



HAZARD RESEARCH & RISK CONSULTANTS LTD.
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COMPANY BROCHURE



OVERVIEW

HAZARD RESEARCH AND RISK CONSULTANTS LTD (HAZREZ) is a technologically advanced safety consultancy and testing company that works closely with our clients to recognise, quantify and manage hazards related to flammable and explosive materials.

We can help you conduct your business in a safer manner.

HazRes' mission is to focus on your organisation's problems and concerns regarding safety, and provide cost effective integrated answers that are of the greatest benefit to your overall programme.

The diverseness and experience of our personnel in conjunction with an extensive knowledge acquired from over three decades of previous R&D work make HazRes unique in the industry.

HazRes and its International Strategic Partners have highly qualified and experienced consultants and scientists, many of whom are internationally renowned in their fields. Our corporate structure allows and fosters multi-disciplinary international support for any programme or project.

We have comprehensive, state-of-the-art experimental facilities and equipment, allowing our personnel to handle an unprecedented range of scenarios on a wide range of scales.

HazRes' product and service portfolio is unparalleled, providing a complete "one-stop-shop" to its clients, including the following services:

ENERGETIC CONSEQUENCES AND BLAST EFFECTS

BLAST RESISTANT STRUCTURAL DESIGN

SAFETY AND RISK MANAGEMENT

EXPERIMENTAL RESEARCH AND TESTING

INVESTIGATION SERVICES

TRAINING AND EDUCATIONAL SERVICES

For the latest information on HazRes' products and services, or to contact us with specific requests, visit www.hazres.com or email us at info@hazres.com



ENERGETIC CONSEQUENCES AND BLAST EFFECTS SERVICES

HazRes can help your organisation identify and understand the consequences of flammable and toxic material releases, including their effects on people, assets and operations.

Prediction capabilities range from dispersion modelling to the physical effects of explosions including blast loads and fragment generators. We work with our clients to develop tailored prevention, mitigation or protection strategies, which can successfully be applied to a wide range of projects, from facility siting and occupied building studies through to blast resistant structural design.

CONSEQUENCE ANALYSIS

Consequence analysis offers a comprehensive understanding of the risks by utilising state-of-the-art methodologies and modelling tools. Some of HazRes' specific capabilities include:

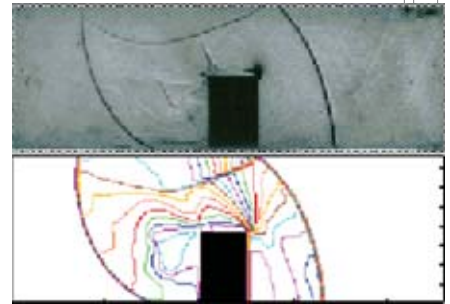
FLAMMABLE AND TOXIC CONSEQUENCE MODELLING

HazRes employs consequence modelling techniques and methodologies that provide quantifiable outcomes of an accidental or malicious release of a toxic and/or flammable material. By simulating accident scenarios, we can produce information for emergency response planning, regulatory compliance, risk analysis and comparison of mitigation measures.

EXPLOSION AND FIRE HAZARD CONSEQUENCE MODELLING

HazRes' blast effects and structural consultants work to identify and understand clients' explosion hazards by predicting such effects as blast loads and fragment generation, and devising prevention, mitigation, or protection strategies. Potential damage and injury are predicted for all types of explosions including accidental, malicious and intentional scenarios. We use a number of predictive models, ranging from vapour cloud explosion (VCE) blast wave prediction methodologies to sophisticated computational fluid dynamics (CFD) and hydrodynamics codes.

