UH ENERGY RESEARCH REPORT

Repurposing Offshore Infrastructure for Clean Energy – Technical Considerations

Authored by ROICE-PIF Workgroups:

- **TC-1 Decommissioning and Reuse**
- **TC-2 Recertification**

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About the Authors

This paper is published as part of the Repurposing Offshore Infrastructure for Clean Energy (ROICE) program led by UH Energy, a multi-disciplinary research entity at the University of Houston. The ROICE program is an industry-government-public-academia program and is advised by individual experts from the over 40 organizations that form the ROICE Project Collaborative (RPC). Several members of the RPC volunteered to serve on one or more of six workgroups that were charged with conducting the research and contributing their expertise to put together a series of papers that will form the ROICE project implementation framework (PIF). This paper was developed by ROICE technical considerations workgroups: TC-1 Decommissioning and Reuse, and TC-2 Recertification. The members of the two workgroups are:

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The authors have written this paper in good faith to provide guidance on the technical considerations for repurposing offshore oil and gas infrastructure for clean energy use. However, the authors and contributors are not liable for any errors or omissions in the guidance or from the consequences of following it.

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Abbreviations

ABS	American Bureau of Shipping
AIM	Asset Integrity Management
API	American Petroleum Institute
ARO	Asset Retirement Obligation
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CCUS	Carbon Dioxide Capture, Utilization, and Storage
CP	Cathodic Protection
CVA	Certified Verification Agent
EPA	U.S. Environmental Protection Agency
FEA	Finite Element Analysis
FFP	Fitness For Purpose
GoM	Gulf of Mexico
HSE	Health, Safety, and Environment
LE	Life Extension
NDE	Non-Destructive Examination
PIF	Project Implementation Framework
ROICE	Repurposing of Offshore Infrastructure for Clean Energy
RP	Recommended Practice
RUE	Right-of-use and Easement
SCF	Stress Concentration Factors
SIM	Structural Integrity Management
TE	Techno-Economic
UH	University of Houston
U.S.	United States

Executive Summary

Repurposing Offshore Infrastructure for Clean Energy (ROICE) is an industry-government-public-academia program formed in February 2022 in the United States (US). Among other deliverables, it is developing a project implementation framework for repurposing a portion of the 1,500 offshore oil and gas platforms in the Gulf of Mexico (GoM) for non-fossil-fuel extraction or "clean" energy uses. Examples include offshore-wind-energy generation, offshore-wind-powered hydrogen generation and/or storage, and carbon dioxide (CO_2) sequestration facilities. The main advantage of repurposing is to defer some portions of – and incentivize funding for all – the decommissioning requirement of oil and gas infrastructure. It could also help to reduce the cost of new offshore clean energy schemes.

The ROICE program is led by UH Energy, a multi-disciplinary research entity at the University of Houston. It receives funding from research grants from state and federal agencies and is advised by experts from over 40 industry, academic, research, and community organizations which form the ROICE Project Collaborative (RPC).

The ROICE program has two main components, a techno-economics (ROICE-TE) analysis and a project implementation framework (ROICE-PIF). ROICE-TE is building detailed design and economic models for clean energy repurposing projects and charting a path to their profitability. ROICE-PIF is developing detailed guidance for all stakeholders of such projects. This includes regulatory compliance requirements, liability transfer pathways, financial assurance mechanisms, commercial and operational frameworks, technical certification of structures, and pre- and post-ROICE decommissioning requirements.

The program is being undertaken in phases. An initial ROICE-TE feasibility study was completed in April 2023 and demonstrated the potential profitability of repurposing for clean energy use. The first phase of ROICE-PIF – formation of the workgroups – was completed in August 2023. Deliverables from the second phase, expected to be completed by June 2024, includes publication of this PIF technical considerations paper, a companion PIF paper on regulatory considerations, along with TE design refinements and cash flow models for offshore-wind-to-hydrogen demonstration projects. Phase 3, due for completion in 2025, includes launching a commercial framework, expanding the regulatory and technical considerations, and selecting and designing a demonstration project. The aim is to have the demonstration project operating by 2032.

This paper focuses on purely technical aspects that would need to be addressed when an existing oil and gas platform in the US GoM is being considered as a candidate for repurposing for a ROICE project. The subjects covered relate to the unique decommissioning and recertification activities that differentiates ROICE from conventional oil and gas operations.

This paper demonstrates that it is technically feasible to decommission, reuse, and recertify existing and ageing oil and gas platforms for clean energy uses. It starts with guidance on selecting the right platform, with larger, 4 or more leg platforms more likely to be suitable for a ROICE project.

The next stage of the platform selection process is to validate its existing condition, with a recommended list of technical documentation provided in Appendix I.

Decomissioning that needs to be done before the start of ROICE project includes plugging and abandoning wells and removing or partially removing conductors and risers. The Bureau of Safety and Environmental Enforcement (BSEE) and the Bureau of Ocean Energy Management (BOEM) also require all oil and gas process equipment to be removed before a platform transitions to clean energy, which can be done in one of two ways.

One option is to take the topsides to shore, refit or replace it, and lift it back onto the jacket, while option 2 is to refit it in situ. A 3rd option is to leave all the redundant oil and gas equipment in place and ask BSEE for an Alternate Compliance approval.

Decommissioning a platform at the end of ROICE project is very much the same as for an oil and gas platform, but with unique aspects dependent on the specific ROICE service.

A ROICE platform will need Structural Reassessment approval from the Bureau of Safety and Environmental Enforcement (BSEE) as defined in 30 CFR 250[1] Subpart I (Platforms and Structures). At the time of writing, this CFR references the 21st edition of RP-2A-WSD[2] (as the applicable standard for the reassessment process. However, also at the time of writing, the listing of documents incorporated by reference in this CFR is in the process of being updated[3] to include the 2014 release of RP-2A-WSD (22nd edition) and the companion document RP-2MET[4] (1st edition).

A potentially significant issue for older platforms is the ability comply with the increased airgap requirements, meaning the vertical distance between mean sea level and the lowest structural deck, specified in RP-2A-WSD and RP-2MET. Some older platforms may have designs that are more robust and may be less affected by the airgap changes. For all platforms this would need to be determined on a case-by-case basis.

The recertification includes a structural reassessment, the process for together with a life extension study and a structural integrity management plan.

[1] Code of Federal Regulations Title 30, Chapter II, Subchapter B, Part 250: Oil and Gas and Sulphur Operations in The Outer Continental Shelf | [2] American Petroleum Institute: Recommended Practice 2A-WSD: Planning, Designing, and Constructing Fixed Offshore Platforms—Working Stress Design | [3] 83694 - Federal Register / Vol. 88, No. 229 / Thursday, November 30, 2023 / Proposed Rule Changes: Oil and Gas and Sulfur Operations in the Outer Continental Shelf— Documents Incorporated by Reference | [4] American National Standards Institute/American Petroleum Institute: Recommended Practice 2MET: Derivation of Metocean Design and Operating Conditions.

