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RAGAGEP Requirements for Relief Systems Design Basis and Documentation

by
Georges A. Melhem, Ph.D.
melhem@iomosaic.com

Recent emphasis on RAGAGEP increased the scope of risk factors that require evaluation in order to develop complete and compliant Pressure Relief and Flare System (PRFS) documentation

- (d)(3)(ii) Employers must document that all equipment in PSM covered processes complies with RAGAGEP
  - Published and widely adopted codes
  - Published consensus documents
  - Published non-consensus documents
  - Corporate Standards and training documents
- Failure to document compliance and the deviations from compliance with RAGAGEP can be cited under (d)(3)(ii)
- OSHA definition of process equipment is very broad

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The PSM standard allows companies to select the RAGAGEP they can apply to their covered processes

- Performance based regulation
- There may be conflicting RAGAGEP or more than one applicable RAGAGEP
- Say what you will do and do what you say
- If internal standards are more stringent then they should be followed
- If internal standards or selected RAGAGEP do not adequately address the hazard to employees then the General Duty clause can be invoked by OSHA for citations for the residual hazards and/or risks

Equipment outside acceptable limits (as defined by PSI) is deficient

- Deficiencies must be corrected before further use or interim safeguards must be established
- Interim safeguards must afford the same level of risk reduction as the permanent safeguards
- Interim safeguards require an MOC for continued safe operation
- Permanent safeguards must be completed in a timely manner
- What qualifies as “timely manner” ?

OSHA made important changes to two PSM standard interpretations on 6/8/2015

- Clarification on how RAGAGEP will be enforced for PSM
- RAGAGEP applies to equipment design, installation, operation, maintenance, inspection and testing (methods and frequencies)
- References CCPS definition of RAGAGEP
- There are two significant court cases challenging (1) OSHA broad definition of process equipment and (2) RAGAGEP memoranda
- Change in the coverage of concentrations of PSM chemicals in mixtures (126 chemicals affected)
- If 1 % or above, calculate the amount of chemical in the process (if partial pressure is > 10 mmHg) and determine if it exceeds the threshold quantity [similar to EPA RMP rule coverage of mixtures]

What is the catch with RAGAGEP?

- Standards referenced in the PSM regulation are frozen in time. Notice and comment are required for rule-making for updating them
- RAGAGEP evolves over time and may be more stringent
- RAGAGEP may be binding without the necessity of rule-making and due process
- Similar to **Best Available Techniques Not Entailing Excessive Costs (BATNEEC).** An approach to pollution control in the UK that requires operating companies to adopt the most effective techniques for an operation at the appropriate scale which are commercially available and where the benefits gained are more than the costs of obtaining them

