

Liquefied Natural Gas Terminals

Services and solutions

Where will our knowledge take you?

BMT is a leading international multi-disciplinary engineering, science, technology and management consultancy, across Europe, Asia, the Americas and Australia.

Our technical expertise, backed by more than 30 years' experience in the maritime and offshore oil and gas industries, provides us with a deep understanding of our customers challenges and allows us to provide a wide range of innovative solutions.

For the LNG market, the location of a terminal and its associated environmental impact, transport links to market and operational constraints, are paramount considerations.

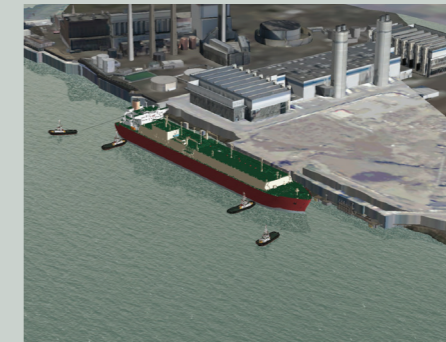
BMT services cover project management, front end engineering design (FEED), detailed design, construction and operation, supporting clients at every stage.

From detailed design and engineering for an LNG terminal expansion in Singapore to enabling the first alongside ship-to-ship transfer of LNG in the UK, BMT has an extensive track record in delivering high-value solutions for storing and safely transporting this important energy source.

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Pre-investment/planning and feasibility

From site selection to rigorous feasibility studies and project management, BMT provides an extensive portfolio of services to guide customers through the early planning stages of LNG facilities.

Site location – assessment and selection

The economic, transport, environmental and social implications associated with LNG terminals mean that the choice of site location is crucial.

BMT's consultants integrate in-depth knowledge of marine accessibility, transport planning, conceptual design, geotechnical, metocean and environmental conditions to thoroughly research and consider all the options to identify the most suitable location to operate safely, reduce delays and cost. BMT takes into account the specific risks associated with loading and unloading LNG tankers and siting regasification terminals in populated areas.

BMT services also include environmental impact assessments and the influence of prevailing metocean and geotechnical conditions on the design of jetties and breakwaters.

Marine facilities and master planning

BMT prepares long, medium and short-term plans for LNG terminals. Our master plans and detailed project reports encompass all aspects of the development and their phasing – including considerations of liquefaction and regasification options, and the impact these options will have on the siting and arrangement of new terminals.

Our specialists prepare conceptual and preliminary front end engineering designs (FEED) that are robust and flexible enough to ensure that the next stage of the project proceeds smoothly. Our experience covers a wide range of LNG solutions, ranging from land-based terminals through to various FSU and FSRU options (downstream) and floating liquefaction options (upstream).

Because we provide an overall project management service, from initial feasibility through to construction and commissioning, our customers do not need to appoint multiple consultants.

Market and economic assessment

One of the challenges facing the LNG sector is transporting gas from stranded gas fields to liquefaction terminals and then onward to the market.

BMT provides financial and commercial assessments for LNG investors. Our technical and commercial expertise extends to assessing liquefaction and regasification options, reviewing traffic flows and planning the optimum routes and size of carriers employed, and competitive analysis of other terminals in the region.

Acting as the owners engineering consultant during procurement, BMT can further assist with guidance of LNG sale and purchase agreements and time charter party agreements for FSU and FSRU options, as well as managing the tender and contract management process for all of the terminal engineering, procurement, construction and commissioning works.

Operational Simulation

BMT's Simulation of Long-term Offshore Oil Production (SLOOP) software is used to investigate the operational risk and economic performance of entire offshore developments. SLOOP works by constructing a model of an oil and gas field or process and then simulating the operation over time. The simulation is repeated many times using different environmental records.

Other random events such as equipment failure, resource availability, and vessel delays may also be included in the model. After the simulations are complete, statistical data can then be analysed for all aspects of the simulation. Simulation results can also be directly interfaced into field economic models.

Manoeuvring and Navigation Studies for Operational Optimisation

The position and layout of terminal offloading jetties and breakwaters is determined by both the environmental conditions and vessel manoeuvrability. BMT uses its real-time ship handling and manoeuvring simulator REMBRANDT to evaluate terminal layouts.

