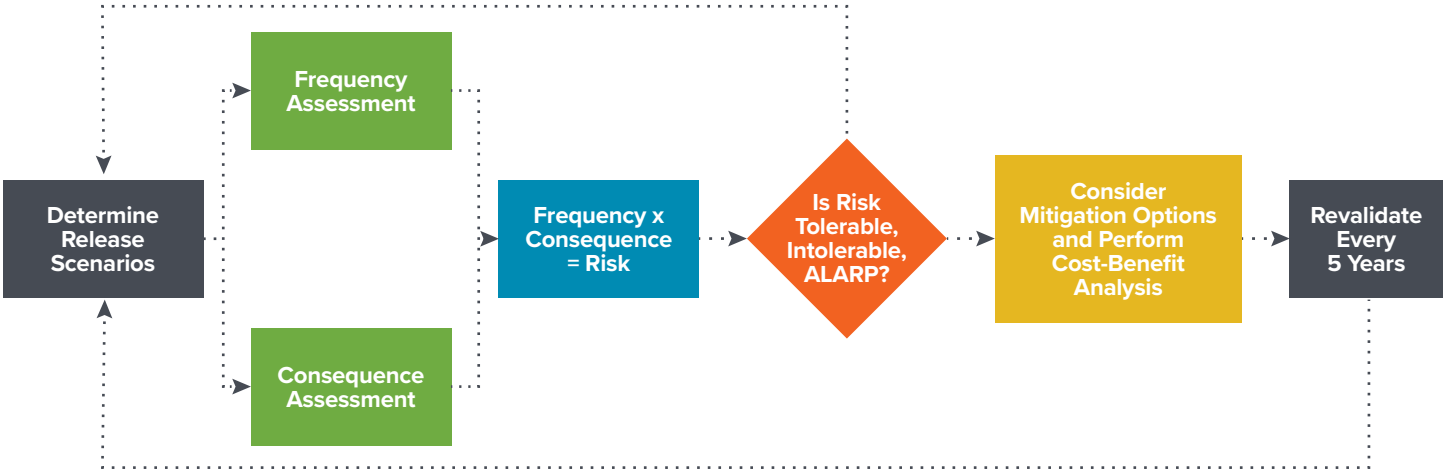
ABS Group

INSIGHT

Facility Siting: Risk-Based Solutions and their Benefits

Facility siting is part of the process hazard assessment (PHA) requirement in process safety management (PSM) as required by CFR 1910.119. API 752/753/756 provide a recommended practice for how to perform a facility siting study.

There are many approaches to facility siting which can be categorized as either consequence or risk based. Both methods consider the release scenario, but a risk-based approach also considers the frequency of the scenario. A risk-based approach to facility siting can provide the best understanding of onsite risks and enables the most cost-effective resolution of facility siting issues. ABS Group's experience in consequence and risk-based Facility Siting assessments, hazard mitigation, and structural engineering provides a one-stop solution to risk-based assessment and hazard mitigation.



What is a QRA?

A Quantitative Risk Assessment (QRA) is a systematic approach to calculate risk and provide a clear, quantifiable understanding of potential risk exposure to personnel, assets, the environment, and your business that affect a facilities' safe and economical operation. In addition, a QRA evaluates the validity of quantitative results by identifying critical assumptions and risk-driving elements. A QRA involves predicting the consequences of a hazard and the frequency at which the threat may occur. These aspects are then combined to obtain numerical values for fatality risk.

QRA studies are invaluable for production and processing facilities, high-pressure pipelines, and storage and importation sites, including Liquefied Natural Gas (LNG). You may need to demonstrate acceptable risk levels when considering plant construction plans or changing operations (including plant modifications) or occupancy levels. Utilizing a risk-based approach to facility siting improves decision-making by highlighting scenarios that contribute most to overall risk. This approach ensures you meet acceptable individual, operational, and environmental criteria demonstrating that risk is As Low As Reasonably Practicable (ALARP).

