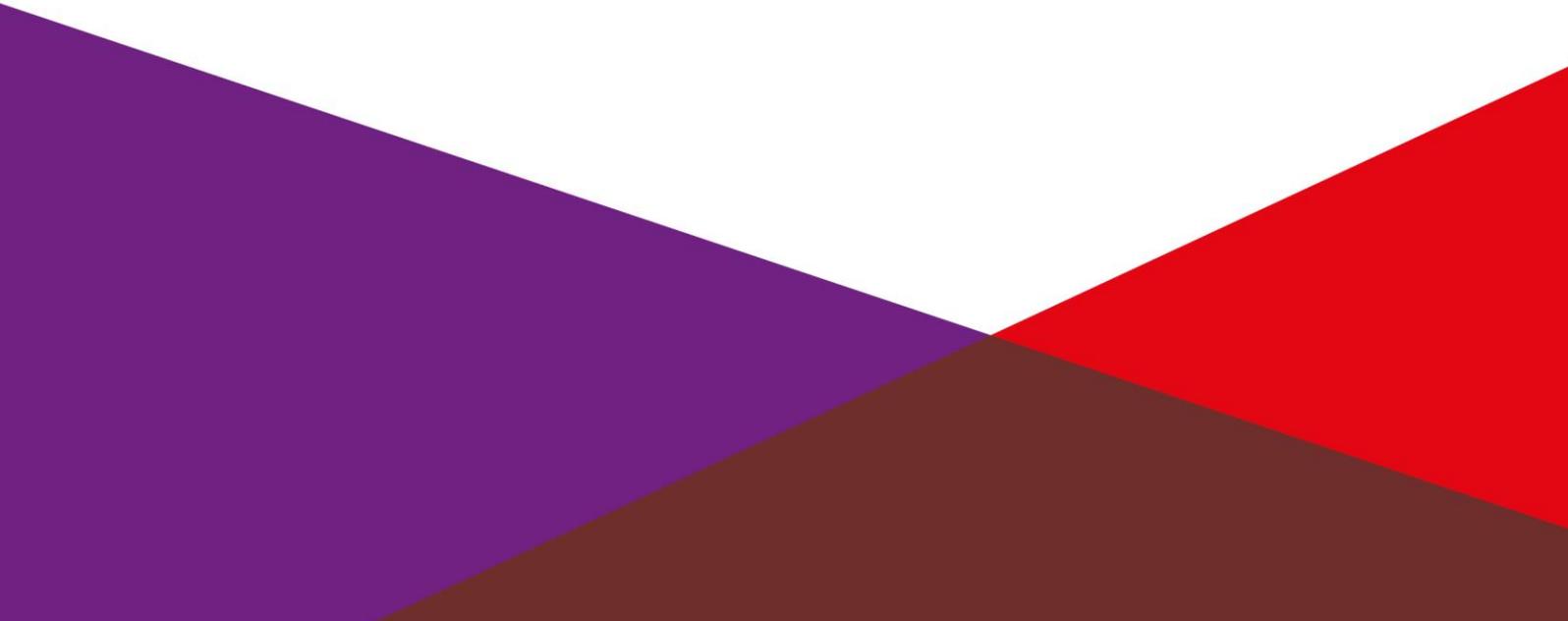


PROPERTY RISK ENGINEERING IN THE CHEMICAL SECTOR

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When chemical sector professionals in Europe think of chemical site safety, they normally think of the Seveso Directives and national regulations as the drivers for safe process plant design and operation. Over and above this there are a other interested parties who have professionals that deal with reducing risk, one of which is insurance companies, such as RSA who have a dedicated risk management team that work closely with customers to minimise and mitigate risks on a daily basis.

Typically when a customer buys property insurance they also take out business interruption coverage, so any insured loss to their property or any ensuing business interruption will be covered. Insurers, like RSA, therefore have a shared interest with their customers in the safety of their process plants to help keep the business running. Insurers, working with all parties such as insurance brokers, therefore seek a proactive relationship with the process plant owners and operators, to work together to minimise losses.

When it provides the property insurance for a customer, RSA effectively shares the exposure to loss with its customers and so wants to fully understand the risks they insure. Using professional risk engineers with chemical engineering or processing backgrounds, a risk engineering survey is completed at the customers' sites to assess different components of the risk such as the physical features, as well as the maintenance and the management systems. This approach is not dissimilar from that used by process safety and general safety professionals, but with a focus adjusted to asset protection: so a focus on plant safety rather than occupational safety.

