[For Internal Use by BSEE]

Evaluating Proposed Use of New Technology on the Outer Continental Shelf

BSEE Standard Operating Procedure for Evaluating the Proposed use of New Technology Under Title 30 Code of Federal Regulations Part 250

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Technical Direction Letter #001, Deliverable C – BSEE's Process Guide

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Acronyms

ALARP	As Low As Reasonably Practicable
AIS	Automatic Identification System
APD	Applications for Permit to Drill
APM	Applications for Permit to Modify
ANL	Argonne National Laboratory
BN	Bayesian Networks
BOP	Blowout Preventer
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulations
DWOP	Deep Water Operations Plan
ERA	Environmental Risk Assessment
ESD	Event Sequence Diagram
ETA	Event Tree Analysis
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes, Effects, and Criticality Analysis
FTA	Fault Tree Analysis
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HMI	Human Machine Interface
HPHT	High Pressure High Temperature
IPL	Independent Protection Layers
LOPA	Layer of Protection Analysis
MAH	Major Accident Hazard
MORT	Management Oversight Risk Tree
MPB	Multiple Physical Barrier
MPD	Managed Pressure Drilling
NDE	Non-Destructive Examination
OCS	Outer Continental Shelf
PFD	Process Flow Diagram
P&ID	Process and Instrument Diagram
PRA	Probabilistic Risk Assessment
PrRA	Preliminary Risk Analysis
QRA	Qualitative Risk Assessment
RBD	Reliability Block Diagram
RFI	Request for Information
SERENE	Safety and Risk Evaluation using Bayesian Nets
SCSSV	Surface Controlled Subsurface Safety Valve
SME	Subject Matter Expert
SOP	Standard Operating Procedure
TAS	Technical Assessment Section
U.S.	United States

Introduction

This *Standard Operating Procedure (SOP) for the Evaluation of Proposed New Technology* was developed to assist Bureau of Safety and Environmental Enforcement's (BSEE's) reviewers and engineers in the evaluation of submissions received that reference new technology. These submissions may cover a range of requests from the Oil and Gas industry including: project specific Deep Water Operations Plan (DWOP), Applications for Permit to Drill (APD), Applications for Permit to Modify (APM), Sustained Casing Pressure, Enhanced Recovery, Platform Verification, Pipeline Applications and Structure Applications. This list is not comprehensive since new technology may also be referenced in "other" relevant submission types. **Figure 1** provides a snapshot of submissions that may include new technology requests. Operators may also request conceptual approval of non-project specific new technologies through the BSEE Technical Assessment Section (TAS). BSEE requires the Operator to provide supporting information as part of their submittal to demonstrate that the proposed new technology presents an increased or equivalent level of safety in accordance with current Outer Continental Shelf (OCS) practices.

This SOP is the culmination of an extensive review of the applicable regulations, existing processes, forms, and various Notices to Leaseholders. It is intended to assist BSEE personnel in determining submission requirements for submittals that reference new technology.

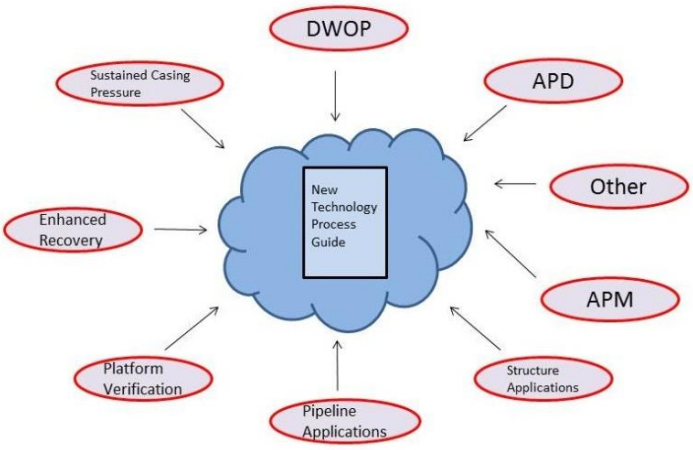

Figure 1: Relationship of New Technology Process SOP to other BSEE Permits

This SOP is organized into five sections to guide the BSEE engineer with reviewing submissions proposing the use of new technology on the OCS. The sections of this guide include:

- Background on New Technology Submissions to BSEE
- Section 1: How to Validate a New Technology Assessment
- Section 2: How to Validate the Operator's Risk Assessment
- Section 3: How to Validate the Operator's Barrier Analysis
- Section 4: How to Review New Technology Submission for Acceptance

Case studies containing different applications of new technology are included in this SOP to provide examples of the type of assessments and analysis that should be received from an Operator. These case studies can be found in **Appendix A: Case Studies**.

Each section of this SOP contains Step/Action Tables, clarifying information and important terms and definitions to assist BSEE engineers with review submissions received from the Operator.

A summary of each section of this SOP is found below:

Section 1: How to Validate a New Technology Assessment
This section outlines procedures that BSEE engineers should use to determine if new technology is going to be proposed in offshore exploration and production as well as the items that must be met to satisfy requirements of a proposed new technology application submittal.

Section 2: How to Validate the Operator's Risk Assessment
This section provides an overview of risk assessments, the identification of major accident hazards and critical barrier system functions. It also includes procedures for BSEE engineers to use to verify the Operators risk assessment results.

Section 3: How to Validate the Barrier Analysis
This section contains an overview of barrier analysis including the introduction of the Barrier Model Template and key features of the model. It also include procedures for BSEE engineers to use to evaluate the Operator barrier analysis, including the linkages of barrier element life cycles phase attributes to associated success criteria.

Section 4: How to Review New Technology Submissions for Acceptance
This section includes procedures for BSEE engineers to review new technology submissions received from Operators. It includes a checklist that can be used to expedite the review process.

How to Use This SOP

When using this SOP, BSEE Engineers should first read this entire SOP to be familiar with procedures contained herein. Beginning in **Section 1: How to Validate a New Technology Assessment**, engineers should follow the instructions outlined in each part, which includes "Step/Action Tables" and "Important Definitions" related to that Section. **Figure 2** provides a visual overview of the workflow progression involved with a new technology submission once submitted to BSEE for review. The workflow diagram shows the various sections of this SOP for easy reference. This workflow is patterned after the workflow that Operators use to prepare a new technology submission. **Appendix B: Operator New Technology Proposal Development and Submission Checklist** is the checklist that Operators use for their new technology submissions, which should be helpful for engineers to become familiar with the contents of a complete submission package.

It is important to note that many new technology applications will be considered as part of a project specific DWOP or other permits submitted to BSEE, including APDs, APMs, Sustained Casing Pressure, Enhanced Recovery, Platform Verification, Pipeline Applications and Structure Applications, among others. Additionally, the use of new technology may also be involved with Alternative Compliance and Departure requests, which the Operators must submit to BSEE.

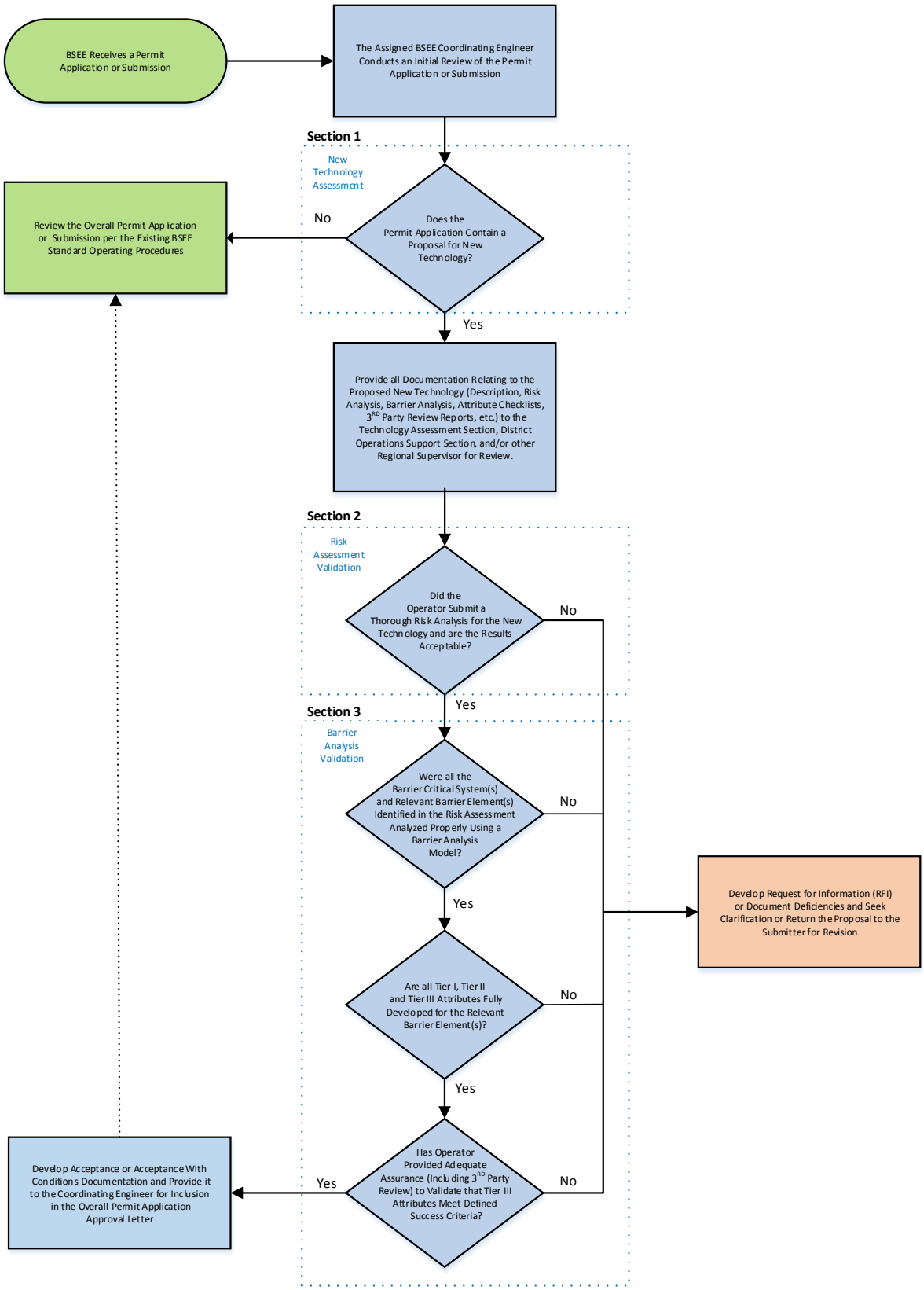

Figure 2*:* BSEE New Technology Evaluation Workflow

Background on New Technology Evaluation for Submissions to BSEE

This section provides guidance for how to define "New Technology" as well as contains a detailed checklist for BSEE to review submissions by Operators.

