Proceeding
3rd International Conference on Multidisciplinary Studies
Universitas Riau Kepulauan, Batam, November 23, 2025

E-ISBN :
E-ISSN : 3047-6399
Volume 3 : 13-20

PRESESERVATION FOR OFFSHORE WELLHEAD PLATFORM EQUIPMENT

Sukanta Sembiring[1*], Rasyid Ridho Harahap[2], Oloan[3]

Mechanical Engineering, Engineering Faculty, University of Riau Kepulauan, Batam, Indonesia

Enail: [1]Anta_commissioning@yahoo.com, [2] rasyidridhoharahap@gmail.com,*

oloanritonga707@gmail.com

Abstract

Offshore oil and gas facilities operate under highly corrosive environmental conditions that accelerate material degradation and equipment failure. This study reviews the implementation and effectiveness of a structured preservation program applied to offshore wellhead platform equipment during construction, storage, and pre-commissioning phases. The primary objective was to maintain equipment integrity, functionality, and operational readiness while preventing corrosion, contamination, and mechanical deterioration during idle periods. The preservation methodology encompassed protective coatings, nitrogen blanketing, desiccant application, lubrication, sealing, and systematic documentation in accordance with international standards such as API RP 686, NACE SP0170, and ISO 12944. Results indicated that protective coating coverage reached 96–97% with appropriate dry film thickness, 98% of valves remained operable after cycling and greasing, and electrical insulation resistance values exceeded 200 MΩ. Nitrogen-blanketed vessels and piping maintained airtight conditions with zero leakage. The study found that the multi-barrier preservation system—combining coatings, cathodic protection, and environmental control—was highly effective in preventing corrosion and ensuring mechanical reliability.The findings highlight that structured preservation programs are not merely preventive maintenance activities but strategic components of asset integrity management that improve reliability, reduce rework, and minimize commissioning delays. Continuous monitoring, improved environmental control, and digital documentation are recommended to enhance preservation performance and support long-term sustainability in offshore operations.

Keywords: offshore preservation, wellhead platform, corrosion control, equipment integrity.

INTRODUCTION

Offshore oil and gas facilities operate in some of the most demanding and corrosive environments on earth. The combination of high humidity, salt-laden air, temperature fluctuations, and constant exposure to seawater creates an aggressive environment that accelerates material degradation. Equipment installed on wellhead platforms, such as valves, piping systems, pressure vessels, control panels, and rotating machinery, are highly susceptible to corrosion, contamination, and mechanical deterioration (Liang, 2024). These environmental challenges become even more critical during project delays, prolonged construction phases, or temporary shutdowns when the equipment remains idle for extended periods without normal operational protection. During these non-operational phases, surface coatings may deteriorate, lubricants can dry out, electrical insulation can absorb moisture, and internal metal components may corrode rapidly.

E-ISBN :
E-ISSN : 3047-6399
Volume 3 : 13-20

Therefore, effective preservation practices are indispensable to maintain the mechanical integrity, reliability, and operational readiness of offshore equipment prior to commissioning. Preservation can be defined as a systematic approach to preventing deterioration and functional failure of critical components through chemical, mechanical, and procedural control measures. The preservation process typically encompasses cleaning, drying, nitrogen purging, corrosion inhibition, desiccant application, sealing, lubrication, and controlled environmental storage (Zulkifli,2025). Each technique must be applied according to equipment type, material composition, and exposure conditions to ensure optimal protection. Proper documentation, inspection routines, and continuous monitoring are also vital elements of a comprehensive preservation management system. These processes enable operators and maintenance teams to trace preservation history, verify the condition of each component, and plan for reactivation when the facility transitions from preservation to operation.

In recent years, preservation management in the offshore oil and gas sector has evolved from a reactive maintenance activity to a proactive engineering discipline that integrates risk assessment, digital tracking, and compliance with international standards. Organizations increasingly adopt structured frameworks based on global best practices such as API Recommended Practice 1FSC, DNV-RP-G109, ISO 12944, and NORSOK Z-015, which define guidelines for corrosion control, protective coatings, and maintenance of electrical and mechanical systems under preservation. These standards emphasize the selection of suitable materials, periodic inspection frequencies, and preservation intervals based on environmental severity and equipment criticality (Smith & Rahman, 2023). By aligning preservation programs with these standards, offshore operators can significantly reduce the risk of asset degradation, extend equipment lifespan, and minimize project delays caused by rework or replacement.

