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GUIDANCE FOR VERIFYING EXISTING BARRIERS

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SEMS AUDIT & CERTIFICATES

DATA COLLECTION, ANALYSIS & REPORTING

GOOD PRACTICE DEVELOPMENT

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1. INTRODUCTION

For the offshore oil and gas industry, no objective is more important than safe operation. Effective barriers are essential to the prevention of major incidents. Barriers protect the offshore workforce as well as the environment and assets. Most, if not all, major incidents involve a failure of one or more of these barriers, either due to inadequate design, fabrication, installation, maintenance, inspection, testing, or activation. Failures can be due to a lack of knowledge of the purpose and function of a barrier and its importance in the sequence of a major incident scenario. This emphasizes the importance of confirming that barriers are performing or will perform their intended function on demand. This 'verification' is the subject of this document which provides guidance to help companies verify that their existing barriers have integrity and are or will be effective.

This document is not intended to supersede any applicable regulatory requirements.

2. SCOPE

API Recommended Practice (RP) 75, 4th Edition, *Safety and Environmental Management System for Offshore Operations and Assets*, states in its Risk Assessment and Risk Controls element that a company should identify hazards, assess risk, and determine and implement Risk Controls for its assets, activities, and tasks. A Risk Control is the actions, equipment, or administrative measures to be established, implemented, or maintained to eliminate, reduce, or mitigate the risk. Safeguard is another term used by industry and is generally interchangeable with Risk Control. Barriers are a subset of Risk Controls with specific characteristics:

- CAPABLE – can fully prevent the unintended event or effectively mitigate the specified undesired consequence(s)
- INDEPENDENT – can function independent of the initiating event and the design or operation of any other Barriers
- VERIFIABLE - evidence exists that the barrier is real, present, and will function as intended

This document focuses on the activity of verifying that existing barriers that are intended for major incident prevention and mitigation have integrity and are or will be effective. It includes both human and hardware barriers, both preventive and mitigative. Existing means that the barrier is in service or is to be taken out of service for maintenance, inspection, or testing. This document does not focus on the other stages of the barrier lifecycle: design, fabrication, installation, commissioning, operation, or decommissioning (*See Figure 1*).

While the focus of this document is on preventing or mitigating major incidents, its principles can also be applied to preventing or mitigating less severe incidents. Each company should determine how to best apply the guidance.

The primary audience for this document is oil and gas industry personnel who have responsibility to verify barriers offshore and those who establish verification methodologies. This includes (but is not limited to) field and office engineers, line management, and personnel who coordinate and oversee Safety and Environmental Management System (SEMS) components related to barriers. While not in scope for this document, it is recognized that there are numerous SEMS programs and practices that underpin the effectiveness of existing barriers. These include but are not limited to shift handover, routine inspections, personnel competence, safety culture, contractor interface, etc.

3. DEFINITIONS / ACRONYMS

Terms not defined in this section should be assumed to have the common dictionary definition.

DEFINITIONS

ASSET (*API RP 75, 4th Edition*) - The equipment (individual items or integrated systems) or software used offshore.

BARRIER - A Barrier is a Risk Control that meets all the following criteria:

a. Capable – can fully prevent the unintended event or effectively mitigate the specified undesired consequence(s)

b. Independent – can function independent of the initiating event and the design or operation of any other Barriers

c. Verifiable - evidence exists that the barrier is real, present, and will function as intended.

EFFECTIVE (*API RP 75, 4th Edition*) - The extent to which the desired result or outcome is achieved.

HARDWARE BARRIERS (I*OGP Report 544*) - Primary containment, process equipment, and engineered systems designed and managed to prevent LOPC and other types of asset integrity or process safety events and mitigate any potential consequences of such events. These are checked and maintained by people (in critical activity/tasks).

HAZARD (*API RP 75, 4th Edition*) - An object, physical effect, or condition with the potential to harm people, the environment, or property.

HUMAN BARRIERS (*IOGP Report 544*) - Barriers that rely on the actions of people capable of carrying out activities designed to prevent LOPC and other types of asset integrity or process safety events and mitigate any potential consequences of such events.

