ABS Group

RISK AND RELIABILITY

TECHNICAL ENGINEERING SERVICES

Extreme Loads and Structural Risk

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Who Are We?

For five decades, ABS Group has set the standard for risk and reliability management, providing technical expertise to a wide range of diverse industries worldwide.

We are a leading independent global provider of risk management services that combine industry expertise, risk modeling and simulation methods, practical engineering and technology-based solutions.

ENGINEERING SERVICES FROM ABS GROUP

Our engineering department is an experienced multi-disciplinary team comprised of civil, structural and mechanical engineers with decades of experience. Working across a broad range of industrial sectors, our engineers have assisted clients with a variety of technical issues and provided data-driven risk and reliability solutions and technical services that help our clients confirm the safety, integrity, quality and environmental efficiency of their critical assets and operations.

We also perform Independent Technical Assessments (ITAs) to help clients validate engineering solutions across multiple stages of a project lifecycle, including quantifying hazard exposure, performing site surveys and verifying designs to various international standards.

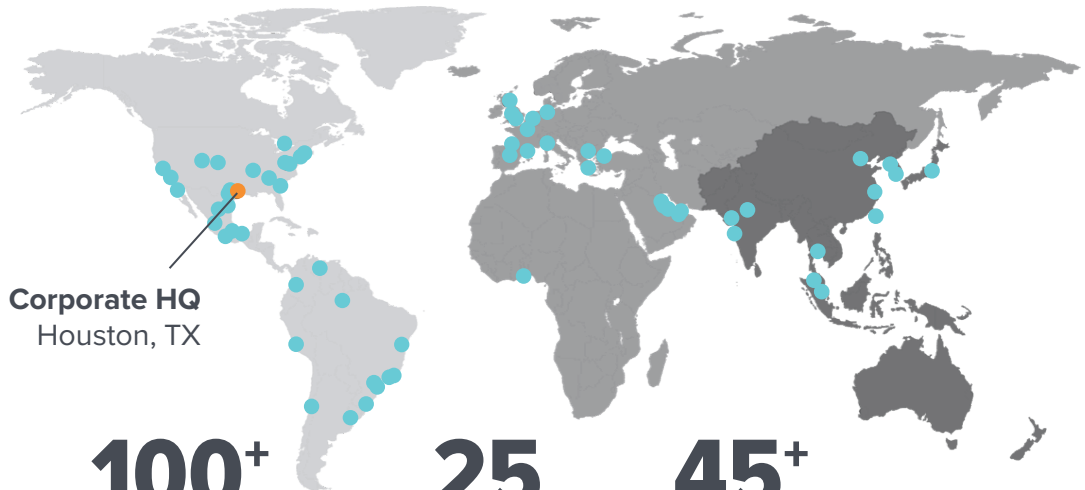
SERVICES WE PROVIDE

- Extreme Load Assessment
- Natural Hazard Assessment
- Civil and Structural Engineering Assessment
- Mechanical and Plant Equipment Assessment
- Numerical Modeling and Analysis

MARKETS WE SERVE

- Manufacturing (automobile, heavy equipment, machinery, electronics, aerospace)
- Nuclear Power
- Government Agencies (defense, energy, security)
- Oil and Gas (upstream, midstream, downstream)
- Chemical/Petrochemical
- Maritime (shipping, ports)
- Utilities (non-nuclear power generation, transportation and communications)
- Insurance/Reinsurance/Financial Services
- Agricultural/Crop Sciences
- Alternative Fuels
- Other Process Industries (food, pulp/paper, pharmaceuticals, consumer products)

GLOBAL REACH



100+ experts

25 countries

45+ years

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Extreme Load Assessment

Across many industries and sites, the impact of both man-made (impact, blast and fire) and natural hazards (weather, flooding and earthquakes) on buildings, plants and equipment needs to be considered to provide a safe working environment for employees and to protect the wider community from risk.

The first stage to assessing the impact of these hazards is to identify the likelihood of an event and the level of risk associated with it. Once this has been established, the imposed loading on the building can be quantified.