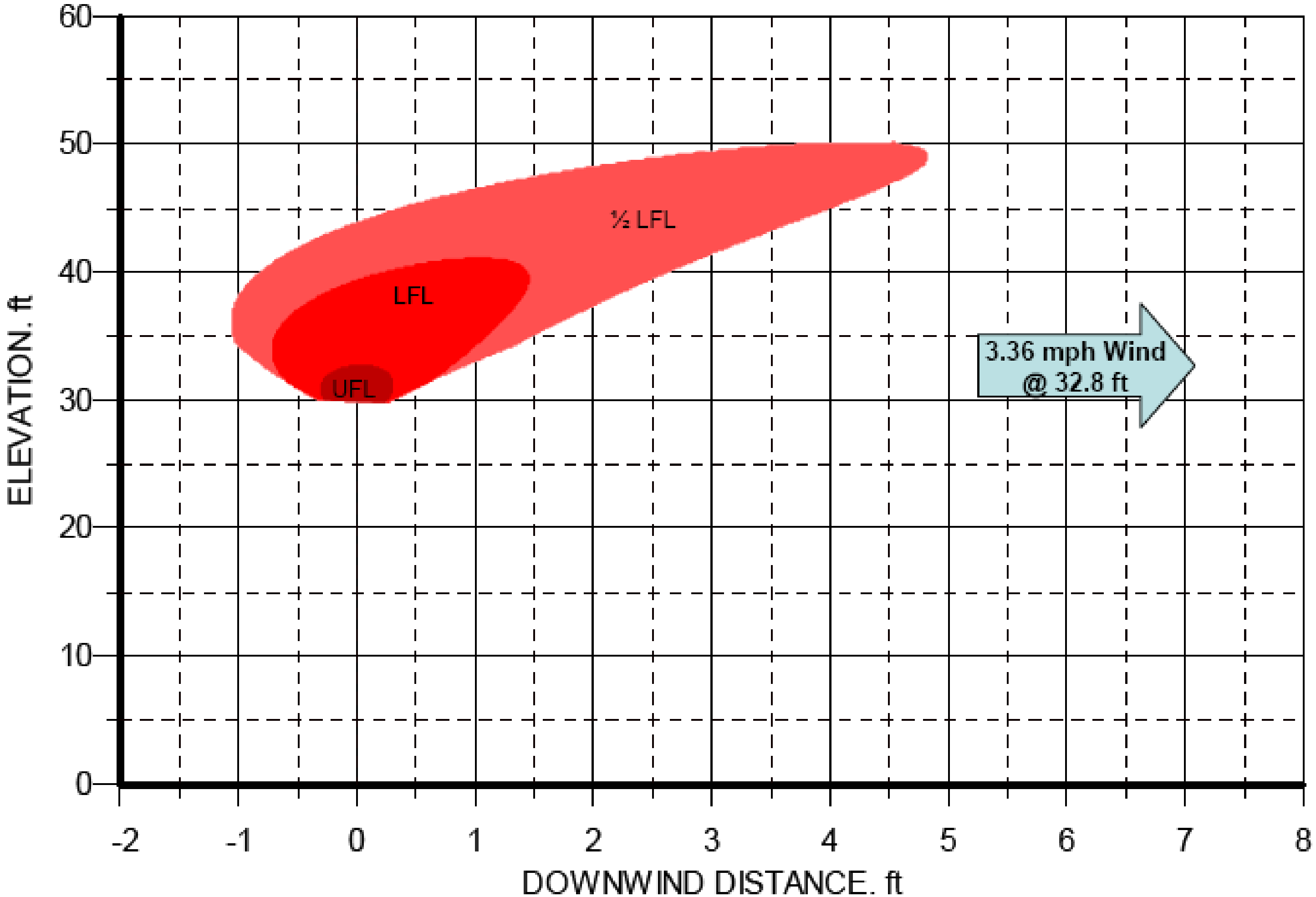
RAGAGEP categories requiring special attention in relief systems include

- Dispersion analysis
- Thermal radiation
- Noise
- Vibration risk
- Reaction forces and structural supports
- Metal cold temperatures due to expansion cooling and two phase flow
- Hot temperatures due to fire exposure and/or runaway reactions
- PRV stability
- Reaction systems (MSDS is not sufficient!)

Dispersion analysis is required in order to have a PSM compliant documentation

- Flame outs (volatile emissions, flares behave like vent stacks)
- Two phase relief (sometimes caused by oversizing PRV)
- Liquid Rainout or flaming rain
- Condensation from hot hydrocarbon relief
- Touchdown can be further down from fence line
- Toxicity, flammability, and overpressure considerations
- Stack downwash
- Low flow and velocity leading to poor dispersion
- Environmental impact

