manoeuvring systems.

6. Expected Dis-benefits:

6.1. Initial Investment Cost:

The procurement and installation of a comprehensive ICCP system typically involve a higher initial capital outlay compared to implementing a sacrificial anode system or continuing with potentially inadequate existing measures. This upfront investment includes the cost of the control panel, anodes, reference electrodes, cabling, and the labor required for installation and commissioning. While this represents a significant expenditure at the outset, it is important to consider this cost in the context of the long-term benefits and savings that the ICCP system will provide over the vessel's operational life.

6.2. Power Dependency:

ICCP systems rely on a continuous supply of electrical power to function effectively. Any disruption to the vessel's power supply could temporarily compromise the corrosion protection offered by the system. However, naval vessels are typically equipped with robust and redundant power generation systems to ensure continuous operation of critical equipment. Furthermore, modern ICCP control panels often incorporate features to manage temporary power fluctuations and provide alerts in case of prolonged outages.

6.3. Potential for Overprotection:

If an ICCP system is not properly designed, installed, and controlled, there is a potential risk of overprotection. Applying excessive cathodic current can lead to undesirable effects such as hydrogen embrittlement in high-strength steels, which can weaken the material, or the detachment of protective coatings from the hull surface. To mitigate this risk, it is crucial to select a reputable manufacturer with experience in designing ICCP systems for naval vessels and to ensure that the system incorporates sophisticated control mechanisms and is operated by trained personnel.

6.4. Complexity Compared to SACP:

ICCP systems are generally more complex in their design, installation, and operation compared to simpler sacrificial anode systems. They involve electronic control panels, a network of anodes and reference electrodes, and require a degree of technical understanding for proper operation and maintenance. However, this complexity is often offset by the enhanced level of protection, monitoring capabilities, and long-term effectiveness that ICCP provides. Furthermore, comprehensive training programs provided by the manufacturer can equip the vessel's crew with the necessary knowledge and skills to manage the system effectively.

7. Financial Appraisal:

A comprehensive financial appraisal is essential to fully understand the economic implications of implementing an ICCP system. This appraisal will consider various cost factors and potential savings over the expected lifespan of the vessel with the ICCP system installed.

- 7.1. Procurement Costs: These costs will include the acquisition of the ICCP system itself, encompassing the control panel, anodes, reference electrodes, cabling, and any associated software or monitoring equipment. The selection of a manufacturer with naval experience and Royal Australian Navy references, while potentially influencing the initial cost, is crucial for long-term reliability and support.
- 7.2. Installation Costs: The installation of the ICCP system will likely occur during a scheduled dry docking period to minimise disruption to the vessel's operational schedule. Costs will include labor for fitting the anodes and reference electrodes to the hull, running and connecting the necessary cabling, and integrating the control panel into the vessel's electrical system.
- 7.3. Crew Training Costs: To ensure the effective operation and basic maintenance of the ICCP system, comprehensive training will be required for the vessel's crew.

These costs will cover the provision of training programs by the manufacturer or their representatives, potentially including on-site instruction and documentation.

- 7.4. Annual Inspection Costs: The requirement for annual inspections by the original equipment manufacturer or their Australian representatives will incur ongoing costs. These inspections are vital for verifying the system's continued performance and ensuring its longevity.
- 7.5. Operational Costs: The primary operational cost associated with the ICCP system is its power consumption. While typically a relatively small amount, this ongoing expense needs to be factored into the overall financial assessment. Potential costs for minor spare parts and consumables may also arise over the system's lifespan.
- 7.6. Cost Savings: The implementation of an ICCP system is expected to generate significant cost savings over the vessel's operational life. The extended hull lifespan will avoid or defer the substantial costs associated with major hull repairs or replacement. Reduced routine maintenance and less frequent dry docking for hull work will lead to considerable savings in maintenance budgets. The anticipated improvement in fuel efficiency due to a smoother hull will also contribute to significant operational cost reductions. Furthermore, avoiding corrosion-related failures in critical systems can prevent costly unscheduled repairs and potential mission disruptions.
- 7.7. Return on Investment (ROI) Analysis: A detailed ROI analysis will be conducted by comparing the total costs associated with procuring, installing, operating, and maintaining the ICCP system over its expected lifespan against the total savings generated from extended hull life, reduced maintenance, and improved fuel efficiency. This analysis will provide a clear indication of the financial benefits of this investment.
- 7.8. Net Present Value (NPV) Analysis: To account for the time value of money, an NPV analysis will be performed. This will involve discounting all future costs and savings back to the present value using an appropriate discount rate. A positive NPV will further demonstrate the financial viability and attractiveness of investing in the ICCP system.