Part 1: How to Define New Technology for a New Technology Submission

New or Unusual Technology

Regulatory guidance for how BSEE is to define "New Technology" can be found within 30 Code of Federal Regulations (CFR) §250.200(b) whereby, "New or Unusual Technologies," is defined as equipment or procedures that:

1.) Have not been used previously or extensively in BSEE OCS Region;
2.) Have not been used previously under the anticipated operating conditions; or
3.) Have operating characteristics that are outside the performance parameters established for this part.

For instance, 30 CFR §250.292(n) requires, "A discussion of any new technology that affects hydrocarbon recovery systems," be included in a DWOP submittal, one of many submission types an Operator is required to send to BSEE.

Operators continuously discover new and existing technology applications for many areas of oil and gas exploration and production. To discuss the requirements of the new technology, the Operator is to arrange a Preplanning Conference meeting with BSEE where BSEE is to make determinations if the new technology meets the definition of "New or Unusual Technology" found within 30 CFR §250.200(b). If acceptable, BSEE and the Operator will have determined the appropriate category of the new technology or existing technology application. New technologies that the Operator has determined do not contain barrier criteria are submitted to BSEE for review and they accept through steps already in place within current regulatory framework. The Operator then takes the results of the Preplanning Conference meeting, conduct their analysis per the Operator's guide for *Assessing the Use of New Technology on the Outer Continental Shelf*, and submit the full set of documents to BSEE for acceptance.

This SOP focuses on new technology equipment or procedures that have been determined, first by the Operator and then during the Preplanning Conference meeting with BSEE, to be specifically part of the oil and gas and sulfur barrier within the requirements of 30 CFR §250.200(b).

Requests for Alternate Compliance or Departures Employing New Technology

BSEE's regulatory guidance within 30 CFR §250.408 allows the Operator to use alternative procedures or equipment during drilling operations after meeting the requirements of 30 CFR §250.141. This includes discussing the alternative procedure or equipment and receiving written approval from the District Manager. In addition, 30 CFR §250.409 allows the Operator to obtain departures from drilling requirements after meeting the requirements of 30 CFR §250.142 and receiving approval from the District Manager. These requests are usually part of the APD submittal process. When new technology is part of these requests, the Operator shall follow the process described for new technology, or existing technology in unknown condition, in making its submittal to BSEE.

Part 2: How to Identify and Route Submissions Incorporating New Technology Proposals

Operator's requests to use a new technology or existing technology in unknown conditions that will affect the barrier are identified separately from the permit application process. It will also be distinct from new technology that was previously determined by BSEE and the Operator not to affect the barrier. A new technology request evaluated by BSEE separately from the rest of the permit application process. From the point of initial identification until the Final Review, the new technology request and the permit application are reviewed independently within BSEE. *As soon as BSEE becomes aware of a new technology submission, the Chief of OORP shall be notified.*

The dedicated Technology Assessment Section should review the new technology request as a team. If new technology request is processed by the District Operations Support Section, the senior engineer would perform the initial review and determine the need, if any, for further internal BSEE reviews by specific internal teams. The responsibility for review and acceptance will be either by a review team or by a Senior Engineer reviewer.

All new technology documents; risk and barrier analysis, attribute checklists and 3rd party review reports submitted by the Operator will be reviewed, validated and accepted or not by the BSEE Technology Assessment Section or District Operations Support Section using the flow chart and checklist methodology. BSEE will issue Requests for Information (RFI) to the Operator when required. BSEE will then issue an acceptance or acceptance with condition for the new technology application. The new technology submittal will then be rejoined to the permit application process for a final review.

Section 1: How to Validate a New Technology Assessment

This section includes guidance on how to determine if the Operator's submission involves the use of new technology. BSEE regularly receives requests by the Operator to use new technology include all types of permit applications, such as APDs, APMs, Structural Installations, Pipeline Permits, PVPs, Enhanced Recovery and Pressure Maintenance Requests, and SCPs, and not just DWOP permits.

Part 1: Identifying the Type of New Technology Submission

The Operator has the responsibility to suggest to BSEE, and get acceptance to use, new technology for exploration, development or production activities on the OCS. BSEE must accept the Operator's request to use known technology in an unknown condition. Initially, the new technology does not have to meet the definition of 30 CFR §250.200(b). It is only necessary that the equipment or procedures meet the new technology application per 30 CFR §250.292(n). BSEE requires a review of all equipment or procedures that meet this requirement. This ensures that all new technology applications are properly screened and a correct determination was made regarding barrier application. There are four categories to consider in the first part of the new technology assessment:

1. Known Technology, Known Conditions
2. Known Technology, Different or Unknown Conditions
3. New Technology, Known Conditions, and
4. New Technology, Different or Unknown Conditions.

BSEE should follow the steps in **Table 1** below to assess the categorization of the Operator's proposed use of new technology.

Table 1: Step/Action – How to Categorize the Operator's Proposed Operations

<table>
<tr><th>Step</th><th colspan="2">Action</th></tr>
<tr><td rowspan="5">1.</td><td colspan="2">Based on the Operator's proposed use of new technology, review the four categories below.</td></tr>
<tr><td colspan="2">Category 1 – Known Technology, Known Condition. For this workflow, there are no expected changes from traditional submissions. This falls inside the current conditions and no additional work is necessary from the owner/Operator's standpoint. No additional risk assessments or barrier assessments are required for this workflow.</td></tr>
<tr><td colspan="2">Category 2 - Known Technology, Different or Unknown Conditions. Known Technology, Different or Unknown Conditions. For applications concerning well-known and established technology in different or unknown conditions, this workflow will be followed by -Operator to evaluate the application. Unknown conditions can include highly corrosive well fluids or low temperatures that will need to be further assessed in the Barrier Analysis. It is important to note that Unknown condition does not mean that Operator is not aware of the conditions but it indicates that Operator does not have an experience in the subject environment. The process will follow a HAZID, review, assessment and analysis, and screening and acceptance. These additional steps include barrier and risk analysis that was not included in the Category 1 workflow. These additional documents are required to be supplied to BSEE before review of this type of application. Examples of Known Technology, Different or Unknown Conditions include:
High Pressure High Temperature (HPHT) and Sour Well Production with Surface Controlled Subsurface Safety Valve (SCSSV) (Case Study 4, Appendix A: Case Studies)
Ultra-Deepwater Drilling (Case Study 1, Appendix A: Case Studies)</td></tr>
<tr><td colspan="2">Category 3 - New Technology, Known Conditions. This workflow will be followed when new technology is applied in known conditions. Examples of Known Technology, Different or Unknown Conditions include:
Deepwater Drilling with a Surface Blowout Preventer (BOP) from a Floating Facility (Case Study 2, Appendix A: Case Studies)
Managed Pressure Drilling in the Gulf of Mexico (Case Study 3, Appendix A: Case Studies)</td></tr>
<tr><td colspan="2">Category 4 – New Technology, Different or Unknown Conditions. Operations in this category includes unknown factors both involving technology and conditions. This will ultimately be the most complex submittal type, both for the owner/ Operator, as well as the BSEE reviewer.
Arctic Drilling with a Capping Stack (Case Study 5, Appendix A: Case Studies)</td></tr>
<tr><td rowspan="3">2.</td><td colspan="2">Identify which category best represents the Operator's proposed plan.</td></tr>
<tr><th>If</th><th>Then</th></tr>
<tr><td>Category 1</td><td>STOP – no additional review needed for risk assessments or barrier analysis.</td></tr>
<tr><td>Category 2, 3 or 4</td><td>The Operator should schedule a preplanning conference with BSEE to review his or her proposed use of new technology.
Proceed to Part 2 of this SOP.</td></tr>
</table>

Figure 3 illustrates the framework based on the category of new te4chnology. Additional risk assessment and barrier analysis will be needed for all new technology classified as category 2, 3, or 4. Category 1 may not require any additional assessment or analysis.

