



Peer Review Plan

Date: October 31, 2023

BSEE Funding Source or Author's Division: Office of Offshore Regulatory Programs
Emerging Technologies Branch 45600
Woodland Road
Sterling, VA 20166

Title: Evaluation of Technology Collaboration Program (TCP) 5024 - Laboratory Testing and Technical Assessments of Corrosion-Resistant Alloys for High-Pressure High-Temperature Subsea Applications

Subject and Purpose:

BSEE funded research to test five (5) Corrosion Resistant Alloys (CRA) for Mechanical and Corrosion behavior under two tasks: Task 1 – **High-Pressure High-Temperature Potential for Equipment Failure**, commonly referred to as "HPHT Equipment Failure;" and Task 2 – **High-Pressure High-Temperature Testing Capability**, widely referred to as "HPHT Testing Capability." The results of the two tasks were presented in a combined report, "**Laboratory Testing and Technical Assessments of Corrosion-Resistant Alloys for High-Pressure, High-Temperature Subsea Applications.**" The research goal included evaluating the performance of the CRA in the HPHT sour service conditions. The research results are expected to assist BSEE in assessing the engineering design, mechanical performance, reliability, and corrosion of high temperature alloy material grades by conducting physical and corrosion testing on these materials. The study will serve as valuable information to predict the potential behavior of new materials in manufacturing of offshore oil and gas equipment and its performance under HPHT sour service environment conditions.

The study presents information gained from laboratory testing of mechanical properties, crack growth, corrosion rates and subsequent microscopy examinations of high-strength corrosion-resistant alloys (CRAs) 725, 825, 945X, 955, and C22HS. These high-nickel-content metals may be suitable for subsea equipment service associated with sour environments often encountered in high-pressure ($\geq 15,000$ psi), high-temperature ($\geq 350^{\circ}\text{F}$) (HPHT), and highly corrosive (H_2S , Cl , S , and CO_2) conditions of the oil and gas wells in the Gulf of Mexico. The alloys were selected since they represent a wide spectrum of CRA materials often chosen for offshore applications. The overall conclusion of the study indicates all five materials behaved well in extended time sour autoclave tests simulating actual HPHT conditions. This conclusion is based on none of the materials suffering significant pitting attack. The crevice corrosion observed can be understood in terms of the relative amounts of alloy content as quantified by the Pitting Resistance Equivalent Number (PREN).

This peer review verifies the scientific and technical merit of the assumptions, inputs, methodologies, modeling, and results for the BSEE study entitled: "**Laboratory Testing and Technical Assessments of Corrosion-Resistant Alloys for High-Pressure High-Temperature Subsea Applications.**" This study applies to Mechanical Property and Corrosion Performance Testing and Assessments of these corrosion-resistant alloys (CRA) 725, 825, 945X, 955, and C22HS to predict the material performance in HPHT sour service environment conditions for deep-water oil and gas operations. This peer review is scientific and technical in nature. It includes reviewing the methods, assumptions, data quality, the strengths of any inferences made, and the overall strengths and limitations of the study.

Disclaimer: The content of this peer review plan has been verified in compliance with the peer review handbook. For peer review contracts executed prior to peer review plan release, there may be differences in language used between the peer review plan and the executed contract.

**Impact of Dissemination:**

BSEE considers this study influential scientific information, which requires a robust evaluation that the scientific community and stakeholders will accept. This study's findings may directly impact the methods, industry standards, best practices, and material selection for equipment utilized for high pressure and high temperature offshore oil and gas operations. This study's results may suggest the need to revise respective industry standards and could affect how BSEE and industry interpret those standards. The results from this study are essential for the review of new projects in deeper waters for offshore operations.

Upon conclusion of the peer review, BSEE will post all possible contracted deliverables, tasks, data, analyses, and information, including the peer-review reporting, reports, and comments on BSEE's research records website: <https://www.bsee.gov/research-record>.

Timing of Review:

June 12, 2023 - June 11, 2024 (Total peer review process of not more than 12 months is desired for this project.)

Manner of Review, Selection of Reviewers, and Nomination Process:

This peer review shall be conducted through the contract BSEE BPA Process. This process will provide for a panel of qualified subject matter experts (SMEs) selected by the agency in order to achieve an optimum level of expertise across the spectrum of issues. The SMEs will be required to maintain both balance and independence while minimizing any potential conflicts of interest. The public will not be consulted in the nomination of potential peer reviewers.

Primary criteria for peer reviewers include the following:

- Mechanical Engineering, Material science, Metallurgical Engineering, Corrosion
- Oil and gas industry background
- Practical experience with metallic material testing and evaluation, metallography, material properties testing, microscopy, mechanical testing, corrosion testing, environmental testing, analytical chemistry
- Practical experience and knowledge of corrosion behavior, including stress corrosion cracking of corrosion resistance alloys, metallic material fatigue, fracture behavior
- Practical experience with offshore equipment design and in high-pressure and high-temperature and sour service environments

Reviewers may be selected from academia, professional societies, other regulatory agencies, Federal agencies that are familiar with the topic, industry, including individual subject matter experts. The group of reviewers shall not include multiple reviewers from the same affiliation, at least one person from outside of the oil and gas industry, and no more than two persons from the oil and gas industry.

Expected Number of Reviewers:

Three reviewers, plus contractor oversight, and writing personnel.

Requisite Expertise:

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- Subject Matter Experts with five years of experience in a relevant field and should also have some other strong credentials, e.g., a Ph.D. with a substantial publication or patent record specific to the evaluated technology, a young investigator award, or a strong pedigree (e.g., a Ph.D. from a high caliber institution or under a recognized leader in the field).
- Publications and Patents. Qualified experts often have many peer-reviewed journals and/or patents on the evaluated technology.
- Other evidence is that the person is a recognized expert in the field. Qualified experts have often managed a public policy program that has had a national impact, has a record of bringing innovations to the market or holds vital patents.
- In a relevant field, an advanced degree - Ph.D., Sc.D., D.Eng., MS, or MBA. Experts with only a bachelor's degree should have other experience and or a record of significant accomplishments indicating their expertise.
- Relevant awards. Qualified experts may have received a prestigious award such as the National Medal of Science, American Chemical Society National Award, Young Investigator Award, R&D 100 Award, or other awards specific to technology (e.g., Fuel Cell Seminar Award).
- Key Society Membership. Qualified experts may be members of a society like the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), the American Physics Society, a National Laboratory Fellow, etc.

Opportunity for Public Comment:

At the time of this peer review plan's posting, the research report will be available on BSEE's Peer Review Public Posting website located here: <https://www.bsee.gov/what-we-do/research/peer-review>. BSEE welcomes public comment, especially from those with experience with tension leg platforms. BSEE invites the public to comment within the 30-day window indicated on the website through the process described below, which is consistent with the guidance on the website:

- For comments pertaining to this peer review plan, send emails to:
bsee_peerreviewplancomments@bsee.gov
- For comments pertaining to the research, send emails to:
bsee_researchpubliccomment@bsee.gov

In the subject line list of a public comment email, please state: "TCP 5024 - Laboratory Testing and Technical Assessments of Corrosion-Resistant Alloys for High-Pressure High-Temperature Subsea Applications" + the words "peer review plan" or "research" + the words "public comment."

- List out any comments, questions, feedback by number (ex. 1, 2, 3, etc.)
- If referencing any sources of published information, please list the complete source information in a recognized reference format (such as APA)
- Please include your name, contact information, and affiliation

The agency will provide public comments deemed significant and relevant to the peer reviewers to address during their review.

Agency Contact: Yasser Fahmy, Ph.D.

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