This system has been continuously refined over the last 25 years and has been used by a wide range of ship and terminal designers and operators. It is also widely used by pilots.

This system has a wide range of high fidelity ship models which can interact with varied environmental conditions and tugs to produce realistic vessel behaviour within the planned layout of the berth.

BMT also carries out sediment transport studies to identify dredging requirements and support breakwater design.

In addition, we provide impartial and expert advice for planning approvals and for mitigating risks cost-effectively.

Swan Energy LNG Terminal, Jafrabad Port, India

BMT carried out cost and feasibility studies at sites in Jafrabad Port to identify the best location for an LNG import terminal. We were subsequently selected for engineering design work and an environmental impact assessment to support an FRSU development. This included disaster management plans and a risk assessment for LNG handling.

Feasibility Report and Bid Package, Dahej, India

Petronet LNG Ltd appointed BMT to prepare a detailed feasibility report and bid package for a stand-by jetty at Dahej Port. Our services included a review of the pre-FEED report, ship mooring analyses, navigation simulation, preliminary design of marine facilities and preparing the specifications and bid package for the engineering, procurement and construction contract.

LNG Marine Terminal Feasibility Study

BMT used REMBRANDT to establish the metocean conditions at an LNG site location in the Caribbean, to evaluate manoeuvring and mooring aspects for various jetty configurations (location and orientation) and predict operational downtime, cargo transfer and storage requirements over a 20-year period.



Detailed engineering and design

BMT's successful track record in maritime engineering, including India's largest LNG jetty, means we are the partner of choice when projects enter the detailed design phase. BMT consultants use state-of-the-art design and optimisation tools to support this crucial phase.

Metocean Design Criteria

Metocean information is essential for the safe and economical design of a marine facility. BMT's understanding of the metocean processes and conditions that influence the design of the marine infrastructure, necessary to facilitate the offloading or import of LNG, is based on extensive experience in the industry.

BMT maintains in-house historical metocean databases, tailored numerical models and a suite of proprietary software for the statistical analysis and extreme value extrapolation of metocean design parameters to ISO standards.

Navigational safety and risk

BMT's internationally recognised suite of proprietary and commercially available vessel response software. It provides risk assessments to aid the development of safe operating procedures, which helps to limit design errors.

The BMT traffic management team, with their extensive knowledge of ship behaviour and AIS traffic data analysis techniques, can assess the effects of LNG operations on other vessel and port operations and advise on the introduction of additional traffic management measure to mitigate against navigational risk, such as changes to vessel traffic monitoring and traffic management schemes.

Breakwater and jetty design

BMT's maritime expertise of vessel design, combined with a thorough understanding of the marine environment, ensures that we provide innovative and cost-effective solutions to aid the design of breakwaters and jetties.

Dredging assessment and hydrodynamic modelling

Silting at terminals requires regular dredging to maintain navigation channels. BMT specialises in planning, designing and project managing all capital and maintenance dredging works. This includes obtaining the required approvals and licences. Using BMT's in-house hydrodynamic modelling capability, our experts can determine the cause of sediment build-up and develop strategies for cost-effective dredging and spoil disposal.

Risk and Safety Engineering

BMT is able to identify hazards and evaluate associated risks by conducting studies such as Quantitative Risk Assessments (QRA), Hazard and Operability (HAZOP), Hazard and fire and gas mapping studies and a full range of consequence modelling.

Consequence Modelling

BMT has conducted consequence studies for many of the world's oil and gas facilities. BMT consultants provide quantitative assessment of the consequences of all major hazards – including fire and explosions – that could potentially damage a structure's integrity and cause personal injury.

The results are used to improve the design, incorporate mitigation measures or devise strategies for keeping the risk within acceptable levels. BMT provides comprehensive consultancy and consequence evaluation, from FEED to detailed design engineering.

This helps HSE specialists and engineers to make informed decisions at every stage of the design process.