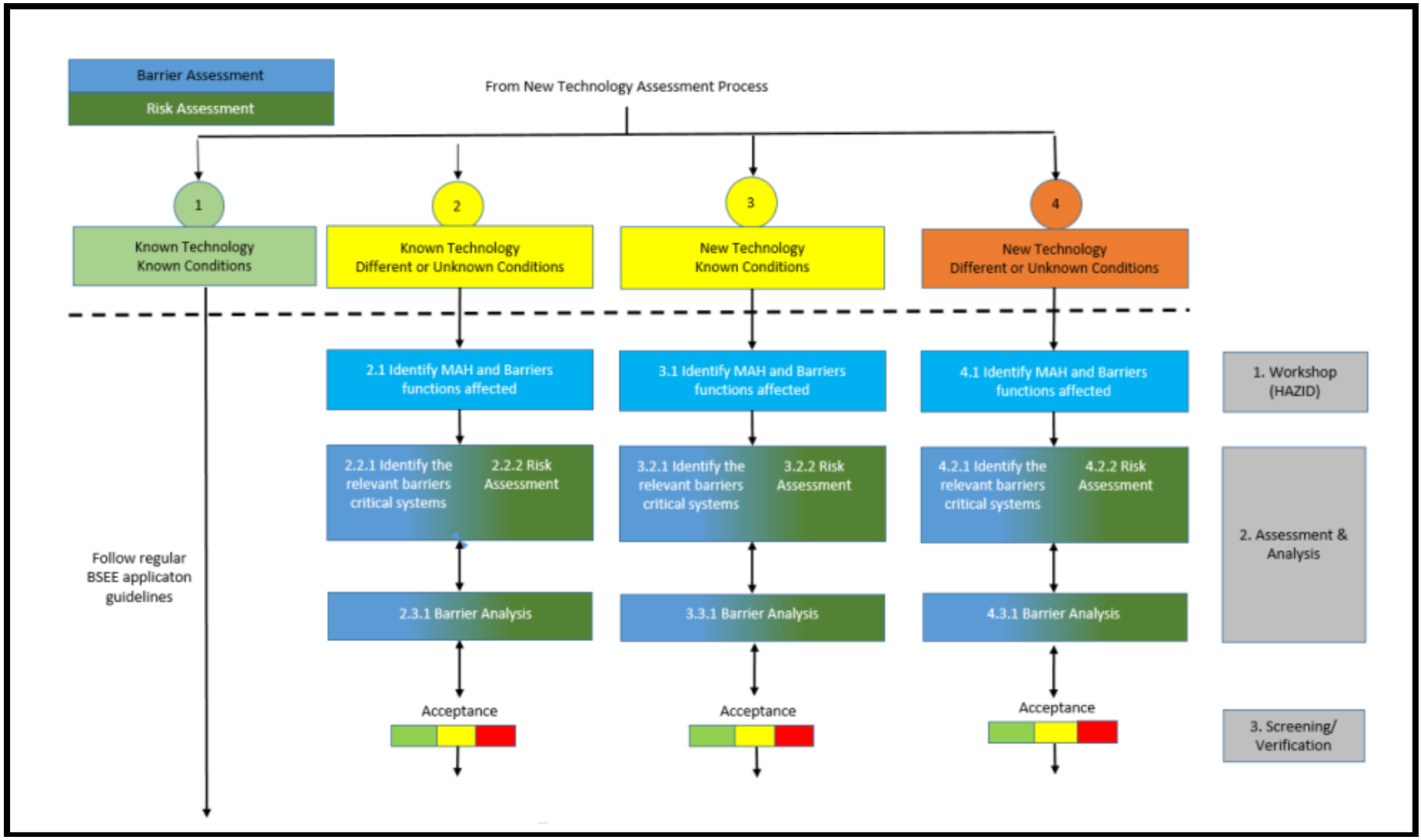

Figure 3: New Technology Assessment Framework

Part 2: What to Discuss with Operators during the Preplanning Conference

Operator should schedule a preplanning conference with BSEE to discuss their proposed use of new technology. During the Preplanning Conference, BSEE should be prepared to discuss the various aspects of the Operator's proposed use of new technology and identify key decision and witnessing points. This preliminary discussion will help BSEE understand the Operator's new technology concept and identify any additional information or actions that the Operator may need to submit as BSEE considers the application's acceptance.

During the Preplanning Conference, if BSEE determines that the new technology will affect the barrier function then the Operator will conduct a risk and barrier analysis evaluation. Similarly, during the Preplanning Conference, if BSEE agrees to use an existing technology in a new or unknown condition then the Operator will perform a barrier and risk analysis. The Operator should inform BSEE of any previous submittals requesting use of this new technology by other programs for other applications if he has knowledge of them. In addition, during this discussion, BSEE may suggest the use of third-party reviews of the risk and barrier analysis, particularly for **Category 4** submissions or other factors.

BSEE should be prepared to discuss additional information that the Operator develops surrounding his or her use of new technology. **Table 2** describes important definitions for BSEE to consider while meeting with the Operator.

Table 2: Important Definitions – Barrier Function and Barrier Element

Term	Definition
Barrier Function	*A function that needs to be realized in order to prevent, control or mitigate a major accident hazard.* Example: Shut in well – to prevent a blowout, and mitigate uncontrolled well situation.
Barrier Element	*A physical element or a subset of physical elements that are needed as part of the barrier critical system, in order for it to perform its intended function.* Example: Barrier elements needed to close and seal on open hole is the blind shear, the blind shear ram and the control system and power supply.

During the Preplanning Conference with the Operator, BSEE should anticipate the review and discussion of the Operator's documents listed in **Table 3**.

Table 3: Step/Action – How to Prepare for the Preplanning Conference with the Operator

Step	Action	
1.	Using the description of barrier functions and barrier elements discussed above, does the Operator's proposed use of new technology relate to a specific barrier function or barrier element	
	If	**Then**
	Yes	The Operator should prepare a description of the barrier function and barrier elements involved in his or her operations. Go to **Step 2** in this table.

Step	Action	
	No	No additional risk assessments or barrier analysis is needed. **Note:** If BSEE determines that the new technology will *NOT* affect the barrier function, then the Operator does not have to conduct a risk and barrier analysis evaluation.
2.	Does the Operator's proposed use of the new technology the first application of its kind?	
	If	**Then**
	Yes	The Operator should prepare a summary of the new technology application detailing how it is a first application of its kind. Go to **Step 3** in this table.
	No	Go to **Step 3** in this table.
3.	Will the Operator's proposed new technology be used in new or unknown environments?	
	If	**Then**
	Yes	The Operator should prepare a summary of the new or unknown environments in which this new technology will be used. Go to **Step 4** in this table.
	No	No additional risk assessments or barrier analysis is needed. **Note:** If BSEE determines that the new technology will *NOT* affect the barrier function, then the Operator does not have to conduct a risk and barrier analysis evaluation.
4.	BSEE should be prepared to review and discuss the proposed use of new technology with the Operator during the preplanning conference, including the following: 1. The category of new technology from Part 1 2. The specific barrier function(s) and barrier element(s) involved in the operations. 3. If applicable, a discussion of how the use of new technology is a first application of its kind 4. The environments in which the new technology will be used 5. Which international or domestic industry standard(s) the Operator plans to use 6. Risk acceptance criteria 7. The verification methods that the Operator plans to employ (e.g., Internal Verification, 3rd Party Verification).	
5.	Following the Preplanning Conference with the Operator, go to **Section 2: How to Validate the Operator's Risk Assessment.**	

Following the Preplanning Conference, if the BSEE reviewer determines the Operator's proposed use of new technology is viable, the Chief, OORP should be notified. Once it appears likely that the Operator is proposing new technology, the BSEE reviewer should work closely with the Chief, OORP to ensure that all available resource including the regional personnel and external resources are available for BSEE to support the review of the new technology submission.

Section 2: How to Validate the Operator's Risk Assessment

This section describes BSEE's steps involved to verify the Operator's risk assessment of the new technology to identify Major Accident Hazards (MAH) and identify relevant barrier critical system(s). More detailed risk assessments, such as Quantitative Risk Assessments/Probabilistic Risk Assessments, may be needed based on the Operator's results of a preliminary risk assessment. This Section is divided into four parts.

- Part 1: How to Verify the Operator's Risk Assessment Methodology
- Part 2: How to Verify the Operator's MAHs
- Part 3: How to Verify the Identification of Affected Barrier Functions
- Part 4: How to Verify the Operator's Risk Assessment

Part 1: How to Verify the Operator's Risk Assessment Methodology

Risk Assessment Methodologies

There are a number of different methods that Operators can use to conduct a risk assessment. The selection of the Risk Assessment Methodology will depend on the results of the initial hazard identification.

Regardless of the method used, BSEE should verify that the Operator used standard recognizable risk methodologies. **Table 4** provides a brief description of the acceptable risk assessment methodologies for proposed new technology used in the OCS of the United States (U.S.). For a more detailed depiction, please **Appendix E: Risk Assessment Technical Note.**

Table 4: Acceptable Risk Assessment Methodologies

Risk Assessment	Description
Hazard Identification	The HAZID study is a brainstorming exercise of the possible causes and consequences of hazardous events.
Hazard and Operability (HAZOP) Analysis	The HAZOP study technique is a systematic review of the system design to identify and evaluate safety hazards of the system, and to identify operability problems that could compromise the system's ability to achieve the design intent.
Event Tree Analysis (ETA)	ETA is an analysis technique that uses decision trees to model the possible outcomes of an event that can produce an accident of interest.
Fault Tree Analysis (FTA)	FTA is a technique that graphically models how logical relationships between equipment failures, human errors, and external events can combine to cause specific accidents of interest.
Layer of Protection Analysis (LOPA)	LOPA is a technique to systematically identify and assess the number and strength of layers of protection against major accident hazards. This information is used to make decisions on existing or proposed layers of protection.
What-if Analysis	What-if analysis is a problem-solving approach that uses loosely structured questioning to (1) suggest upsets that may result in accidents or system performance problems and (2) make sure the proper safeguards against those problems are in place.
Bowtie Analysis	Similar to LOPA, bowtie analysis is a technique for identifying layers of protection for major accident hazards, but bowtie enables analysts to consider multiple scenarios simultaneously.
Failure Modes and Effects Analysis (FMEA)	FMEA is a reasoning approach best suited to reviews of mechanical and electrical hardware systems. The FMEA technique (1) considers how the failure modes of each system component can result in system performance problems and (2) makes sure the proper safeguards are in place.
Change Analysis	Change analysis looks logically for possible risk effects and proper risk management strategies in changing situations (e.g., when system layouts are changed, when operating practices or policies change, when new or different activities will be performed).
Trend Analysis	Trend analysis is a technique to analyze historical accident and near miss data over time to identify consistent trends to predict future accidents.
Pareto Analysis	Pareto analysis is a ranking technique based only on past data that identifies the most important items among many. This technique uses the 80-20 rule, which states that about 80 percent of the problems are produced by about 20 percent of the causes.
Relative Ranking/Risk Indexing	Relative ranking/risk indexing uses measurable features of an operation or facility to calculate index numbers that are useful for comparing risks of different options.

