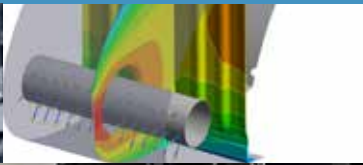


## Defence Sector Services



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Founded in 1983, Geosyntec is a leading consulting and engineering family of companies with over 1,200 practitioners that operates globally, with focus on North America, Europe, Asia, and Australia.

Our high-value services, first-to-field deployment of emerging technologies, and innovative solutions are recognised by many clients as a key differentiator and reason for using Geosyntec, whether from the private or public sector.

Our private sector clients come from a variety of industries, including oil and gas, chemical, aerospace, pharmaceutical, diversified manufacturing, advanced technology, power and utility, and environmental management. They also include regional and national developers, large commercial property owners, and the legal-financial sector. Our public sector clients comprise departments and agencies of national, regional, state, provincial, and municipal governments.

For over 30 years we have grown based on the application of sustainability principles to projects involving environmental contamination studies and remediation; water and natural resources assessment and restoration; compliance management of air emissions, wastewater discharges, and waste disposal; and engineering and design of environmental, water resources, and civil infrastructures. Geosyntec holds a unique position in the consulting and engineering marketplace through our ability to combine innovative technology and practice leadership with exceptional client service and project delivery excellence. Our services and solutions are highly valued and sought after by our clients, with most of our assignments coming via repeat client business.



engineers • scientists • innovators

MMI Engineering (MMI) is a division of Geosyntec and provides specialised engineering, safety, security and risk management services to Geosyntec's clients on a global basis. We undertake projects on facilities to:

- Minimise risks from natural, accidental, and malicious events - such as fires, explosions, earthquakes, impacts, and tsunamis;
- Manage the integrity of facilities to ensure their safe, long-term performance; and
- Optimise process improvements - reducing risk to business performance.

MMI helps clients manage risks on their facilities that could affect life, the environment, asset performance, or business interruption by providing:

- Safety and risk management studies to identify risks and their likelihood;
- Detailed computational modelling studies to predict behavior; and
- Analysis and engineering to mitigate hazards or optimise processes, delivering designs and advice that can be implemented.

MMI advises clients in the areas of defence and security, nuclear, oil and gas, chemical and petrochemical, conventional power, clean energy, water utilities, and the legal and financial sectors. Our people have diverse backgrounds in research, design, consulting, construction, and operations. Skill sets cover the mechanical, structural, civil, chemical, process engineering, physics, and chemistry disciplines - often to PhD level. Like our colleagues at Geosyntec, MMI has internationally recognised practitioners who have established the state-of-the-art in most of our practice areas.

# The Defence Lifecycle

## Concept

We work with our clients to understand their needs to enable us to frame their problem in such a manner that will foster innovation within the user requirements. Our knowledge and skills allow us to support our clients in planning how to execute the short-term project, as well as the through life management planning (TLMP) and business case submissions for the assessment stage.

## Assessment

Based on our knowledge across the engineering spectrum and our systems engineering approach, we can develop novel and pragmatic designs to solve specialised or complex challenges. Our expertise is drawn from a wide range of scientific and engineering backgrounds that enable us to deliver credible solutions based on knowledge of underlying regulation and statutory requirements. This is supported by our ability to develop system requirements that provide a direct link to the user need, and allow the most cost-effective technological and procurement solution to be selected while managing risk.

## Demonstration

We use software as a tool to investigate real-world problems - an aid to predicting loads or other parameters, assessing capacity or performance, or optimising designs. But simply running the software is not enough, and many of our engineers and scientists have studied the fundamental science incorporated within simulation software, or have been software programmers for major vendors. A strong understanding of the science and engineering principles of the system being simulated, combined with in-depth project and operational experience to determine whether the predictions make sense, forms the cornerstone of our analysis, test and simulation service. This fundamental knowledge enables us to support clients to progressively assure designs and support solutions.

## Manufacture

From verification through analysis, to management of requirement verification, we ensure progressive assurance to deliver solutions that meet user needs, to time, cost and quality.

## In-Service

Our personnel utilise their knowledge and experience to ensure that equipment will maintain levels of performance within tolerance specifications, and drive down the annual cost of ownership. This can be in relation to supporting upgrades/improvements, refits, or acquisition increments.

