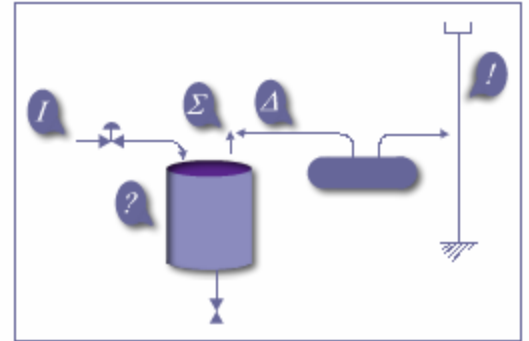


Comprehensive Emergency Relief System Design Services

ioMosaic Corporations' Solutions

EMERGENCY RELIEF SYSTEM DESIGN

Emergency relief system (ERS) design is a keystone in achieving process safety. Effective ERS design helps companies meet risk-management goals, compliance requirements, and sound business practices. With our comprehensive ERS design services, from reactivity testing for design basis determination to calculations for Z-axis deflection from dynamic loads, ioMosaic provides a total ERS solution.



PSI FOR PRESSURE RELIEF

The Process Safety Information element of the OSHA PSM Rule (29 CFR 1910.119) requires companies to compile information on the design and design basis of relief systems. In existing facilities, this information can be hard to find—scattered among design books or simply outdated because of plant capacity increases. As a result, when staff members are urgently needed for core business issues, they may be required to reconstruct the design information database instead.

To help companies meet this need, ioMosaic ERS design engineers can collect and field-verify the data for existing pressure-relief devices. Equipped with our standardized pressure-relief device data sheets, our hands-on engineers will efficiently compile the information required to verify the sizing basis and conduct a Process Hazard Analysis (PHA)



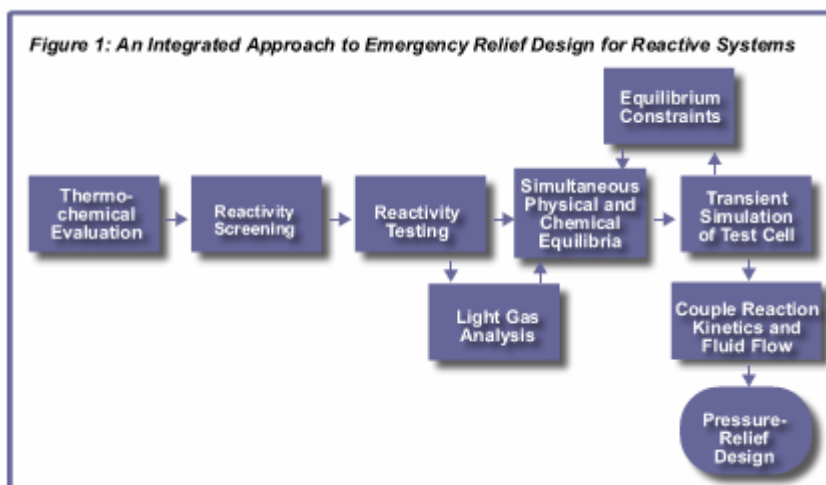
CODIFIED DESIGN BASIS DETERMINATION

The critical first step in designing or verifying an emergency relief device or system is establishing and documenting the design basis. Safeguarding Documentation, an industry-established methodology, provides a framework to determine the controlling relief scenarios for all pressure-relief devices and vents. Like a HAZOP, it uses “guidewords” to identify operating deviations that result in potential overpressure events for equipment. Safeguarding Documentation provides the design engineer with a road map for developing sizing calculation. This approach is the most thorough technique available for identifying all possible pressure-relief device contingencies. Once Safeguarding Documentation is complete, sizing computations are relatively straightforward. Moreover, by covering many equipment design deviations, Safeguarding Documentation significantly reduces the time it takes to complete a PHA.

Selecting the design basis for pressure-relief devices often rests on defining the worst *credible* relief scenario. Using fault tree analysis software, our hazard analysts have assisted many companies in risk-based selection of pressure-relief scenarios. ioMosaic’s risk-based approach helps companies mitigate near-unventable scenarios to a tolerable level of risk and develop economical designs for more credible events.