Identify issues surrounding QRA

Hiring a risk consulting company does not always yield actionable results. There are various commercial and private software tools for conducting the Quantitative Risk Assessments (QRA). Variations exist between consultants on how much or how little is included and the extent of assumptions made. Many can identify hazards, quantify exposure, and calculate risk. These items are the extent of most risk consulting companies' capabilities, resulting in an unclear path forward. While the hazard risk is better understood, the question of what to do next is not apparent with a QRA.

Examples of questions you may ask after receiving a QRA from others:

1. "What and how can additional modeling of select controlling scenarios improve my risk?"
2. "How do I retrofit a building when I do not have design loads or occupancy established?"
3. "Without clear hazard contours, where can I site blast-resistant buildings, trailers, and other portable or temporary buildings?"
4. "What is the best cost-effective solution to protect occupants of a building from hazards?"

A QRA is not just about having a software tool and running complex multivariate analysis. You need practical experience in knowing what to do once you have the results from the QRA to be of use in managing risk to operations. The QRA process identifies sources of the highest hazards such that measures can be taken to develop emergency response plans, adjust occupancy, retrofit structures, locate new permanent and temporary buildings, and install automated detection systems.

Our Approach to QRA

ABS Group offers a global multidisciplinary network of engineers and a full scope of risk-based analysis experience and tools, in a cradle to grave approach to QRA. In addition, we possess the ability to integrate detailed consequence modeling such as computational fluid dynamics. Our QRA process utilizes a data-intensive approach in identifying scenarios by including all process equipment with hazard potential and modeling a wide range of release sizes and historical weather conditions.

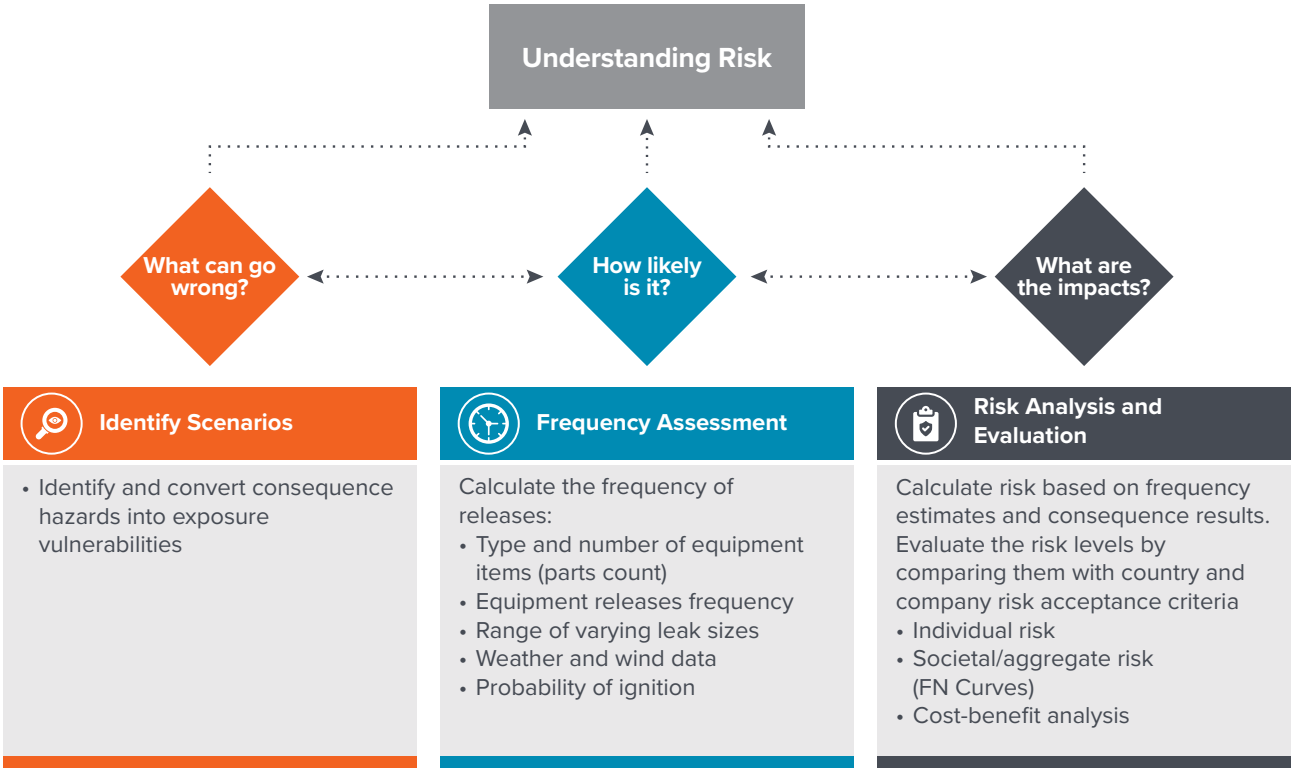
We have developed software tools such as FACET3D and proprietary data analysis and frequency prediction spreadsheets to model a range of unique outcomes.