Property risk engineering assessments normally run parallel with and complement those developed for general site safety. Key hazards covered are fire and explosion as well as natural perils like storm, flood and earthquake. Insurance cover may also be provided for sudden and unforeseen breakdown of equipment so an assessment of maintenance procedures will be undertaken.

The frequency of visits is determined by a number of factors:

- The value of the site to a business, both in monetary terms and general criticality to a business' profitability;
- The occupancy of the site in terms of hazard;
- The risk rating and response to risk improvements; and
- Changes planned such as new process lines.

Site surveys usually take two days on-site for a reasonably complex plant, or one-day for a small less-complex chemical site.

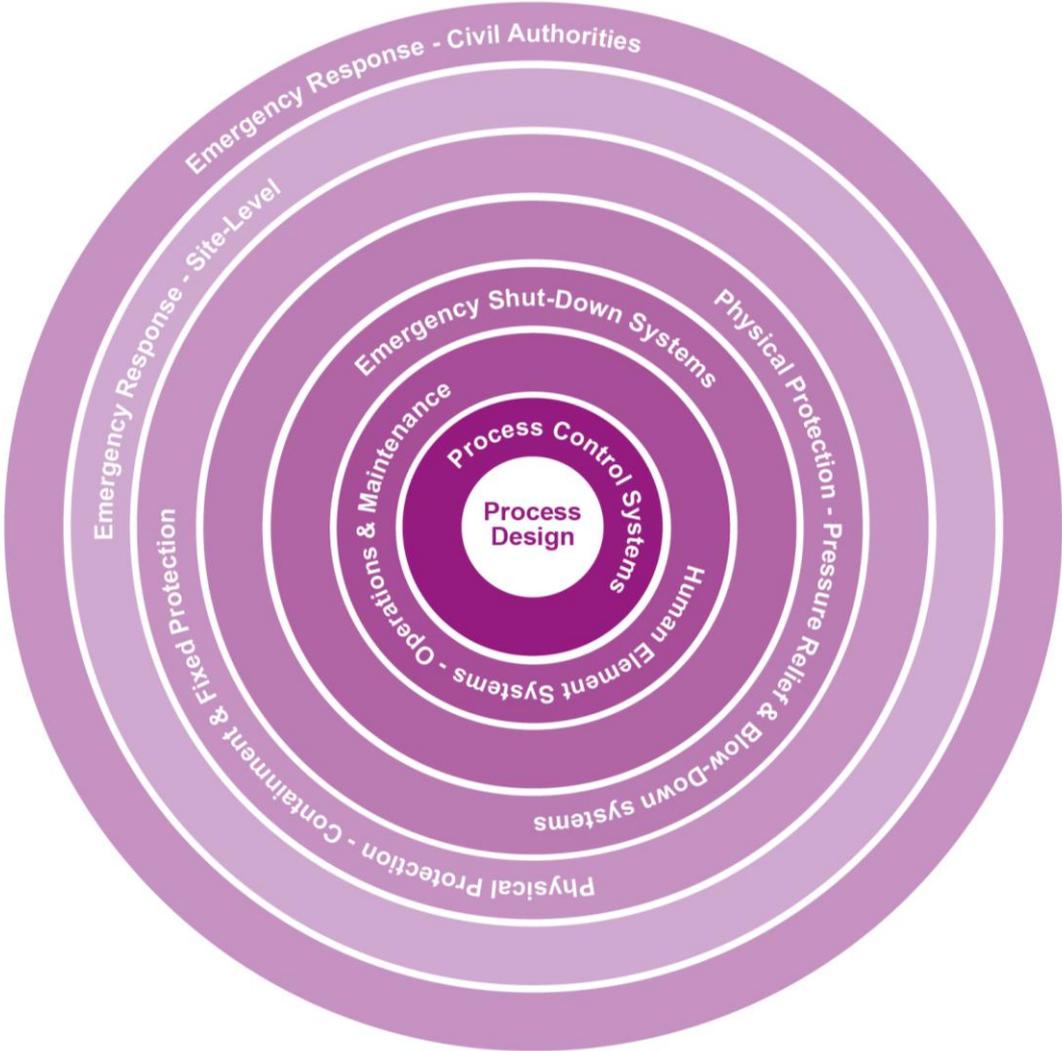
A typical risk survey will consist of discussions and interviews with key site managers and engineers, assessment of risk related management systems, review of maintenance and inspection systems and a tour of the site to make a visual assessment. The risk engineer will often ask to witness representative tests of fire protection, such as vessel-deluge and fire monitors. Any areas for improvement are discussed and a report issued which can be used by a business as part of its overall risk management strategy for business asset protection.