## Disposal

We ensure the efficient, effective, and safe disposal of equipment through thorough planning from early within the concept, assessment, demonstration, manufacture, in-service, and disposal (CADMID) cycle, with detailed knowledge of the underpinning regulations.

# Defence Services

Our combined services enable us to deliver solutions pertinent to the Defence Sector.

## Environmental and Geotechnical Services

- Site investigation and monitoring programmes;
- Contaminated land and ground water assessment and remediation;
- Water supply and management;
- Environmental management, analysis and systems; and
- Geotechnical survey, analysis and reports.

## Specialised Engineering Services

- Major hazards engineering;
- Fluid mechanics;
- Blast engineering;
- Fire engineering;
- Seismic engineering;
- Impact engineering;
- Structural engineering; and
- Nuclear engineering.

## Specialised Support Services

- Systems engineering;
- Supportability analysis;
- Threat vulnerability, assessment and mitigation;
- Technical safety;
- Risk assessment; and
- Data management, analysis and visualisation.



## Site Investigation and Monitoring Programmes

Geosyntec practitioners rank among the world's top professionals in providing site assessment and remediation services at a wide range of impacted sites. We provide public and private clients with a range of services for their toughest challenges, including developing and advocating successful compliance strategies, cost-effective and "goal-focused" site investigation, remediation planning engineering, remediation construction and implementation, construction management – and much more.

Geosyntec's engineers and scientists leverage the power of chemical, physical, geological, and biological processes and reactions toward developing innovative approaches for characterising, detoxifying, immobilising, and eliminating exposure risks for a wide range of chemicals in the environment, especially those that are difficult to treat by more conventional means.

## Groundwater Assessment and Remediation

Our engineers and scientists design and implement award-winning, technology-based remediation strategies for public and private sector clients. We are often contracted by the Defence Sector and other government agencies to write comprehensive technical guidance on state-of-the-art management methods for managing and remediating contaminated groundwater. We are experienced in the assessment and remediation of a broad suite of contaminants, including munitions constituents and propellants, metals, chlorinated organic chemicals, and petroleum hydrocarbons - in addition to a diverse suite of new and emerging contaminants. A hallmark of our service is efficient site characterisation, even at sites that exhibit complex groundwater flow regimes. Many of our hydrogeologists specialise in modelling the fate and transport of contaminants through the most difficult types of media, including fractured and karst bedrock, and low-permeability geologies such as clay, till, and silt.

Once a site has been characterised, we are adept at designing and implementing remedial schemes, long-term monitored natural attenuation (MNA) monitoring-based strategies, and other site management strategies. While we are also highly experienced in conventional technologies, we are practice leaders in the application of in-situ remedial technologies, including: bioremediation and bioaugmentation; chemical oxidation, reduction and thermal remediation - including a self-sustaining smoldering based technology. We have established patents for many of the technologies and equipment that we have developed.



## Water Supply and Management

In part linked to the environmental management services outlined below, but specific to groundwater and water, Geosyntec provides services to clients linked to establishing viable alternative water supplies for sites. This can be in the form of the design, installation, testing and commissioning of groundwater supply wells and associated infrastructure, where sites are located on good aquifers of potable (suitable) quality. It can be more about water management and minimisation programmes, including the management and use of rainfall, and smart water harvesting systems and infrastructure.

## Environmental Management, Analysis and Systems

### Environmental Management Systems (EMS) and Compliance

Geosyntec helps clients manage risk while meeting their organisational goals for environmental stewardship and financial management. Our environmental management services include the building of compliance solutions, generating defensible valuations of impaired properties, distinguishing between potential and actual environmental risks, and reducing energy and water-resource utilisation.

### Environmental Liability Valuation

Geosyntec evaluates the financial relevance of environmental liabilities and opportunities by applying fundamental engineering and scientific analysis within a specific financial, legal and risk management framework. We provide a better cost certainty, potentially reducing both the size and share of costs related to insurance transactions, risk transfer, financial report, and portfolio management.

### Due Diligence

Geosyntec provides value-added support during transactions by locating both the obvious and hard-to-find environmental liabilities and quantifying their underlying financial and business risks. Our mergers, divestitures and acquisitions (MD&A) team help evaluate risks associated with environmental health and safety issues, financial reporting requirements, recalcitrant contamination, vapour intrusion and indoor air quality concerns, geotechnical challenges, hazardous building materials, protected wildlife and wetlands, and cultural resources.