The following table provides a hypothetical financial comparison of the options over a 25-year vessel lifespan:

Cost/Benefit Category	Option 1 (Do Nothing)	Option 2 (SACP)	Option 3 (ICCP)
Initial Investment	$0	$150,000	$300,000
Annual Maintenance Costs	$50,000	$30,000	$10,000
Fuel Costs (Annual)	$1,000,000	$980,000	$950,000
Major Repairs (Over 25 yrs)	$1,000,000	$500,000	$100,000
Hull Replacement (at 20 yrs)	$5,000,000	$5,000,000	$0
Total Cost (25 Years)	**$7,250,000**	**$6,400,000**	**$2,750,000**
Total Benefit (Savings)	**$0**	**$850,000**	**$4,500,000**
Net Present Value	**-$7,250,000**	**-$5,550,000**	**$1,750,000**

Note: These figures are illustrative and would need to be based on detailed quotes and projections.

This hypothetical analysis strongly suggests that while the initial investment for the ICCP system is higher, the long-term cost savings, particularly from avoiding hull replacement and reducing fuel and maintenance expenses, result in a significantly lower total cost of ownership and a positive net present value over the vessel's lifespan.

8. Risk Analysis:

8.1. Project Implementation Risks:

Several risks are associated with the implementation phase of this project. Delays in the procurement process, including the issuance of the Request for Proposal (RFP), evaluation of bids, and contract award, could potentially push back the installation schedule. Unexpected technical issues may arise during the installation process, particularly when integrating the new ICCP system with the vessel's existing infrastructure. There is also a risk of cost overruns if unforeseen complications occur during procurement or installation. Furthermore, challenges may arise in ensuring seamless integration of the ICCP system with other on-board systems. Thorough planning, engaging experienced contractors, and establishing contingency budgets are crucial mitigation strategies for these potential implementation risks.

8.2. Risks of Not Implementing a Robust ICCP System:

The risks associated with not implementing a robust ICCP system are substantial and have been previously alluded to. Accelerated corrosion of the vessel's hull and underwater components is a primary concern, potentially leading to structural damage that could compromise the vessel's integrity and safety. This accelerated corrosion will inevitably result in increased maintenance costs and a higher frequency of repairs, impacting the vessel's operational availability. The vessel's operational lifespan could be significantly reduced, necessitating earlier and more costly replacement. Increased hull roughness due to corrosion will lead to higher fuel consumption, increasing operational expenditure. Finally, the potential for structural weakening or system failures due to corrosion poses significant safety implications for the vessel and its crew.

8.3. Proposed Mitigation Strategies:

The most effective mitigation strategy for the risks associated with not implementing a robust ICCP system is, of course, to proceed with the procurement and installation of such a system. The benefits outlined in Section 5 directly address these risks by providing long-term corrosion protection, reducing maintenance needs, extending the vessel's lifespan, improving efficiency, and enhancing safety. Selecting a high-quality system from a reputable manufacturer and ensuring proper installation, crew training, and ongoing maintenance through annual inspections will further minimise any residual risks.

9. Equipment Quality and Safety:

9.1. Critical Quality Standards and Certifications:

Ensuring the quality and reliability of the ICCP system is paramount for its long-term effectiveness and the safety of the vessel. Therefore, the selected manufacturer must possess relevant quality certifications, such as ISO 9001, which demonstrates a commitment to a robust quality management system in the design, manufacturing, and service of their products. Compliance with applicable naval engineering standards, such as NES 704 or equivalent DEF STAN specifications, is also a critical requirement, ensuring that the system meets the specific demands of naval applications. Furthermore, the ICCP system should have approvals from recognised marine classification societies, indicating that it meets stringent industry standards for safety and performance. Adherence to standards like ISO (Cathodic Protection) can also provide assurance of the system's quality and safety. The procurement process should prioritise manufacturers who can provide evidence of these certifications and approvals.

9.2. Safety Considerations for ICCP Systems:

Safety is a non-negotiable aspect of any equipment installed on a naval vessel. ICCP systems, being electrical in nature, require careful consideration of electrical safety during both operation and maintenance procedures. The system should be designed with built-in safety features to prevent accidental electrical shocks to personnel. Furthermore, as mentioned earlier, the potential for overprotection needs to be addressed through proper system design and control to avoid hydrogen embrittlement or damage to hull coatings. Safe handling and disposal procedures for all components of the ICCP system, including anodes and any chemical elements within reference electrodes, must also be established and followed to minimise any environmental or health risks. Comprehensive crew training will play a vital role in ensuring that personnel are fully aware of all safety procedures related to the ICCP system.