RSA Global Consulting has a team of risk engineers with chemical engineering qualifications, who are specifically trained to assess chemical process and storage risks. Working as a team of sector experts, they work with customers and underwriters to help manage risks at site level and ensure they are understood by the insurance market, underwriters and brokers alike. RSA's sector expertise approach also ensures that customers get a consistent, pragmatic approach.

The methodology taken for risk engineering assessments in the chemical and pharmaceutical sectors follows typical themes across the insurance market, but there is some variation between the approaches between different insurers and brokers.

RSA apply the principles of 'layers of protection' to structure chemical and pharmaceutical sector risk assessments.

LAYERS OF PROTECTION



Starting with the design of the plant and how process safety assessment has been applied, RSA Global Consulting develop the risk assessment up through the various layers of protection, including control systems, human element systems, physical protection systems and emergency response.

This is structured in RSA's quantified 'Chemical Risk Assessment (CRA)'. This risk profiling tool is focussed on fire and explosion hazards and controls. Using the CRA a process site's 'Inherent Hazard Factors' are assessed against 'Loss Control Factors' and 'Engineered Fire Protection'.

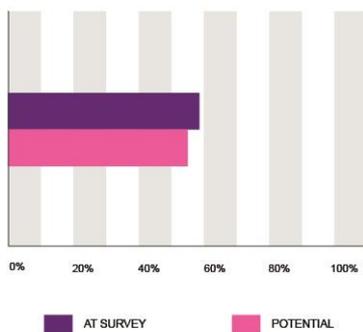
Inherent Hazard Factors cover topics such as the type of process, process pressures, quantities of combustible and flammable inventories and how the plant is laid-out.

Loss control factors are those that relate to the equipment design & maintenance and also human element programmes like permit systems, process hazard assessment, management of change and emergency response.

Engineered Fire Protection factors relate to fixed protection systems such as water-spray, how good area drainage is, the standard of structural fireproofing and design features such as the location of emergency process shut-off valves.

An overall risk rating can then be established by reviewing the loss control and engineered fire protection scores against those for inherent hazard. This is assessed for both a chemical facility 'as found' at survey and for potential when reasonable risk improvements are implemented.