## Geotechnical Survey, Analysis and Reports

- Geotechnical and geological studies and investigations;
- Geotechnical and geological site characterisation;
- Static and seismic stability analysis;
- Earth dams, embankments, and foundations;
- Levees and flood control structures;
- Rock engineering;
- Geotechnical modelling;
- Conceptual and detailed design;
- Construction-phase engineering;
- Construction management and quality assurance; and
- Post-construction monitoring.

Geosyntec provides nationally recognised expertise and specialised geotechnical and geological engineering (geo-engineering) services to evaluate and improve the design and construction engineering properties of soil and rock foundations. Our geo-engineering specialists form one of the leading practices in the United States and the United Kingdom. We are recognised for our ability to develop practical guidance, and efficient designs conducive to aggressive construction schedules commonly imposed by project economics.

Our geo-engineering practice focuses on difficult and challenging sites where the development of dependable, cost-effective foundations, and other geo-structural solutions are critical to the success of the project. Our practitioners accomplish this by establishing a thorough understanding of the project site, developing a technical framework for the project, and incorporating the critical management drivers, such as schedule and project economics, into the early stages of our planning.

Our geo-engineering professionals have responded to the challenges of increasingly unfavourable site conditions by developing and applying sophisticated approaches to investigate and characterise sites; analysing foundation behaviour; altering the engineering characteristics of the soil and rock at a specific site through soil and rock improvement; and environmentally remediating sites. We implement these approaches so foundations and other subsurface structures can be constructed safely to support the built environment, and withstand potential geo-hazards. Our geotechnical practitioners are fully familiar and experienced with the practical application of these tools.



## Major Hazards Engineering

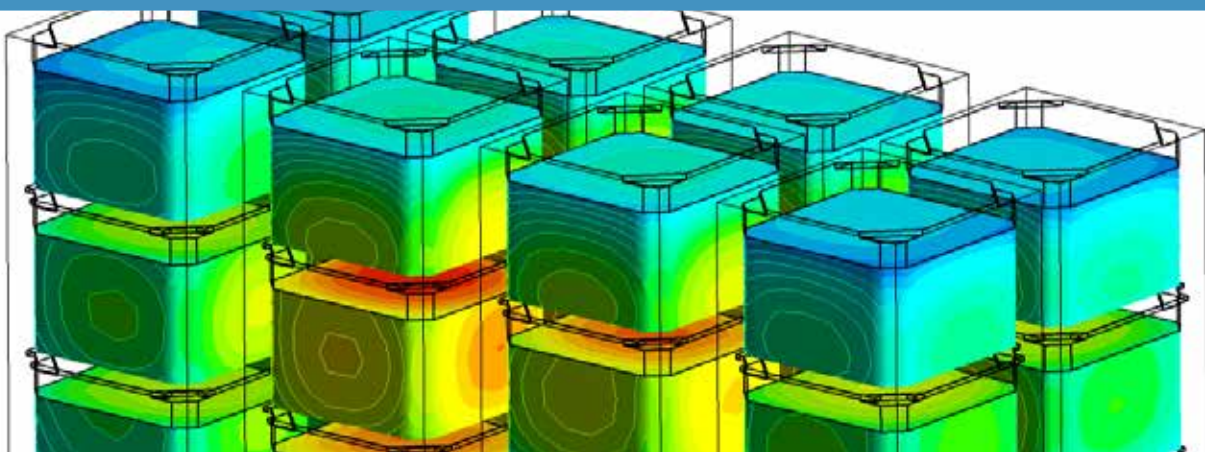
Designing structures and components to mitigate the effects of major hazards, or deliberate attack, is part science, part art. MMI has established itself as a recognised provider of novel and innovative design solutions to meet some of the most demanding loading conditions, including fire, flood, blast, earthquake, and impact. Our starting point is always to recognise that for any design solution to succeed, it must be safely built and installed. By combining expertise in code-based design, advanced engineering analysis, destructive testing, and fabrication and construction, MMI provides fully substantiated designs, from concept right through to oversight of construction and installation.