Dispersion analysis is required in order to have a PSM compliant documentation

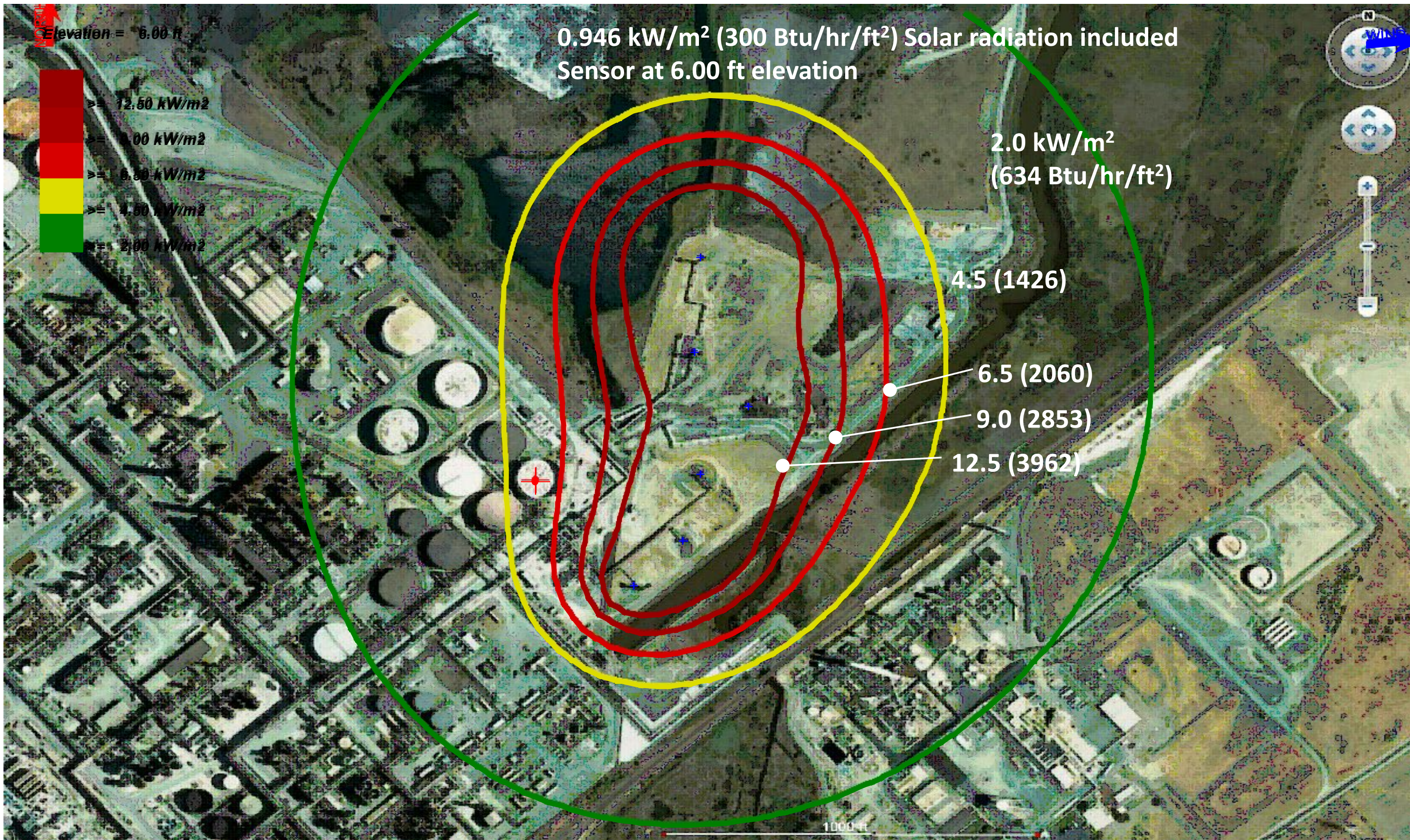


Source: SuperChems Expert

Thermal radiation is required in case a discharge to atmosphere is ignited

- Vent stacks behave like flares
- Immediate ignition can cause flame jets
- Delayed ignition can cause vapor cloud fires and explosions followed by flame jets

Thermal radiation is required in case a discharge to atmosphere is ignited



Source: SuperChems Expert

Vibration risk is now required by API-521

- Excessive AIV/FIV can cause piping and equipment failures
- Excessive AIV/FIV can cause cracks allowing air ingestion/ingress into flare and vent systems creating an explosion hazard
- Use of equivalent pipe length methods for fitting losses can lead to inaccurate estimates of sound power levels
- High superimposed constant backpressure can reduce the value of sound power level from AIV/FIV