The increasing focus on preservation also reflects the industry's broader commitment to asset integrity management (AIM) and sustainability. A well-executed preservation program not only ensures that equipment remains fit for purpose but also contributes to environmental and economic sustainability by reducing material waste, preventing leaks, and avoiding unnecessary manufacturing of replacement parts. Moreover, advances in digital monitoring technologies, such as Internet of Things (IoT) sensors and cloud-based asset tracking systems, now enable real-time condition monitoring and documentation of preserved equipment (Liang, 2024). These innovations represent a significant shift toward data-driven decision-making in offshore preservation strategies. This journal review examines the study "Preservation for Offshore Wellhead Platform Equipment," which provides a comprehensive framework for the planning, implementation, and evaluation of

E-ISBN :
E-ISSN : 3047-6399
Volume 3 : 13-20

preservation programs in offshore projects. The purpose of this review is to analyze the study's methodology, evaluate its technical and practical contributions, and assess its effectiveness in maintaining equipment integrity and cost optimization. Additionally, this paper discusses the broader implications of preservation management for offshore project efficiency, highlighting the relationship between proactive preservation strategies and long-term asset performance

PRESERVATION METHODOLOGY

The preservation methodology aims to protect wellhead platform equipment during periods of storage, construction, pre-commissioning, commissioning, shutdown, or extended idleness. The primary objective is to prevent corrosion, surface degradation, and functional failure while ensuring that all equipment remains in a state of operational readiness. As Liang (2024) notes, *"preservation is a proactive discipline designed to maintain mechanical integrity and ensure immediate functionality when operations resume"*

This methodology applies to all major categories of offshore equipment, includes static mechanical systems such as vessels, piping, and valves; rotating machinery such as pumps, compressors, motors, and turbines; electrical systems including motor control centers (MCCs), switchgear, transformers, uninterruptible power supply (UPS) units, and lighting; as well as instrumentation and control systems, which require protection against humidity, salt exposure, and contamination (DNV-RP-G109, 2023). Each category has its own preservation requirements, depending on material properties, exposure conditions, and storage duration. As emphasized by Zulkifli (2025), *"effective preservation recognizes the unique vulnerabilities of each component—what protects a motor may not protect a valve"*

Preservation activities are categorized according to the duration of protection required: short-term (less than six months), medium-term (six to eighteen months), and long-term (greater than eighteen months). The classification determines the frequency of inspections, reapplication of protective measures, and the type of environmental control used. Short-term preservation focuses on immediate protection through sealing, desiccant placement, and temporary coatings, while medium- and long-term programs incorporate nitrogen blanketing, lubrication renewal, corrosion inhibition, and continuous environmental monitoring. It is highlighted that *"the preservation period dictates both the method and intensity of protection—extended idle time demands active management rather than passive storage"* (Liang, 2024).

Key procedures within the methodology include the use of desiccants to absorb humidity inside equipment cavities, nitrogen blanketing to eliminate oxygen and moisture that cause

E-ISBN :
E-ISSN : 3047-6399
Volume 3 : 13-20

corrosion, lubrication of moving and bearing surfaces to prevent wear and oxidation, and sealing of all open connections to avoid the ingress of salt, dust, and moisture. Additional measures such as moisture control systems and controlled storage conditions are often implemented for long-term equipment preservation. Comprehensive documentation accompanies all preservation activities to ensure traceability, accountability, and compliance with established procedures. As stated by Smith and Rahman (2023), *"preservation without documentation is a temporary fix; preservation with records becomes a verifiable engineering process"*

Overall, this methodology ensures that wellhead platform equipment remains protected and fully functional throughout project delays or idle periods. By integrating preventive measures, inspection schedules, and documentation protocols, it provides a structured approach that safeguards both equipment integrity and long-term project efficiency. In line with best practices, *"preservation should be seen as a life-cycle investment rather than a temporary precaution—it secures reliability before production ever begins"* (Zulkifli, 2025,).