30 CFR 250 Subpart I (Platforms and Structures) requires that if major modifications are made to an existing fixed oil and gas platform, the operator may need to engage a certified verification agent (CVA) to review the proposed modifications to verify compliance with appropriate codes and standards. It is possible that a ROICE project would be subject to the same requirement unless the exemption requirements of 30 CFR 250.910 can be met.

Note: CFR 30 285[5] Subpart G – Facility Design, Fabrication and Installation includes similar requirements for a CVA.

Key Recommendations

The RPC recommends that stakeholders in a ROICE project focus on the following technical considerations:

- **Continuing communication with BOEM, BSEE, and API.** The rules and standards put out by three organizations have influenced the work that went into producing this paper. Continuing significant interaction with BSEE and BOEM is needed to ensure that the path followed meets with their approval and the necessary technical submissions to these authorities are well defined, noting that regulations will evolve and change with time. Ongoing dialogue with API sub-committee SC2[6] will also ensure that the ROICE program is fully aligned with its current recommended practices and any updates to or new documents that may be forthcoming.

- **Developing case studies.** Case studies should be developed to understand and quantify the feasibility, extent, and options for repurposing fixed offshore installations. The process should start with obtaining full records for a selection of platforms, even those which have already been decommissioned. After determining which are appropriate for a ROICE project for each of three clean energy use cases being considered, develop a high-level estimate of the work required and costs involved in repurposing, together with an operational safety plan.

- **Define the Design Basis and Asset Integrity Requirements.** The recertification process for ROICE projects should be based on a pre-defined design basis. A generic, encompassing design basis should therefore be developed to guide the initial evaluation of an existing platform for a ROICE application. The design basis should contain a range of potential loads for the new topsides, list of standards to be applied, and environmental criteria considerations.

- **Risk Assessments.** In phase 3 of the ROICE program, a HAZID (hazard identification qualitative risk analysis technique to identify threats in a process) or other similar "what-if" risk analysis is needed and this could be applied to one or more of the case studies. This will add a significant level of sophistication to the project and highlight aspects that are likely to depart from the norm for offshore oil and gas.

- **Investigate Compliance Options.** Current BSEE mandates are that the platform deck height must meet current API recommendations and that all oil and gas equipment (and risers and conductors) must be removed before repurposing. The techno-economic options for meeting these requirements or determining alternative compliance options should be investigated.

- **Future Considerations.**

  o New technologies such as remote inspections and new coating systems should be considered when reassessing an existing facility for a ROICE project.

  o Deepwater floating assets should be evaluated for ROICE application in a future phase of the program.

  o Electrification of offshore platforms still producing oil and gas should also be considered as a potential ROICE option.

Future ROICE-PIF papers will discuss potential new operational exposures that may arise that were not envisioned (for example unintended release of CO_2 into ocean, saline water disposal into the sea, oxygen release, and impact of seafloor cables) and ways to avoid and/or mitigate such occurrences.

[5] Code of Federal Regulations, Title 30, Part 285 – Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf

[6] API Committee on Standardization of Oilfield Equipment and Materials (CSOEM) Subcommittee on Offshore Structures

1. Introduction

There are around 1,500 oil and gas structures on the United States (US) Outer Continental Shelf (OCS) in the Gulf of Mexico (GoM) that have reached, or will soon reach, the end of their oil and gas production phase. Each of them will need to be decommissioned in the next few decades as required by both national and international law and as part of the offshore leasing process.

Decommissioning is a potentially expensive process: it includes plugging and abandoning of wells, removing or keeping in place pipelines, removing oil and gas equipment, and disassembling supporting structures and bringing them back to shore, followed by site restoration. According to the US Government Accountability Office, decommissioning all assets in the GoM is estimated to cost $40–70 billion.[7]

Decommissioning responsibility is based on the principle of "joint and several liability", where all current and previous asset owners are subject to the "asset retirement obligation" (ARO). The Bureau of Ocean Energy Management (BOEM) estimates that only around 10% of decommissioning costs are covered by surety bonds, with the rest dependent on the balance sheet of present or past operators.[8] This often results in individual asset decommissioning plans being prolonged while predecessor liability is reviewed. Over $2 billion of decommissioning is currently "stalled" by some estimates and may not be covered by financial assurances.[9]

Due to the recent surge in bankruptcy proceedings filed by large operating companies on the OCS, parties and the bankruptcy courts have looked to surety bonds to support decommissioning obligations of insolvent operators. As a result, the surety bond market has been subjected to intense financial pressures. As of the first quarter of 2024, the number, and financial capabilities, of surety bonding companies to serve the offshore oil and gas sector has significantly retracted, adversely impacting both operators some and decommissioning contractors.

1.1 How a ROICE Project Can Help

Decommissioning can be encouraged by supporting and adopting Repurposing Offshore Infrastructure for Clean Energy (ROICE) projects, which create a post-oil-and-gas revenue stream from clean energy. A ROICE project could, for example, involve building fixed or floating wind turbines around an existing oil or gas platform, with the resulting electricity sent ashore or used to make "green" hydrogen, which is made from wind energy and sea water only. The existing platform could house equipment for either power export or hydrogen generation.

The jacket (support structure) and the topsides (the decks above the jacket) are probably going to be the most cost-effective components of existing platforms to reuse in ROICE projects. The rest of the equipment will have to be decommissioned in the usual way, with wells plugged and abandoned and all hydrocarbon-processing equipment and non-essential units removed.

The ROICE approach has various advantages. By creating a revenue-generating life extension, it will be easier to raise funds for the pre-ROICE decommissioning phase from current and past operators. Getting surety bonds to cover the remaining decommissioning phase will also be simpler given there will be an ongoing income stream. ROICE project investors will receive a share of clean energy revenue for 10–20 years or more, while the current operator will benefit from a 10–20 years delay to the final decommissioning phase and get a financial contribution towards the cost of this.

1.2 ROICE Project Challenges

To establish the viability of the ROICE approach, government, industry, public and academia need to conduct technical feasibility studies, evaluate project economics, establish regulatory pathways, review liability and commercial aspects and engage stakeholders.

The University of Houston UH Energy program has therefore been leading a study into the feasibility of ROICE projects since June 2021. An industry-government-public-academia advisory group, the ROICE Project Collaborative (RPC), has been created from over 40 organizations to provide specialist expertise, resources, and knowledge from similar global projects. Key US regulatory bodies including the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE) are being kept informed of the results of the program and have strongly encouraged its goals and scope.

Initial techno-economic feasibility studies were completed in April 2023, demonstrating the potential profitability of ROICE projects. The program is now planning wind-to-hydrogen demonstration project in the GoM, which could be extended in future phases to include solar and wave energy, hydrogen storage, and carbon dioxide (CO_2) sequestration.