Understanding Your Risk

When we work with our clients, we offer a three (3) step solution

1. Understand the Risk
2. Analyze the Risk
3. Mitigate the Risk

Below are the main steps involved in a typical QRA study. This diagram also indicates how the outputs of each part feed into the next phase of the process.



ABS Consulting provides our clients with a comprehensive, detailed report that defines inputs, explains calculation methodology, and summarizes results in meaningful tables and figures, as shown below. We also offer mitigation options to target the most notable contributors to the total risk enabling improvement measures addressing those factors where significant risk reduction is likely to be gained.

Building	Blast	Flash Fire	Jet Fire	Pool Fire	Toxic	Individual	PD
Administration Building	2.28E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.28E-07	Acceptable
Maintenance Building	5.37E-08	1.89E-06	1.19E-06	6.93E-06	0.00E+00	1.01E-05	ALARP
Warehouse A	5.60E-07	1.92E-06	1.72E-06	8.31E-06	0.00E+00	1.25E-05	Acceptable
Warehouse B	7.53E-07	1.88E-06	2.01E-06	6.76E-06	0.00E+00	1.14E-05	Acceptable
IT Building	3.71E-07	3.08E-06	3.94E-06	1.22E-05	0.00E+00	1.96E-05	Intolerable

Table 3. Individual and Aggregate Risk Results Summary EXAMPLE

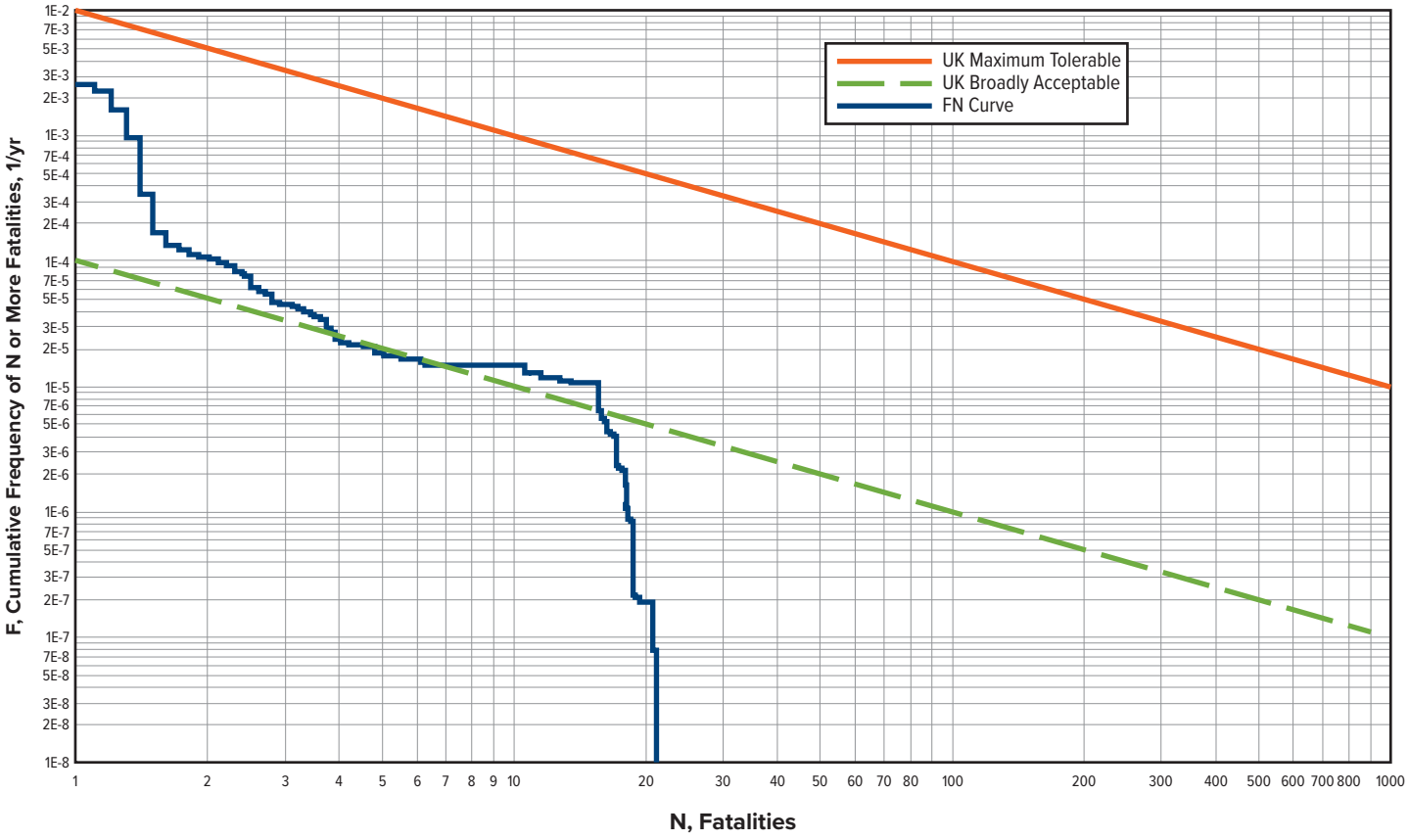


Figure 2. Example F-N Curve

Interpreting a QRA

Controlling Risk Sources

One main benefit of a QRA is that it identifies the controlling risk sources. Since scenarios are developed across the process, risk results are ranked by scenario to indicate which processes provide the highest risk and are good candidates for risk reduction via process controls and hazard mitigation. We provide individual risk for each scenario and aggregate risk (in the form of risk indices) by scenario and hazard type. Targeted mitigation has a significant risk reduction impact across the facility using these results.