The assessment of existing structures and components is often a critical activity for many facility operators, and can have far reaching implications for the continued operation and integrity of assets. Fully understanding the current, as-built condition of the elements in question is paramount. MMI has a strong track record in assessing and reappraising a wide range of structures and components, in many cases demonstrating previously unrecognised capacity, or, identifying potential remedial measures to support continued safety and integrity. Our techniques range from experienced-based, qualitative assessment, through to detailed computational analysis, fatigue and fracture mechanics methods.

## Fluid Mechanics

MMI Engineering has extensive knowledge of fluid mechanics and heat transfer processes, which we regularly apply to engineering problems across different industry sectors. This fundamental knowledge of fluid dynamics, hydraulics and reacting flows is supplemented by the use of modern analysis tools, including computational fluid dynamics (CFD), finite element analysis (FEA) and fluid network modelling, using a range of commercial and internally developed tools.

MMI Engineering has expertise with ANSYS-CFX, ANSYS-Fluent, Flowmaster, Open-FOAM, Code-Saturne, FLACS, KFX, and many other fluid modelling tools. We have expertise in certain specialist areas, which have resulted in the development of new techniques, bespoke software tools, and modifications to commercial software to address complex coupled systems. These specialist areas include conjugate heat transfer (combined conduction, convection and thermal radiation) for systems such as nuclear transport flasks, aircraft wing anti-icing, and boiler heat exchangers, where these systems can also include boiling and condensing phase change heat and mass transfer.





# Blast Engineering

MMI's experience in blast engineering covers all sources of blast loading, including rapid deflagration, vapour cloud explosion, dust explosions, improvised explosive devices (IED's) and weapons effects. In each case the initiation of the explosion, the propagation of the blast wave, and its interaction with the built environment, can be robustly assessed and evaluated. The range of required skills includes:

- Blast vulnerability assessments;
- Characterisation of the explosive material;
- Determination of the resulting pressures and impulses;
- Blast wave interaction with obstructions;
- Dynamic, non-linear analysis of cladding systems, structural frames and attached piping and equipment;
- Design of structural members to undergo controlled plastic deformation;
- Design of connections, anchorages and ductile detailing;
- Co-ordination and interpretation of blast testing;
- Knowledge and experience with anti-terrorism force protection (ATFP);
- Knowledge and experience with ICS 705 (intelligence community standard); and
- Knowledge and experience with TEMPEST and HEMP protection measures.

MMI employs engineers who are members of the Register of Security Engineers and Specialists.



## Fire Engineering

MMI's world-leading Passive Fire Protection (PFP) practice brings together experienced practitioners and project personnel, offering independent advice and practical solutions in a discipline that appears simple in theory, but is difficult to achieve in reality. MMI undertakes bespoke PFP consulting, PFP scheme development for new construction and existing facilities, and PFP inspection and integrity management on ageing assets.

The practice operates globally through MMI's network of regional offices. Our experienced personnel, with "hands-on" application experience and solid backgrounds in materials, technology, guidance and specification development, integrate with MMI's technical safety, hazards modelling and structural engineering teams to provide a complete fire hazards management solution.

Using advanced analytical CFD and FEA modelling techniques, together with detailed materials knowledge and fire testing and application experience, we provide independent, expert advice that delivers fit-for-purpose, compliant solutions - satisfying regulatory requirements and asset and environmental protection needs.

## Seismic Engineering

Seismic engineering is a specialised sub-set of structural engineering, which requires careful assessment of the applied cyclic dynamic loads and analysis of their interaction with the structural form, along with increased attention to the required construction details that will ensure adequate strength and ductility. MMI supports the full range of seismic engineering requirements, including:

- Seismic vulnerability assessments;
- Seismic hazard assessment and characterisation of seismic ground motions, including soil-structure interaction;
- Dynamic analysis of structures, systems and components;
- Design and ductile detailing of structural members and connections;
- Seismic qualification of equipment items and anchorage, including using seismic walkdown methodologies;
- Preparation of seismic design substantiation documents;
- Co-ordination and interpretation of shake table testing; and
- Pre-commissioning seismic walkdowns to confirm as-installed adequacy.