The ROICE program has two components, a techno-economics (ROICE-TE) analysis and a project implementation framework (ROICE-PIF). ROICE-TE builds detailed design and economic models for clean energy repurposing projects and charts a path to their profitability. ROICE-PIF develops detailed guidance for all stakeholders of such projects. This includes regulatory compliance requirements, liability transfer pathways, financial assurance mechanisms, technical certification of structures, and pre- and post-ROICE decommissioning requirements.

[7] GAO-24-106229 Offshore Oil and Gas: Interior Needs to Improve Decommissioning Enforcement and Mitigate Related Risks (Jan. 25, 2024).

[8] BOEM Press Release "BOEM Proposes stronger financial assurance requirements for offshore oil and gas industry to protect taxpayers from being forced to pay decommissioning costs" (June 27, 2023).

[9] GAO-16-40 Offshore Oil and Gas Resources: Actions Needed to Better Protect Against Billions of Dollars in Federal Exposure to Decommissioning Liabilities (Dec. 18, 2015).

1.3 What a ROICE Operator Needs to Know

A would-be operator of a ROICE project is likely to be made up of one or more of the following stakeholders:

- Existing operator and/or companies that were previous owners or operators of the oil or gas structure
- Clean energy developers, including offshore wind operators, hydrogen producers, and CO_2 sequestration firms
- Investors, lenders, and financial surety issuers
- Regulatory bodies, such as BOEM, BSEE, the U.S. Environmental Protection Agency (EPA), and the United States Coast Guard
- Equipment manufacturers, such as turbine and electrolyzer companies
- Engineering, procurement, decommissioning, and construction companies
- Community and skill pool organizations.

The ROICE operator will need to be aware of and comply with regulatory requirements in place and planned, including:

- Offshore oil and gas lease AROs that govern decommissioning of oil and gas production assets
- Procedures for delaying decommissioning of offshore structures and allowing them to transition to other use, such as alternate use right-of-use and easement (RUE) permit or other routes approved by BOEM and/or BSEE
- Understanding financial assurance mechanisms for current oil and gas phase and setting up new mechanisms for the clean energy phase
- Establishing commercial agreements to transfer liability to the ROICE operator and setting up firewalls between previous and future operations
- Checking that pre-ROICE decommissioning is being planned and will be done, understanding that post-ROICE decommissioning will transfer to the ROICE operator
- Checking structures repurposed for ROICE comply with technical requirements and get BSEE approval for life extension certification and compliance with structural regulations.

More guidelines and requirements will be discovered as the ROICE demonstration project is planned, implemented, and operated.

1.4 ROICE-PIF

UH Energy launched ROICE-PIF in April 2023. More than 40 experts from industry standards organizations, operators, engineering companies, and academic and regulatory consultants have collaborated since then to develop the PIF. They completed the first phase in August 2023, with the formation of six workgroups of 5 to 10 members each (see Table 1).

Table 1. ROICE-PIF Workgroups

Regulatory Considerations (RC) Workgroups	RC-1: Regulatory Oversight for ROICE Projects RC-2: Financial Assurance for ROICE Projects
Commercial Considerations (CC) Workgroup	CC-1: Financing and Business Models for ROICE Projects
Technical Considerations (TC) Workgroups	TC-1: Decommissioning and Reuse in the ROICE Context TC-2: Recertifying Assets for ROICE Projects TC-3: Transportation and Storage Considerations for ROICE Projects

The RC-1, RC-2, TC-1, and TC-2 workgroups met in phase 2 to develop the framework elements for their respective remits. They were each asked the question, "What do ROICE project stakeholders need to know about regulatory oversight, financial assurance, decommissioning and reuse, and recertifying assets when considering repurposing fixed offshore structures for wind power generation, hydrogen generation, or CO_2 sequestration?"

Phase 2 is limited to fixed assets (as opposed to floating structures) under the following scenarios:

- Current owner ceasing oil or gas operations and switching to a ROICE project
- Current owner leasing assets to a ROICE operator
- Current owner selling assets to a ROICE operator

Other special cases such as bankrupt asset scenarios, hybrid scenarios (where clean energy operations are added to a platform while oil or gas operations continue), and floating assets are to be handled in phase 3. Phase 3 will also convene the commercial considerations workgroup (CC-1) and the transportation and storage workgroup (TC-3), which will issue papers like this one.

The second phase was completed in June 2024, with the publication of two papers: this paper (ROICE-PIF 001) by TC-1 and TC-2 on technical considerations and a companion paper (ROICE-PIF 002) on regulatory considerations by RC-1 and RC-2. A combined summary of these papers was published by members of the four workgroups at the Offshore Technology Conference in May 2024.[10]

[10] OTC-35474-MS: Repurposing Offshore Infrastructure for Clean Energy (ROICE) Vs. Decommissioning – Regulatory Considerations (2024), https://doi.org/10.4043/35474-MS.

1.5. Scope of Work by Workgroups TC-1 and TC-2

During initial meetings, the TC-1 and TC-2 workgroups developed a list of topics that could be considered under the general heading of decommissioning, reuse, and recertification of fixed offshore platforms.

The topics were addressed by referring to the applicable regulatory and guidance documents and through discussions with the workgroup members. A specific focus for TC-1 was to identify gaps in current platform repurposing and decommissioning frameworks and recommend ways to address them. TC-2 concentrated on identifying the technical activities, engineering efforts, and structural analyses required to determine if an existing offshore structure is suitable for recertification for a ROICE application.

The work groups' general assumption was that a ROICE project will always reuse the jacket of an existing fixed oil and gas platform. Depending on project-specific considerations, topsides structures and non-oil-and-gas utilities – such as decks, accommodation, cranes, and emergency and evacuation systems – could also be considered for reuse. Existing transmission pipelines and associated risers may also be repurposed, again on a project-specific basis, but these will be the focus of a future ROICE-PIF paper. All the rest of the oil and gas infrastructure will need to be decommissioned per normal GoM offshore industry practices.

Between August 2023 and January 2024, the workgroups investigated the predefined topics using their collective knowledge and experience. Additionally, they sought the advice of others to reach collectively agreed opinions, conclusions, and recommended further actions. This included defining justifiable recommendations for further studies. This paper is the result of their combined efforts.

2. Selecting the Right Platform

Not every oil and gas platform in the US GoM will be suitable for repurposing as a ROICE project. The major considerations will be available deck space for the ROICE equipment, modules, and facilities as well as structural capacity, platform condition, and meeting BSEE structural reassessment requirements.

2.1. Available Deck Space and Structural Capacity

Platforms come in a variety of configurations, ranging from simple mono-piles (one leg) to tripods (three legs) and upwards (eight or more legs). As a rule, the greater the number of structural legs, the greater the plan area and load carrying capacity. Each platform should be assessed on a case-by-case basis to determine usable workspace and load capacity.