10. Manufacturer Assessment:

10.1. Identification of Potential ICCP Manufacturers:

Based on the research conducted, several manufacturers have a significant presence in the marine ICCP market and possess experience in supplying to naval clients. These include:

- Cathelco (now part of Evac): Provides ICCP hull corrosion protection systems designed for various vessel types, including naval vessels, and has supplied systems to over 40 navies globally.

10.2. Emphasis on Naval References, Including the Royal Australian Navy:

A critical requirement for this procurement is the manufacturer's proven track record in the naval sector, with a specific emphasis on references including the Royal Australian Navy. While the makers offer general naval references for some manufacturers (over 40 navies for Cathelco), direct evidence of supplying to the Royal Australian Navy is limited within this material. Further investigation will be necessary during the procurement phase to specifically verify which of these manufacturers, or others, have supplied ICCP systems to the Royal Australian Navy. This verification process should involve direct inquiries to the manufacturers and potentially to the Royal Australian Navy procurement authorities. Demonstrable experience with the RAN will be a significant factor in the manufacturer selection process, indicating familiarity with their specific requirements and standards.

10.3. Evaluation Criteria for Manufacturers:

The selection of the ICCP manufacturer will be based on a comprehensive evaluation of several key criteria:

- Proven Experience in Supplying to Naval Clients: Demonstrated history of providing ICCP systems to naval forces, with preference given to those with Royal Australian Navy references.
- Evidence of High-Quality and Reliable ICCP Systems: Track record of producing durable and effective ICCP systems suitable for the demanding marine environment of naval vessels.
- Availability of After-Sales Support in Australia: Established presence or partnerships in Australia to provide timely and effective technical assistance, spare parts, and repair services.
- Comprehensive Crew Training Programs: Ability to offer thorough training programs for the vessel's crew on the operation, maintenance, and safety aspects of the ICCP system.
- Capability to Conduct Annual Inspections in Australia: Capacity to perform annual equipment inspections by the original equipment manufacturer or their certified Australian representatives.
- Compliance with Relevant Quality and Safety Standards: Possession of necessary certifications (e.g., ISO 9001) and adherence to relevant naval and marine industry standards.

11. After-Sales Support and Crew Training:

11.1. Requirements for After-Sales Support in Australia:

Robust after-sales support within Australia is essential to ensure the long-term reliability and effectiveness of the ICCP system and to minimise potential downtime. Key requirements for after-sales support include:

- Availability of Local Technical Assistance and Troubleshooting: Access to qualified technicians based in Australia who can provide prompt assistance with any operational issues, troubleshooting, and remote or on-site support.
- Warranty Terms and Conditions: Clear and comprehensive warranty coverage for the ICCP system and its components, with reasonable terms and efficient processing of claims.
- Spare Parts Availability and Delivery Times within Australia: Assurance of readily available spare parts within Australia and efficient logistics for their timely delivery to minimise any disruption in the system's operation.
- Repair and Maintenance Services Offered Locally: Access to authorised repair and maintenance facilities or technicians within Australia capable of performing necessary servicing and repairs on the ICCP system.

11.2. Necessary Crew Training Programs:

Comprehensive training programs for the vessel's crew are crucial for the safe and effective operation and basic maintenance of the ICCP system. These programs should cover:

- Operation of the ICCP Control Panel and Monitoring Systems: Detailed instruction on how to operate the control panel, interpret monitoring data, and understand the system's various settings and indicators.
- Basic Maintenance Procedures: Training on routine maintenance tasks that can be safely and effectively performed by the crew, such as visual inspections and basic troubleshooting.
- Safety Procedures Related to the ICCP System: Thorough instruction on all safety precautions associated with the ICCP system, including electrical safety protocols and procedures to prevent overprotection.
- Troubleshooting Common Issues and Understanding Alarm Indicators: Guidance on identifying and addressing common operational issues, as well as understanding the meaning of different alarm signals and the appropriate response.

12. Annual Equipment Inspections:

12.1. Necessity and Scope of Annual Inspections:

Annual inspections of the ICCP system by qualified personnel are vital to verify its continued effectiveness and ensure optimal performance over its lifespan. These regular inspections should encompass a thorough examination of all critical components, including the anodes, reference electrodes, control panel, and cabling, to identify any signs of wear, damage, or malfunction. The scope of the inspection should also include the measurement of the vessel's hull potential to confirm that the ICCP system is providing adequate cathodic protection levels and adjusting the system's output as necessary to maintain optimal performance.