## Impact Engineering

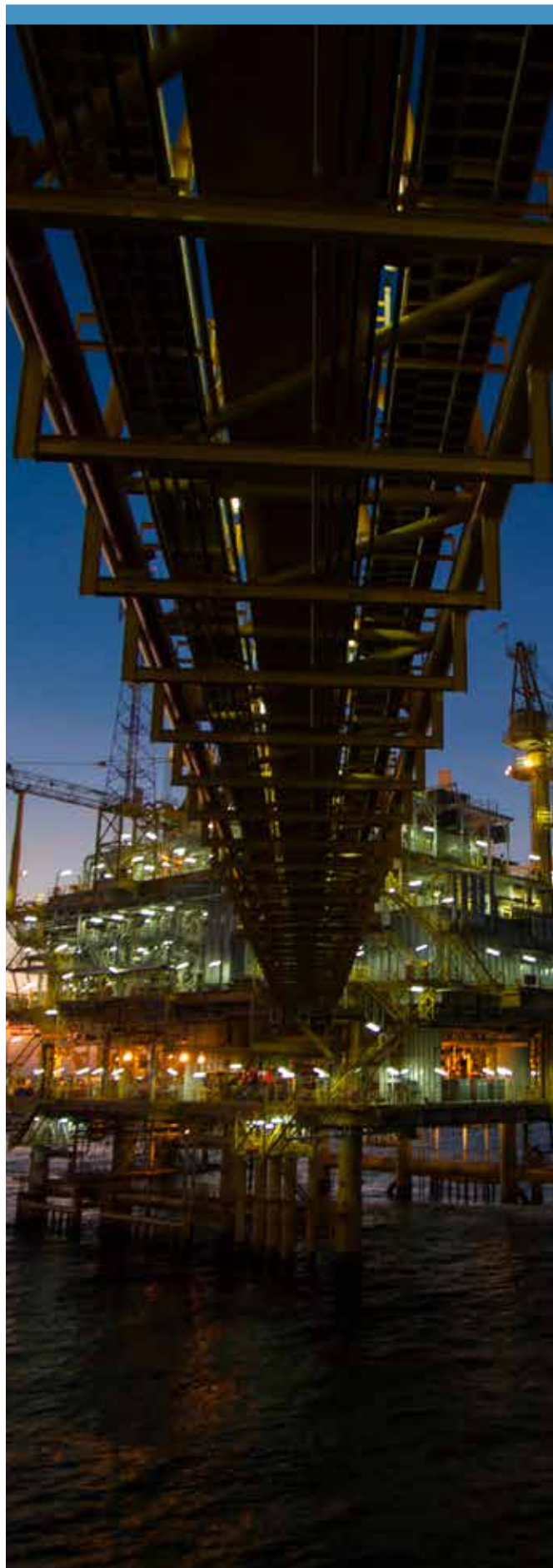
As a specialised field which relates to civil, structural and mechanical engineering, impact engineering requires a robust understanding of structural dynamics, collision physics, material non-linear behaviour and attention to detail at welds, seals and other critical points. MMI's skills that support this field include:

- Energy balance and inelastic energy absorption;
- Structural dynamic and collision physics;
- Non-linear dynamic finite element analysis;
- Material technology and weld integrity; and
- Interpretation of impact testing.

## Structural Engineering

Structural engineering experience and skills underpin MMI's major hazards engineering capability. These skills include the ability to design new structures and assess existing structures, taking into account applied loadings, load paths, material technology, satisfaction of code requirements beyond code performance, and presentation of construction information. Our skill areas may be summarised as:

- Building surveys and condition assessments;
- Structural analysis using a variety of techniques;
- Structural design to UK codes, Eurocodes and US codes; and
- Preparation of drawings and specifications.



# Systems Engineering

A systems engineering approach is all about getting the right solution to the right problem throughout the lifecycle. Systems engineering differs from sector to sector - however, consistently it is a disciplined and structured approach that is used to understand a problem holistically across all disciplines and constraints, rather than focusing solely on the individual elements. From this grounded understanding, solutions can be managed to ensure they meet the end-users' needs and deliver fit-for-purpose solutions to time, quality and cost. Within MMI, systems engineering is delivered through three key areas:

- Requirements engineering and management – Specifying the right solution for the right price on-time, including validation and verification of the requirements;
- Asset performance - Understanding existing assets and predicting potential of new assets to inform investment and support solutions through a detailed understanding of when items are likely to fail and the resulting consequences; and
- Asset management (integrated logistics support and logistics support analysis) – Developing and optimising a support solution that can maximise potential availability while minimising through life management (TLM) costs to deliver long-term value for end-users.