There are, however, some general guidelines that can be applied when making the initial selection of a platform for a ROICE project:

- Mono-pile platforms have little deck space and load carrying capacity. It is very unlikely that these would be suitable for ROICE projects.
- Tripod platforms have similarly little deck space and load carrying capacity. These would probably be unsuitable for typical ROICE projects but may have a use depending on ROICE project requirements. For example, they could support wind power export projects which typically have lesser support equipment space requirements than a hydrogen export project.
- Platforms with four or more legs will be larger than the above two cases and are more likely to be better suited for a range of ROICE projects.
- Platforms originally designed as drilling and production facilities should have more deck space and load carrying capacity than those designed for production only. This is because drilling and production platforms must support the substantial weight of a drilling rig and associated items in addition to the process equipment, utilities, accommodation, and so on.
- Platforms further offshore and, therefore, in deeper water, tend to be larger than those near shore. In deeper water for a given field development, it is more economic to install fewer platforms each with multiple uses, more deck space, and greater load capacity. Other factors are:
    - o deeper waters usually will require floating wind turbines (versus fixed bottom), which tend to be more expensive per megawatt of power generated
    - o for offshore wind projects, longer power cable(s) would

need to be installed and this could impact the type of cables used and equipment needed for power treatment

o installation costs for new build or retrofit costs for reuse of existing pipelines would be higher

o there would also be higher transportation costs and time impacts for both the construction and operational phases.

2.2. The Potential Deck Height Problem

Significant changes in structural design criteria were introduced in 2014 by an update of the API recommended practice RP-2A-WSD and the creation of RP-2MET following a series of major hurricanes in the mid-2000s, including storms Ivan, Katrina, and Rita. These 2014 updates are, at the time of writing, not included by reference in 30-CFR-250. The November 30, 2013, notice of proposed changes to this CFR states that the inclusion by reference of these 2014 API document updates, at the time of writing, is imminent. The biggest issue for platforms designed before these API document updates is compliance with the increased airgap requirements (height from mean sea level to the lowest structural deck). BSEE has stated that repurposed platforms would need to comply with the latest versions of RP 2A-WSD and hence platforms installed before approximately 2010 may not readily comply with the airgap requirements, but this would need to be determined on a case-by-case basis.

There may be options for achieving compliance via an engineering and or risk approach as explained Section 5. Any such solution would need an Alternate Compliance approval from BSEE.

Additionally, the structural design of some pre-2010 platforms may be more robust than the minimum requirements of the prevailing API recommended practices at the time of their construction and, if so, airgap may not be a critical issue. This, also, would need to be assessed on a case-by-case basis.

2.3. Validating the Existing Condition

A preliminary validation of the structural condition is needed as part of the platform selection process. This is not the rigorous reassessment process needed for recertification. It is a high level review using as much available data as possible, noting that in some cases this may be limited because of erosion of historical data with time and change of ownership.

Appendix I provides a comprehensive list of documentation for validation. As a minimum the following documents should be included:

• The latest API levels I, II, and III in-service inspection reports as defined in API-RP-2SIM – these provide a good overview of the above and below water condition.

• Details of any incidents of non-compliance from the BSEE websites (but note matters other than structural integrity may be included in these).

• Status and history of structural modifications, maintenance, and repair.

While the task of gathering and assessing documentation may seem straightforward, it becomes a real challenge when documents are not available, people with historical knowledge are not available, and people who know the location of missing documents are no longer available (for example, documents are in an offsite repository but not catalogued). The gradual loss of available historical documents with time and change of owners can be addressed by conducting physical surveys, re-engaging personnel familiar with the history of the platform, and taking measurements to develop as-is engineering drawings. Site surveys with bespoke work scopes may also be needed, but there are time, logistics, and cost implications so the work needs to be justified.

Inevitably, despite best efforts, there may still be gaps that create uncertainties in the validation outcome. However, as stated above this is not the full recertification analysis, which comes later. That process needs to be thorough and detailed as it is the final determination of the structural capacity of the platform. At the initial validation stage, gaps and uncertainties should be catalogued and the confidence level of the validation should be assessed and stated.

3. Risk Assessments

Risk assessments should be performed to help determine an existing asset's suitability for a ROICE application. For the structure, API-RP-2SIM provides guidance for risk evaluation of platforms in terms of structural integrity. This recommended practice document could be used as a framework for the evaluation of ROICE platforms, making sure the consequence scenarios (life safety, environment, business disruption) and exposure categories (high, medium, low) are properly identified and used in the risk assessment exercise.

The most important aspect of the risk assessment and evaluation is to consider specific aspects related to a ROICE application. This includes the consequence of failure of the specific technology involved, such as hydrogen production and storage, seawater desalinization, and high-voltage electricity distribution. Human interface and human factors also need to be considered. For all these the risks to life safety, environment, and business disruption should be included in the assessment.

Some additional factors that may be included in a risk assessment could include:

- The means of access to the facility (boat and or helicopter).
- Location of the platform in relation to marine traffic.
- Potential decommissioning operations of other facilities in the vicinity.
- For normally unmanned platform, the frequency of access for maintenance, intervention, and so on.

4. Decommissioning Challenges for US GoM Operators

Decommissioning offshore platforms and facilities is a well-established process within the GoM oil and gas industry. This paper focuses on the unique decommissioning needs and challenges before and after a ROICE project.

It is presumed that ROICE project planning will start while the oil and gas platform is still producing but coming towards the end of its field life. It is also presumed the change to clean energy use will not happen until after oil and gas operations stop and all approvals, certificates, commercial agreements, and so on are in place.

4.1. Decommissioning Before Start of a ROICE Project

An inventory should be made in the planning stage showing clearly what the oil and gas operator has to decommission before handing the platform over to the ROICE operator, and what will be left for the ROICE operator to decommission. The ROICE operator should then carry out a handover inspection to check that all required decommissioning has been completed, including all certification and termination reports for wells, pipelines, and other equipment.

4.1.1. Plugging and Abandoning Wells

All existing wells must be plugged and abandoned prior to commencing a ROICE project. The work is to be carried out according to BSEE and BOEM requirements.

This paper does not specifically cover repurposing of existing wells for carbon dioxide capture, utilization, and storage (CCUS). New offshore CCUS rules are being prepared by BOEM which may have a bearing on this.

4.1.2. Dealing with Conductors and Risers

For fixed platforms in deeper water, the conductors and risers may only need to be removed to around 30 m (100 ft) below sea level. This is deep enough to reduce the effects of severe storm surge and wave action on conductors and risers, which impacts platform fatigue life.

All underwater components of offshore platforms, including conductors and risers, can become marine habitats, so there are environmental benefits to leaving them undisturbed where possible.