Our engineers can determine both existing operational load conditions on structures and potential hazard loads. This information can then be used to aid physical risk and security assessments as well as support insurance and other regulatory compliance documentation.

ABS Group develops solutions to complex problems and situations, including the following loads:

- Blast/Shock
- Impact
- Seismic
- Weather (wind, rain, snow, ice)
- Flood
- Fire

EXPLOSION AND THERMAL HAZARDS

Our Extreme Loads and Structural Risk (ELSR) division includes engineers whose careers have focused on the evaluation of explosion and thermal hazards for industrial and government clients. We use advanced simulation tools to model the dynamic response to blast overpressure, fragment impact and blast-generated debris. Our team performs explosion testing services to validate modeling methods or proof-test protective structures, including explosives range and shock tube testing, providing us with unique insights into the behavior of structures to blast impact.

Natural Hazard Assessment

ABS Group is a global provider of risk, safety and engineering solutions related to natural hazards, offering a broad range of services across many markets.

Our engineers have decades of experience performing natural hazard risk and vulnerability assessments, detailed design for new and existing structures and equipment installation mitigations.

Additionally, our team provides detailed finite element analysis, design reviews and financial loss evaluations for seismic, hurricane, typhoon, flood and other severe natural hazards events (PML/MFL/NLE).

ABS Group has more than 45 years of on-site experience in risk assessment and mitigation analyses for virtually every kind of facility including single-site locations, commercial buildings and complex chemical, petrochemical, manufacturing, beverage, utility, energy transmission and distribution operations.

Services Provided:

- CAT Modeling
- Facility Vulnerability Audits
- Detailed Engineering Design, Analysis and Assessment
- CAPEX Reviews
- Emergency Preparedness
- Supply Chain Analysis

We support our clients from initial exposure assessments to the development and implementation of complete risk reduction programs that utilize our engineering expertise for detailed mitigation design and third-party independent technical reviews.

Civil and Structural Engineering Assessment

Identifying and assessing civil structures is a key element of our engineering services, whether existing structures are required to withstand new demands and hazards, or new structures are being commissioned for bespoke projects.

ABS Group has extensive experience in analytical and design-based solutions; we help clients to identify and alleviate potential vulnerabilities in new or existing civil structures. Using a combination of onsite inspection, modeling software and structural calculations against harmonized international codes of practice, we can identify and mitigate hazard risk at a wide range of sites and mitigate the potential for operational losses at any point in the life span of their infrastructure.

Material Expertise

- Steel
- Reinforced Concrete
- Masonry
- Timber

Service Offerings

- Structural assessment and substantiation against static and dynamic load cases, including blast, seismic and other natural hazards
- Design of structural elements, connections and retrofit solutions to mitigate structural vulnerabilities
- Production of engineering substantiation calculations with technical specifications and drawings

Codes and Compliance Services

- American Society of Civil Engineers (ASCE)/ American Concrete Institute (ACI)
- Nuclear/Petrochemical Specific Standards
- Eurocodes
- Historic Codes of Practice (e.g. British standards)

We offer services supporting complex dynamic loading scenarios, including:

- Soil Structure Interaction
- Finite Element Assessments
- Coupled Structural Analysis with Mechanical Plants
- Non-linear Engineering Solutions (e.g. Seismic Time History Analysis)
- Blast, Fire and Thermal Structural Assessments

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Mechanical Plant and Equipment Assessment

ENGINEERING SUBSTANTIATION OF PLANT AND EQUIPMENT

ABS Group offers a wide range of services associated with the engineering assessment of plant and equipment. Our team can review new and existing equipment against normal operations or extreme load cases.

As part of our engineering substantiation of plant and equipment we provide the following services:

- Engineering Calculations to Substantiate Equipment and Support Systems
- Design of Retrofit Solutions Packages
- Stress and Fatigue Analysis of Pipe Systems
- Analysis of Pressurized Systems

EQUIPMENT QUALIFICATION

Qualification of plant and equipment against external hazards is often a requirement to ensure safe operations and mitigate the potential for operational loss incurred from damaged critical equipment while also increasing protection to site personnel and the public.