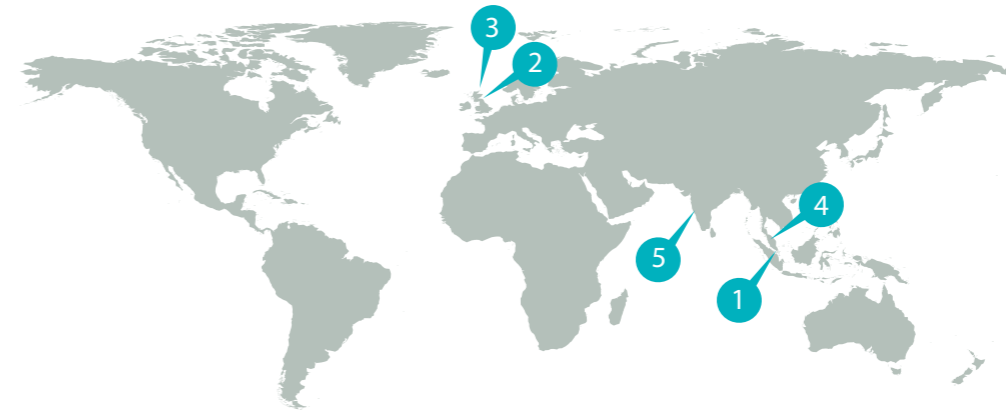
Minimum Safety Distance Analysis

BMT is familiar with the recognised standards such as the British Standard "Installation and Equipment for Liquefied Natural Gas – Design of onshore Installation" EN 1473 and can provide high level screening studies of potential major accident scenarios for loss of containment at LNG terminals to define safety distances, taking into account residential areas, port activities, industrial areas and or other activities in the neighbourhood.

Wind Tunnel Testing

BMT operates large in-house wind tunnel facilities to help designers assess wind loads on a facilities structure and design layout.

BMT's large boundary layer facility allows precise 3D mapping of wind fields over complex terrains where winds can be far more turbulent than those found in open sea conditions. These measurements are very important for port and terminal design where – due to the growing size of ships – detailed simulation models are vital for the investigation of manoeuvring and berthing operations.



1: Detailed Design and Engineering, Singapore

BMT was appointed by the Singapore LNG Corporation as a consultant for the complete detailed design and engineering of a secondary berth for the LNG terminal on Jurong Island. The scope of work included a secondary jetty to accommodate an LNG carrier range of 60,000 m³ to 265,000 m³.

2: LNG Ship-to-Ship Transfer, Teesport

BMT developed a safety strategy for the UK's first alongside ship-to-ship transfer of LNG at Teesport. It was also the first to be conducted in the northern hemisphere. This ground-breaking feasibility study and assessment involved close co-operation with regulators, operators and stakeholders.

3: LNG Re-gasification Project, Malaysia

BMT provided FEED for an LNG re-gasification unit and island berth in Mukim Sungai Udang, Melaka. We were subsequently appointed as consultants for detailed engineering and design and technical support during the engineering, procurement, construction and commissioning stages of the island berth and facilities.

4: Navigational Risk Assessment, Bonny Channel

The anticipated increase of Liquefied Natural Gas (LNG) tankers transiting the Bonny Channel in Nigeria required various options for two way traffic to be considered as a means of ensuring safe passage for these vessels.

Based on BMT's experience track record of similar studies of this nature, it was chosen to facilitate and chair a structured risk assessment process.

Some \$40M worth of savings was identified as part of a capital dredge programme. In addition, several strategic risk reduction methods were identified in order improve the safety of shipping.

5: Lenders Engineer and Due Diligence Services for Jaigarh Port

BMT provided a comprehensive due diligence exercise for the development of Jaigarh Port, offering complete design and contract review and verification of cost estimates.





Construction and operation

Drawing on its global expertise in project management, metocean forecasting, navigational safety and risk mitigation, BMT provides vital support during construction, operation and maintenance of terminals.

Navigational simulation and training

BMT's real time ship-handling and manoeuvring simulator, REMBRANDT, is used by pilots, ship operators, naval architects and port authorities worldwide. The accuracy of its modelling simulations over multiple scenarios makes it a flexible and affordable training tool.

