Consequence analysis

OIL & GAS CONSULTANCY SERVICES
Managing the risks of Oil & Gas exploration, production and transport involves a quantitative assessment of the consequences of all major hazards that have the potential to damage the integrity of the asset and cause harm to personnel.

The most dangerous hazards associated with both onshore and offshore O&G facilities are undoubtedly those associated with the loss of containment of hydrocarbon products and their subsequent ignition. As the demand for global energy drives us into more inhospitable fields, deeper water, higher pressure reserves, and more sour streams, an understanding of these risks becomes even more crucial to the safe design of the asset.

Consequence analysis provides quantitative information on the risk and potential hazards that could be caused by dispersion, fire and blasts. With this information, it is possible to improve the original design, incorporate mitigation measures, or devise hazard and management strategies to keep the risk at acceptable levels. BMT provides comprehensive consultancy and consequence evaluation services in support of design from FEED through to detailed design engineering. These services help HSE specialists and engineers make informed decisions at every stage of the design process.

BMT has a long history of conducting consequence studies for many Oil & Gas facilities across the world over the past 25 years. BMT’s services were called upon to provide expert advice to the inquiry into the Piper Alpha incident following which radical changes were made to North Sea safety regulations. Through this experience, BMT is extremely familiar with safety issues relevant to both offshore and onshore oil & gas developments.

Loss of containment and subsequent dispersion of fluids is a potential risk source for offshore and onshore infrastructure. Accidental leaks from pressurized tanks, pipelines, processing equipment and wellheads can result in the dispersion of toxic gases into the atmosphere and the formation of flammable gas clouds. Hydrocarbon liquid releases also have the potential to ignite to form pool fires or they could flash to gas and form explosive gas clouds. Subsea liquid releases also pose environmental risks as they disperse through currents, wave action and thermoclines.

BMT use a range of tools from highly sophisticated Computational Fluid Dynamics models to simple statistical dispersion models to our own wind tunnel facilities. These are combined with over 25 years of engineering experience in the Oil & Gas industry to provide cost effective, accurate and timely dispersion engineering services. Our tools and process can take into account all the relevant influences to dispersion such as transient decays, leak directions, wind, wave, current and thermal conditions, topographic influences, controlled mechanical ventilation and full representations of three-dimensional structures where impingement and confinement may take place.

The key deliverable of our dispersion analyses is typically flammable and toxic gas clouds and dispersion plume sizes. However, we utilize our specialist knowledge to provide added value with recommendations for reducing gas cloud sizes, advising on HVAC and ventilation strategies, assessing impact to helicopter operations (CAP 437 & NORSOK C-004), advising on gas detector location suitability, and reviewing design compliance with regulations.
Fires are potentially catastrophic events that can result in heavy damage to life and infrastructure. Accidental releases of flammable gases and liquids combined with sources of ignition can lead to jet and pool fires. Fires pose a direct hazard to structures and personnel due to the high temperatures and heat released from the combustion process as well as smoke and dispersion of toxic combustion products. Large-scale fires, like in the case of an oil spill pool fire, release great quantities of toxic smoke.

BMT offers in-depth expertise performing modeling and analysis of fire hazards and smoke propagation. Fire studies provide risk and consequence information about heat transport (conduction, convection, radiation), chemical reactions (fuel and oxidant consumption rates) and smoke generation and dispersion. This information is used to quantify risk, and determine the most effective location of fire walls, spray curtains, smoke curtains, smoke detectors, mechanical ventilation and sprinkler systems.

The same type of analysis can also be used for purposeful combustion processes such as flaring where the impact to equipment and personnel of thermal radiation needs to be controlled through tower design and mitigating water sprays.

**EXPLOSIONS AND BLASTS**

Analysis of explosions caused by the ignition of dispersed flammable gas clouds within process areas are a critical design step for ensuring structural integrity of Safety Critical Elements (SCE) of offshore and onshore process plants. BMT has been providing consultancy services in explosion modeling and probabilistic risk assessment for the Oil & Gas and Process industries for over 10 years now. We use industry standard software such as FLACS together with industry standard regulations and practices such as NORSOK Z-013 and UKOAA Fire and Explosion Guidance.

The magnitude of blast loads from the ignition of flammable gas clouds depends on several factors such as gas composition, isolation, ventilation, ignition sources, confinement, and congestion. BMT start every blast analysis with a detailed review of the client’s design of the facility to ensure that all these factors are considered before planning the scenarios to be assessed.

Three-dimensional Computational Fluid Dynamics (CFD) blast models of the production facilities that include structural, equipment and pipework detail are constructed to perform the analysis. Transient explosion simulations are then carried out for a range of realistic gas clouds sizes predicted by gas dispersion calculations for the local wind conditions at the site. The explosion simulations provide overpressure time histories that can be used to extract peak values and can be used for dynamic response analysis. The simulations can also provide average blast overpressures on large surfaces and drag loads on small-scale items such as pipework. Remedial measures to mitigate high blast loads can be investigated and verified through simulation. Mitigation measures could include layout changes, pressure (blow-out) panels and water deluge which BMT can advise on.
BMT maintains a resourceful in-house numerical modeling group that specialises in the application of state-of-the-art Computational Fluid Dynamics (CFD) for consequence analysis projects, including a variety of commercial and in-house modeling packages to carry out ventilation, gas dispersion, fire and explosions assessments.

Exceedance analysis is used to assess quantitative risk levels. It is carried out for each safety critical element of interest by combining the results of the dispersion, fire or blasts simulations with the corresponding event frequencies. A great number of scenarios are assessed ranging from high probability/low consequence events to low probability/high consequence events, and the impact that all of these scenarios have on each SCE are summed to generate a probability exceedance curve. These curves give the likely frequency of a scenario resulting in a given consequence (e.g. blast overpressure, impulse, temperature etc.). Sensible design parameters can be derived from these exceedance curves for a threshold frequency deemed to present an acceptable level of risk to human life and facilities.

A key benefit of this approach is that realistic design loads can be obtained that are not overly conservative because the calculation process takes into account a large number of possible scenarios. BMT use its comprehensive computational resources to maximize the number of scenarios assessed thereby ensuring the most accurate results possible for our clients.

The exceedance analysis approach to design load calculation can be used at either FEED or detailed design stage even when project data is still immature. BMT can use its experience and database of past projects to add artificial congestion to models to ensure blast load calculations are representative of the final design.

BMT experiences CFD staff using state of the art resources.