We are industry leaders in walkdown methodologies and engineering justification procedures with a proven record in providing critical assessment and qualification services to a range of industries. We utilize established procedures from well-known guidelines and frameworks such as the Department of Energy (DOE), Seismic Qualification Utility Group (SQUG) and Nuclear Quality Assurance (NQA1).

Examples of plant and equipment frequently qualified using walkdown methodologies include:

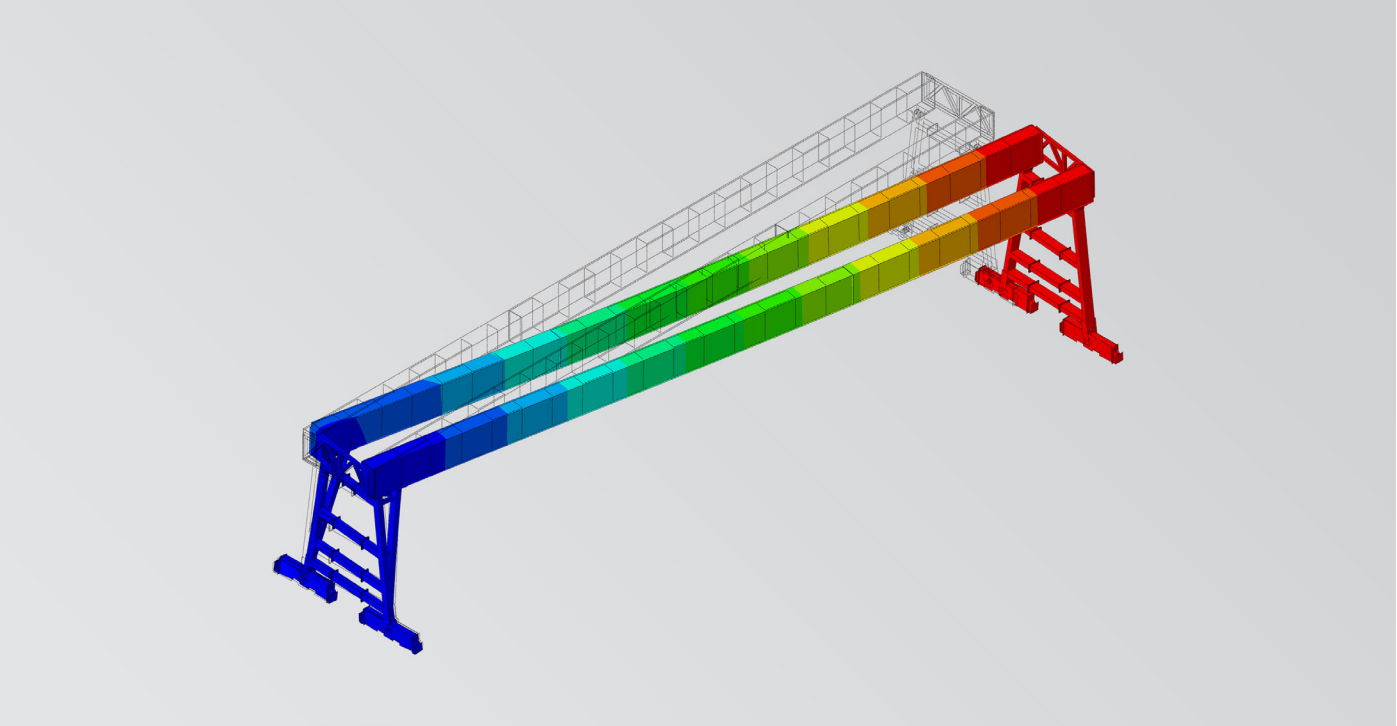
- Electrical Panels and Cabinets
- Cable Raceways
- Gloveboxes
- Ventilation Systems
- Fire Fighting Equipment
- Tanks and Vessels
- Pipework
- Other Critical Equipment

CRANE ANALYSIS AND DESIGN REVIEW

Helping clients understand the potential vulnerabilities associated with their cranes by quantifying associated risks reduces potential safety and operational impacts. By considering variances in loading conditions, a detailed analysis can take place to understand the integrity of the structure.