REMBRANDT gives pilots a realistic experience of large vessels, such as LNG tankers. It is also used to train crew in arrival and departure manoeuvres in relation to the operational jetty, giving them an accurate feel for the conditions. The feasibility of future expansion plans for a terminal may be supported with the use of REMBRANDT to study design plans and operational limits.

Weather downtime and operational forecasting

BMT uses its state-of-the-art capabilities in data collection, data management, data analysis, numerical modelling and forecasting to improve safety, efficiency and reliability during construction and operation.

Our forecasting services help customers minimise time lost due to bad weather and ensure operations are conducted within safe working limits.

Integrated Marine Monitoring and Berthing Aid Systems

A combination of the BMT marine environmental (metocean) monitoring system, with additional components such as berthing aid and mooring load monitoring (hook loads) components fully integrated into the one software package, can assist the approaching tankers via a ship to shore communication, thus ensuring safe and efficient operations at the LNG site.



Risk assessment

BMT assesses the safety and environmental risks involved in handling and storing LNG and advises on the most appropriate ways of reducing them. This work extends to subsea pipelines transporting the gas. Our experience in hazard assessment and marine safety enables us to accurately identify the relative risks of various transit routes, particularly in busy and narrow water channels.

3D Dredging Model of Walker Shoal, Australia
Following a review of the geotechnical data at Walker Shoal, BMT developed a 3D model to support dredging works at the Ichthys LNG development to accommodate the required export facilities. Previously we supplied a range of specialist dredging consultancy services during the FEED and tender phases of the project.

LNG Metocean Forecasting, Yemen
BMT provided operational forecasting of offshore winds, offshore and near shore waves, currents and water levels in support of operations at the Balhaf LNG export facility in Yemen. Port operability was optimised by minimising weather-related downtime.

Chevron Gorgon project, Australia
BMT has been providing extensive marine and coastal environmental services into the Chevron Gorgon LNG project, situated on an A-Class reserve in Western Australia. Robust quality assurance control systems coupled with extensive statistical knowledge have allowed us to deliver a high quality service.



Floating Liquefied Natural Gas (FLNG)

FLNG has become an important concept for the development of gas reserves in locations where connection to shore facilities is not viable on economic or environmental grounds. BMT's wealth of knowledge of all types of offshore oil and gas assets gives us a unique capacity to assess risk and guide actions to meet the specific challenges of the design and operation of an FLNG facility offshore.

Metocean studies

Both the design and the operability of an FLNG unit depend critically on the sea state conditions which may vary considerably depending on the site chosen. BMT can provide detailed metocean studies to ensure not only the design, but the operation of the FLNG unit is optimised for the proposed development. Bespoke weather forecasting and ocean modelling can further assist with the planned offloading operations to improve efficiency and provide input into the operational risk assessment, once the development is fully commissioned.

Vessel manoeuvrability and mooring analysis

BMT has extensive experience in evaluating the feasibility of ship-to-ship and ship-to-structure operations. Manoeuvring simulations made with our in-house vessel simulation software determine limiting wind, wave and current conditions for the safe arrival and departure of LNG carriers to the FLNG barge.

Wind Load Testing Facilities

The wind loads acting on the topsides of FLNG facilities and LNG carriers can also play an important role during installation

and operational conditions.

BMT is a recognised authority on offshore helideck aerodynamics and flight safety. World-class wind tunnel facilities and state-of-the-art computational modelling resources may be used to provide designers and operators clear and insightful assessments of proposed helideck designs.

In regions affected by extreme wind events such as tropical revolving storms, wind load represents a highly influential factor in the design. Mean aerodynamic wind load coefficients, especially for critical scenarios such as the offloading configuration, are routinely investigated in BMT's large boundary layer wind tunnel

Facility Layout Hazard Analysis

A key challenge in designing FLNGs is space: fitting all necessary modules, both hazardous and safe, in or above the same hull, and in a way that does not put the personnel, asset or operations at risk. BMT builds on its background in offshore and onshore industrial engineering to offer topside layout assessments in compliance with recognized standards and supported by risk studies.