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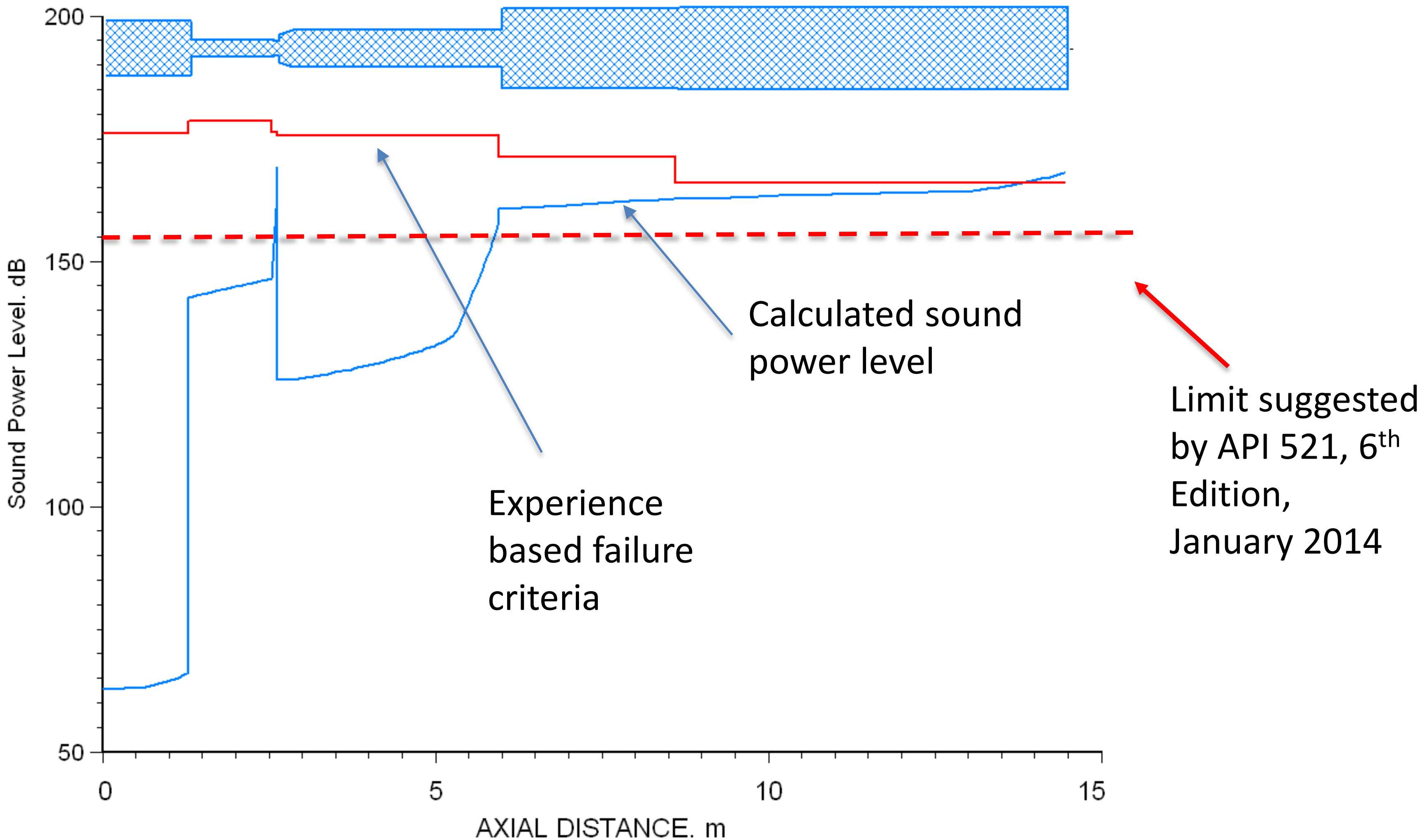


Source: SuperChems Expert

Reaction forces are not always properly calculated and documented

- Dynamic loads and dynamic loads durations vs. structural response time [How long does it take to fill the discharge pipe]
- Static loads for different relief device types
- Design case for reaction forces may be different than the governing scenario for relief capacity
- Use of equivalent pipe length methods for fitting losses can lead to inaccurate estimates of reaction forces especially for gas and multiphase flow
- Safe upper limits can be established by neglecting the attached relief piping to the relief device