Reducing the amount of hardware removed also cuts costs, but that is unlikely to be relevant to the Alternate Compliance request to BSEE needed for partial removal of conductors and risers.

4.1.3. Removing Oil and Gas Processing Equipment

BOEM and BSEE require all oil and gas processing equipment, including all piping and other associated items, to be removed before a platform transitions to clean energy. There are two options that comply with this requirement and that third possibility that would require an Alternate Compliance approval.

Option 1: Lift off the whole topsides above the jacket with a suitable floating crane, barges, and other support vessels. The complete structure(s) would then be taken to an onshore facility for final disposal of the oil and gas equipment.

Option 1 involves fewer but larger lifts than option 2 (see below), and it may require a larger crane and barges. The time on site is probably shorter than option 2 and using bigger equipment may reduce weather disruption.

Option 1 includes the removal of all utilities, accommodation, helideck, and so on, leaving just the tubular framed jacket structure.

Once the complete structure(s) are located at a suitable onshore facility, the options would be:

a) after removing all oil and gas and other unneeded equipment and modules, repurposing and reinstalling the original topsides structure back on the jacket structure. Deck heights could be reconfigured prior to reinstallation to address the insufficient airgap of many older platforms

b) completely disposing of the topside structure, and fabricating and installing a new purpose-built topsides. Deck heights for the new topsides structure could be configured to address the current required deck height.

The layout of either the repurposed or the new topside structure would be designed to accommodate the modules for the ROICE project, including accommodation, utilities, crane, lifeboat davits, helideck, and so on as necessary for a specific project.

Option 1 (a) is intended to be the base case for ROICE phase 3.

Option 1 (b) has several merits including being able to address the airgap problem, if it exists, with the new design, and shortening the project duration by completing the new build ahead of lifting off the existing structure allowing the new and fitted out topsides to be installed in the same offshore campaign as the removal of the original.

Options 2 and 3 below were considered by the TC-1 and TC-2 workgroups and are therefore included as being technically viable.

The comparative project costs, logistics, and timelines needed for all three3 options will be investigated in ROICE phase 3.

Option 2: Keep the topsides in place and just take off the process modules and equipment using a floating crane, jack-up crane, or even the platform crane.

Small barges and other floating equipment will be needed by removing the oil and gas processing equipment and modules in smaller lifts.

Items like accommodation, helideck, utilities, crane, and safety and evacuation systems could be re-used by the ROICE project if they meet project and regulatory requirements.

Structural alterations may be needed to fit the clean energy modules and equipment and this work will need offshore teams, workboats, and so on.

Older platforms may have insufficient deck heights, which would need addressing if the original is reused by the ROICE project.

Construction materials, safety systems, utility systems, and so on may not be suitable or acceptable for the different operating conditions of the clean energy project, so these too will need addressing if using option 2.

The third option, set out below, would require Alternate Compliance approval from BSEE.

Option 3: Keep the platform as is, except for conductors and risers, and add the clean energy equipment and modules, where space is available and platform structural capacity permits.

All process equipment would need to be made gas-free and possibly more thoroughly cleaned than required if the topsides structure and /or process modules were removed.

All unused equipment and modules would be mothballed to limit deterioration until final decommissioning at the end of the ROICE project. The worst-case scenario of the platform toppling in severe weather means ensuring that the oil and gas contaminated items do not create ocean pollution.

This option may limit the amount of equipment and modules added for the ROICE project and subsequently the clean energy capacity may be significantly reduced.

The decommissioning costs at the front end of the ROICE project would be significantly reduced as heavy lift cranes, transportation barges and other associated watercraft would not be required for decommissioning in the ROICE set-up phase.

There is not a “one size fits all” solution to deciding what could or could not be repurposed of how the platform is reconfigured. To create more clarity on this, the ROICE phase 3 project will examine a limited selection of existing platforms and develop specific possibilities and options as case studies. This study needs to consider achievable ROICE production rates, modifications possibly needed to comply with latest API recommended practices, project duration, and impacts of seasonal weather variations.

Regardless of the BOEM and BSEE requirement to remove oil and gas equipment, it is unlikely such equipment would have any use in a clean energy project. The key factors from a ROICE project perspective are safety, cost, schedule, physical space, and structural capacity of the platform.

4.1.4. Upgrading Platform Cranes

Most offshore oil and gas platforms are fitted with a pedestal crane for general use. They are usually inadequate for installing or removing large modules but may be a useful asset to keep on a ROICE project and, if necessary, recertify.

One option could be to fit a bigger pedestal crane, either complementing or replacing the existing unit. The aim would be to have a crane of sufficient dynamic capacity to handle all or part of oil and gas decommissioning as well as ROICE project construction, operation, and maintenance. Floating or jack-up cranes may still be needed from time to time for certain heavy lifts.

4.2. Decommissioning at the End of a ROICE Project

There will be a final decommissioning at the end of the ROICE project, and the original and new operators should be in full agreement regarding scope, obligations, and liabilities.

Like oil and gas platforms, ROICE platform removal could be part of the rigs-to-reef program, either on location or by being moved to a new location and returning the seabed to its original state.

The ROICE operator will need to lift off all equipment and dispose of it in an appropriate way.

For carbon dioxide sequestration, injection wells would need to be plugged and abandoned in compliance with whatever regulations will be in place in the future, which is currently unknown. Well pressures may be higher than in oil and gas end-of-life plugging and abandoning, as the well will have been continually pressurized over the project life.

5. Platform Recertification Challenges

All stakeholders and in particular BSEE will need to be assured of the adequacy of the entire structure in terms of strength and longevity. In addition to validating the existing condition (Section 2) and risk assessments (Section 3), this includes structural reassessment(s), a life extension study, and a structural integrity management plan.

Platforms identified for potential ROICE projects will need to be structurally assessed (see Appendix II) so it is important to choose ones which are well designed, fabricated, installed, maintained, and operated.

BSEE has stated that the repurposed platform would need to comply with the requirements of the API recommend practices, in particular RP-2A-WSD. BSEE has stated that the latest version would apply. This is currently the 22nd edition dated November 2014.

As discussed in Section 4, deck height or airgap is potentially a major issue for an older (pre-2010) platform that would need to be addressed and resolved:

- If the existing topside structure is retained without modification, the potential issue of deck height would need to be addressed and resolved with BSEE, possibly by making an alternate compliance request for a fully engineered solution.

- If the original topside structure is removed and replaced (option 1 in Section 4), the new topside structure would need to meet the requirements including, but not limited to deck height, of the latest editions of RP-2A-WSD and RP-2MET.

There are likely to be changes in structural loading from that typically seen in oil and gas operations because of the potential size, weight, and location of the clean energy modules and equipment. This may or may not work to the advantage of the ROICE project.

There may be an increased wind area if there are a substantial number of “shipping container” modules positioned on the deck. This could increase wind loading over and above that experienced in normal oil and gas operations.