Examples of these mitigation measures include:

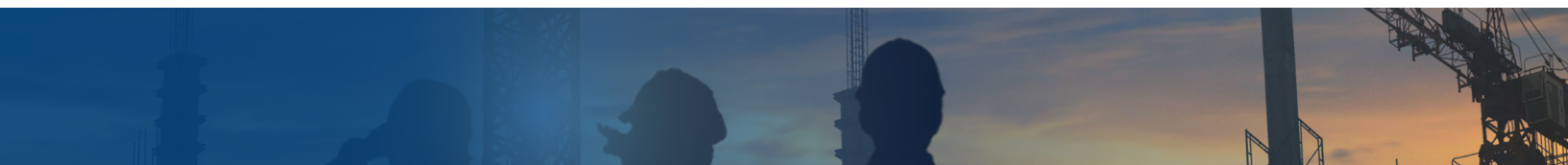
- Leak isolation via LEL detection and isolation
- More frequent and extensive mechanical inspections to identify degrading equipment
- Replacement of high leak frequency equipment with low-frequency alternatives (welded pipe for flanges; double seal pumps)
- Installation of explosion suppression water deluge systems
- Building isolation and sealing to prevent toxic infiltration
- Evacuation PPE for toxic and fire hazards

Building Occupancy

Building occupancy has a direct impact on calculated risks. The most hours worked by any individual determines the time fraction used for individual risks. Therefore, reducing the time spent in the building directly reduces the individual risk. Over a week, the total number of people in the building impacts the aggregate risk. In some cases, moving people to lower-risk buildings can be an acceptable risk mitigation strategy. QRA requires a company to have quantitative risk criteria for individual and aggregate risk. Quantitative criteria development requires understanding the different risk criteria, the best practices for developing the criteria, and the industry risk criteria precedents. Since we wrote the book on developing and applying quantitative risk criteria, entitled *Guidelines for Developing Quantitative Safety Risk Criteria*, published by CCPS, we are well-positioned to help companies navigate the quantitative risk criteria development process.