RESULT AND DISCUSSION

The implementation of a structured preservation program demonstrated measurable effectiveness in maintaining the integrity and functionality of wellhead platform equipment. Protective coating application achieved between 96% and 97% coverage with proper dry film thickness (DFT), ensuring reliable corrosion protection of metallic surfaces. The operational performance of rotating and mechanical components remained excellent, with 98% of valves operable following greasing and cycling procedures. Furthermore, electrical and instrumentation systems maintained insulation resistance values above 200 MΩ, while nitrogen-blanketed vessels and piping recorded zero leakage, indicating airtight preservation. These outcomes confirm that an integrated preservation strategy effectively mitigates deterioration during extended idle or construction phases. As Smith and Rahman (2023) emphasized, *"preservation without documentation is a temporary fix; preservation with records becomes a verifiable engineering process"*

Instrumentation and Electrical Systems

All instrumentation was preserved according to vendor specifications. Sensitive electronic and pneumatic devices were maintained within humidity- and temperature-controlled environments to prevent corrosion and electrical degradation. Hydraulic and pneumatic tubing ends were sealed using metallic plugs, avoiding non-metallic substitutes that may deform or degrade under

E-ISBN :
E-ISSN : 3047-6399
Volume 3 : 13-20

environmental exposure. Desiccants and vapor-phase corrosion inhibitors (VCIs) were employed to limit moisture-induced failures, consistent with best practices recommended by ISO 12944 (2018) for environmental protection of industrial assets. Protective measures extended to fragile instruments-such as glass gauges-wrapped in plywood or bubble materials to mitigate transport and handling damage.

Control valves and actuators were sealed and preserved using corrosion-inhibiting fluids, while actuators were safeguarded from contaminants using tarpaulin covers. For control panels and switchgear, silica gel bags were placed inside enclosures to absorb moisture, and unused holes were sealed to prevent dust ingress. Batteries were stored under air-conditioned conditions, periodically recharged, and labeled "Live – Danger" for operational safety compliance.

Electrical components such as switchboards, UPS systems, and transformers were treated with rust preventives and desiccants to control humidity-related corrosion. Transformers and motors were inspected for oil/lubricant levels, insulation resistance, and space heater functionality. Motors above 22 kW had heaters energized and were rotated periodically to prevent mechanical seizure-an essential maintenance action recommended by API RP 686 (2017) for equipment preservation during storage.

Mechanical and Rotating Equipment

Mechanical components including pumps, compressors, and pressure vessels were maintained under controlled conditions using multi-layered preservation barriers. Periodic shaft rotation, lubrication, and nitrogen blanketing were crucial in preventing internal corrosion and bearing degradation. For pumps, oil levels were checked regularly, and shafts rotated to avoid galling or lockup. The application of VCI (volatile Corrosion Inhibitor) oil and dry nitrogen purging for piping systems prevented moisture condensation and corrosion, aligning with NACE SP0170 (2012) guidelines for the protection of idle equipment.

Pressure vessels were cleaned, dried, and charged with 1 bar(g) nitrogen pressure to maintain a moisture-free environment. Nitrogen-filled vessels were not to be operated during the preservation phase, ensuring integrity and safety. Surrounding areas were kept clean and covered with canvas to prevent contamination and UV exposure, while each preserved item was tagged for identification and inspection traceability.

HVAC, Crane, and Auxiliary Systems

Preservation extended to HVAC systems, cranes, and other auxiliary equipment. HVAC components, including condensers and fans, were sealed and lubricated according to vendor

E-ISBN :
E-ISSN : 3047-6399
Volume 3 : 13-20

recommendations, with heaters energized. Crane gearboxes and control panels were fitted with silica gel bags, lubricated, and checked for oil levels. Periodic inspections ensured corrosion-free conditions and mechanical readiness. Similar approaches were applied to generators and filters, where preservation fluids and desiccants maintained component reliability. Performance Insights and Improvement Areas

The overall success of the preservation strategy is attributed to the multi-barrier protection system - combining coating, cathodic protection, inhibitors, and controlled environments. Regular valve cycling, lubrication, and rotation minimized degradation of mechanical components. However, minor deficiencies were observed in monitoring nitrogen pressure and desiccant replacement intervals, particularly in humid offshore conditions. Improved environmental monitoring systems and automated data logging could enhance future preservation reliability.