Assessment capabilities include:

- Structural / Mechanical Stress Analysis
- Seismic Assessment with Coupled Structural Assessment
- Dynamic Loading
- Structural Plastic Deformation
- Fatigue and Stress Condition Analysis
- Design Review Against International Codes of Practice



Numerical Modeling and Analysis

ADVANCED FINITE ELEMENT ANALYSIS

Our team utilizes numerical modeling in the form of Finite Element Analysis (FEA) to break down complex engineering problems into more understandable behaviours to support critical engineering decisions.

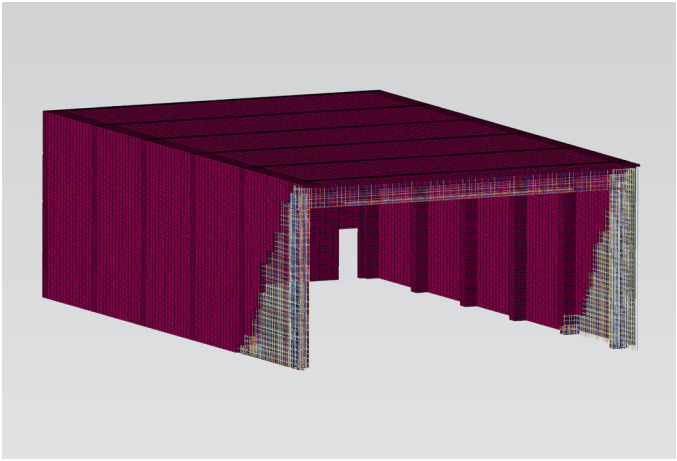
At ABS Group, we apply our knowledge of FEA to a range of engineering applications, whether it be an electrical cabinet, waste container, pipework system or building structure. Our range of FEA capabilities include:

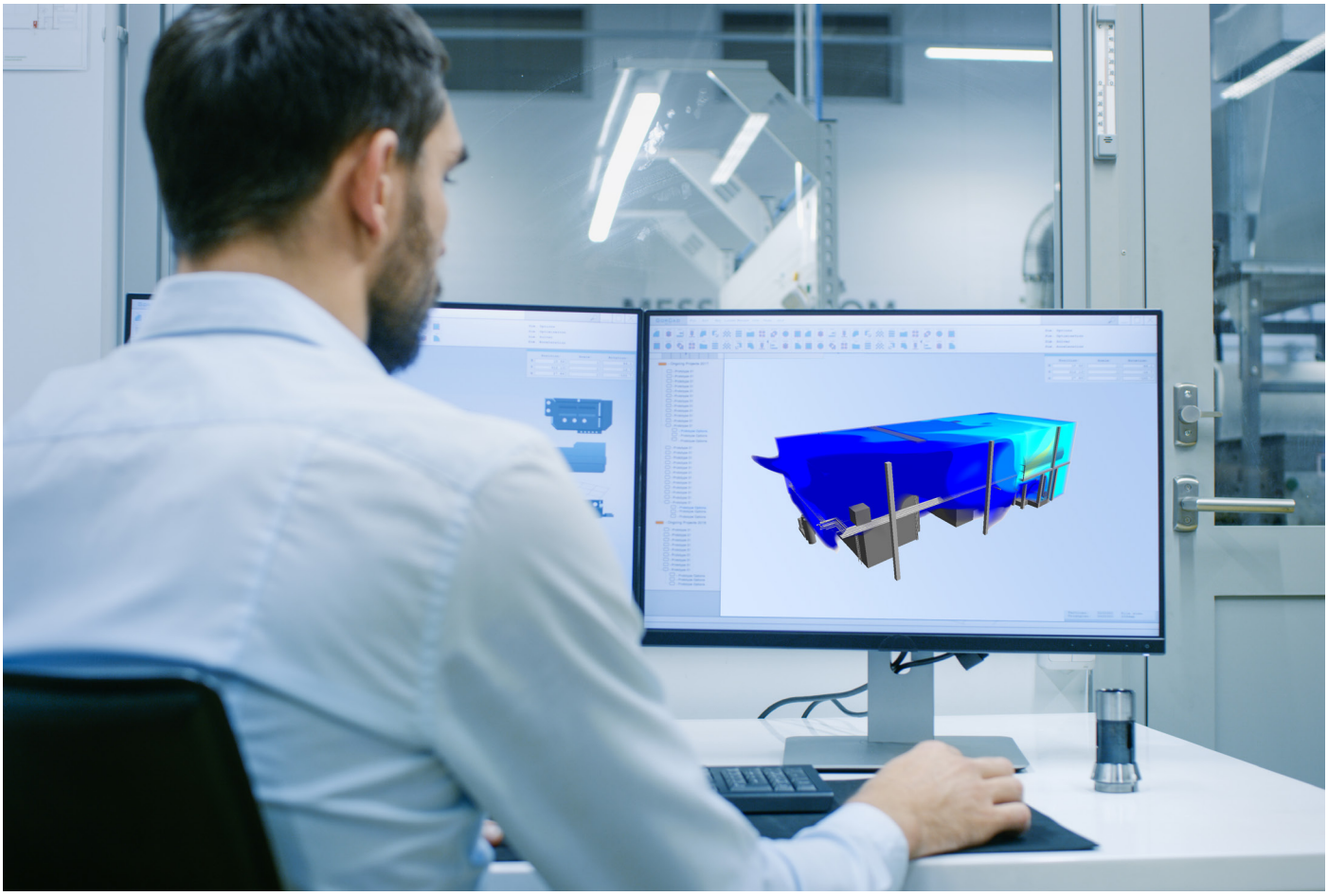
- Structural Assessment (Stress, Strain, Deformation)
- Dynamic Behavior Response (Seismic, Blast, Shock, Impact Loading)
- Linear and Non-Linear Behaviors (Geometric, Material and Interfaces)
- Thermal Analysis
- Fatigue Analysis
- Fracture Mechanics (Crack Modeling)
- Material Model Development