HUMAN PERFORMANCE (*API RP 75, 4th Edition*) - Systematic application of knowledge and learnings to improve management systems and the interactions of individuals with each other, equipment, and systems as an enabler of safety and environmental performance.

INTERFACE AGREEMENT (*API RP 75, 4th Edition*) - Agreement that provides clarity on which SEMS policies, processes, practices, or procedures will be followed for the performance of work.

KNOWLEDGE (*API RP 75, 4th Edition*) - A person's understanding of the requirements needed to perform a role or fulfill an activity.

MAJOR INCIDENT (*IOGP 456*) - Hazardous event that results in:

a. multiple fatalities or severe injuries, or

b. extensive damage to structure, installation, or plant, or

c. large-scale impact on the environment (e.g., persistent and severe environmental damage that can lead to loss of commercial or recreational use, loss of natural resources over a wide area or severe environmental damage that will require extensive measures to restore beneficial uses of the environment).

PERFORMANCE CRITERIA (*IOGP Report 6.36/210*) - Performance criteria describe the measurable standards set by company management to which an activity or system element is to perform.

PROCEDURE (*API RP 75, 4th Edition*) - Approved and documented instructions about a specific task or activity that is used to enable the safe and consistent execution of that task or activity.

RISK (*IOGP Report 6.36/210*) - The product of the chance that a specified undesired event will occur and the severity of the consequences of the event.

RISK ASSESSMENT (*API RP 75, 4th Edition*) - An act of identifying hazards, evaluating the risks posed by the hazards, including the potential consequences and likelihood of such consequences, and identifying risk controls.

RISK CONTROL (*API RP 75, 4th Edition*) - The actions (human or otherwise), equipment, or administrative measures to be established, implemented, or maintained to eliminate, reduce, or mitigate the identified safety and environmental risks, including risks from the interactions of individuals with each other, equipment, processes, and systems.

ROLE (*API RP 75, 4th Edition*) - A function assigned to a person.

SKILL (*API RP 75, 4th Edition*) - A person's ability to apply knowledge and demonstrate proficiency in performing a role or work.

ACRONYMS

API RP 75 – American Petroleum Institute Recommended Practice 75

COS VEB WG – Center for Offshore Safety Verifying Existing Barriers Work Group

BOP – Blowout Preventer

LOPC – Loss of Primary Containment

OEM – Original Equipment Manufacturer

OIM – Offshore Installation Manager

P&ID – Piping and Instrumentation Diagram

SEMS – Safety and Environmental Management Systems

4. INFORMATIVE REFERENCES

API RP 75, 4th Edition – Safety and Environmental Management System for Offshore Operations and Assets (2019)

Bow Ties in Risk Management (CCPS), Chapter 6 – Barrier Management Program (2018)

IOGP Report 544 – Standardization of Barrier Definitions (2016)

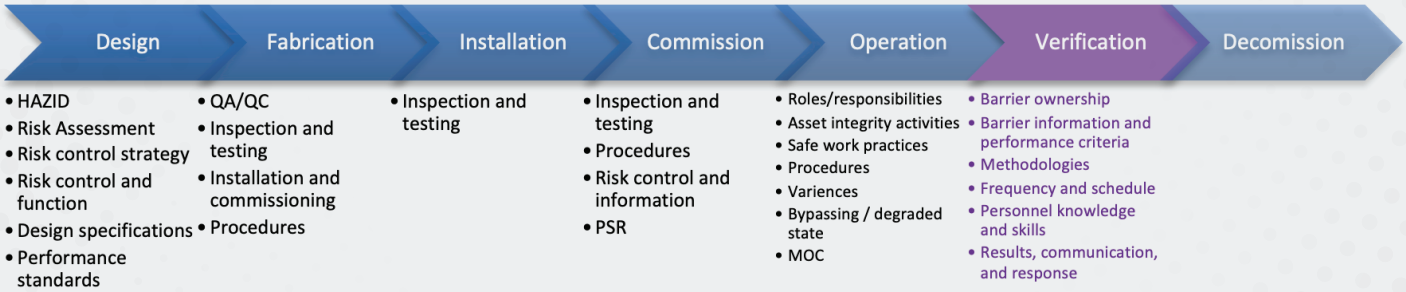
PSA 29.01.2013 – Principles for Barrier Management in the Petroleum Industry (2013)

API RP 14C, 8th Edition (2017)

5. PURPOSE AND APPLICATION

The purpose of this document is to help companies prevent or mitigate major incidents by verifying the integrity and effectiveness of existing barriers. It is intended to be used as part of the development and/or improvement of a company's SEMS.