If it is found that the simplified reassessment shows shortcomings, conservatism in the original design and today’s advanced computer modelling technology may provide some benefits for the structural reassessment. Money spent on engineered solutions is almost always much cheaper than having to make onsite structural modifications and/or repairs.

5.1. Life Extension

Life extension means extending a structure's operational life beyond the period considered during the original design. BSEE reviews and evaluates all requests for GoM oil and gas platform life extensions thoroughly, only accepting those where operators can demonstrate the platforms are suitable for continued operations. API-RP-2SIM provides fitness-for-purpose criteria for offshore oil and gas platforms in US waters.

5.2. Structural Integrity Management Plan

It is essential to keep decades of operations in mind when developing a ROICE project. As such, a long-term structural integrity management should be developed and agreed with BSEE.

API-RP-2SIM provides a methodology and recommendations for developing and implementing a risk-based structural integrity management plan. It primarily deals with oil and gas platforms and was developed from the extensive knowledge and understanding of the performance of these structures.

The change in use to ROICE would require a careful interpretation of this document to consider the following:

- There are no established US regulatory processes or recommended practices for long-term integrity for aging repurposed structures that are likely to be near or beyond the original design life at the project start point. API-RP-2SIM includes consideration of ageing structures but, logically, it focuses on end-of-life factors such as weight and slamming force management of an existing facility. While a ROICE project could take advantage of these oil and gas end-of-life considerations, the ROICE project effectively resets the clock to a new time-zero.

- At the start point of the project, the probable 20+ year old structure may have experienced some localized structural damage or fatigue, and atmospheric corrosion. Additionally, corrosion protection systems may be nearing the end of their service life and need some attention at the outset or in the early years of the ROICE project.

The structural integrity management plan will need to satisfy the requirements of BSEE including but not limited to defining appropriate in-service inspection requirements.

5.2.1. ROICE Project Baseline Survey

The ROICE project-specific baseline survey should be completed as soon as possible after ROICE start-up and a realistic goal is to complete it within one year of the start-up of ROICE operations. The process would be like that defined in API-RP-2SIM for a newly installed platform but addressing additional factors based on the life extension study. This survey would also confirm the new as-built condition.

5.2.2. ROICE In-Service Inspection Plan

The basis of developing the in-service inspection plan should be API-RP-2SIM, but additionally guided by the platform historical data review (including past inspection reports), the structural reassessment, the risk studies, and the new baseline survey. The change in service from oil and gas, the size and weight of ROICE equipment and modules, and expected levels of people on board may also influence the plan, as will the current physical condition and expected remaining service life of corrosion protections systems.

5.3. The Need for a Certified Verification Agent

30-CFR-250 specifies that when making major modifications to existing oil and gas platforms stipulate that the operator engages a certified verification agent (CVA) to review the proposed modifications to verify compliance with appropriate standards. It is possible that a ROICE project would be subject to the same requirement unless the exemption requirements of 30 CFR 250.910 can be met.

Very early in the planning, the future ROICE operator should confirm with BSEE if there is the need for a CVA. If so, the CVA should be appointed at the earliest opportunity. The scope, responsibilities, and lines of communication for all parties (operator, appointed engineering, and consulting companies, BSEE, and the CVA) should be well established at the outset.

6. Conclusions

The ROICE TC-1 and TC-2 workgroups have brought together the extensive knowledge and experience of their members. Additionally, the groups sought information from a range of sources, including subject matter experts, conference papers and other publications, federal regulations, and regulatory guidance notices. Key recommendations for a ROICE project are provided here.

6.1. Recommendations

This paper has demonstrated that it is technically feasible to decommission, repurpose/reuse, and recertify existing and ageing oil and gas platforms for clean energy uses. However, there are regulatory matters that must be addressed logically, effectively, and safely. This will reassure both BSEE and BOEM that a proposed ROICE project does not present unacceptable risks for the health and safety of people (both onboard workers and the GoM community at large) and the environment. It will also minimize the economic risk for project stakeholders.

ROICE project planning ideally should start near to the end of the oil and gas field life, but transition should only occur after certain BOEM and BSEE mandates are addressed. These are that all wells are plugged and abandoned; oil and gas equipment, risers and conductors are removed; and pipelines are decommissioned or removed in accordance with current practices. BSEE has also clarified that all applications for repurposing shall clearly define the planned ROICE application and provide detailed engineering details of the intended changes and modifications. During the planning phase, it must be clearly determined what the oil and gas operator will decommission prior to handover and what will become the responsibility of the ROICE operator.

When considering a specific platform as a possible candidate for a ROICE project, serious consideration needs to be given to airgap as defined in API-RP-2A-WSD and API-RP-2MET, as not being able to meet the requirements could significantly compromise project viability.

30-CFR-250 requires that if major modifications are made to an existing and still operating oil and gas fixed platform, the operator engages a certified verification agent (CVA) to review the proposed modifications and the structural reassessment to verify compliance with appropriate standards. It is likely that the significant change in use and structural modifications planned for the ROICE project would be subject to the same requirement.

The key to a ROICE project's success is the thoroughness of the recertification process set out in Section 5. Early discussion with BOEM and BSEE, and appointment of a CVA, if needed, are essential components of this. The CVA will add costs but undertaken in the right way the CVA should bring value and benefit to the project.

An important factor to address is that at the outset of the ROICE project or at some point during the new operational life, the platform will have exceeded its original design life. It is therefore probable that platform shall be subject to a life extension study when being repurposed for a ROICE project. Life extension is the process of determining the ability and means to extend operational life beyond the original design life, which may include structural upgrades, retrofitting cathodic protection and updating or replacing critical systems such as lifesaving.

In the ideal world a wide range of engineering and operation data is compiled and assessed for the engineering analysis. This should include engineering calculations, structural and other design documents, current and historical inspection, maintenance, and repair records, and, if any, regulatory issues. Particularly for older platforms with a succession of owners, there may well have been erosion of data with time making the actual available data less than ideal. In such cases supplementary site surveys, interviews with people knowledgeable about the current and past events, and reverse engineering would benefit the life extension study.

As part of the assessment process for future service life, consideration should be given to accumulated fatigue degradation effects. Where levels III and/or IV inspections as defined in API-RP-2SIM have been performed and any known damage is assessed and/or repaired, no additional analytical demonstration of future fatigue life is required. Alternatively, adequate fatigue life may be demonstrated by analytical procedures compatible with those specified in RP-2A-WSD.

As part of developing the structural integrity management (SIM) plan, surveys to re-baseline the structure should be performed within 12 months of the start-up of the ROICE project as a practical timeline given the start-up and operations effort and challenges that are likely particularly as this would be a unique offshore development. This would consider and examine structural changes, if any, the change in loading from the ROICE equipment and the output of the life extension study.