Interpreting the risk results when compared to the criteria is often a point of confusion. Individual risk is straightforward since most companies define a maximum criteria value above which risk reduction is required. Aggregate risk illustrated as FN curves is more complex, consisting of an intolerable upper region, an As Low As Reasonably Practicable (ALARP) middle region, and a broadly acceptable lower region. The intolerable region requires risk reduction, while the ALARP region requires more risk assessment and risk reductions when practicable. Risk reductions are viable when the effort and cost are not disproportionate to the potential benefits achieved. While no single value defines a disproportionate cost-to-benefit ratio, the typical implied price for averting a fatality (ICAF) in the UK offshore industry is £6,000,000 [3].

Companies must decide how current to keep their risk studies. Process safety management (PSM) defines a 5-year revalidation cycle for facility siting in the US. PSM also requires the Management Of Change (MOC) program to evaluate the impact of significant facility changes. It is not reasonable or practical to update the QRA for every process change; however, some level of risk impact should be performed for significant process unit changes or the addition of new occupied buildings. Minor changes like replacing a pump can be documented and addressed during the next QRA revalidation cycle.



QRA is dependent on many assumptions and a large set of data to define the scenarios, consequences, and frequency. A QRA performed by one practitioner is likely to differ in results from one performed by someone else since each will have different methods of assessing these values. Therefore, QRA risk results should be evaluated for their magnitude range rather than precise values. Some limitations we have seen in QRA studies include:

- Overly simplified building response analysis when determining the building response to explosions (use of library buildings vs. component-based analysis)
- Overly conservative consequence assessment methods for the explosion, fire, and toxic hazards that inflate the risk results (using advanced QRA software like FACET3D [2] vs. simple spreadsheet methods)
- There was no consideration for existing mitigation systems and site-specific equipment reliability when determining the scenario leak frequency (how detailed was the event tree?)

Closing Statement

ABS Group is uniquely positioned based on experience to provide clients with facility siting using risk-based methods. Risk-based facility siting offers a more rigorous study of potential significant accident hazards. It is crucial for industry PSM to understand the minimum requirements for a QRA and what to look for when interpreting QRA studies. Working with industry experts like us provides easy solutions to the complex issues surrounding QRAs.

Evaluating impacts and doing cost-benefit are usually the limits for most consultants. We offer a solution-focused approach, with the QRA being the starting point in the journey toward safer operations. Risk ranking and prioritization, mitigation planning, cost-benefit studies, design, and implementation planning, allow us to provide a turnkey solution for the facility siting lifecycle.

Want to learn more:

Attend a training session (LINK) to learn more. (217/240 COURSE)

Keywords

Facility Siting, QRA, Risk, API 752, Explosion, Fire, Toxic

References

[1] API 752

[2] FACET3D www.facet3d.com

[3] HSE 2006. Offshore Installations (Safety Case) regulations 2005 Regulation 12 – Demonstrating Compliance with the Relevant Statutory Provisions, HSE Offshore Information Sheet No. 2/2006.

About ABS Group

ABS Group of Companies, Inc. (www.abs-group.com), through its operating subsidiaries, provides data-driven risk and reliability solutions and technical services that help clients confirm the safety, integrity, quality and environmental efficiency of critical assets and operations. Headquartered in Spring, Texas, ABS Group operates with more than 1,000 professionals in over 20 countries serving the marine and offshore, oil, gas and chemical, government and industrial sectors. ABS Group is a subsidiary of ABS (www.eagle.org), one of the world's leading marine and offshore classification societies.

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