

# ioMOSAIC STATEMENT OF QUALIFICATION

## RISK MANAGEMENT & PIPELINE SAFETY

### SAFETY & RISK MANAGEMENT

#### *MANAGING PROCESS SAFETY*

Process safety regulations were first implemented in California and New Jersey. Later the OSHA process safety management (PSM) standard followed by the EPA RMP Rule regulated process safety in the entire United States. Since then many countries worldwide have promulgated PSM regulations similar to the OSHA PSM standard. Most companies have implemented their PSM systems to comply with these regulations. More proactive companies have realized the business benefits of process safety management and have expanded the implementations of PSM systems to processes and facilities not regulated. These companies are realizing the full business benefits of PSM by establishing corporate responsibility, creating business value, earning the respect of the local community, realizing the freedom of self-determination and avoiding the costs associated with accidents.

ioMosaic provides consulting services to help clients meet their regulatory requirements and to realize the quantitative and qualitative benefits of a comprehensive process safety and risk management program.

#### *PROCESS SAFETY AND RISK MANAGEMENT SYSTEMS*

The key to implementation of effective process safety and risk management systems is to develop a common framework that includes all local regulatory requirements and all corporate standards. Facilities in countries that do not regulate process safety or have different requirements from the US do not want to comply with US standards. Processes that pose lower risk or are more inherently safe than others should have different process safety and risk management systems requirements.

ioMosaic partners have worked with numerous industry groups and companies to develop safety and risk management systems, guidelines and standards, and audit protocols. Our services include baseline and compliance audits, preparation of implementation/follow-up plans, development of guidelines and standards, and implementation of program elements. We can help you comply with internal company standards; CCPS, CMA, API, and other industry guidelines; and the regulatory requirements of OSHA's Process Safety Management Standard and EPA's Risk Management Program (RMP) Rule.

#### *HAZARD AND RISK ASSESSMENT*

Risk assessment can be accomplished both qualitatively and quantitatively and at varying levels of detail. When compa-



nies are carrying out qualitative risk assessments, ioMosaic's ioFIRST software supports risk screening activities, while our major risk survey approach guides more detailed risk assessments. If a quantitative review is needed, we have extensive experience using both fault-tree and event-tree analyses to determine the frequency of potential incidents and evaluate risk. SuperChems, our hazard assessment modeling software includes source term and vapor dispersion models. Safety as well as F-N curve generation and risk contour plotting capability. Our techniques have been applied to the assessment of facility siting and layout.

### PIPELINE SAFETY EXPERIENCE

Our principals have many years of experience in pipeline safety and have conducted numerous studies on pipelines transporting a wide variety of materials including:

- ◆ Natural Gas
- ◆ Natural Gas Liquids
- ◆ Liquefied Petroleum Gas
- ◆ Hydrogen & Carbon Monoxide
- ◆ Ethylene and Propylene Oxide
- ◆ Nitrogen
- ◆ Crude Petroleum & Refined Products
- ◆ Supercritical Ethylene

We provide consulting support to the pipeline industry covering a wide range of safety services. These services offer a foundation for implementation of pipeline integrity management to comply with DOT Pipeline Safety Regulation 195.452.



#### *PIPELINE SAFETY COMPLIANCE AUDIT*

- ◆ For a U.S. corporation involved in pipeline transport of natural gas, our principals conducted a safety and code compliance assessment of its facilities, which included natural and sour gas pipelines, sour gas treating facilities, NGL extraction facilities, and underground natural gas storage caverns. The corporation operates about 12,750 miles of underground pipelines with a peak daily delivery capacity of 5.4 billion cubic feet of gas. Sixty compressor stations provide 1.1 million horsepower required to move the gas through the pipelines. The code compliance review included both company and government mandated codes and standards, and involved on-site inspections of all their unique installations and a representative number of their common facilities. The focus of the safety effort was to identify acute risks to company personnel and the general public. For each area of concern, we recommended possible mitigating measures.

#### *PIPELINE INTEGRITY MANAGEMET RISK ASSESSMENT*

- ◆ For an independent petroleum company operating in California, our principals conducted risk assessments of two separate hazardous liquid pipeline systems for compliance with 49 CFR195.542. The hazardous liquids included petroleum emulsion and treated crude oil. For one system, the produced fluids originated from a sour field. During this assignment, our safety engineers reviewed the IM information compiled by the operator, conducted a process hazard analysis, interviewed operations and technical staff, and surveyed the pipeline right-of-way and associated high consequence areas (HCAs).