## Supportability and Through Life Management

Engineering is a constantly evolving discipline - trying to deliver more for less while understanding existing assets, or predicting the potential of new assets. MMI Engineering offers supportability and TLM services across the range of relevant technical and strategic areas, including:

- Asset reliability management; reliability, availability and maintainability; and throughput, reliability, availability and maintainability analysis (ARM, RAM and TRAM);
- Integrated logistics support (ILS), management and planning;
- Full JSP 886 and DEF STAN 00-600 analysis and management;
- Risk-based strategy development;
- ARM case development;
- Reliability predictions and accelerated life testing;
- Failure mode and effects analysis; failure mode, effects and criticality analysis; failure mode, effects and diagnostic analysis (FMEA, FMECA, and FMEDA);
- Asset management planning and through life cost analysis;
- Spares analysis and obsolescence management; and
- Optimised maintenance strategies (reliability-centred maintenance [RCM], etc.).



## Threat Vulnerability, Assessment and Mitigation

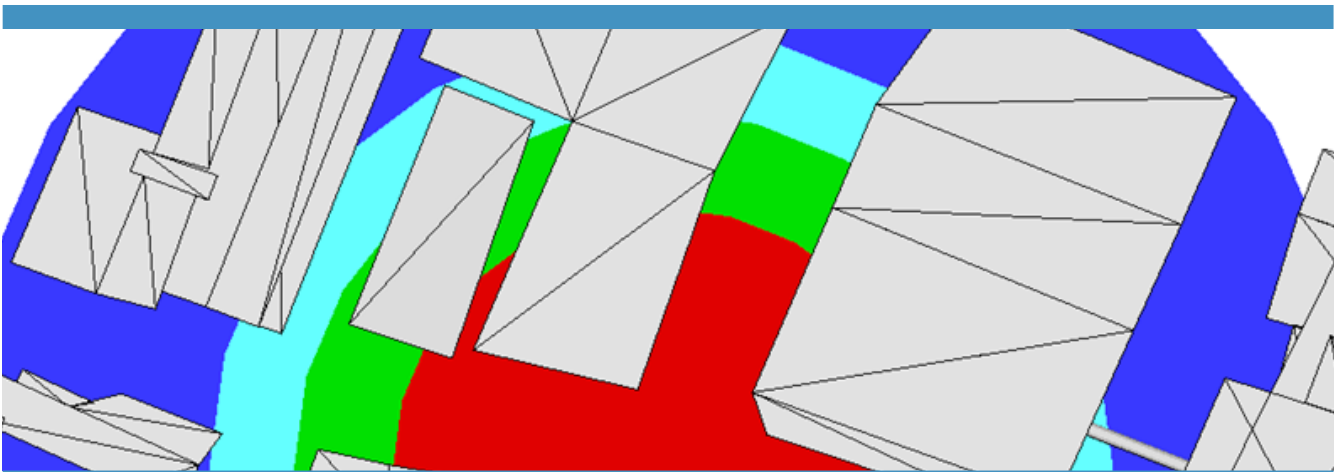
MMI has specialised experience in the full spectrum of security engineering services. Our capabilities include threat assessment, vulnerability analysis, and mitigation and design. Protection against terrorism is one of the most significant challenges faced by the security and engineering communities today. Our capabilities include:

- Threat definition: MMI has an acute understanding of improvised explosive devices (IED's) and vehicle borne IED's (VBIED's) using military-grade (i.e., RDX), homemade (i.e., ANFO), or fuel-air devices (such as the failed New York Times Square bombing on May 1, 2010);
- Definition of blast loading: We use sophisticated CFD modelling to quantify blast pressures and the effects of blasts on structures;
- Access control points (ACP) layout and design: Using parameters such as road layouts and barriers, MMI has worked with airports, military bases and nuclear and petrochemical facilities to develop perimeter security measures;
- Sensitive compartmented information facilities (SCIF) design: We combine our expertise in structural analysis and vulnerability assessments of internal information technology (IT), heating, ventilation and air conditioning (HVAC) and control systems to provide SCIF design services;
- Chemical, biological and radiological (CBR) protection: Our engineers use their expertise in gas dispersion modelling under free and forced ventilation conditions to assess the threat of release and dispersion of hazardous substances in buildings and large population centres;
- Blast resistant design and analysis: MMI uses tools ranging from simplified single degree of freedom system response to comprehensive nonlinear analyses, using ANSYS, ABAQUS and LS-DYNA, to assess structural response to blast loading.

