RISK

# Quality vs. Safety

## Priorities at odds in the oil and gas industries

by Mustafa Ghaleiw

## In 50 Words Or Less

- Quality is often viewed as secondary to safety in the oil and gas industries.
- Unless quality is elevated to a top priority, safety in these industries will be compromised, possibly leading to loss of life, pollution and damage to a company's reputation and revenue.

The absence of a quality culture gave rise to six serious quality management failures, wrote Lowellyne James, a lecturer at the Aberdeen Business School in the United Kingdom, in his personal blog about the 2010 BP Deepwater Horizon oil spill. Together, he wrote, these failures caused a tragic loss of life and catastrophic environmental disaster.

The absence of a quality culture cost BP a $91 billion drop in its market value between April and June 2010. It sparked 350 lawsuits from the general public, damaged its brand image, led environmental groups to attack all offshore drilling, caused shareholder dissatisfaction and knocked the organization from its position as an industry leader.

"Safety is not the issue," James concluded. "It is a lack of an understanding of quality management and its impact on the triple bottom line: economic, social and environmental." In other words, quality should be first in everything an organization does.[1]

That principle cannot be emphasized enough for oil and gas projects, which deal with complex systems containing high pressures and temperatures. This article aims to show the relationship and interdependency between quality management and safety management, citing examples and tools used in oil and gas asset design projects. Assets include: plants; factories; oil and gas refineries; onshore, offshore and subsea platforms; production lines and pipelines; and all associated equipment.

## Case by case

The petroleum, petrochemical and natural gas industries are risky by nature and can cause damage to the environment, human health and safety.[2] The assets exist in systems and subsystems that harness powerful energy that must be adequately contained. System failures can kill people, pollute the environment and hurt the operator's reputation and finances.

Quality and safety in design projects should be delivered at the highest level to build safe, reliable, operable and maintainable assets. Risks in projects must be identified, analyzed, assessed and mitigated. Health, safety and environment (HSE) cases are planned and implemented in projects. Safety cases explain how an organization plans to manage risks. These cases typically include:

Major accident hazards and high-HSE risks are identified, assessed, recorded and managed to a level deemed to be as low as reasonably practicable (ALARP).

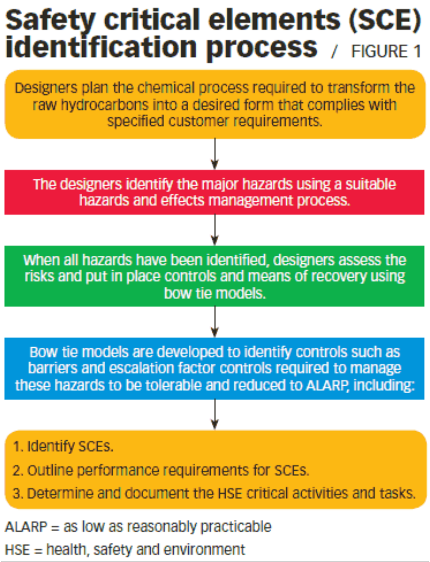



Figure 1

Safety-critical elements (SCE) and performance standards are identified, reviewed by competent engineers and documented as formal project deliverables. Figure 1 shows a systematic process for SCE identification.

HSE-critical activities and tasks also are identified, reviewed by competent engineers and documented as formal project deliverables.[3]

What happens when critical activities and tasks are not managed effectively to deliver the desired results at a specified quality standard? If the identified SCEs are produced and installed in assets with poor quality standards, can the organization prevent, control and mitigate risks? If quality is not managed effectively during project delivery stages, will the organization be able to reduce risks to the operators and the general public?

There is a strong relationship and interdependency between quality and safety, but quality is often overlooked. In the gas industry, a project's SCEs, performance standards, critical activities and tasks typically emphasize safety. Ample budgets and resources are provided to the project safety team to launch campaigns and host workshops during projects. Quality is treated as a nice-to-have support function for one task—auditing.

## Disparate definitions

The definition of quality varies by industry, organizational and even departmental levels. While the meaning depends on the context in which the term is expressed and by whom, the most common definition is meeting requirements. As stakeholders change, so do the requirements and methods to achieve quality.

Product or service providers must understand what customers want. The product or service must possess the characteristics customers require. These requirements define product attributes, such as its physical and functional characteristics: strength, weight, shape, color, speed, capacity, portability, operability, maintainability and durability. All projects must be delivered free from defects, deficiencies and impairments to safety, functionality, operability, reliability, availability and maintainability.[4]

Safety is a quality characteristic of oil and gas plant systems and subsystems. To achieve customer satisfaction, it is essential that customers participate in the design process. Designers can translate customer needs into specifications and drawings that become part of construction contracts. Before an organization can deliver safe products, the needs of all project stakeholders must be met.