Risk Assessment	Description
Pairwise Comparison	Pairwise comparison is a risk ranking technique for multiple issues that relies on a collection of Subject Matter Experts (SMEs) systematically rating the relative risks between combinations of two issues.
Preliminary Risk Analysis (PrRA)	PrRA is a simplified approach to accident-based risk assessment. The main goal of the technique is to define the risk related to important accident scenarios.
Interface Analysis	Interfaces are An approach to systematically identify, assess and manage non-technical interface risks.
Management Oversight Risk Tree(MORT)	MORT is a comprehensive, analytical, disciplined method for determining the causes and contributing factors of major incidents.
Probabilistic Risk Assessment (PRA)	Probabilistic risk assessment is an integration of FMEA, FTA, and other techniques to assess the potential for failure.
Safety and Risk Evaluation using Bayesian Nets (SERENE)	The SERENE method is concerned with the functional safety of complex systems. Takes into account both random and systematic failures.
Integrated System Hazard Analysis	Specific integrated analyses are appropriate to evaluate interactions, such as Human – Human Interface Analysis; and, Machine – Abnormal Energy Exchange, Software Hazard Analysis.

Part 2: How to Verify the Operator's MAHs

As part of any risk assessment, BSEE must verify the Operators identification and documentation of any MAHs. MAHs are significant events that could occur during installation or operation. Because each application for an offshore installation is unique in terms of its design, operating environment and application of new technology it is impossible for the Operator to provide a standard definition of MAHs that fits every application. The most effective way to identify MAHs is by conducting an HAZID workshop, where SMEs apply their knowledge and experience to the task of identification. The following are examples of some of the MAHs to be identified:

- Fire
- Explosion
- Uncontrolled Flooding
- Major damage to the structure
- Loss of stability
- Loss of well control
- Release of dangerous substances (flammable, corrosive, pollutant, etc.)
- Collision or Allision
- Personal injury or death

The HAZID will form the baseline of any subsequent work and as such is an integral part of the Operator's application process. The focus of the HAZID will depend on which workflow is relevant; e.g. whether new conditions or new technology are most prevalent, or a combination of the two. The HAZID should identify if there are any possible degradations of barriers or an increase in the consequence of an unwanted incident identified. It should be an expressed focus of the HAZID workshop to identify unknowns related to the new technology and/or conditions, to ensure that the design takes into

account the threats and associated responses. For additional details, please refer to **Appendix C: Risk Assessment Technical Note**.

Part 3: How to Verify the Identification of Affected Barrier Functions and Barrier Critical Systems

Once the Operator completes the risk assessment and identified the MAHs, BSEE's next step is to verify if the Operator has identified the barrier functions and affected critical barrier system functions that are related to each MAH identified. **Table 5** provides important definitions that are helpful in verifying the Operator's identification of critical system functions.

Table 5: Important Definitions – Identifying Critical Barrier System Functions

Term	Definition	Example
Barrier Function	*A function that needs to be realized in order to prevent, control or mitigate a major accident hazard.*	Shut in well – to prevent a blowout, and mitigate uncontrolled well situation.
Barrier Critical System	*A defined system that by performing its intended function(s) realizes the barrier function, either alone or together with other barrier critical systems of the same barrier function.*	Casing/Cement, Wellhead, BOP, Marine Drilling Riser and Drill string.

Part 4: How to Verify the Operator's Risk Assessment

BSEE should follow the steps in **Table 6** to verify that the Operator has conducted a complete and appropriate risk assessment.

Table 6: Step/Action – How to Verify the Operator's Risk Assessment

<table>
<tr><th>Step</th><th colspan="2">Action</th></tr>
<tr><td>1.</td><td colspan="2">Yes □ No □ Did the Operator utilize an appropriate risk assessment methodology? (See Table 4)</td></tr>
<tr><td>2.</td><td colspan="2">Yes □ No □ Did the Operator identify all applicable MAHs associated with the proposed new technology?</td></tr>
<tr><td>3.</td><td colspan="2">Yes □ No □ Did the Operator address the key questions during the HAZID?</td></tr>
<tr><td>4.</td><td colspan="2">Yes □ No □ Did the risk assessment identify all applicable barrier critical system function(s) and barrier element(s) related to the new technology? (See Table 5)</td></tr>
<tr><td rowspan="3">5.</td><td colspan="2">Were the answers to steps 1 through 4 "yes"?</td></tr>
<tr><td>If Yes</td><td>If No</td></tr>
<tr><td>Accept the Risk Assessment Results. Proceed to Section 3.</td><td>STOP: Contact the Operator to discuss the risk assessment.</td></tr>
</table>

NOTE: BSEE senior management in the Office of the Director (or designee) should receive timely updates throughout the process. The Chief, OORP should be notified as soon as BSEE becomes aware of a submission involving new technology. The Chief, OORP will be responsible for working closely with regional personnel during the new technology evaluation process.

Section 3: How to Validate the Barrier Analysis

The Barrier Analysis involves the review of barrier(s) to understand what needs to succeed in order for it to perform its function(s). Typically, for this purpose a barrier model is developed and analyzed to determine the ways in which the barrier can succeed as well as fail to perform its function. A good understanding of the success logic is critical in determining the requirements and related activities for ensuring the integrity of the barrier.

Common modeling methods and techniques are used for building a barrier model for analyzing specific barriers especially when it involves new technologies. One of the prerequisites for barrier analysis is the identification of the major accident scenario(s) with relevant barrier(s) and their corresponding role(s)/function(s) in risk reduction. Once barriers and their relevant functions have been identified along with any critical systems, the next step is to develop a detailed barrier model. The barrier model will help identify what needs to succeed or work correctly in order for the barrier to function as intended.

Several methods are available to model barriers. The most suitable method depends on the barrier type, what information is needed and what the objective is for the barrier model. Barrier models reviewed by BSEE regarding new technologies included:

1.) Argonne National Laboratory (ANL) Multiple Physical Barrier (MPB) Approach
2.) Reliability Block Diagram (RBD)
3.) ETA/Event Sequence Diagram (ESD)
4.) FTA

Based on the review of barrier analysis applications in different industries and barrier modeling methods, a barrier model template along with definitions was developed. The template has a top down tree structure and is strongly influenced by the Fault Tree and ANL MPB approaches. This template will be a useful tool for BSEE and the Operators to perform barrier analysis in a systematic and structured manner.

The application of the barrier model template is intended to provide insight about the realization of a barrier function by identifying contributing critical systems and elements. The purpose of barrier analysis using the proposed barrier model template can be either to ensure the functionality of existing barriers in new conditions or environments, or to ensure that the new technology actually serves its intended purpose which is to realize the barrier function.

Part 1: Overview of Barrier Models

Barrier Model Definitions

Before introducing the barrier model template and its features, it is important to define the terms that will be used in association with the barrier model.

Table 7 provides important terms and definitions for each tier in the barrier model template. For additional details, please refer to **Appendix D: Barrier Analysis Technical Note.**

Table 7: Important Definitions for Barrier Modeling

Term	Definition	Example
Barrier Function	*A function that needs to be realized in order to prevent, control or mitigate a major accident hazard.*	• *Shut in well – to prevent a blowout, and mitigate uncontrolled well situation*
Barrier Critical System	*A defined system that by performing its intended function(s) realizes the barrier function, either alone or together with other barrier critical systems of the same barrier function.*	• *Casing/Cement, Wellhead, BOP, Marine Drilling Riser and Drill string*
Barrier Critical System Function	*A function that is performed by the barrier critical system in order to realize the barrier function, either alone or together with other functions of the same barrier critical system.*	• *Functions needed to be performed by the BOP to shut in well is to disconnect LMRP, strip drill string, close and seal on open hole, and shear drill pipe and seal well bore*
Barrier Element	*A physical element or a subset of physical elements that are needed as part of the barrier critical system, in order for it to perform its intended function.* These can include the following below:	• *Barrier elements needed to close and seal on open hole is the blind shear, the blind shear ram and the control system and power supply*
	Physical Tasks *Task performed automatically or initiated by a human action as intended by the design of the barrier element, in order to realize/perform the barrier critical system function.* Example: Power systems must deliver sufficient hydraulic power	• *Power systems must deliver sufficient hydraulic power*
	Operational Tasks *Human action that is needed by the barrier element or the barrier critical system in order to realize/perform the barrier critical system function.* Example: the Operator must activate the control system (push the button)	• *The Operator must activate the control system (push the button)*

Barrier Model Template

The barrier model template and breakdown structure are presented in **Figure 4**

Barrier modeling and analysis involves the review of barrier(s) to understand what needs to succeed in order for it to perform its intended function(s). Typically, for this purpose a barrier model is developed and analyzed to determine the ways in which the barrier can succeed as well as fail to perform its function. **Figure 4** provides an illustration of the barrier model template.