## Technical Safety

Technical Safety is the term used to describe the activities that provide assurance of a safe basis of design, and the validation that the systems required to deliver the said safe basis of design remain fit-for-purpose throughout the asset life cycle. Technical safety services offered by MMI include:

- Hazard identification (HAZID) analysis;
- Environmental identification (ENVID) analysis;
- Hazard and operability (HAZOP) studies;
- Safety integrity level (SIL) determination;
- Layers of protection analysis (LOPA);
- BowTie analysis;
- Hazard consequence assessment; and
- Emergency response studies.



## Risk Assessment

MMI Engineering provides technical consulting services to enable effective risk management. We assist our clients in the analysis, mitigation and management of risks posed by natural and man-made hazards.

The effective management of risk, whether safety, environment or business-related, requires a sound analysis of hazards and their associated consequences. We provide solutions based on the sound application of engineering and science and technology - combined with experience in design, construction, operations and project management. MMI has extensive quantitative risk assessment (QRA) experience in the following:

- Onshore and offshore assessments - e.g. floating production, storage and offloading (FPSO) units, floating storage units (FSU), floating liquefied natural gas (FLNG), fixed platforms, normally unmanned installations (NUI's);
- Concept, basic engineering / front end engineering design (FEED), detailed engineering, final investment decision (FID), brownfield, facility modifications;
- All sizes of facilities - from very large million tons per annum (MTA) liquefied natural gas (LNG) plants, to small pipeline receiving house assessments onshore and multi-jacketed bridge linked complexes, to small NUI manifold platforms;
- Detailed offshore blowout risk quantification; and
- Facilities in the UK and worldwide.

MMI has developed a Microsoft Excel and visual basic (VBA)-based QRA model, MMIQRA. This model was developed in response to requests from industry for a robust, transparent and user-friendly QRA model that could be tailored to an individual client's requirements.

The key advantages of MMI's MMIQRA model are:

- Ease of use. Inputs and outputs are made using Microsoft Excel – simplifying data input and manipulation;
- Rapid assessment of changes. Sensitivity studies can be performed in minutes, allowing risk reduction assessment during workshops;
- Ability to view all calculation steps that go towards overall risk results. This gives users a clear understanding of the basis (and limitations) of the software;
- No specialist software required; and
- Links to MMI's MMIFRA tool to perform detailed fire risk assessment (FRA) and PFP studies.



# Nuclear Engineering

## New Build Power

As a third generation of nuclear reactors begin construction in the UK based around the European pressurized reactor (EPR), advanced boiling water reactor (ABWR) and AP1000 reactor designs, MMI is working with operators and designers to ensure safety - taking into account modern codes and standards.

## Civil Nuclear Power

The industry has come to the end of a pioneering cycle where the first generation (Gen I) Magnox stations have ceased generating and the second generation (Gen II) advanced gas-cooled reactor (AGR) fleet is ageing. MMI is working with station operators on plant life extension and decommissioning projects throughout the UK.

## Transport and Storage

Our work is used to support package safety cases, by demonstrating safe containment in not only normally ventilated environments, but also under the extreme conditions generated by accident events, including impact and fire.

## Decommissioning and Disposal

Finding a solution for the long-term disposal of legacy radioactive waste is crucial for the continued safe use of nuclear energy in the UK, and is a pre-requisite for new nuclear generation. MMI assists with the safe removal and storage of nuclear waste material.

## Nuclear Defence

Our work has included advice on nuclear safety cases and the evaluation of hazards at defence installations. We have been involved in inspection, assessment and the design of systems, structures and components associated with the UK's nuclear deterrent.

## Fusion

MMI is in a position to assist researchers working to develop fusion as a new source of clean energy for tomorrow's power stations.