Figure 1 shows the life cycle of a typical barrier. As indicated in purple, the area of verifying existing barriers is one of many aspects of the overall life cycle of a barrier. Each of the aspects listed under Verification are addressed in this document.



6. APPROACH

This document is aligned with *API RP 75, 4th Edition* and is intended to support companies as they implement SEMS. The following is a partial list of topics within this document and how they link to SEMS (API RP 75).

- Barrier information links to the SEMS Information element
- Barrier ownership links to the Leadership and SEMS Interface Management elements
- Barrier inspections and testing links to the Procedures and Asset Design and Integrity elements
- Certain mitigative barriers link to the Emergency Preparedness and Response element
- Barrier verification links to the Evaluation and Improvement and the Knowledge and Skills elements
- Compromised, defective, or degraded barriers link to the Risk Assessment and Risk Controls element

This document assumes that the company has defined and identified its barriers according to their SEMS and that there will be some variability between companies in the number and type of barriers. With those assumptions, the document is intended to help the companies systematically and reliably verify the integrity and effectiveness of those existing barriers.

The following is a partial list of human and hardware barriers for illustrative purposes. A more extensive list is provided in the appendix.

- **HARDWARE BARRIERS**
  - Preventive
    - Pressure safety valve
    - Blowout preventer
    - Safety instrumented systems
  - Mitigative
    - Fire and gas detector
    - Ignition controls
    - Firefighting equipment
    - Lifeboat
- **HUMAN BARRIERS**
  - Preventive
    - Following an operating, maintenance, inspection, or testing procedure
    - Activating a blowout preventer
    - Responding to an alarm
  - Mitigative
    - Firefighting
    - Mustering
    - Decision to abandon
    - Deploying a lifeboat

7. BARRIER OWNERSHIP

Each barrier should have a designated owner. The owner should have the ability to actively monitor the barrier and the authority to take action to address any deficiencies (e.g., site supervisor). The owner is responsible for understanding the role of the barrier in preventing or mitigating a major incident, for regularly monitoring the integrity and effectiveness of the barrier, and for engaging line management to address any deficiencies. The barrier owner is not necessarily the Offshore Installation Manager (OIM), although the OIM does have ultimate work authority for the facility.

The barrier owner and/or delegate(s) should verify that barrier integrity and effectiveness is consistent with the performance criteria specific for that barrier (e.g., testing, routine surveillance/inspections, verification of human performance factors, etc.). When personnel discover that a barrier does not meet the performance criteria, the barrier owner should be notified immediately. This discovery could be made by an employee, a partner, or a contractor, so it's important that all entities understand the need and mechanism to notify the barrier owner.

8. BARRIER INFORMATION AND PERFORMANCE CRITERIA

For barriers that already exist, there should be information available to and accessible by personnel who have ownership and responsibility for the process of verifying that the barriers are effective or will be effective on demand. This information is generated or obtained through many of the elements of the SEMS and should include:

- Documentation on the role or function of the barrier and its relationship to other barriers in a given incident scenario
- Documentation on how the barrier prevents or mitigates a threat or consequence within the incident scenario
- Documentation on the systems the barrier depends on to function
- Documentation on how the barrier is operated or activated and its operating limits, including interfaces with people and the performance criteria
- Documentation on barrier maintenance procedures
- Documentation on how to respond if the barrier is:
  - **Compromised, defective, or degraded**
  - **Placed out of service**
  - **Changed**
  - **Bypassed**