We use a wide range of commercial FEA packages, including:

- ABAQUS
- ANSYS
- LS-DYNA
- STAAD
- CrackWise

Our expertise allows us to provide a cost-effective simulation alongside engineering justification and validation, without the need for detailed physical testing or prototypes against a range of loads and behaviors. This helps the client understand the behavior of the item modeled and ultimately make an informed decision in response to the output.





COMPUTATIONAL FLUID DYNAMICS

ABS Group has extensive experience in the application of Computational Fluid Dynamics (CFD) tools to simulate ventilation, dispersion, explosion and fire-related phenomena.

We perform CFD modeling to analyze and assess hazards to personnel and facilities that are exposed to energetic events involving flammable material (liquid and solid), toxic compounds and flammable dusts.

We also assess the performance of event mitigation measures to reduce the severity of the incident, design protective construction measures for personnel to survive the initial event and model the ability of personnel to evacuate hazardous environments.

We provide a range of engineering consulting to government agencies and private companies who are involved with dangerous, hazardous, reactive or explosive materials.

CFD CAPABILITIES

- Ventilation Analysis
- Flammable Gas Dispersion Analysis
- Toxic Gas Dispersion Analysis
- Explosion Analysis in Confined Volumes (with and without venting)
- Deterministic and Probabilistic Vapor Cloud Explosion Analysis (in congested volumes)
- Fire and Gas Detector Mapping

Our skilled team use a wide range of CFD packages, including:

- FLACS
- ANSYS/LS-Dyna
- ABAQUS/CFD
- ANSYS/CFX
- ANSYS/Fluent
- FDS
- OpenFOAM.

About ABS Group

ABS Group of Companies, Inc. (www.abs-group.com), through its operating subsidiaries, provides data-driven risk and reliability solutions and technical services that help clients assess the safety, integrity, quality and environmental efficiency of critical assets and operations. Headquartered in Spring, Texas, ABS Group operates with more than 1,000 professionals in over 20 countries serving the marine and offshore, oil, gas and chemical, government and industrial sectors. ABS Group is a subsidiary of ABS (www.eagle.org), one of the world's leading marine and offshore classification societies.

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