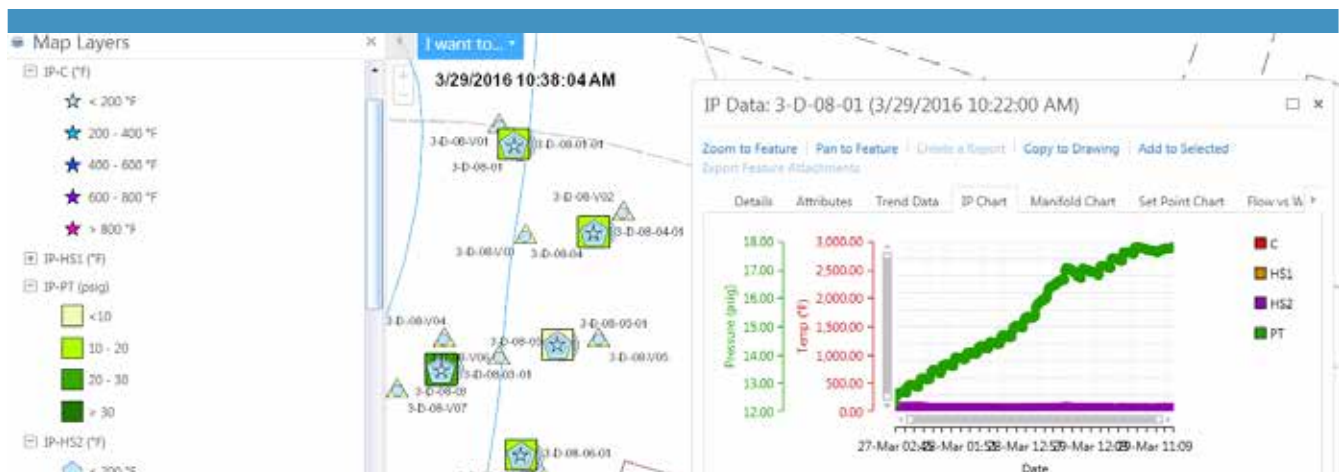
# Data Management, Analysis and Visualisation

Geosyntec has significant expertise and resources in the management, analysis, visualisation, presentation, and sharing of environmental site data. We use a series of highly customised tools and techniques that ensure data quality, integrity, and usability at each stage of the “life cycle” of laboratory and field data, from sample planning through validation/verification and importing, to our cloud-accessible enterprise database - from which data can be served to analytical tools and stakeholders.

Using a variety of web-based reporting and visualisation tools, we design and provide dynamic “self-serve” access to data (as soon as it is available) and analyses based on that data, via interactive maps using (GIS) geographic information systems technology and other tabular and graphical reports. A key tenet of our data services is to never “hold your data hostage”, but rather allow you to access it in a meaningful way. Our data management experts include engineers, geologists, and other technical specialists. We regularly publish materials and offer courses on environmental data management principals and technologies.



ArcGIS Server





# Groups and Associations

We are members of the following groups and associations:

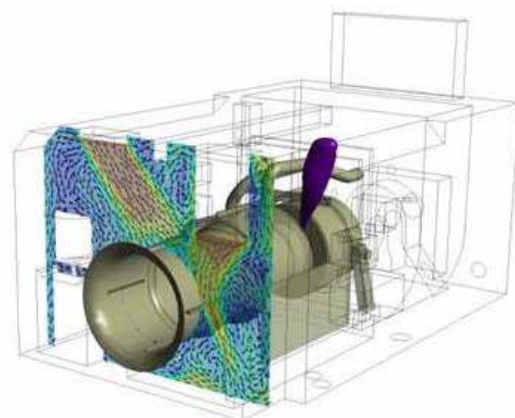
- Carbon Capture & Storage Association;
- Center for Chemical Process Safety;
- Fire and Blast Information Group;
- IChemE Safety Centre;
- NAFEMS;
- Nuclear Industry Association;
- Register of Security Engineers & Specialists;
- Safety And Reliability Society;
- Society for Earthquake and Civil Engineering Dynamics; and
- UK Hydrogen Association.



# Tools

We use a wide range of analysis tools:

- ABAQUS;
- AERMOD;
- ANSYS;
- BowTieXP;
- CFX;
- Code Aster;
- Code Saturne;
- FLACS;
- Flowmaster;
- FLUENT;
- KFX;
- LS-Dyna;
- MMI-QRA;
- OpenFoam;
- PHAST;
- Pipenet;
- Pro-E;
- PSA5;
- RELAP5;
- Reliasoft;
- Solid Works;
- STAAD Pro;
- USFOS; and
- VessFire.





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