12.2. Benefits of OEM or Certified Australian Representatives:

Engaging the original equipment manufacturer or their certified Australian representatives to conduct these annual inspections offers several key benefits. These entities possess specialised knowledge and expertise specific to their ICCP systems, ensuring a more thorough and accurate assessment of the system's condition. They also have access to proprietary diagnostic tools and software that may not be available to third-party service providers. Utilising the OEM or their certified representatives ensures that the inspections are conducted to the highest standards, potentially leading to the early detection of any potential issues and allowing for preventative maintenance to be performed, thus maximising the system's reliability and longevity.

12.3. Potential Regulatory Requirements:

Further investigation is required to determine if any specific naval regulations or rules from relevant marine classification societies mandate annual inspections of ICCP systems on naval vessels. If such regulatory requirements exist, they must be strictly adhered to, and the selected ICCP system and manufacturer must be capable of meeting these obligations. Compliance with mandatory inspection regimes is crucial for maintaining the vessel's operational certifications and ensuring adherence to safety standards.

13. Timescales and Implementation Plan:

The implementation of the ICCP system will involve several key stages:

1. Procurement Process: This will include the development of a detailed specification, issuing an RFP to potential manufacturers, evaluating the received bids based on the criteria outlined in Section 10.3, and awarding the contract to the selected manufacturer. This stage is estimated to take approximately 3-6 months.
2. System Design and Engineering: Once the contract is awarded, the manufacturer will undertake the detailed design and engineering of the ICCP system tailored to the specific vessel. This phase is expected to take 2-4 months.
3. Manufacturing and Delivery: Following the design phase, the manufacturer will proceed with the fabrication and assembly of the ICCP system components. The manufacturing and delivery timeline is estimated to be 4-8 months, depending on the complexity and lead times for specific components.
4. Installation: The installation of the ICCP system will ideally be scheduled to coincide with a planned dry docking period to minimise disruption to the vessel's operational schedule. The installation process, including hull preparation, fitting anodes and reference electrodes, and cable routing and connections, is estimated to take 2-4 weeks.
5. Crew Training and System Commissioning: Following the physical installation, the manufacturer's representatives will conduct comprehensive training for the vessel's crew on the operation, maintenance, and safety procedures for the new ICCP

system. This will be followed by the commissioning of the system to ensure it is functioning correctly. This stage is expected to take 1-2 weeks.

6. Ongoing Monitoring and Annual Inspections: After commissioning, the vessel's crew will be responsible for the day-to-day monitoring of the ICCP system's performance. Annual inspections by the OEM or their certified Australian representatives will be scheduled to ensure the system's continued effectiveness over its operational life.

These timescales are estimates and may vary depending on the specific manufacturer selected and the complexity of the installation on the vessel. A detailed project plan with firm timelines will be developed once a manufacturer has been selected and a contract awarded.

14. Recommendations:

Based on the analysis presented in this business case, it is strongly recommended that the procurement and installation of a high-quality impressed current cathodic protection (ICCP) system on-board the naval vessel be approved. The evidence overwhelmingly supports the long-term benefits of ICCP in mitigating corrosion, extending the vessel's lifespan, reducing maintenance costs, improving operational efficiency, and enhancing safety.

It is further recommended that the selection of the ICCP manufacturer prioritise those with a proven track record in the naval sector, with a specific emphasis on references including the Royal Australian Navy. The evaluation process should focus on equipment quality and safety standards, the availability of comprehensive after-sales support within Australia, the provision of thorough crew training programs, and the capability to conduct annual equipment inspections by the original equipment manufacturer or their certified Australian representatives.

The financial appraisal indicates that while the initial investment in an ICCP system is higher than alternative options, the long-term cost savings and benefits significantly outweigh this initial expenditure, resulting in a positive return on investment and a lower total cost of ownership over the vessel's lifespan. The risks associated with not implementing a robust ICCP system, including accelerated corrosion, increased maintenance, reduced lifespan, and potential safety compromises, underscore the urgency and importance of this investment.

15. Conclusion:

The procurement and installation of a high-quality ICCP system represents a strategic and financially sound investment in the long-term health and operational capability of the naval vessel. By proactively addressing the persistent threat of corrosion, this project will ensure the vessel's structural integrity, enhance its safety, improve its efficiency, and ultimately contribute to the overall effectiveness of the naval fleet. The emphasis on selecting a manufacturer with proven naval experience, particularly with the Royal Australian Navy, and ensuring robust after-sales support, comprehensive training, and regular inspections will maximise the benefits and minimise the risks associated with this critical investment. The potential negative consequences of failing to implement an effective corrosion protection system further reinforce the necessity of proceeding with the recommendations outlined in this business case.