$$F_{ST} = u_e W + P_e A_e - P_a A_e$$

$$F_{UT} = \frac{\partial}{\partial t} \int u \rho A \, dx$$

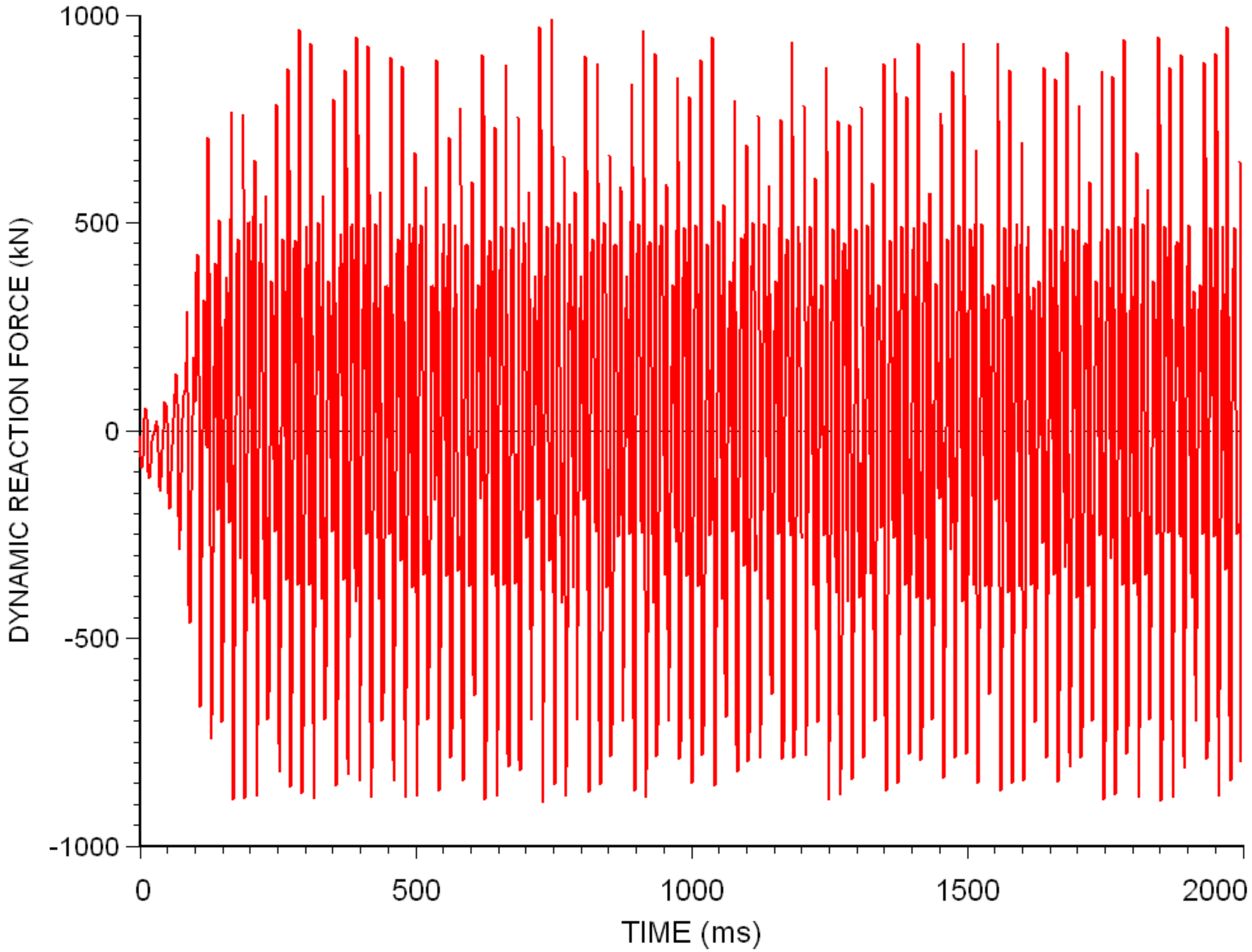
$$F_{UT} = \frac{d(\rho A L u)}{dt} = \frac{d(LW)}{dt} = L \frac{W_2 - W_1}{t_2 - t_1}$$