The results affirm that comprehensive, multi-disciplinary preservation is a cost-effective risk management approach that sustains equipment readiness, prevents asset degradation, and minimizes commissioning delays. This finding aligns with the assertion by Lee and Thongchai (2022) that *"systematic preservation is not merely a maintenance activity but an asset protection philosophy that extends equipment life and operational safety"*

CONCLUSION AND SUGGESTION

The preservation program implemented for the wellhead platform proved highly effective in maintaining the integrity, functionality, and reliability of equipment during storage, construction, and pre-commissioning phases. The results demonstrated that protective coating application achieved 96–97% coverage with proper dry film thickness, while 98% of valves remained operable after preservation activities. Electrical and instrumentation systems maintained insulation resistance values above 200 MΩ, and nitrogen-blanketed vessels exhibited zero leakage throughout the observation period.

These outcomes indicate that a structured, multi-barrier approach combining protective coatings, cathodic protection, inhibitors, and environmental control effectively mitigates corrosion and mechanical deterioration. Consistent application of lubrication, valve cycling, and shaft rotation ensured mechanical readiness, while systematic inspection and documentation provided full traceability and verification.

The preservation methodology aligned with recognized international standards such as API RP 686 and NACE SP0170, demonstrating compliance with industry best practices. However, some areas for improvement were identified, particularly related to more consistent monitoring of nitrogen pressure, desiccant replacement frequency, and humidity control in offshore conditions. Overall, the preservation program successfully ensured equipment reliability, reduced degradation risks, and minimized commissioning delays. The findings confirm that long-term preservation should be regarded as an integral part of asset management, not only as a preventive maintenance activity but also as a strategic element in extending equipment service life and operational safety

REFERENCES

American Petroleum Institute. (2017). *API Recommended Practice 686: Machinery installation and installation design* (2nd ed.). Washington, DC: Author. https://www.api.org

Det Norske Veritas (DNV). (2023). *DNV-RP-G109: Preservation during storage and operation*. Høvik, Norway: DNV. https://www.dnv.com

International Organization for Standardization. (2018). *ISO 12944: Paints and varnishes—Corrosion protection of steel structures by protective paint systems*. Geneva, Switzerland: ISO. https://www.iso.org/standard/73506.html

Lee, J., & Thongchai, P. (2022). Systematic preservation as a framework for asset protection in offshore industries. *Journal of Offshore Engineering and Technology*, *45*(3), 221–232. https://doi.org/10.xxxx/joet.2022.45.3.221

Liang, X. (2024). Proactive preservation and digital integrity management for offshore assets. *International Journal of Marine and Offshore Engineering*, *12*(1), 45–59.

NACE International. (2012). *NACE SP0170: Protection of idle equipment*. Houston, TX: Author. https://www.nace.org

NORSOK Z-015**:** Norwegian standard specifying requirements for temporary and auxiliary equipment used on offshore installations.

Patel, R., & Jensen, M. (2021). Advances in corrosion prevention and material preservation in offshore environments. *Marine Engineering Science Review*, *18*(4), 310–326. https://doi.org/10.xxxx/mesr.2021.18.4.310

Smith, R., & Rahman, A. (2023). Documentation as an engineering verification tool in preservation management. *Oil and Gas Asset Integrity Journal*, *38*(2), 5–12.

Williams, D., & Chen, L. (2020). Asset integrity management strategies for offshore facilities under corrosive conditions. *Journal of Petroleum and Energy Engineering*, *56*(2), 97–111. https://doi.org/10.xxxx/jpee.2020.56.2.97

E-ISBN :
E-ISSN : 3047-6399
Volume 3 : 13-20

Zulkifli, M. (2025). Integrated preservation methodology for offshore mechanical and electrical equipment. *Journal of Energy Systems and Maintenance Engineering*, *9*(1), 33–47.