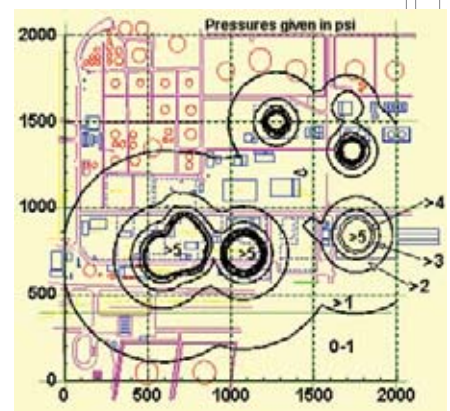
HazRes also has the ability to quantify thermal radiation effects using independent analysis tools, and can analyse the dosages from pool fires, jet fires and fire balls.



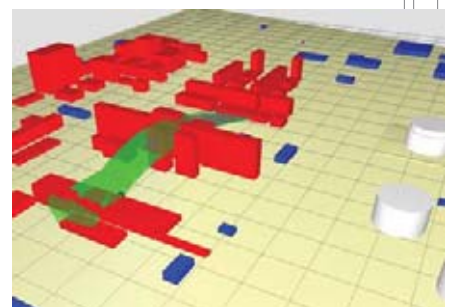
Experiment versus Prediction



Vapour Cloud Explosion Testing



Predicted VCE Pressure Contours



Vapour Cloud Dispersion Modelling

BLAST RESISTANT STRUCTURAL DESIGN SERVICES

Organisations concerned with providing protection from accident and/or terrorist threats can take advantage of HazRes' specialist structural design and analysis skills, research and design capabilities and practical construction experience.

Previous applications have included the design and analysis of structures protecting against air blast, fragmentation impact and other impulsive loads, blast containment chambers and structural upgrades to existing buildings. A fundamental understanding has been achieved of how buildings and structures respond under blast loading and their modes of failure by conducting accident investigations, structural explosion testing, and advanced analyses.

We offer the following structural services:

Construction technique analysis to evaluate performance under blast loads

Upgrade of construction to resist blast loads

Conceptual design of new facilities to determine optimal siting and construction requirements while meeting blast criteria

Design of new buildings to resist the effects of close-in explosions

Design of "Enhanced-Conventional" construction to resist moderate blast loads from nearby explosions or far-field blast loads

Upgrade of existing blast resistant buildings to enhance blast capacity

Design and evaluation of barricades used to control fragments and suppress blast from potential explosions

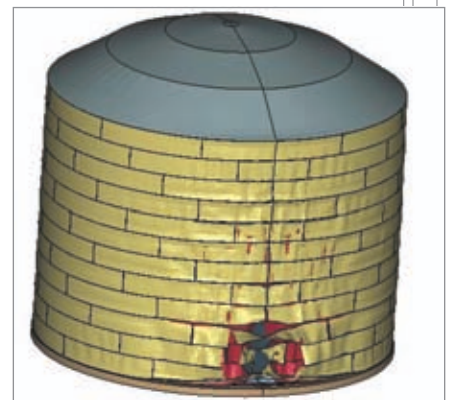
Counter terrorist structural mitigation techniques for new and existing structures



Aftermath of Pipeline from Internal Gas Detonation



Blast Resistant Control Room under Construction



Finite Element Analysis (FEA) of Tank Damage from Terrorist Event

SAFETY AND RISK MANAGEMENT SERVICES

Safety and Risk Management protects assets and employees by not only identifying and evaluating threats, hazards or other exposures to losses and costs, but also mitigating them through the development of sound management strategies. Outlined below are HazRes' numerous assessment techniques, which provide tools for further risk management decision-making.