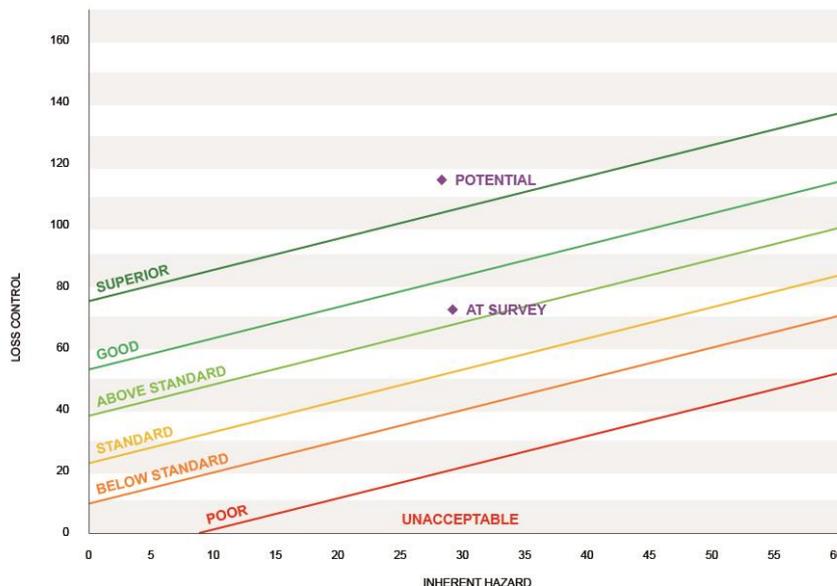
INHERENT HAZARD



LOSS CONTROL

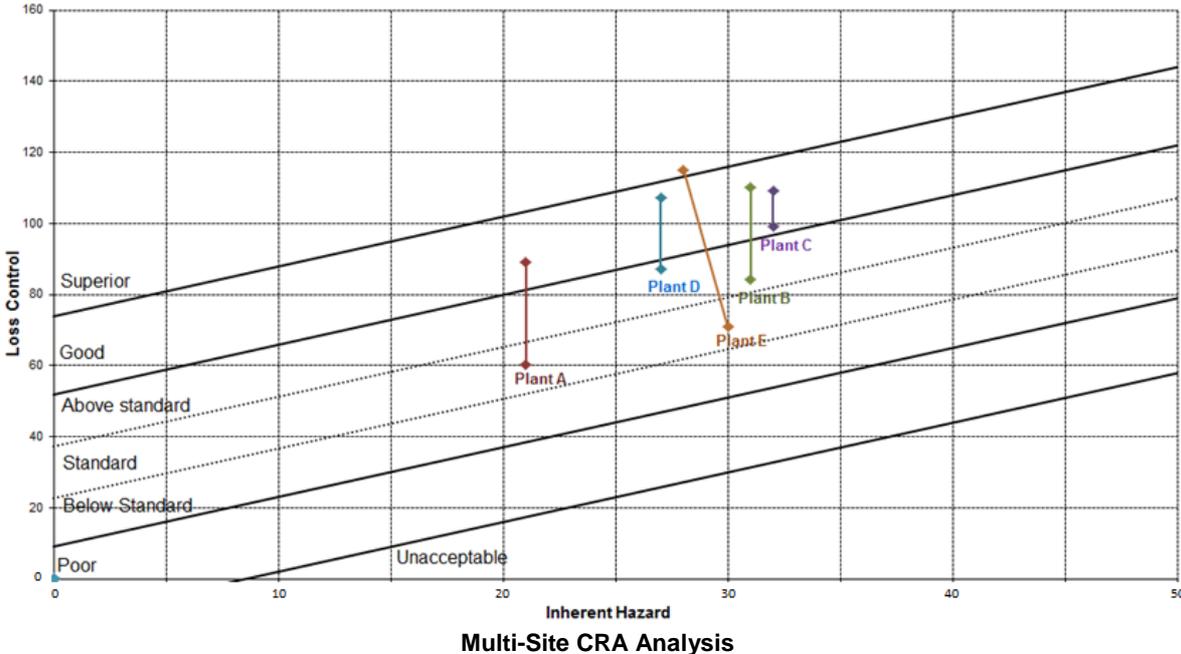


CHEMICAL RISK ASSESSMENT GRAPH



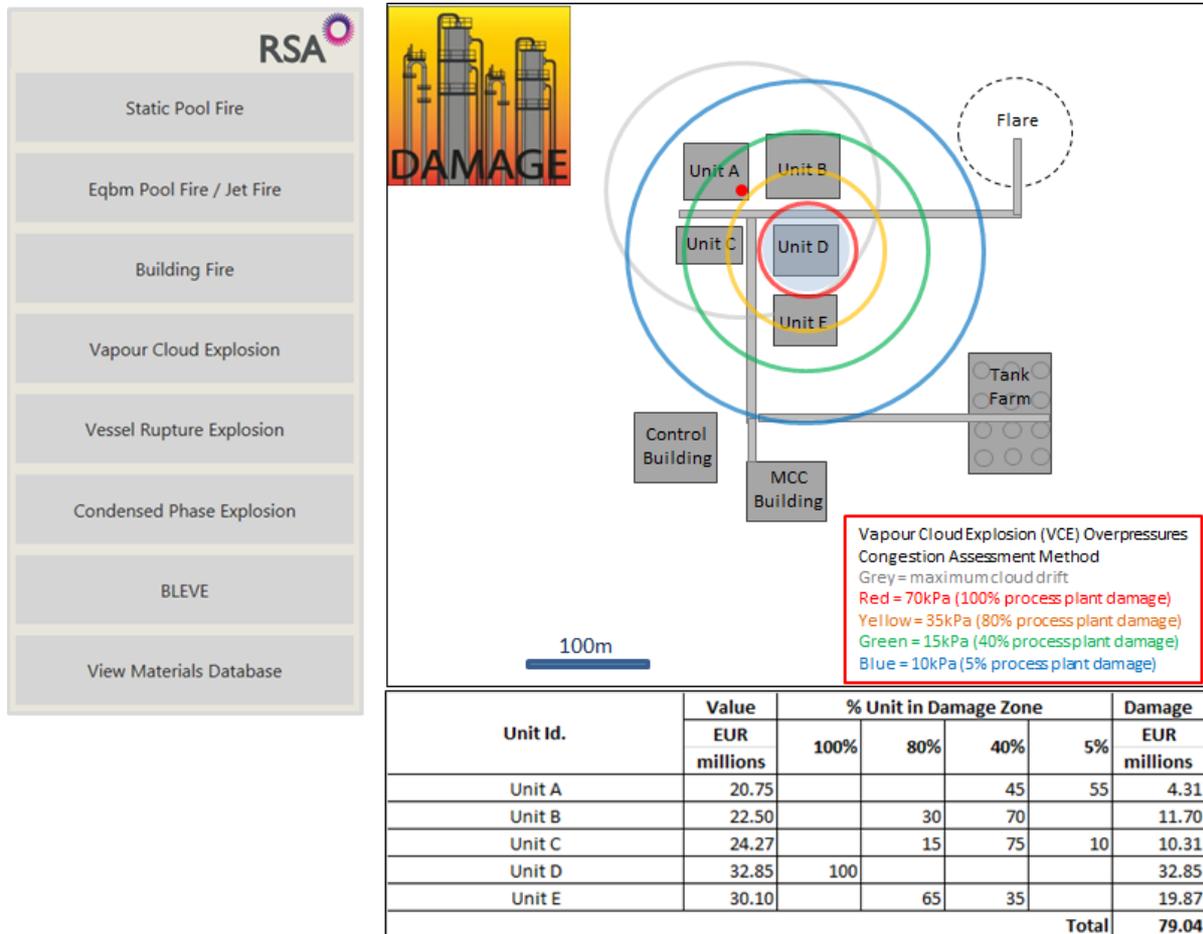
SINGLE SITE CHEMICAL RISK ASSESSMENT (CRA) - GRAPHICAL OUTPUT

Risk ratings for individual process units are compared against each other, which provides important information for risk management professionals to assess the overall risk profile of a chemical company, or division of a chemical company. This is a very effective tool in assessing where effort and resources can be best targeted to improve management systems and direct risk improvement budgets.



The next element of a property risk engineering assessment is evaluation of losses that could occur. RSA Global Consulting calculate an 'Estimated Maximum Loss', which