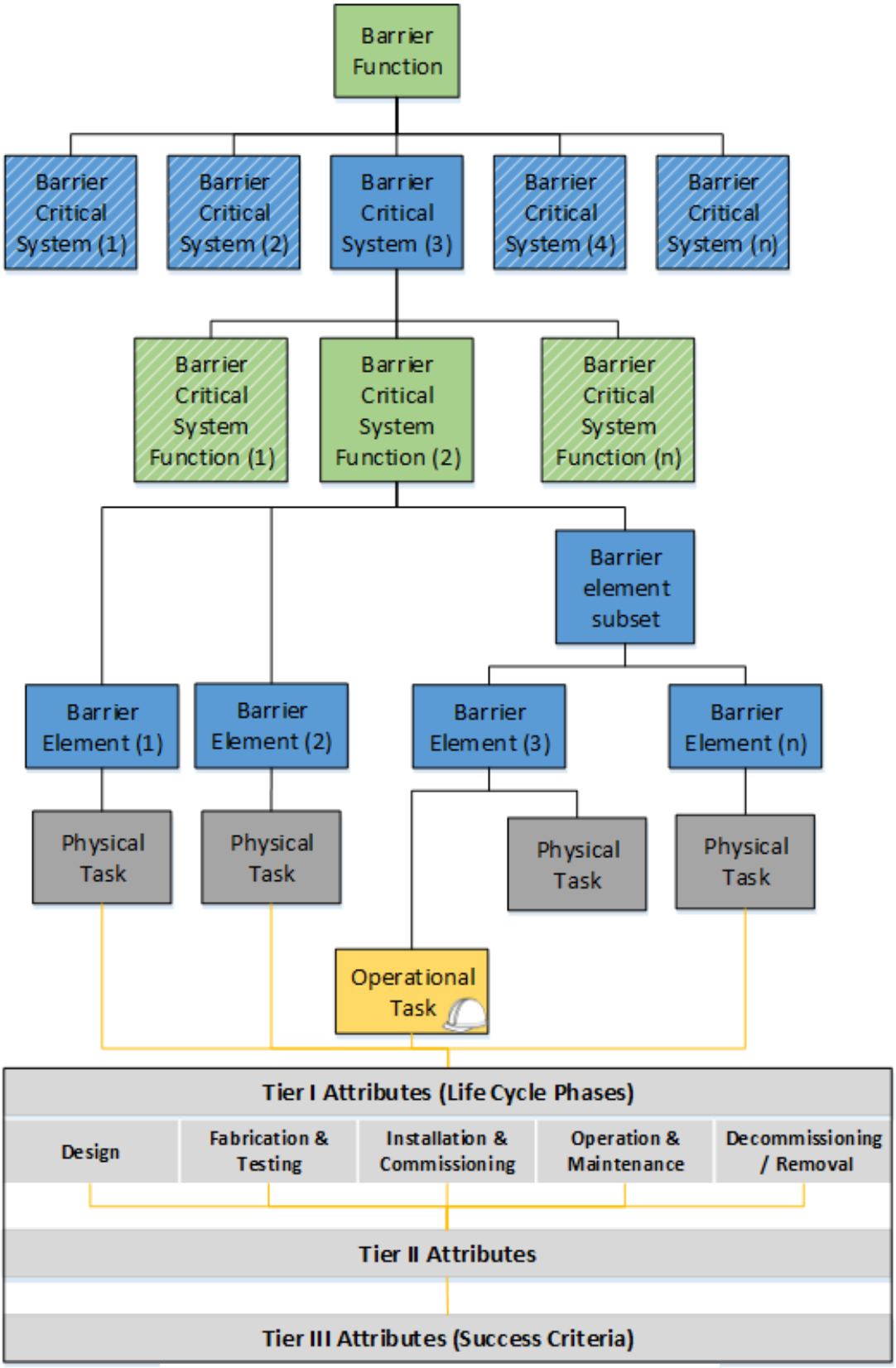

Figure 4: Barrier Model Template

A good understanding of the success logic is critical in determining the requirements and related activities for ensuring the integrity of the barrier. This success path logic enables the identification of interconnectivities and interdependencies early in the barrier analysis. The tree structure of the model helps in visualizing and thereby making it easier to identify interdependencies between systems and elements.

One of the prerequisites for barrier analysis is the identification of the major accident scenario(s) with relevant barrier(s) and their corresponding role(s)/function(s) in risk reduction. The first two blocks of **Figure 5** are examples of a Barrier Function and a Barrier Critical System as they are applied within the Barrier Model. This example is used to illustrate these two definitions.

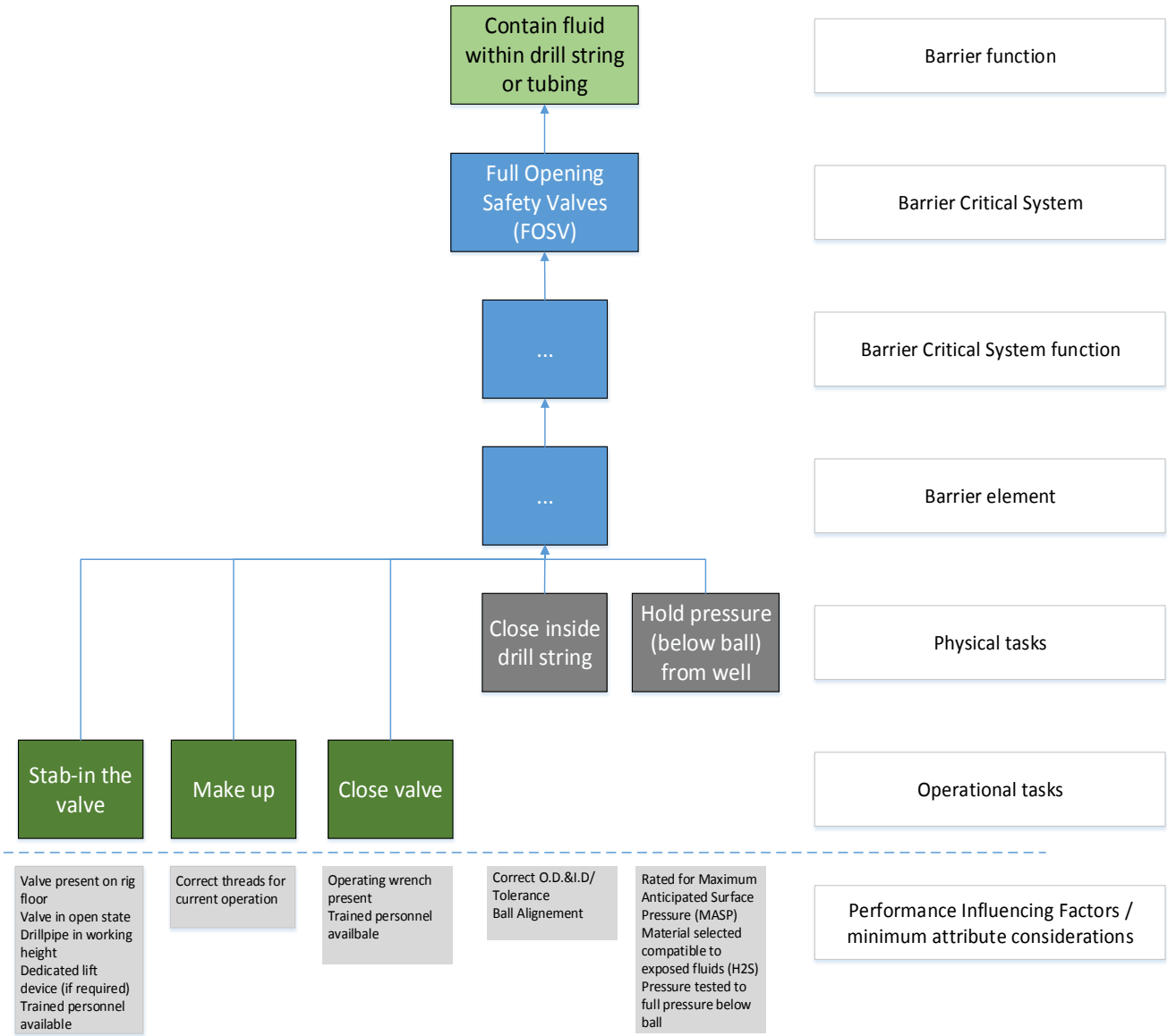

Figure 5: Barrier Model Highlighting Barrier Function and Barrier Critical Systems

The Operator must use the definitions to determine what Barrier Functions apply. BSEE must validate the Operator's identification of all Barrier Critical systems that relate to and are part of a given Barrier Function. In **Figure 5** above, only one Barrier Critical System is shown. However, it is likely that more than one Barrier Critical System will apply to a Barrier Function as shown in the Barrier Model Template above. It is also likely that more than one Barrier Function will apply to a proposed new technology. Once the Operator has identified the Barrier Function and Barrier Critical Systems have been identified, BSEE must verify if the Operator has conducted a risk assessment.

The risk assessment must focus on identifying MAHs that may exist and their effect on each Barrier Critical System and their associated *Tier III* attributes (see discussion on *Tier III* attributes below). BSEE reviewers should review the Operators submissions for completeness, to ensure each Barrier Function and Barrier Critical System has been identified and adequately assessed. BSEE reviewers should ensure that all required supporting documentation has been submitted to support the risk assessment, functionality tests, and associated *Tier III* attributes as required.

See **Appendix F: Barrier Analysis Technical Note** for key features of the barrier model template.

Barrier Attributes

Tier I Attributes

The first tier covers the life cycle phases that are usually assessed during the development of a new design as shown in **Figure 6**.

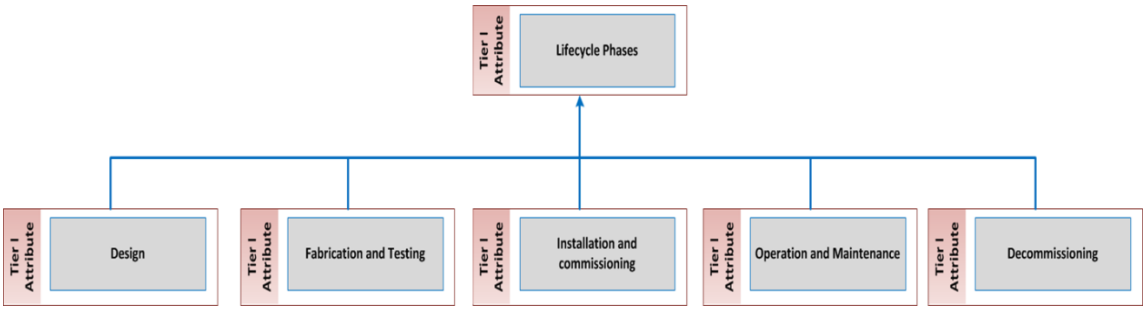

Figure 6: Tier I Attribute Types

Tier I attributes are identified in the submission. The *Tier I* attributes include:

- **Design** – The Operator will need to explain why the design is suitable and adequate to meet the barrier function. The Operator should compare the new technology to comparable existing technology and describe the benefits of the new technology.
- **Fabrication and Testing** –The Operator should articulate how the new technology has been procured and fabricated/constructed to meet the defined design specifications and that testing has been undertaken to confirm all of the defined design specifications have been met.
- **Installation/Commissioning** –The Operator should describe how the new technology will be installed correctly and how suitable commissioning tests will be completed before the systems are operated. The Operator should provide procedures for adequate storage, installation, testing and commissioning. The procedures should clearly explain how the barrier(s) installation and commissioning will not pose any immediate or future safety hazards.