All parties must create and maintain a strong focus on quality during each project stage: design, engineering, procurement, construction and installation, precommissioning and commissioning. In addition, organizations must take a holistic approach to quality. Quality applies not only to customer-facing products and services, but also to every process, task, activity and decision made organizationwide. Quality should be intrinsic and exist in everything the organization does.[5]

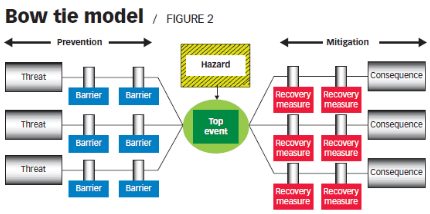
## Designing quality and safety

Gas plant designers do their best to ensure designs are correct and safe. They use every tool at their disposal to verify and demonstrate that their design output meets the desired and agreed-on standard to provide assurance to the project client. Those practices include:

- Operating a robust and effective design process that uses competent designers and the right design software.
- Ensuring that design inputs are reviewed, understood, complete, and can be met and clarified when required.
- Ensuring that design outputs are internally checked, reviewed, verified and validated by a competent team of multidisciplined designers.
- Ensuring that design outputs are reviewed and certified by a competent third party.
- Planning and deploying safety cases at different stages of the plant design process.[6]

## Bow tie model

Based on the Swiss cheese model, the bow tie model was developed by Royal Dutch Shell to meet risk assessment requirements and to integrate an understanding of how accidents happen.[7] Bow tie models identify necessary barriers, as explained in Figure 1.




[Figure 2](Figure 2)

The role of a barrier is to prevent or limit the consequences of a major incident. The left-hand side of the bow tie (see Figure 2) describes how events and circumstances, either in isolation or in combination, can release a hazard and lead to an undesirable, harmful event that can impact assets, people, the environment and an organization's reputation.

The right-hand side represents various scenarios that might develop from the undesired event. Mitigation depends on the effectiveness of systems and activities to stop the progression to lasting harm and damage.

Critical concepts in the bow tie model are hazards, top events and consequences. The top event is a specific occurrence with significant potential for undesirable consequences, linking the potential sequence between hazard and consequences.[8] Bow tie diagrams reveal the strength of an organization's defensive structure and the number and types of barriers in place.[9]

Barriers include design features, hardware, processes or operational intervention tasks. Hardware SCEs, a requirement of gas plant systems, may include:[10]

- Foundation structures.
- Topside structures.
- Process containment such as pressure vessels, heat exchangers, piping and relief systems.
- Detection systems for fire, gas, water and security breaches.
- Protection systems for fires and explosions and chemical injections.
- Emergency shutdown systems, depressurization systems and pipeline isolation valves.
- Communication systems and uninterruptable power supply systems.

If, for example, the hazard is a hydrocarbon condensate pipeline leak and the top event is loss of containment, then a threat that may trigger this hazard could include flange, gasket or value leaks, or material corrosion. The barriers that must be identified, designed and implemented are:[11]

- Thoughtful material selection and equipment design, fabrication, inspection and testing and adequate site installation.
- Coatings and coating rehabilitation.
- Cathodic protection systems.
- Corrosion inhibitors.
- A regular inspection and maintenance program during the operation phase.

The consequence that must be mitigated in this example is a hydrocarbon spill and the formation of a toxic, flammable gas cloud. The recovery measures the system needs include:[12]

- Closed hydrocarbon drain system.
- Personal hydrogen sulfide gas detectors and monitors to detect release.
- Flammable and toxic gas detection system and alarms.
- Natural ventilation to prevent gas buildup.
- Emergency response plans.

While this example is applicable to a natural gas offshore platform design project, the technique is ideal for assessing all types of risk in many industries, including those related to design and construction, banking and finance, IT, transportation, defense and security management.[13]

To demonstrate the strong link between and interdependence of safety and quality management, look to the role of hardware barriers and their indispensable role in ensuring system safety by providing a great value in the prevention, detection, control and containment of major accidents.

## Weighing costs and benefits

Every SCE is considered a hardware barrier. An SCE is any piece of equipment, structure, system (including computer software) or component whose failure could lead to, or contribute substantially to, a hazardous event. SCEs also include equipment meant to prevent or limit the consequences of a major incident. A major incident is defined as an uncontrolled occurrence in the operation of a site that leads to severe or catastrophic consequences to people, assets, the environment or an organization's reputation.

Formally documented safety case studies using hazard identification and operability workshops are carried out during the project design stage to identify potential risk reduction measures to ensure risk levels are demonstrably reduced to tolerable and ALARP levels. Risks categorized as ALARP must show that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained.