is typically based on an explosion or fire under reasonably adverse conditions and also a 'Normal Loss Expectancy', which is based on a loss with most controls working as expected.

The 'Estimated Maximum Loss' is normally based on a vapour cloud explosion, vessel explosion, pool fire or jet fire. RSA's proprietary software 'Damage' is used to make detailed fire and explosion loss calculations.



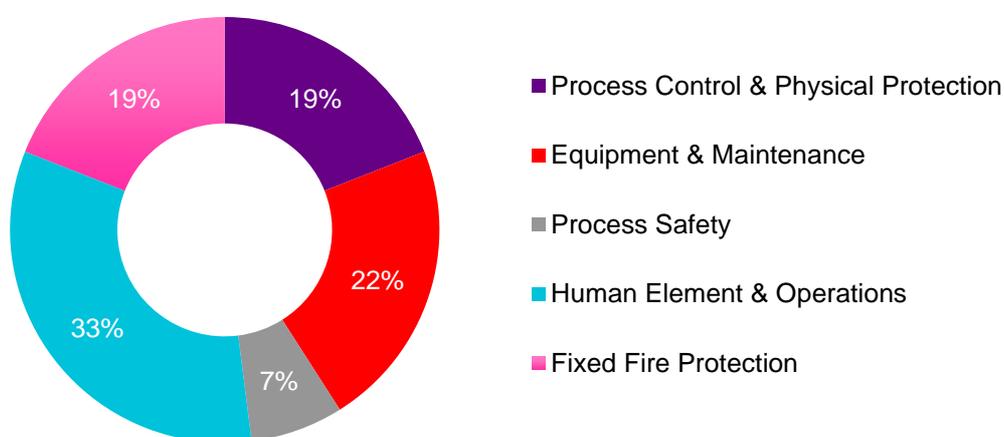
The 'Normal Loss Expectancy' is usually a fire loss occurring during normal plant conditions. This is based on a higher frequency event such as a release of flammable gas or liquid from a small hole in a large pipe, failure of a small bore pipe, a pump seal failure or a flange gasket failure. This is modelled on a release from a 25mm diameter hole in the equipment or pipework.