- **Operation and Maintenance** – The Operator should provide information about the processes, procedures, maintenance and testing that will preserve the design function of the barrier. The Operator should clearly explain design limitations, procedures, operation and maintenance activities that specifically meet the design specification and procedural requirements for the new technology.
- **Decommissioning** – The Operator should provide information about the processes and procedures for the removal/decommissioning of the barrier. The Operator should provide information about the disassembly of the barrier and interactions with other equipment that need to be considered.

Tier II Attributes

The second tier breaks these down into aspects that are required to be assessed as part of each life cycle phase. For example, Design attributes can be decomposed into specific design parameters, which are driven by relevant Codes, Standards and Regulations as shown in **Figure 7.**

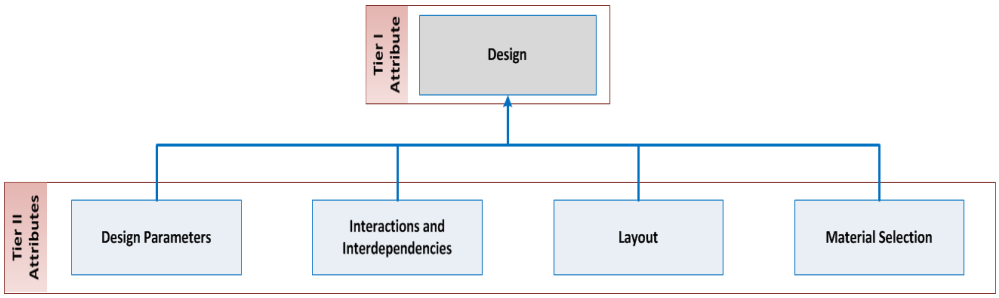

Figure 7: Tier II Attributes

Tier II Attributes – *Tier II* attributes support each phase of the *Tier I* attributes. **Table 8** provides a list of the minimum level of *Tier II* attributes that should be addressed in the submission.

Table 8: Tier II Attribute Descriptions

Tier II Attribute	Attribute Features
Design phase	Design Parameters
	Interactions / Dependencies
	Layout
	Material Selection
Fabrication and Testing phase	Material Procurement & Quality Assurance
	Welding and Non-Destructive Examination (NDE)
	Testing and Validation
Installation and Commissioning phase	Inspection
	Storage
	Examination Pre-installation
	Installation
	Testing and Validation Post-Installation
	Commissioning
Operation and Maintenance phase	Limits
	Procedures
	Operation

Tier II Attribute	Attribute Features
	Maintenance
Decommissioning/Removal phase	Process
	Disassembly
	Interaction / Dependencies

Tier III Attributes

Tier III details are usually derived from relevant codes, industry standards and technical specification. *Tier III* attributes are linked to each *Tier II* attributes within each of the life cycle phases. *Tier III* attributes require the greatest level of detail that should be submitted to BSEE for review and evaluation of any proposed new technology. The *Tier III* attributes detail the considerations that Operator assesses for each *Tier II* attribute. Each *Tier III* attribute is evaluated against the success criteria of the physical and operational tasks for the barrier element/ barrier critical system. With each *Tier III* attribute, Operators should provide supporting documentation for all testing, design specifications, third party testing and evaluation reports, and emergency procedures. BSEE reviewers will evaluate each of the *Tier III* attributes and supporting documentation to ensure each *Tier III* attribute meets the acceptable safety and risk criteria required by BSEE. **Figure 8** provides examples of *Tier III* attributes.

The Operator should ensure that all *Tier III* attributes are addressed in their submission. The Operator should address each *Tier III* attribute listed in **Figure 8**.

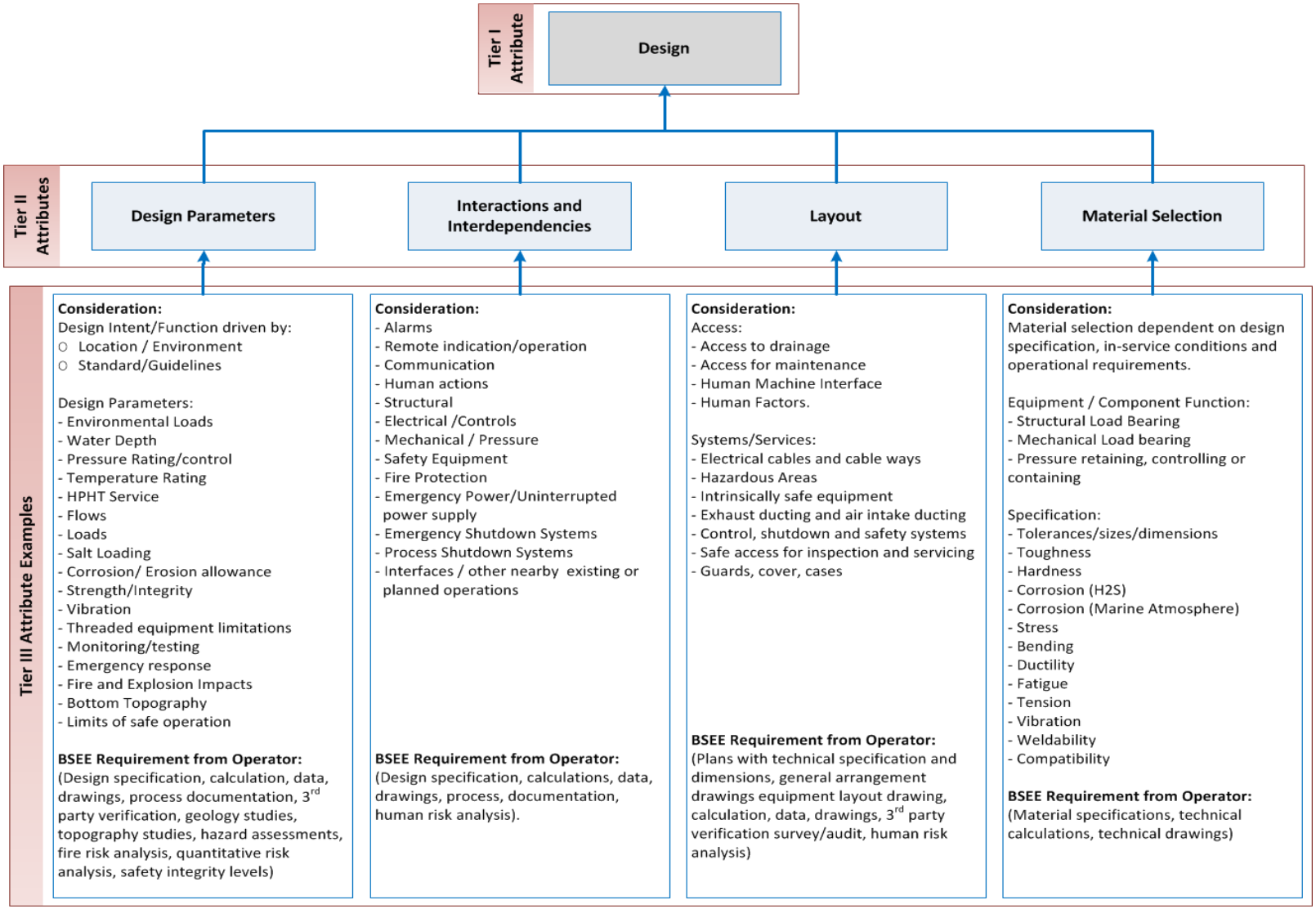

Figure 8: Tier III Attributes

Barrier Element Success Checklist

In the final step of the new technology Barrier Assessment, BSEE should verify if the Operator linked the *Tier III* attributes to success criteria. To assist BSEE's review, and the Operator's submission, a *Barrier Element Success Checklist* has been developed to complement and link the barrier elements life cycle phase attributes to its success criteria. **Figure 9** provides an illustration of a blank *Barrier Element Success Checklist*. A specific example of a blank BOP Shear Ram checklist is provided in **Appendix C: Risk Assessment Technical Note**

Appendix D: Barrier Analysis Technical Note

Appendix E: Example of Barrier Analysis BOP Blind Shear Ram Checklist.

Barrier Function:															
Barrier Critical System:															
Element:															
1-1 DESIGN PARAMETERS															
Checklist Ref.	Barrier Critical System Function	Task Type	Task	Success Criteria	Success Criteria	Applicant Assurance	First Check Date	First Check Result (Y/N)	First Check ID	Second Check Date	Second Check	Second Check ID	Supervisory Check Date	Supervisor ID	Remarks
These are the parameters driven by relevant Codes, Standards and Regulations and also by the location/environment of the offshore unit. E.g. environmental hazards, pressure/temperature ratings, loads, corrosion/erosion allowance, strength/integrity, impacts etc.															
1-2 INTERACTIONS / DEPENDENCIES															
Checklist Ref.	Barrier Critical System Function	Task Type	Task	Success Criteria	Success Criteria	Applicant Assurance	First Check Date	First Check Result (Y/N)	First Check ID	Second Check Date	Second Check	Second Check ID	Supervisory Check Date	Supervisor ID	Remarks
The interactions/dependencies that are required for the barrier to achieve its intended function should be identified and assessed. E.g. alarms, remote indication, human actions and emergency power etc.															