Then, generally in line with API-RP-2SIM, a risk-based SIM plan needs to be developed for the ROICE project lifetime, considering the age and condition of the platform at time-zero for the ROICE project and the factors impacting the baseline survey. BSEE approval of this SIM plan shall be required, and this may be subject to a deviation request as it is likely that the ROICE SIM may vary from the conventional oil and gas norms.

6.2. Key Considerations

This paper has identified and investigated many of the building blocks needed to develop and recertify an existing facility in the GoM for ROICE service. What is now needed is a study to join these building blocks together and develop a roadmap for reusing, recertifying, and finally decommissioning a ROICE project. This needs significant interaction with BSEE and BOEM to ensure that the path followed would meet with their approval and that the necessary submissions to these authorities are well defined – noting that regulations will evolve and change with time.

The following initiatives will help to develop and clarify the way forward.

6.2.1. Continuing Communication With BOEM, BSEE, and API

BOEM and BSEE have generously given time to listen to and get to understand the ROICE project objectives and direction. They have given clear advice on their expectations of submissions to both authorities at the appropriate stages in the ROICE program development. This has given RPC invaluable insight into the challenges ahead, in a positive way, for repurposing existing oil and gas assets in the GoM for clean energy. A key element of this interaction is to allow the ROICE program to understand how it can contribute to both authorities achieving their goals and objectives.

Members of TC-1 and TC-2 workgroups attended meeting of the API Committee on Standardization of Oilfield Equipment and Materials Subcommittee on Offshore Structures (SC2) and SCT members reviewed an early draft of this paper.

RPC looks forward to continuing the meaningful dialogue with BOEM, BSEE, and API as it moves forward into ROICE phase 3 and beyond.

6.2.2. Developing Case Studies

To date the ROICE program has dealt predominantly with hypothetical cases but with significant input from the RPC. Moving forward, the technical planning of ROICE must be done closely with operators which have candidate platforms. This is certainly needed for meaningful discussions with BSEE to determine what exactly would meet its criteria for approval for repurposing, and what flexibility and consideration there may be with alternate compliance requests. Data from any existing GoM platforms, even those on the decommissioning list, would be very useful for developing hypothetical case studies for possible options for the demonstration ROICE project planned for phases 3, 4, and beyond.

It is recommended that case studies are developed to understand and quantify the feasibility, extent, and options for repurposing fixed offshore installations. The process should be as follows:

- Obtain photographs, site geotechnical and metocean characterization data, design drawings, design documents, pile installation records, and in-service inspection reports for a selection of platforms. These do not have to be potential ROICE pilot candidates. They could be facilities which are being or have been decommissioned, which would avoid any sensitivities.
- Determine which of these platforms have the appropriate characteristics (size, location, condition, and so on) for a ROICE project for each of the three use cases being considered.
- Develop a high-level estimate of the work required and costs involved in repurposing. Consider pre- and post-ROICE decommissioning costs as well as operational costs over say a 15–20-year life.
- Develop an operational safety plan.

6.2.3. Defining the Design Basis and Asset Integrity Requirements

The recertification process for ROICE projects should be based on a pre-defined design basis. A generic, encompassing design basis should therefore be developed to guide the initial evaluation of an existing platform for a ROICE application.

The design basis should contain a range of potential loads for the new topsides, list of standards to be applied, and environmental criteria considerations.

It will also be necessary to define the necessary asset integrity requirements for the new platform life under a ROICE application, including the inspection regime and structural maintenance tasks.

6.2.4 Risk Assessments

In phase 3 of the ROICE program a HAZID (hazard identification qualitative risk analysis technique to identify threats in a process) or other similar “what-if” risk analysis is needed and this could be applied to one or more of the hypothetical cases suggested above. This will add a significant level of sophistication to the project and highlight aspects that are likely to depart from the norm for offshore oil and gas.

6.2.5. Investigate Compliance Options

Current BSEE mandates are that the platform airgap must meet current API recommendations and that all oil and gas equipment (and risers and conductors) must be removed before repurposing.

The techno-economic options for meeting these requirements or determining alternative compliance options should be investigated. For example, the advantages and challenges of complete topsides liftoff compared to partial removal need to be identified.

6.2.6. Additional Considerations

Some aspects not yet included in the ROICE studies but are worthy of consideration for a future phase of the project include:

- **Technology Enablers:** With the rapid technological advancement and implementation of remote inspections techniques, new coating systems, and so on, it is important to consider these enablers when reassessing an existing facility for a ROICE project. New technology may allow a prolonged life for the structure, a more effective asset integrity management and consequently, a more efficient ROICE application.

- **Repurposing of Floating Structures:** This paper has focused on fixed platforms for ROICE applications. With a series of deepwater floating assets coming to the end of their life in the GoM and starting the decommissioning process, their evaluation for ROICE application should be within the scope of a future phase. Although not designed to be mobile, floating structures can move to other installation sites and be reused for different applications. A series of different evaluations need to be considered for floating structures, including marine systems and other marine aspects that may involve other regulatory agencies.

- **Electrification of Producing Platforms as a ROICE Application:** Given that oil and gas operations will continue in the GoM for the foreseeable future, electrification of offshore platforms still producing oil and gas is being considered to reduce greenhouse gas emissions. Examples include Brazil where suitable projects are being identified but regulations are needed, and various jurisdictions in the North Sea, where projects are already underway.

Appendix I: Condition Validation Process

Condition validation is a simplified process of demonstrating the adequacy of a platform as part of the platform selection process. It is not to be confused with structural reassessment, which is a rigorous process of confirming structural adequacy of the platform for the planned ROICE application.

The goal of this stage of the investigation phase is to collect and review as much data as possible to define the history and current conditions of the asset. The more information is available, the more precise (and potentially easier) the reassessment and recertification is. A typical list of documentation that should be collected and evaluated includes:

- Original geophysical and geotechnical site characterization studies.
- Original foundation design data and as-built foundation installation data.
- Structural drawings and (if available) original analysis.
- Construction and installation documents (if still available).
- History of structural modifications and adding/removing equipment and modules, if any.
- In-service inspection plan and inspection reports (levels I, II, III and IV as applicable).
- Inspection findings, corrective action tracking and mitigations.
- Repair records including post-repair inspections and non-destructive examinations (NDE).
- Asset integrity management document if this is available.

It is understood that with some platforms there is erosion of key data with time and change of owners. Some gaps in knowledge can be filled by conducting physical surveys, interviews with personnel familiar with the history of the platform and taking measurements as necessary to develop as-is engineering drawings. Surveys may need to address some or all the following to fill knowledge gaps:

- Visual survey for structural damage, from the seabed to the top of jacket, including coating integrity.
- Condition of the coating in the splash zone
- Visual survey of the platform mudline foundation elements for gapping or scour with measurements
- Visual survey to verify the presence and condition of the anodes.
- Visual survey to confirm the presence and condition of installed equipment.
- Measurement of the as-installed mean water surface elevation.
- Record of the as-installed platform orientation.
- Measurement of the as-installed platform level.