- Documentation on the history of the barrier, both general regarding the barrier type, and specific, meaning this exact barrier, such as learnings from failures and management of barrier changes
- Interface agreements which may define the source on much of the documentation above

The information above is essential to the personnel responsible for barrier verification. Of particular importance is the role of the performance criteria. The performance criteria should include:

- The essential action or activity the barrier is expected to perform with a certain capacity and effectiveness (e.g., operator expertise, bubble-tight valve closure)
- Availability of the barrier when needed (e.g., reliability, survivability)
- The barrier's ability to function under relevant incident scenarios and loads (e.g., load resistance, robustness)
- The barrier's failure/acceptance criteria (e.g., corrosion allowance, industry codes, company standards, regulatory requirements)

For a hardware barrier, the performance criteria can include items such as integrity status (e.g., acceptable piping wall thickness), maintenance (e.g., last scheduled PM performed per schedule), and availability (e.g., relief valve in correct position).

For a human barrier, the performance criteria can include items such as training (e.g., procedure training completed on time), collective competency (e.g., sufficient skills on the facility), independent verification (e.g., supervisor present during critical task), and Emergency Response drill completion (e.g., executed on schedule and per plan).

9. BARRIER VERIFICATION METHODOLOGIES

Once the barrier information and performance criteria are established, barrier verification can be performed. The current status of each barrier should be evaluated against its corresponding performance criteria. The performance criteria should be documented in a way that enables clear and straightforward verification.

Barrier verification can be achieved through a variety of methodologies, some of which are described below. Each company should use a risk-based approach to determine the optimal method for verifying its existing barriers. Learnings over time may lead to adjustments to the approach.

Some barriers can be verified by direct human observation. An example would be an individual on rounds making a weekly check that a specific relief valve is in the open position and car sealed open. It would not be sufficient only to rely on the P&ID to verify that the valve is available. Another example would be a supervisor being present and overseeing a critical step in a procedure being performed. While the individual might have the sufficient knowledge and skills, independent verification provides a method to reduce the likelihood of human error during the critical step.

Another verification method is preventative maintenance, inspection, and testing. Examples include firewater pump maintenance, blast wall structural inspection, and BOP pressure and function tests. When these activities are performed on time and per procedure, it provides verification that hardware barriers have integrity and are expected to perform as intended.

Other barriers can be verified by monitoring. For example, the fluid column can be monitored during well intervention activity. Barrier verification can occur both in the field and in the office, whichever is most appropriate.

SEMS audits may also serve as a method to survey the management system elements related to maintaining barriers, as well as how the management system is supporting barrier health overall.

10. BARRIER VERIFICATION FREQUENCY AND SCHEDULE

The frequency of verification will be specific to each particular barrier. These frequencies should be established by subject matter experts and approved by management, and consider OEM recommendations and industry standards, as applicable. Frequency schedules should also comply with applicable regulatory requirements. This applies to both hardware and human barriers. These frequencies should be based on risk and may vary from pre-use, daily, weekly, monthly, yearly, or multi-year.

A typical work team faces ongoing challenges to complete tasks related to maintenance, inspection, testing, and ongoing operations. Scheduled plans are routinely rationalized and adjusted, and work reprioritization is a regular occurrence. When a site's schedule becomes challenged, it is normal to extend target dates for these planned activities. However, given the importance of barriers in preventing or mitigating major incidents, site leadership should prioritize barrier verification activities accordingly. Prior to barrier verification being deferred from the established schedule, the barrier owner should be informed to determine if a risk assessment is needed and whether the operation should continue with the deferral.

11. KNOWLEDGE AND SKILLS OF VERIFICATION PERSONNEL

Verification of existing barriers should be performed by personnel with the appropriate knowledge and skills to verify whether the barrier is meeting performance criteria or if there are deficiencies. The personnel verifying barriers should understand the basic intent of the barrier, the function of the barrier, and its role in the overall barrier strategy. For example, if the barrier to be verified is a relief valve, the verifier should have knowledge of how the valve works, what results occur when the valve is activated, and the consequences of valve failure. In addition, the verifier should be familiar with performance criteria associated with this valve.