$$I = \int_{t=t_1}^{t=t_2} F_{UT} \, dt$$

$$I = L (W_2 - W_1)$$

$$F_{PT} = u_1 W + P_1 A - P_a A$$

Reaction forces are not always properly calculated and documented

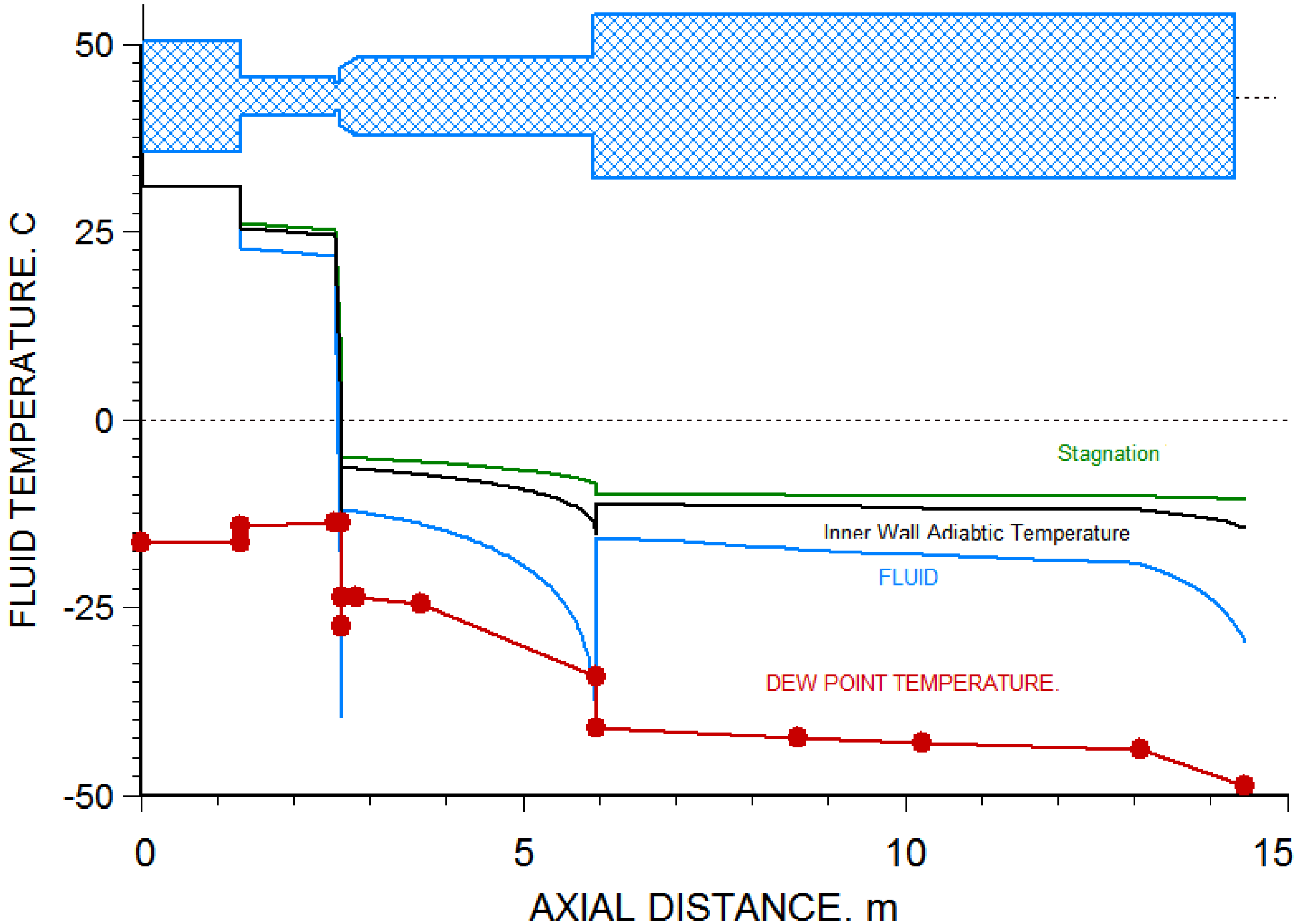


Source: SuperChems Expert

Temperature excursions can cause metal failures

- Cold temperature due to expansion cooling can lead to embrittlement
- Piping and equipment downstream of expansion point can see fluid temperatures if condensation occurs
- Piping and equipment downstream of expansion can collect liquids from condensation when it occurs
- Hot temperatures due to flame jet or pool fire impingement or flame radiation can cause vessel failure at the reseat point of the PRV if the fire duration is long enough
- Use of equivalent pipe length methods for fitting losses can lead to inaccurate estimates of temperatures for gas flow and multiphase flow because of how choke points are influenced