Appendix II: Structural Reassessment Process

The structural reassessment of the existing structure planned to be retained should incorporate the results of the document review, surveys (if conducted), and risk assessments. Deck loads, wastage, marine growth, scour, and any modifications and damages should be incorporated in the reassessment.

Where available, the original fabrication materials and fit-up details should be established such that proper material characteristics are used in the reassessment and any stress concentrations are accounted for.

Strength and/or fatigue reassessment, design review, and surveys (when necessary) should be based on the following:

- An assessment of the validity of the existing site and soil investigation data and application of current practice methods and analyses for in-place structures to develop foundation response under the projected loads.
- For structures, systems, or equipment not modified and maintained to the original design (excluding geotechnical foundation elements), the design review should be based on the design codes used in the original design but with current environmental data.
- For added or modified structures, systems, or equipment, the design review should be based on the design codes at the time of the contract for the life extension with current environmental data.

More recent geophysical and geotechnical data may be available from the project site or nearby locations that could be leveraged to increase the appraisal of site conditions and potential geohazards. The feasibility and value of acquiring modern geotechnical data should be assessed, particularly where access to or the quality of existing data is limited.

The results of the reassessment may be an indicator of areas needing bespoke inspection for life extension. If so, targeted inspections may need to be planned and completed in the life extension assessment phase unless it is deemed acceptable to do these later during the ROICE baseline survey.

The analytical reassessment may determine that mitigations or corrective measures are required, and that modifications of structural components will be needed to allow continued service of the installation.

The reassessment for recertification may also determine that suspected areas may not require immediate corrective action but be subject to increased inspection to monitor development of cracks, progression of corrosion, or any other anomaly that may have been detected. This needs to be considered in the implementation phase.

The subsea cathodic protection (CP) system is to be reevaluated to verify that existing anodes can serve the extended design life of the installation. If found necessary by the reevaluation, a retrofit CP system would need to be installed at the appropriate time based on CP measurements and anode depletion. For many of the platform in the 20–30 year age group, and sometimes even older platforms, the originally installed (at construction) sacrificial anodes have been found to be fully active and providing acceptable CP. There is some conservativeness in CP which usually accounts for this. Depending on the age of the platform and the ROICE design life the original CP system may provide adequate protection until final decommissioning. The ROICE inspection service plan needs to address verifying the performance of the CP system. Should retrofit CP be needed there are well proven seabed positioned sacrificial anode systems available that are economically installed.

The condition of protective coatings in the splash zone and above water, if found deficient, should be rectified and maintained in a satisfactory condition.

The current recommendation by API is for flooded member detection (FMD) testing in potentially suspect areas. However, NDE for thickness measurement and crack detection may need to be carried out for an accurate assessment of the current condition.

Residual Strength

The ultimate strength of an offshore structure in a deteriorated or damaged condition is expressed as the structure’s residual strength. This is highly dependent on the inherent robustness of the structure. For ROICE application, the platform residual strength for the jacket and topsides (if being reused) needs to be evaluated considering factors that may include material loss from corrosion and/or erosion, dented or damaged members, modified topsides weights, changes in wind area loads due to changes in equipment and modules, current geotechnical design data for in-place structures accounting for installation records and observed condition, any updates in metocean data, and any other deviations from the original design considerations.

API-RP-2SIM provides guidance on assessment of members' residual strength using simplified methods or detailed analytical techniques.

Determining Remaining Fatigue Life

Per API-RP-2SIM, in the GoM cracking due to fatigue is not generally experienced. However, some elements may experience fatigue cracking, such as joints in the first horizontal conductor framing below water, main brace to leg joints in the vertical framing above the seabed, or at the perimeter members in the vertical framing at the first bay below water level, normally resulting from boat impact. Fatigue cracking in conductor guide frames is a known issue and this may only be relevant if these guides are used to secure seawater intake caissons, either for fire water or feedwater for hydrogen projects.

As part of the assessment process for future service life, consideration should be given to accumulated fatigue degradation effects. Where level III and/or IV inspections are made and any known damage is assessed and/or repaired, no additional analytical demonstration of future fatigue life is required. Alternatively, adequate fatigue life may be demonstrated by an analytical procedure compatible with those specified in API-RP-2A-WSD.

Areas originally designed as non-inspectable are not required to be inspected if adequate fatigue life is available for the extended service life. At the owner's or operator's request, the CVA and/or BSEE may consider the reduction of safety factors for fatigue life for past service life if a single inspection is carried out. The extent of such an inspection is to be agreed between the CVA, BSEE, and owner or operator.

Structural Re-Analysis

For the original design of the platform, certain conservative assumptions may have been made for the structural geometry, applied loads, stress concentration factors (SCF), or environmental effects. The software and analysis techniques available today are more advanced and can more accurately consider these effects to eliminate any conservatism in the design.

For some tubular and/or complex joints in the platform jacket, topsides, or at the topsides-jacket interface, conservative SCFs may have been estimated using empirical formulae. Advanced finite element analysis (FEA) tools can be used to accurately model the details and calculate these SCFs. By using reduced SCF values, more favorable fatigue lives can be calculated.

Advanced FEA can also be used for performing strength assessment of structures that may not meet code requirements using simplified analysis techniques. Areas where significant corrosion has occurred, and material has been lost can be analyzed using FEA methods that show structural adequacy for the extended life of the asset, or the need for and details of local strengthening.

Safety factors considered during design phase for difficult-to-inspect or difficult-to-repair connections can be reduced if these locations are made accessible for inspection and repair. A reduction in safety factor will result in a higher fatigue life to satisfy any code requirements for the extended life of the platform. This is extremely useful for underwater connections that were considered non-inspectable but can now be inspected using state-of-the-art inspection techniques.

Appendix III: Engaging a Certified Verification Agent

30 CFR 250 requires that if major modifications are made to an existing and still operating oil and gas fixed platform, the operator engages a certified verification agent (CVA) to review the proposed modifications to verify compliance with appropriate standards.

The regulations define a CVA as “an individual or organization, experienced in the design, fabrication, and installation of offshore marine facilities or structures, who will conduct specified third-party reviews, inspections, and verifications in accordance with this part.”

It is likely that the structural modifications planned to the platform for a ROICE project would be subject to the same requirement.

BSEE requires the CVA to be nominated by the operator when submitting the verification plans. As the CVA can only start its activities after nomination is accepted by BSEE, it is important to submit the plans and nominate the CVA as early as possible.

The CVA’s activities cover the recertification of the existing platform for ROICE application, including any modification or repairs required by the analytical work. The CVA will also be required for the design, fabrication, and installation of the new structures.

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