Based on the assessments of fire and explosion damage, values for damaged property and the value relating to interruption of business are calculated for both adverse and normal plant conditions.

The final part of the risk engineering survey is to develop and present risk improvement recommendations. These are to correct deficiencies identified in management programmes and maintenance systems and to improve the safety of site installations and fire protection systems. RSA aim for all sites to achieve at least a 'Good' rating on the CRA system.

Examples of typical risk improvements are to improve permit-to-work systems, implement management of change systems, to improve installed process safety controls and to install fixed fire protection such as water-spray. Our report and data platform 'RSAded' allows customers to view our survey reports, loss estimates and risk improvements on-line and to provide real-time updates on the progress of risk improvements.

TYPICAL DISTRIBUTION OF PROPERTY RISK IMPROVEMENTS IN THE CHEMICAL SECTOR



Process Control & Physical Protection (Engineering Controls)

e.g. relief systems, safety shut-off valves, drainage/containment, detection, redundancy of control systems, fire proofing

Equipment & Maintenance

e.g. high integrity pump seals, vibration monitoring, critical spare parts, mechanical and electrical maintenance, maintenance of fire protection equipment

Process Safety

e.g. management of change, process hazard analysis, P&ID updates, emergency operating procedures, commissioning

Human Element & Operations

e.g. permits to work, housekeeping, alarm management, emergency team, operator training, safety audits, contractor management, security, incident-accident analysis

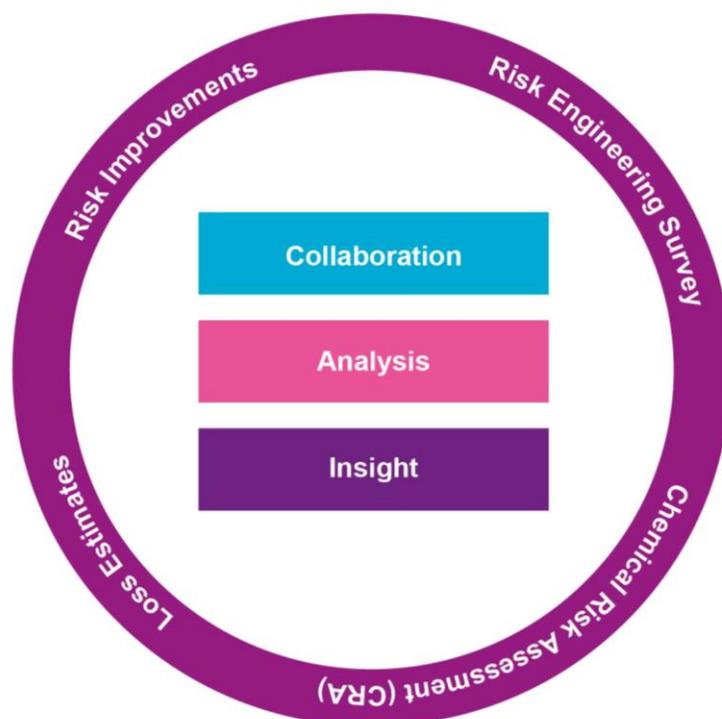
Fixed Fire Protection

e.g. water-spray (deluge) systems, foam application systems, water-foam fire monitors, sprinklers

RSA's analytical and collaborative approach provides for:

- Depth of understanding of each customers business;
- Quantified risk assessment that drives informed prioritisation risk improvement;
- Right-sized and refined insurance costs; and
- Support and advice on risk engineering matters.

PROPERTY RISK MANAGEMENT FOR THE PROCESS INDUSTRIES



The four elements of risk assessment; **Risk Engineering Survey, CRA, Loss Estimates and Risk Improvements**, combine to provide a complete systems of property risk management for the process industries that help our customers reduce risk and minimise the losses that could damage their businesses.

Adrian Butler
Head of Technical Risk
RSA Global Consulting

MAKING THINGS BETTER, TOGETHER.