Temperature excursions can cause metal failures



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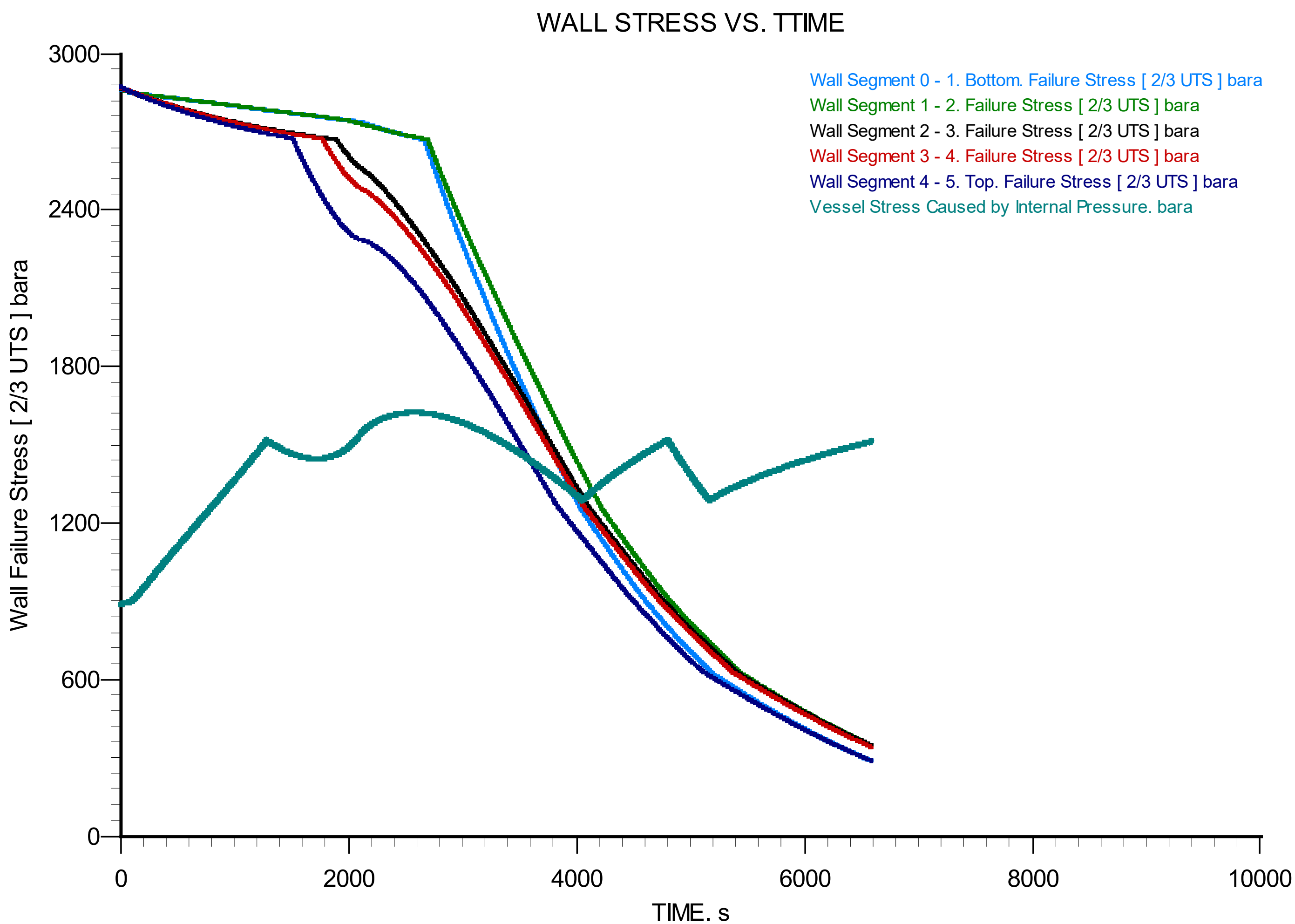
Temperature excursions can cause metal failures