Correct ERS design for reaction systems also depends on accurate modeling and an integrated approach (Figure 1). For example, the pressure-vessel-temperature relationship of each system is fundamental and unique. For a specific relief device set pressure, there is a unique corresponding system temperature. For reactive systems, this temperature corresponds to a reaction rate.

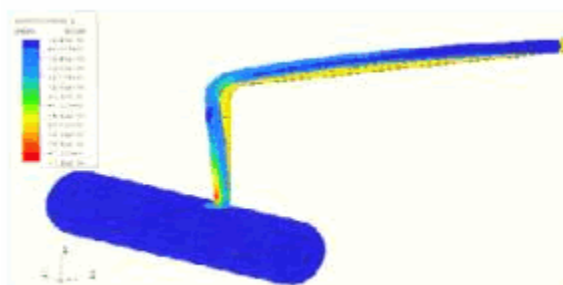
Errors in estimating temperature or rate can lead to inadequate sizing and potential catastrophic vessel failure. ioMosaic has the expertise and know how, to safeguard against error and provide integrated solutions. With our reactivity screening and data testing capabilities, companies can feel confident about the specifications supporting even their most difficult ERS situations.



LEADING EDGE PRD DESIGN COMPUTATION

ioMosaic is the developer of leading-edge technology used by DIERS. We are working with DIERS to provide the next-generation computer program for ERS and effluent handling design. The computer program *SuperChems™ for DIERS* is a dynamic simulator, capable of performing ERS and effluent handling designs for complex geometries and multiphase reaction systems. For more straightforward API-based evaluations, the QuikSize feature will allow fast verification of relieving capacity.

SuperChems' powerful capabilities also help technical staff increase the efficiency of the validation and documentation of ERS design basis—which can lower the unit cost per pressure-relief design. This is achieved by linking several design cases sequentially in a single run.





STRUCTURAL DYNAMICS

Containment systems and relief piping must withstand the dynamic loading caused by shocks, steady-state forces, and rapid temperature increases of an over-pressure release event. Because these stresses are typically complex, designers often compensate for a lack of confidence in the analysis of the design with overly conservative safety factors. With our extensive experience in dynamic, static, and thermal stress analysis of complex structural systems, ioMosaic provides you with a thorough understanding of the forces that arise during a release event. We support this expertise with the technical rigor of our comprehensive capabilities in finite element-based computational analysis. The results for companies include increased confidence in the design, more appropriate safety factors, and reduced costs.

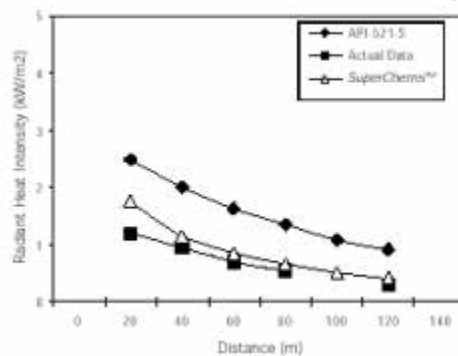


INTEGRATED EFFLUENT HANDLING

Complete ERS design goes beyond estimating relief-device size to assess how the effluent handling system interacts with the pressure relief design. Our validated, industry standard, simulation tool *SuperChems™* allows the integral evaluation of relief dynamics and downstream system effects. For example, *SuperChems™* can evaluate the time-dependent history of pressure, temperature, and composition in a reactor as the relief occurs. At the same time, *SuperChems™* models effluent discharge to determine flow parameters and meet established (regulatory or internal) criteria.

SuperChems™ also has flame models for determining flare radiation levels at user-specified coordinate points. Radiation values computed by *SuperChems™* compare exceptionally well with measured radiation levels from a real flare.