In most cases, personnel with the required knowledge and skills to verify existing barriers are available within the company. In some cases, there may be a need to enhance an individual's skills and knowledge to enable completion of a required verification. The company is responsible for determining the appropriate knowledge and skills required for each verification activity, identifying and training the individual(s) who will conduct those verifications, and assuring the appropriate level of knowledge and skills is maintained.

12. VERIFICATION RESULTS, COMMUNICATIONS, AND RESPONSE

After the verification activity has occurred, the results should initiate follow-up communication and response.

RESULTS OF BARRIER VERIFICATION

Verification results typically indicate one of the following:

1. Barrier meets performance criteria
2. Barrier is compromised, defective, or degraded
3. Barrier is out of service
4. Barrier is bypassed

Results should be documented to enable communication to the barrier owner and any other appropriate personnel, as well as stewardship of any action items.

If a barrier does not meet performance criteria, there may be degrees of deviation that introduce varying levels of risk (e.g., scheduled maintenance overdue vs. critical safety valve inoperable). The timing of communication and response activities can be established based on the associated risk.

COMMUNICATION OF BARRIER VERIFICATION RESULTS

Stop Work Authority should be applied for any instance where verification results present an imminent risk.

Verification results that do not meet performance criteria should be promptly communicated to the designated barrier owner and to management to determine the need for any follow-up actions and the corresponding urgency to address them.

Verification results that meet performance criteria should be communicated to the barrier owner and to management on a regular basis as agreed by management to provide insight to the ongoing performance of SEMS as related to verifying effective barriers.

Management should establish criteria for using the collective verification results to inform future verification schedules and activities.

Criteria for communication of barrier verification results beyond the barrier owner, as needed, should be established and implemented.

RESPONDING TO VERIFICATION RESULTS

For verification results that do not meet performance criteria, the barrier owner should work with the appropriate technical, operations, and management representatives to determine action items to address any gaps. Action items should be assigned to a responsible person and then stewarded to closure, at which point the barrier will meet the

performance criteria.

Verification results should be evaluated for opportunities to improve applicable documents, processes, and programs, such as:

1. Risk management
2. Barrier strategy
3. Barrier design
4. Barrier information and performance standard

For barriers that are not readily able to be brought into line with the performance criteria, a risk assessment should be performed to determine if further action is appropriate.

Management should periodically analyze verification results to respond to potential indications of risk.

13. APPENDIX – EXAMPLES AND SEMS ELEMENTS

EXAMPLE CASES

EXAMPLE CASE #1 (HARDWARE BARRIER): SHUTDOWN VALVE ACTUATOR FAILURE

On a hypothetical offshore platform, SDV-123 is a boarding valve (first valve on) and is considered an existing barrier for the facility. In the case of a loss of containment on the platform, its function is to isolate the inventory of hydrocarbons feeding the process.

The maintenance supervisor on the platform has been assigned as the owner for SDV-123. He understands the importance of the valve and regularly monitors its status. The performance criteria for SDV-123 includes completing preventative maintenance and function testing according to the Company's SEMS. As the barrier owner, the maintenance supervisor checked the records to verify that the preventative maintenance for SDV-123 was completed on schedule and that the most recent test was successful. Because the maintenance supervisor has shared the documented performance criteria with the crew and reinforced the details through regular communications, they have been instructed to inform him of any circumstances when the performance criteria for SDV-123 is not being met. The maintenance supervisor periodically reviews the performance criteria with the crew to reinforce their understanding.

However, during a planned shutdown, the actuator for SDV-123 fails, rendering the valve unavailable to perform its function. The technician who identified the failure immediately notifies the maintenance supervisor since he is the barrier owner. The maintenance supervisor immediately confers with the OIM, and the OIM notifies the asset manager. Since the performance criteria for SDV-123 includes availability to function on demand, they decide to postpone start-up of the platform until the situation can be resolved. They promptly order a replacement actuator from shore and the OIM requests a risk assessment to help determine if there is an option to start up safely in the interim until the replacement actuator could be delivered and installed in a few days.