LNG Tank Sloshing Assessment

FLNG units need to operate safely with tanks partially filled, but wave motions create sloshing loads that may damage containment systems. BMT perform sloshing analyses according to established industry methods and supported by the multi-purpose CFD software, CFX.

Cryogenic Spill Mitigation Strategy

A cryogenic spill on an FLNG facility can cause severe damage to topsides and hull structures, depending on volume, nature and location. A large cryogenic gas or vapor leak can also potentially cause cryogenic failures of structures depending on volumes and duration of leak. BMT can help identify any additional hazards which may arise from a cryogenic spill management system (e.g. Rapid Phase Transition (RPT) in case of massive cryogenic release overboard).

Marine Integrity Monitoring

For FLNG, BMT can provide Integrated Marine Monitoring Systems (IMMS) to help reduce operational risk and costs and contribute to an overall safer floating facility environment.

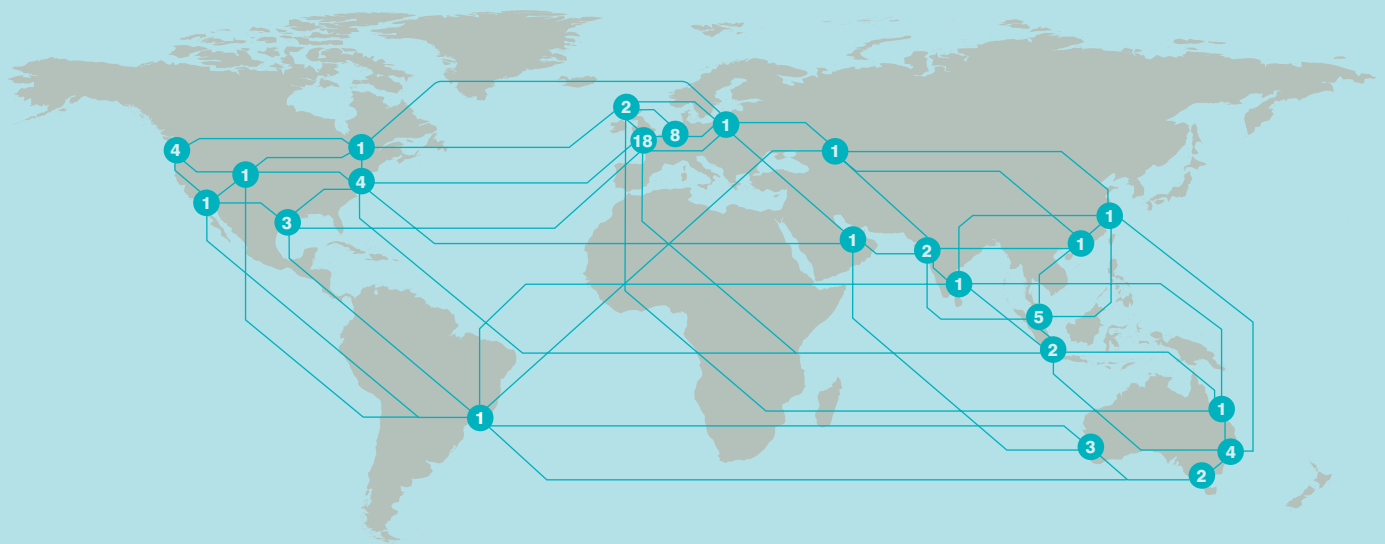
FLNG structural parameters such as mooring line tension, position, and motion are simultaneously monitored in real time with the environmental conditions, such as wind speed, current profiles, air gap, and wave height, using components of the IMMS presented on a single software package.

Data may be transferred to the approaching LNG carriers using ship to ship communication. This reduces operational risks and costs, whilst aiding the overall safety of operations during offloading.

Long-term data sets may be archived for future analysis, such as fatigue assessments and health checks of the integrity of the asset over the lifetime of its operation.

BMT is an international design, engineering and risk management consultancy, working principally in the energy and environment, transport and defence sectors.

With locations in all of the major markets we serve, ours is an active network that sees us sharing skills and knowledge, combining disciplines and building international teams to create integrated answers to the questions of our customers.



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