Figure 9: Barrier Element Success Checklist

Each checklist is separated into individual sheets for the different life cycle phases (Design, Fabrication/ Testing, Installation/Commissioning, Operation/Maintenance, and Decommissioning/ Removal). BSEE should verify that the Operator filled out the first seven columns of the checklist. The checklist ensures that the Operator addresses each life cycle phase and the success criteria for the relevant *Tier III* attributes. In addition, BSEE should verify that the Operator provided documentation that verifies the capacities or capabilities of *Tier III* attributes identified to demonstrate that the *Tier III* attributes support the physical or operational tasks of the barrier.

Each checklist is separated into individual sheets for the different life cycle phases (Design, Fabrication/ Testing, Installation/Commissioning, Operation/Maintenance, and Decommissioning/Removal). Each sheet is used to record information about the barrier element attributes for each life cycle phase in order to analyse the success criteria for each of the relevant *Tier III* attributes. Each sheet of the checklist is organized to capture the following information:

- **Barrier Function** – The top level function of the barrier (e.g., Shut in Well in event of a kick scenario).
- **Barrier Critical System** – One of the critical system in achieving the barrier function (e.g., BOP).
- **Barrier Element** – Element of the system in this case the Shear Rams of the BOP.
- **Barrier Critical System Function** – Description of function of the barrier critical system (e.g., for the BOP, close and seal on open hole).
- **Task Type** – Detail if the task required in maintaining the barrier critical system function is Operational or Physical.
- **Task** – Description of the operational or physical task required for performing the barrier critical system function (e.g., for the shear ram a physical task is close and seal on open hole).
- **Success Criteria** – Performance requirement or success criteria for each attribute in the success path of the barrier element so that it can perform its intended function.
- **Basis** – Reference to applicable Codes and Standards, Technical or Functional Specification etc. from which the success criteria for the attribute is derived.
- **Operator Assurance** – Assurance provided by the Operator verifying that each barrier element success path attribute can meet the required success criteria (e.g., relevant design documents or test reports).
- **BSEE Review Quality Assurance Processes** – Processes required by BSEE to ensure all Quality Assurance requirements for the new technology review have been met.

BSEE should verify that the Operator completed their portion of the checklists and provided it with their application submission for BSEE review. The checklists are designed to expedite the review process by providing a consistent format and structure that will allow BSEE reviewers to determine quickly if the Operator has provided all the relevant information. The remaining nine columns of the checklist are for BSEE's quality assurance processes. The checklist also provides accountability by documenting who and when review activities occur.

The performance influencing factors for each barrier element are related to different life cycle phases of the new technology as this provides a better overview with respect to what specific factors need to be considered and when they are of significance to the new technology. During the life cycle of an oil and gas asset, activities are carried out to ensure that the integrity of the asset is maintained from design through to decommissioning. Similarly, the building blocks for the barrier model needs to take into consideration the different life cycle phases in order to maintain overview and control of the safety challenges and the different operations that are required during various phases of the product's life cycle. In other words, the overall success for the barrier critical system or barrier element is achieved when all attributes for the performance influencing factors in each life cycle phase collectively succeed. This process can also be used to identify areas that may not successfully meet the relevant codes/ standards or the functional requirements as defined in the functional specification for the new technology.

Linking Barrier Attributes to Success Criteria

In the final step of the new technology Barrier Assessment, BSEE should verify that the Operator linked the *Tier III* attributes to success criteria. To assist the BSEE and the Operator, as previously mentioned, a Barrier Element Success Checklist has been developed to complement and link the barrier elements life cycle phase attributes to its success criteria. Each checklist is separated into individual sheets for the different life cycle phases (Design, Fabrication/ Testing, Installation/ Commissioning, Operation/ Maintenance, and Decommissioning/ Removal). It is the responsibility of BSEE to verify that the Operators filled out the first seven columns of the checklist. **Appendix C: Risk Assessment Technical Note**

Appendix D: Barrier Analysis Technical Note

Appendix E: Example of Barrier Analysis BOP Blind Shear Ram Checklist shows a sample checklist and its *Tier III* attributes for the 'Design' life cycle phase. The checklist ensures that the Operator addressed each life cycle phase and the success criteria for the relevant *Tier III* attributes. BSEE should verify that the Operator provided documentation that confirms the capacities or capabilities of the *Tier III* attributes identified to demonstrate that the *Tier III* attributes support the physical or operational tasks of the barrier.

BSEE should verify that the Operator completed the portion of the checklists and provided it with the application submission for review. The checklists are designed to expedite the review process by providing a consistent format and structure that will allow BSEE reviewers to determine quickly if the Operators have provided all the relevant information. The remaining nine columns of the checklist document are for BSEE's quality assurance processes. The checklists also provide accountability by documenting who and when review activities occur. BSEE reviewers should use the checklist to evaluate each of the barrier elements to determine if the submission is complete. The following represent the various columns of the checklist and provides a description of the information that is required to be submitted by the Operator:

1.) **Barrier Critical System Function –** The Operators should provide a description of the function of the barrier critical system that is adequate enough to understand it functions
2.) **Task Type –** The Operators should assert, if the primary task of the barrier critical system function is categorized as 'Operational' or 'Physical'
3.) **Task –** The Operators should describe the 'Operational' or 'Physical' task of the barrier critical system function
4.) **Success Criteria –** The Operators should provide the performance requirement and success criteria for each attribute for each barrier element
5.) **Basis –** The Operators should provide references to applicable codes, standards, technical or functional specification for the success criteria
6.) **Operator Assurance –** The Operators should provide an assurance verifying that each barrier element success path attribute can meet the required success criteria

Part 2: How to Verify the Operator's Barrier Analysis

BSEE reviewers need to identify that the Operators have adequately identified the Barrier Functions and Barrier Critical Systems in the Barrier model and have completed the Barrier Attribute Checklist. BSEE should follow the steps in **Table 9** to verify the Operator's barrier model and attribute analysis.

Table 9: Step/Action – How to Verify the Operator's Barrier Analysis

Step	Action	
1.	Yes □ No □	Did the Operator **identify** the *Barrier Function(s)* related to each of the MAH(s) identified during the risk assessment. (See **Table 7**)
2.	Yes □ No □	For each Barrier Function, did the Operator **list** the *Barrier Critical System* that is designed to perform the barrier function(s). (See **Table 7**)
3.	Yes □ No □	For each Barrier Critical System, did the Operator **list** the *Barrier Critical System Function(s)* that is to be performed in order to realize the barrier function. (Note: One barrier critical system can perform one or more barrier critical system functions.) (See

Step	Action	
	Table 7)	
4.	Yes □ No □	For each Barrier Critical System Function, did the Operator **list** the *Barrier Element(s)* that are needed in order for it to perform its intended function. (See **Table 7**)
5.	Yes □ No □	For each Barrier Element, did the Operator **list** the *Physical Tasks* that each barrier element needs to perform in order for the barrier element to fulfil the barrier critical system function. (See **Table 7**)
6.	Yes □ No □	For each Barrier Element, did the Operator **list** the *Operational Tasks* that each barrier element needs to perform in order for the barrier element to fulfil the barrier critical system function. Note: Operational tasks usually involve human interaction for the barrier element to perform its function. (See **Table 7**)
7.	Yes □ No □	Did the Operator identify the *Tier I* attributes for each of the life cycles of the barrier element that was identified in the barrier model developed in **Part 2** of this Section. See **Figure 6** for an example.
8.	Yes □ No □	For each *Tier I* attribute, did the Operator identify the associated *Tier II* attributes. See **Figure 7** for an example.
9.	Yes □ No □	For each *Tier II* attribute, did the Operator identify the relevant *Tier III* attributes, which are derived from Codes, Standards and the technical specifications of the equipment being analyzed. See **Figure 8** for an example.
10.	Yes □ No □	Did the Operator complete the Barrier Element Success Checklist? The checklists have been developed to complement and link the barrier element's life cycle phase attributes to the attribute's success criteria. See **Figure 9** and Error! Not a valid result for table. for an example.
11.	Were the answers to steps 1 through 10 "yes"?	
	If Yes	If No
	Accept the Barrier Analysis results. Proceed to Section 4.	**STOP**: Contact the Operator to discuss the Barrier Analysis.

NOTE: BSEE senior management in the Office of the Director (or designee) should receive timely updates throughout the process. The Chief, OORP should be notified as soon as BSEE becomes aware of a submission involving new technology. The Chief, OORP will be responsible for working closely with regional personnel during the new technology evaluation process.

Section 4: How to Review New Technology Submission for Acceptance

This provides BSEE guidance on how to review the new technology submissions for acceptance.

Part 1: How to Verify that the New Technology Submissions is Complete

Once BSEE determined the Operator's application included new technology and had an adequate risk assessment, barrier modeling, and barrier analysis, BSEE should comprehensively brief the BSEE leadership in the Office of the Director to grant the final approval. **Table 10** provides the proper steps to verify that the new technology assessment is complete. A copy of the checklist is contained in **Appendix F: BSEE New Technology Process Review Checklist**.