Following the risk assessment, the asset manager determines that the platform can safely be restarted with interim mitigations in place. Alternative barriers are provided by two functioning SDVs downstream of SDV-123, and the team confirms that the condition of the piping downstream of SDV-123 is adequate. Regular rounds/surveillance at the affected area are increased. Communication protocol between the relevant platform teams are upgraded and tested. The team also limits cargo off-loading to/from the platform to must-do items only until SDV-123 can be restored. Any critical lift requirement during this period will be escalated to the asset manager for approval. All other related barriers are evaluated and deemed to be acceptable.

The OIM widely communicates the status and plans to personnel on the platform.

The asset manager informs the asset leadership team of the situation and the decision to start up with interim mitigations until the actuator can be replaced.

EXAMPLE CASE #2 (HUMAN BARRIER): SHUTTING IN A WELL UPON INFLUX BELOW BOP

On a hypothetical offshore drilling rig, certain actions taken by the Driller are considered to be a barrier to preventing a surface blowout. In the event of an influx below the BOP, the Driller must respond by shutting in the well to prevent uncontrolled hydrocarbon release to the rig floor. This action by the Driller is considered a human barrier.

The Company established the following performance criteria for the barrier of shutting in the well:

- Whenever flow is detected, the Driller is to self-initiate shut-in of the well without any further approval
- All personnel authorized to activate the system are included in the drills and trained to operate the well shut-in system.
- Well control drills are conducted to ensure that drilling personnel can shut-in the well in the shortest time possible. The drills are held at least weekly with each crew. The results of drills are assessed and recorded in the daily drilling reports.
- Detailed rig and well-specific shut-in procedures are developed and posted on the rig floor. This procedure is practiced during drills, so all crew members know their roles and responsibilities.

The Company has assigned the Wells Supervisor to be the barrier owner. As such, she regularly checks on the performance criteria to ensure that they are being met. She knows that if any of the performance criteria are not being met she needs to engage the asset leadership to determine if operations should continue, if a risk assessment should be performed, and/or if additional interim barriers should be established.

Some of the activities undertaken by the Wells Supervisor to confirm barrier status include:

- checking drill records to verify that they are occurring weekly and that the appropriate drilling personnel are included in drills
- periodically walking the rig floor to verify that the shut-in procedures are clearly posted
- conversing with the drillers to verify that they understand their role as a human barrier for this scenario

EXAMPLES OF BARRIERS

These examples are provided as reference and are not intended to be all inclusive.

EXAMPLES OF HARDWARE BARRIERS

- Subsurface safety valve
- Surface safety valve
- Underwater safety valve
- Pipeline isolation valve
- Boarding shutdown valve
- HIPPS (surface and subsea)
- ESD
- Vented gas detection system
- Pressure safety / relief valves / blowdown systems
- Surface gas lift SDV
- Fire detection
- Surface and subsea blowout preventer
- Diverter when used with surface BOP riser
- Snubbing unit pressure control system
- Coiled Tubing pressure control system
- Wireline pressure control system
- Logic solver (or other software that supports hardware barriers)
- Lifeboats/TEMPSCs
- Station keeping systems
- Emergency disconnect systems

EXAMPLES OF HUMAN BARRIERS

- Actions to activate a hardware barrier, for example:
  - BOP
  - ESD
  - EDS (Emergency Disconnect System)
- Response to process alarms and upset conditions (e.g., outside safe envelope)
- Response to emergencies (e.g., decision to abandon facility)
- Competency to perform a critical task, for example:
  - Breaking containment
  - Energy isolation
  - Performing a critical lift over live process equipment
- Operating in accordance with procedures (performing critical steps in the procedure)

SEMS ELEMENTS FROM *API RP 75, 4TH EDITION*

- Leadership
- Managing Interfaces
- Risk Assessment and Risk Controls
- Procedures
- Safe Work Management and Safe Work Controls
- Knowledge and Skills
- Asset Design and Integrity
- Management of Change
- Pre-Startup Review
- Emergency Preparedness and Response
- Incident Investigation and Learning
- Evaluation and Improvement
- SEMS Information

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