Figure 2: Radiation Prediction Method Comparison



BENCHMARK CALORIMETRY

An exothermic runaway reaction occurs when the system's exponential heat-generation rate exceeds its heat-removal capacity. To help companies evaluate the hazard potential and relieving requirements of reactive systems, ioMosaic testing services using industry standard adiabatic calorimetry to provide:

- Actual temperature and pressure data for kinetic modeling
- Confirming predicted events following the activation of an emergency relief system
- Directly measuring physical property data of complex mixtures



STATE-OF-THE-ART SOFTWARE

SuperChems™ is an advanced tool for pressure-relief design, consequence analysis, and thermal hazard assessment. Developed by our principals while at Arthur D. Little, *SuperChems™* helps companies meet process safety design and management needs and objectives. The program contains an extensive data-bank of more than 1,200 components with equation-of-state-based computer code and many features that add tremendous value to the quality of a detailed hazard analysis. Its accuracy has been extensively validated against experimental data. SuperChems™ also features scenario/object-drive architecture, which allows a defined object (such as a vessel or piping configuration) to be used in multiple scenarios. Once a scenario is defined, it can be duplicated to facilitate what-if or sensitivity analysis.



PROCESS SIMULATION STUDIES

Maintaining up-to-date, accurate process simulation data is paramount to the safe, efficient operation of a plant and is a valuable aid to process optimization. ioMosaic offers our Process Simulation service as a standalone line of service, as part of an Emergency Relief System (ERS) Design project, or as part of our Process Technology Evaluation and Assessment services.

ioMosaic is able to combine the use of their leading edge ERS and dynamic simulation computer program SuperChems™, together with the industry standard process simulation tool, HYSYS®, to offer this complete service.

Using our considerable process expertise gained in the petrochemical, chemical, and pharmaceutical industries, ioMosaic can include the following as part of our Process Simulation studies:

- Development of heat and material balances, for existing operations,
- Sensitivity analyses to identify the optimal design based on operating and business targets,
- Assessment of equipment deficiencies, such as heat exchanger fouling, and column flooding,
- Equipment sizing verification, and recommendation,
- Evaluation of feed changes, upsets, and equipment downtime.



TRAINING

We offer leading-edge courses in pressure-relief design and related topics such as:

- Thermal Hazard Evaluation and Pressure-Relief Design
- Advanced Data Analysis for Adiabatic Calorimetry Process Safety for Flammability and Explosions
- Consequence Analysis

About ioMosaic

Founded by former Arthur D. Little Inc. executives and senior staff, ioMosaic Corporation is the leading provider of safety and risk management consulting services. ioMosaic has offices in Salem, New Hampshire and Houston, Texas.

Since the early 1970's, ioMosaic senior staff and consultants have conducted many landmark studies including an audit of the Trans-Alaska pipeline brought about by congressional whistle blowers, investigation of the Bhopal disaster, and the safety of CNG powered vehicles in tunnels. Our senior staff and consultants have authored more than ten industry guidelines and effective practices for managing process safety and chemical reactivity and are recognized industry experts in LNG facility and transportation safety.

ioMosaic Corporation is also the leading provider of pressure relief systems design services and solutions. Its pressure relief system applications are used by over 250 users at the world's largest operating companies. It holds key leadership positions in the process industries' most influential and active pressure relief system design, and chemical reactivity forums, and plays a pivotal role in defining relief system design, selection, and management best practices.

Please [contact us](#) for more information about our services

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Safety & Risk Management Consulting Services

- ◆ Auditing
- ◆ Calorimetry, Reactivity, and Large-Scale Testing
- ◆ Due Diligence Support
- ◆ Effluent Handling Design
- ◆ Facility Siting
- ◆ Fire and Explosion Dynamics
- ◆ Incident Investigation, Litigation Support, and Expert Witness
- ◆ Liquefied Natural Gas (LNG) Safety
- ◆ Pipeline Safety
- ◆ Pressure Relief Design
- ◆ Process Engineering Design and Support
- ◆ Process Hazards Analysis
- ◆ Process Safety Management
- ◆ Risk Management Program Development
- ◆ Quantitative Risk Assessments (QRAs)
- ◆ Structural Dynamics
- ◆ Training

Software Products:

ioXpressKM (ioXpress Knowledge Manager is a web-based enterprise application for corporate electronic information management).

SuperChems (SuperChems is an advanced tool for pressure relief design, consequence analysis, and thermal hazards assessment).

HAZOPtimizer is a software product for recording and managing process hazard analysis.