SCEs are identified during the design stage through bow tie analysis. This analysis reveals the systems and equipment required to prevent, control or mitigate major accidents for the facilities. This is an integral part of risk management.

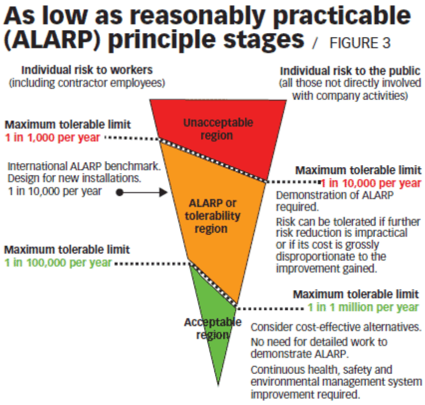



Figure 3

The intent of risk management is to demonstrate hazards have been identified, their risks evaluated and that measures are, or will be, in place to reduce the risk to ALARP levels. Also, plans must be established to maintain residual risks at ALARP levels. Figure 3 shows three risk bands are defined in ALARP criteria:[14]

1. **The unacceptable region** includes risks that are highly likely to occur or result in an unacceptable outcome, therefore it must be refused altogether.
2. **The ALARP or tolerability region** includes risks that must be reduced to the lowest levels practicable.
3. **The acceptable region** includes risks that do not need additional HSE measures because the risk is so small and further precaution is unnecessary other than ensuring the risk remains at an acceptable level.

Identification of SCEs is only one aspect of risk reduction. Performance standards also must be developed for functionality, reliability, availability, survivability and dependency throughout the assets' life cycles. Project specifications determine the requirements that SCEs are assessed against. These requirements serve as main inputs for the design, fabrication, production, installation and testing processes.

SCE performance greatly depends on, and is ensured by, the quality of the SCE. The quality of SCEs is achieved through the identification, planning and implementation of safety-critical activities and tasks. Examples of safety-critical activities and tasks defined by a safety case for an offshore platform and subsea pipeline might include ensuring:

The hydrocarbon piping systems meet international standards and codes.

- The choke valves are designed to prevent cavitation.
- The topside structures are designed for adequate fatigue life as specified by international standards and codes.
- All welds are appropriately specified to international standards and codes.

Aren't these activities and tasks part of the project's value-realization process? The design and engineering, procurement, construction and installation and commissioning and handover processes? These activities are planned and operated to satisfy the project client's needs and expectations. Quality is meeting requirements, so these are, in fact, activities and tasks critical to the quality of asset systems. If the tasks and activities are performed well, safe assets will be delivered.

Considering the definition and function of SCEs and the related critical activities and tasks that occur, the link between safety and quality becomes apparent. If SCE quality is questionable for any reason—poor design, incorrect material selection, poor fabrication and testing, poor installation at site or inadequate site inspection—the probability is higher for a major accident to occur that would jeopardize human lives, asset integrity and company reputation. That means reduction measures were wasted.

## Critically important

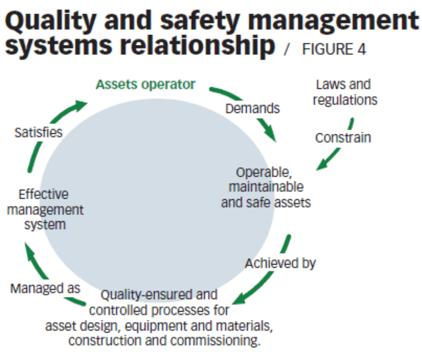



Figure 4

Senior managers of oil and gas projects focus on safety without realizing its critical link to quality (see Figure 4). Quality applies to everything an organization does or does not do. Examples of factors that can directly affect quality include:

- Leadership.
- Process design, risk identification, assessment and mitigation.
- Equipment and materials used in process components (including SCEs).
- HSE programs (such as permits to work, HSE policies and enforcement, inductions, training and audits).
- Competencies and behaviors of the workforce.
- Construction, commissioning and start-up of oil and gas asset systems.

Should quality or safety come first? The answer is clear. Phrases such as process safety, asset integrity, asset availability, safe production and manufacturing excellence are frequently used in headings for hydrocarbon industry production work processes, departments and improvement campaigns.

Without making quality first in everything the industry does, its processes won't be safe, the integrity of assets will be questionable, production lines will be dangerous and manufacturing processes will be subpar.

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## References and Notes


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11. Ibid
12. Ibid
13. See reference 9.
14. Vine, "Corporate Health, Safety, Security and Environmental Standard," see reference 3.


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