RISK ANALYSIS

HazRes offers a comprehensive range of risk analyses, including risks to people, production, assets, business, the environment and markets:

- Facility Siting and Work Place Risk Analysis Studies
- Qualitative Risk Assessment and Risk Ranking
- Quantified Risk Assessment (QRA)
- Fault Tree Analysis (FTA)
- Safety Instrumented Systems (SIS) Evaluation and Verification
- Demonstrations of 'as low as reasonably practicable' (ALARP)
- Production and management of complete 'safety cases'
- Failure Mode and Effect Analysis (FMEA)
- Layer of Protection Analysis (LOPA)
- Control Of Major Accidental Hazards (COMAH) Implementation
- Occupied Building Analysis Studies
- Hazard & Operability (HAZOP) and Hazard Identification (HAZID)
- ATEX Directive and DSEAR Regulation Compliance
- Security/Terrorism Vulnerability Assessments
- Independent Assessment of In-house Risk/Safety Documents

RISK MANAGEMENT

HazRes personnel have helped many companies in creating, developing and placing overall risk management systems into action, as well as individual risk analysis procedures. Risk management systems using a multitude of criteria not only measures for recognising and analyzing risks, but also procedures for risk-based decision making. These include:

- Process Safety Management (PSM)
- Insurance Risk Engineering (IRE)
- Loss Prevention Engineering
- Risk Based Decision Making
- Emergency Response Planning
- Due Diligence



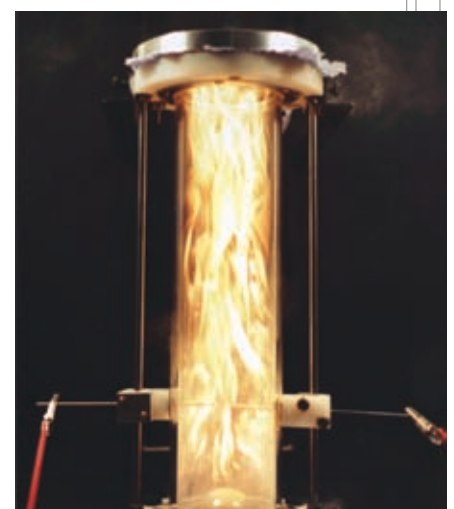
Individual Risk Contour Map



Risk Assessments of LNG Operations



Aftermath of Accidental Vapour Cloud Explosion



Assessing Dust Explosion and Ignition Risks

EXPERIMENTAL RESEARCH AND TESTING SERVICES

The basis to provide a truly accurate hazard prevention solution, is through comprehensive testing and scientific analysis. Our extensive and technologically advanced testing facilities allow us to verify the results of Computational Fluid Dynamics (CFD) simulations and structural analysis predictions, as well as providing state-of-the-art R&D services. Additionally, our consultants' considerable experience with scientific experimental techniques and the latest instrumentation gives us unique testing abilities in the field of explosion and shock wave physics.

Our laboratories are equipped with a wide range of shock, flame and detonation tubes, which are used to study the combustion and dynamics of gaseous systems. Existing diagnostic techniques include pressure gauges and microwave techniques for combustion front velocity measurements. Hot-wire and Laser Doppler Anemometry has been used successfully to measure transient gas flows typically found in actual explosions. A wide variety of high quality optical based techniques are also available, including spark and streak Schlieren photography, high speed digital video and double-pulsed holographic techniques.

Multi-channel advanced instrumentation is available to monitor pressure, illumination, temperature and material strain rates. Systems with data capture rates up to 10 million samples per second are used in both laboratory and field scale experiments. In addition to reactive system explosions, non-reactive systems such as Boiling Liquid Expanding Vapour Explosions (BLEVE) can be studied and tested. We are also able to investigate the structural dynamics of larger explosively loaded systems. Larger scale experiments are undertaken at one of our remote field sites, which can be used for unconfined vapour cloud explosions and larger confined testing.

The extensive internal and external testing facilities available to HazRes offer a comprehensive and diverse range of testing abilities. Our facilities include:

- An internal laboratory for consultation testing associated with small scale fundamental combustion, explosion and shock studies.

- Instrumentation and data acquisition to measure high speed energetic events such as temperature, pressure, velocity, displacement and material response with data capture speeds up to 10 million per second.

- Small diameter research apparatus to investigate energetic reactions including flames and flame acceleration, detonations and shock waves whilst varying physical parameters.