Table 10: Step/Action Table – How to Verify the New Technology Submission for Acceptance

BSEE – New Technology Evaluation Review Checklist

Step	Action
1.	Yes □ No □ Has the Operator held a Preplanning Conference with BSEE to discuss the new technology submission?
2.	Yes □ No □ Extract the new technology documentation for use by the BSEE engineer to review the new technology submission: □ Description of the proposed new technology, including the specific barrier system(s) and critical function(s). □ Risk assessment results □ Barrier analysis results □ Independent 3rd party verification (if provided)
3.	RISK ASSESSMENT: Yes □ No □ Does the Operator utilize an appropriate risk assessment methodology? Yes □ No □ Does the Operator identify all applicable MAHs associated with the proposed new technology? Yes □ No □ Does the risk assessment identify all applicable barrier critical system function(s) and barrier element(s) related to the new technology? Yes □ No □ Does BSEE accept the risk assessment results?
4.	BARRIER ANALYSIS: Yes □ No □ Does the Operator develop a barrier model for each barrier function related to a MAH using the barrier template? Yes □ No □ Does the barrier attribute checklist(s) confirm that the barrier function(s) and element(s) will satisfy the success criteria? Yes □ No □ Did the Operator complete the Barrier Element Success Checklist? Yes □ No □ Does BSEE accept the barrier analysis results?
5.	INDEPENDENT 3RD PARTY REVIEW: (If applicable) Yes □ No □ Does the Operator provide appropriate independent 3rd party validation documentation for proposed new technology? Yes □ No □ Does the independent 3rd party verification documentation validate the Operator's *Tier III* attributes for each critical barrier system function?
6.	Does the Operator provide evidence that the new technology proposal provides an acceptable level of risk: Yes □ No □ Provides an equivalent level of risk compared to existing technology OR promotes an 'as low as reasonably practicable' (ALARP) risk strategy? **NOTE**: *If new technology is not acceptable, BSEE should inform the Operator and provide a course of action for the Operator to take (This iterative process may continue for several cycles):* ○ *Operator may adjust and resubmit new technology application* ○ *Operator may modify the application to remove new technology request*

NOTE: *Upon completion of the new technology review, provide the results to the coordinating engineer:*

□ *Recommendation for acceptance/denial of proposed new technology submission.*

□ *Details of any additional acceptance criteria.*

If the coordinating engineer's recommendation is to accept the submission, schedule a meeting with the BSEE senior leadership in the Office of the Director and provide a comprehensive briefing to grant the Operator's proposed use of new technology.

Appendix A: Case Studies

Case Study 1: Ultra Deepwater Drilling with a Subsea BOP

Case Study 2: Drilling a Well Using a MODU with a Surface BOP

Case Study 3: Managed Pressure Drilling (MPD)

Case Study 4: HPHT and High Corrosive Environment

Case Study 5: Drilling from a Semi-Submersible in the Artic

Appendix B: Operator New Technology Proposal Development and Submission Checklist

Completed	NA	OPERATOR – New Technology Process Review Checklist
□	□	Yes □ No □ Has the Operator determined that the submission involves the use of new technology (30 CFR §250.292(n) AND **Section 1** of the *New Technology Operator's Guide*)? *Check the appropriate category:* □ Category 1*. Known Technology, Known Conditions □ Category 2. Known Technology, Different or Unknown Conditions □ Category 3. New (Unknown) Technology, Known Conditions □ Category 4. New (Unknown) Technology, Different or Unknown Conditions *NOTE: *If Category 1, no additional risk assessment or barrier analysis is required*.
□	□	Yes □ No □ Has Operator contacted BSEE to schedule a Preplanning Conference to discuss the new technology application in order to gain BSEE agreement/initial buy-in?
□	□	Has Operator discussed the proposed submission with BSEE in order to: Yes □ No □ Verified the new technology category, i.e. Category 2,3, or 4? Yes □ No □ Identified the minimum risk assessment and barrier analysis that should be conducted for the submission? Yes □ No □ Identified the need of independent 3rd party verification for the new technology proposal?
□	□	Has Operator conducted a risk assessment using the appropriate risk assessment methodology? Yes □ No □ Has Operator identified MAH associated with the new technology? Yes □ No □ Has Operator identified the affected barriers that control or mitigate the MAHs?
□	□	Yes □ No □ Has Operator completed the barrier analysis and validated the success criteria for the barrier element attributes?
□	□	Yes □ No □ Has Operator demonstrated that barrier critical system functions and elements satisfy the success criteria based on the barrier analysis?
□	□	Yes □ No □ Has Operator sought independent 3rd party verification of the risk assessment and barrier analysis, as discussed with BSEE during the preplanning conference?
NOTE: *Operators should include all of the new technology risk assessment and barrier modelling documents, including any independent 3rd party review/certification documentation as part of the permit application. Operator should include this with their submission to BSEE*.		

Appendix C: Risk Assessment Technical Note

Appendix D: Barrier Analysis Technical Note

Appendix E: Example of Barrier Analysis BOP Blind Shear Ram Checklist

Barrier Function: Shut in the Well															
Barrier Critical System: BOP															
Element: Blind Shear Ram BOP															
1-1 DESIGN PARAMETERS															
Checklist Ref.	**Barrier Critical System Function**	**Task Type**	**Task**	**Success Criteria (Attribute)**	**Success Criteria Basis**	**Applicant Assurance**	**First Check Date**	**First Check Result (Y/N)**	**First Check ID**	**Second Check Date**	**Second Check Result (Y/N)**	**Second Check ID**	**Supervisory Check Date**	**Supervisor ID**	**Remarks**
These are the parameters driven by relevant Codes, Standards and Regulations and also by the location/environment of the offshore unit. E.g. environmental hazards, pressure/temperature ratings, loads, corrosion/erosion allowance, strength/integrity, impacts etc.															
1-1-1	Close and Seal on Open Hole	Physical	Close and Seal on Open Hole	Rams designed to have, as a minimum, a RWP equal to the MAWHP to be encountered	API 53 (7.1.1.2)	Designers specification (document reference) details that the subsea BOP RWP equal to the MAWHP to be encountered of 15,000 psi Calculations are submitted Design certified during design review	xx	xx	xx	xx	xx	xx	xx	xx	
...															
1-2 INTERACTIONS / DEPENDENCIES															
Checklist Ref.	**Barrier Critical System Function**	**Task Type**	**Task**	**Success Criteria (Attribute)**	**Success Criteria Basis**	**Applicant Assurance**	**First Check Date**	**First Check Result (Y/N)**	**First Check ID**	**Second Check Date**	**Second Check Result (Y/N)**	**Second Check ID**	**Supervisory Check Date**	**Supervisor ID**	**Remarks**
The interactions/dependencies that are required for the barrier to achieve its intended function should be identified and assessed. E.g. alarms, remote indication, human actions and emergency power etc.															
1-2-1	Close and Seal on Open Hole	Physical	Close and Seal on Open Hole	Dependency: Control system required to be capable of actuating the rams	API 53 (7.3.1.2)	Design specification details that control system will automatically actuate components in the BOP stack including Blind Shear Rams Design of control system shall be designed, manufactured, and installed API 16D Design certified during design review	xx	xx	xx	xx	xx	xx	xx	xx	
...															
1-3 LAYOUT															
Checklist Ref.	**Barrier Critical System Function**	**Task Type**	**Task**	**Success Criteria (Attribute)**	**Success Criteria Basis**	**Applicant Assurance**	**First Check Date**	**First Check Result (Y/N)**	**First Check ID**	**Second Check Date**	**Second Check Result (Y/N)**	**Second Check ID**	**Supervisory Check Date**	**Supervisor ID**	**Remarks**
The layout of the barrier needs to be assessed in terms of protection from potential damage (e.g. hazardous areas and guards/covers etc.) and also for access for maintenance, inspection and human interface etc.															
1-3-1	Close and Seal on Open Hole	Physical	Close and Seal on Open Hole	Stack configuration to be in accordance with API 53	API 53	Design specification details that the BOP stack configuration meets the requirements of API 53 Design certified during design review	xx	xx	xx	xx	xx	xx	xx	xx	
...															

Appendix F: BSEE New Technology Process Review Checklist

Complete	NA	BSEE - New Technology Process Review BSEE Internal Checklist
□	□	Yes □ No □ Has the Operator held a Preplanning Conference with BSEE to discuss the new technology submission?
□	□	Yes □ No □ Extract the new technology documentation for use by the BSEE engineer to review the new technology submission: □ Description of the proposed new technology, including the specific barrier system(s) and critical function(s). □ Risk assessment results □ Barrier analysis results □ Independent 3rd party verification (if provided)
□	□	RISK ASSESSMENT: Yes □ No □ Does the Operator utilize an appropriate risk assessment methodology? Yes □ No □ Does the Operator identify all applicable MAHs associated with the proposed new technology? Yes □ No □ Does the risk assessment identify all applicable barrier critical system function(s) and barrier element(s) related to the new technology? Yes □ No □ Does BSEE accept the risk assessment results?
□	□	BARRIER ANALYSIS: Yes □ No □ Does the Operator develop a barrier model for each barrier function related to a MAH using the barrier template? Yes □ No □ Does the barrier attribute checklist(s) confirm that the barrier function(s) and element(s) will satisfy the success criteria? Yes □ No □ Did the Operator complete the Barrier Element Success Checklist? Yes □ No □ Does BSEE accept the barrier analysis results?
□	□	INDEPENDENT 3RD PARTY REVIEW: (If applicable) Yes □ No □ Does the Operator provide appropriate independent 3rd party validation documentation for proposed new technology? Yes □ No □ Does the independent 3rd party verification documentation validate the Operator's *Tier III* attributes for each critical barrier system function?
□	□	Does the Operator provide evidence that the new technology proposal provides an acceptable level of risk: Yes □ No □ Provides an equivalent level of risk compared to existing technology OR promotes an 'as low as reasonably practicable' (ALARP) risk strategy? **NOTE**: *If new technology is not acceptable, BSEE should inform the Operator and provide a course of action for the Operator to take (This iterative process may continue for several cycles):* ○ *Operator may adjust and resubmit new technology application* ○ *Operator may modify the application to remove new technology request*
NOTE: *Upon completion of the new technology review, provide the results to the coordinating engineer:* □ *Recommendation for acceptance/denial of proposed new technology submission.* □ *Details of any additional acceptance criteria.*		