The information and knowledge obtained was used in the preparation of the risk assessment, which included the quantification of spill release rates and resulting spill areas and thermal radiation and/or toxic hazard zone. The hazard zone quantification was performed using advanced consequence modeling tools in SuperChems™.

#### *PIPELINE HAZARD ANALYSIS*

- ◆ For the Dabhol India power project, our principals conducted a HAZOP study of the gas pipeline from the LNG send-out facility at the engineering contractor's office in India. Previously, we had conducted a HAZOP study of the LNG facilities at the offices of the engineering contractor in London.
- ◆ For the pipeline subsidiary of a major oil company, our principals developed a generic hazard identification tool for pump stations. The tool was based on the What-if hazard identification technique and consisted of a spreadsheet with pre-loaded what-if questions and scenario descriptions. The user was required to consider the consequences of these operational deviations and identify the existing engineered and administrative controls for mitigating risks. We also piloted the tool for the client by facilitating its use on an existing pump station.

#### *PIPELINE RELIABILITY ANALYSIS*

- ◆ Our principals performed a reliability and capacity availability study for a mid-western U.S. gas utility facilities for supplying natural gas during peak demand periods. The gas supply facilities included a substitute natural gas (SNG) plant, a liquefied natural gas (LNG) storage tank and vaporizer, an underground gas storage field, and a propane/air injection unit. Using the estimated capacity utilization and system availability levels for the individual gas supplies, the probabilities of different combinations of facility outages and associated gas delivery capacities were determined. This enabled the utility company to assess the adequacy of reserve margin, in support of their presentations to the state public utility commission.

### PROCESS EVALUATION

Often, companies in the process industries need impartial evaluations of process technologies for making strategic and tactical business decisions. Some of the situations that force this need include; outside technology acquisition (licensing), benchmarking internal technology developments, screening toll manufacturers, assessing scale-up potential and risk, and process selection for projects. Using the experience of our staff of senior process engineers and dynamic process simulation capability, ioMosaic Corporation provides comprehensive process evaluation solutions.

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



## QUANTITATIVE RISK ASSESSMENT

Quantitative Risk Assessment (QRA) is an invaluable method for making informed risk-based process safety and environmental impact planning decisions, as well as being fundamental to any facility-siting decision-making.

ioMosaic has a proven track record in performing QRAs. Our professionals have performed assessments on a wide range of facilities, such as refineries, chemical plants, pharmaceutical plants, tar sands, crude oil refineries, pipelines, LNG facilities, and rail and marine transportation terminals.

### QRA USING SUPERCHEMS™

ioMosaic has now added QRA capabilities to its SuperChems™ Expert software product. This additional functionality now makes SuperChems™ the most advanced tool in the industry for performing consequence analysis, quantitative risk analysis, and emergency relief system design—all on one platform! SuperChems™ QRA features include:

- ◆ Broad range of models for modeling discharge, dispersion, thermal radiation and explosion
- ◆ Advanced multi-component discharge and dispersion modeling
- ◆ Comprehensive chemical database with over 3000 standard components
- ◆ Built-in probability data
- ◆ Customizable graphing and reporting features
- ◆ Consequence and risk results overlaid on site map
- ◆ User-friendly layout
- ◆ F-N curve and risk contour generation

ioMosaic's risk analysts have performed hundreds of QRA studies, some examples of our project experience are as follows:

- ◆ Quantitative Risk Analysis of an ammonia transport terminal in Singapore
- ◆ Transportation quantitative risk analysis for a North American railway company
- ◆ Reliability, Availability, Maintainability (RAM) study of LNG-fueled power plant
- ◆ Quantitative Risk Analysis of argon purification operation for large international chemical company
- ◆ Quantitative Risk Analysis for large Canadian Refinery
- ◆ Ethylene and ethylene derivatives plant Quantitative Risk Analysis for client in the Middle East

In addition, our risk analysts have authored and contributed to many DIERS and CCPS publications that provide guidance across a wide spectrum of safety and risk topics.

## 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.

### 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.

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