- Large scale testing apparatus including pipelines of various internal diameters up to 18", explosion chambers and heated apparatus to investigate gas explosion phenomena on larger industrial scales.

- Specialist equipment for in-situ performance, operating and forensic testing.

- An extensive database of over 35 years of previous R&D work.



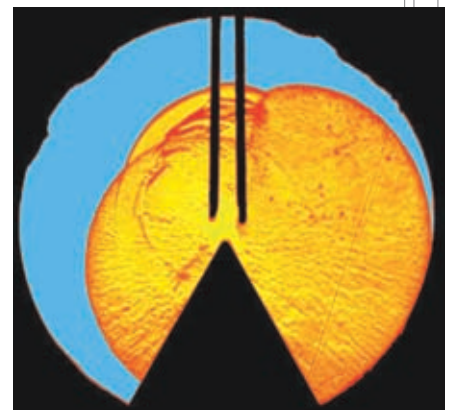
Unconfined Vapour Cloud Explosion Tests



Boiling Liquid Expanding Vapour Explosion Tests



Schlieren Photography of Shock Wave Interaction with Flame Bubble



False Colour Schlieren Photography of Transition to Detonation

INVESTIGATION SERVICES

Investigation of accidental and intentional events is a prime focus for HazRes. Our aim is to resolve and establish the root cause of an event, and provide recommendations and advice on prevention and mitigation techniques against future occurrences. We also offer litigation support in legal cases in the form of expert witnesses.

HazRes can provide a fast response to assist clients in exercising control, organisation and investigation execution, as well as assisting the client in responding to authorities and stakeholders. We can supply technical expertise and experienced leadership to assist clients through all phases of an investigation. Examples of activities that can be carried out by our personnel to support accident investigation include:

- Planning and coordination
- Collecting, preserving, control and retention of evidence
- Interviewing witnesses
- Documenting damage to structures and equipment
- Mapping fragment and debris throw
- Conducting chemical and metallurgical analyses
- Developing potential accident scenarios
- Determining explosion source and energy
- Developing blast load contours
- Simulating the accident through modelling
- Conducting experiments to investigate scenarios
- Determining origin and root cause
- Providing litigation support and expert testimony
- Third party site access and request coordination
- Accident site control procedures
- Control and maintenance of paperwork (Chain of Custody, protocols, etc.)
- Safety and health procedures (site safety plan, etc.)



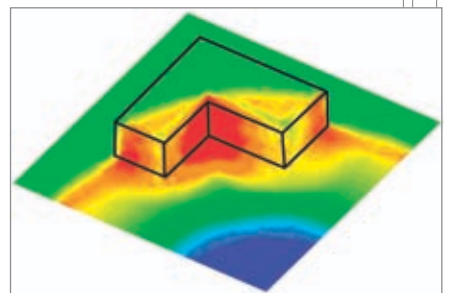
Evidence Collection after Dust Explosion Accident



Documenting Damage at Accident Scene



Gas Plant Vapour Cloud Explosion



Modelling of Building Blast Loads from an Accidental Explosion

TRAINING AND EDUCATIONAL SERVICES

In addition to our extensive consultancy and testing services HazRes is able to provide customers with short courses and training on various specialised topics. Training can be provided as residential or non-residential courses at a number of locations in the UK and USA or at customer's premises. We also offer a range of independent and in-house workshops to develop safety awareness and culture within organisations. For more information on our future courses and training that we have to offer please consult our website on www.HazRes.com.



Main Office Technium Aberystwyth
Y Lanfa, Trefechan
Aberystwyth, Ceredigion, SY23 1AS
Wales, UK / Cymru, DU

Registered Office Tŷ Caersant House
14 Maes Seilo, Penrhyncoch
Aberystwyth, Ceredigion, SY23 3EL
Wales, UK / Cymru, DU

Contact us ☎ +44 (0) 845 838 2026
☎ +44 (0) 845 838 2027
info@hazres.com
www.hazres.com



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