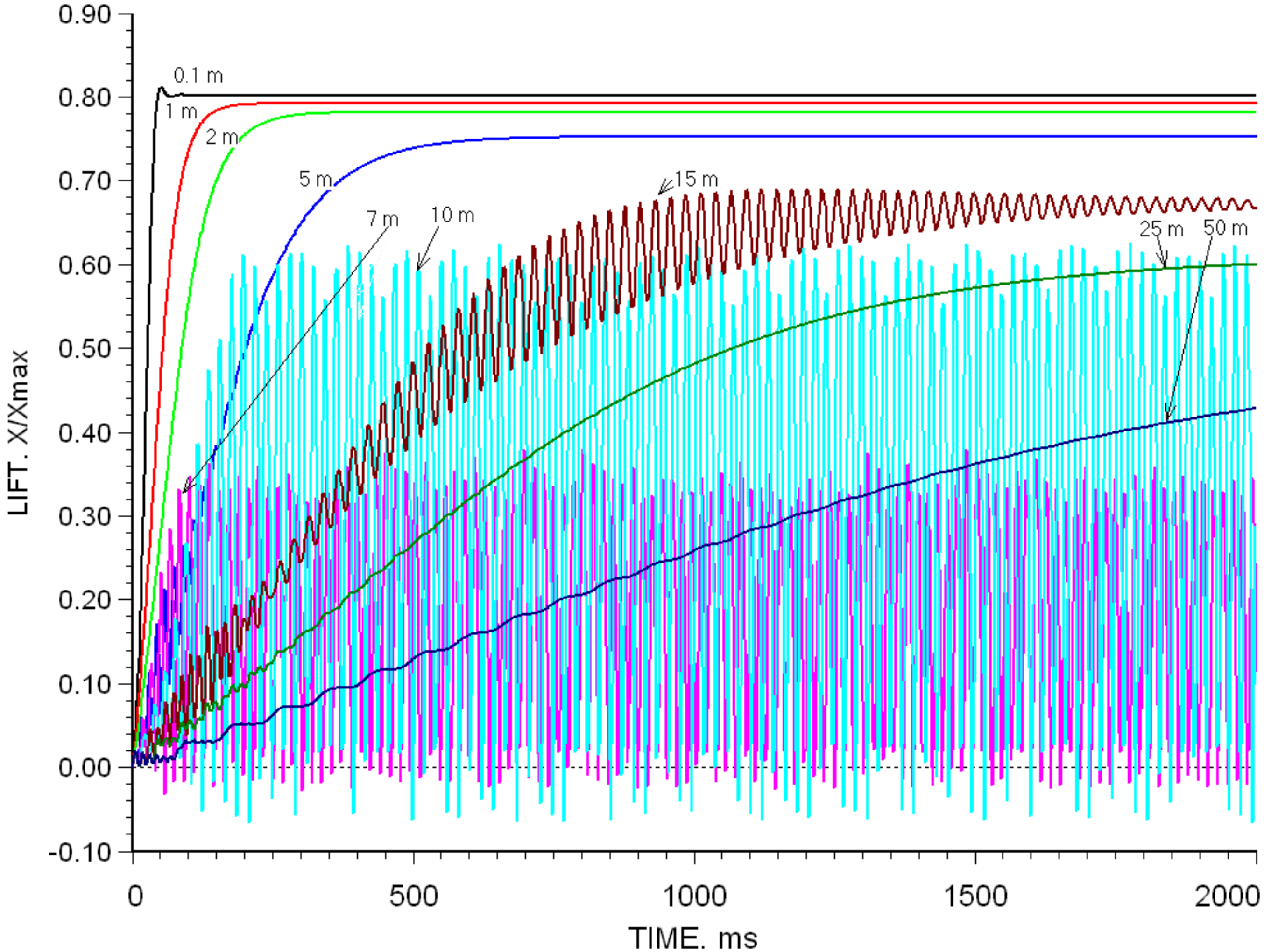


Source: SuperChems Expert

Excessive pressure loss or backpressure causing PRV instability

- Governing case for PRV stability may be very different from the governing case for PRV sizing or structural support
- Existing installations where inlet pressure loss exceeds 3 %
- Engineering Analysis as defined by API 520 II

Excessive pressure loss or backpressure causing PRV instability

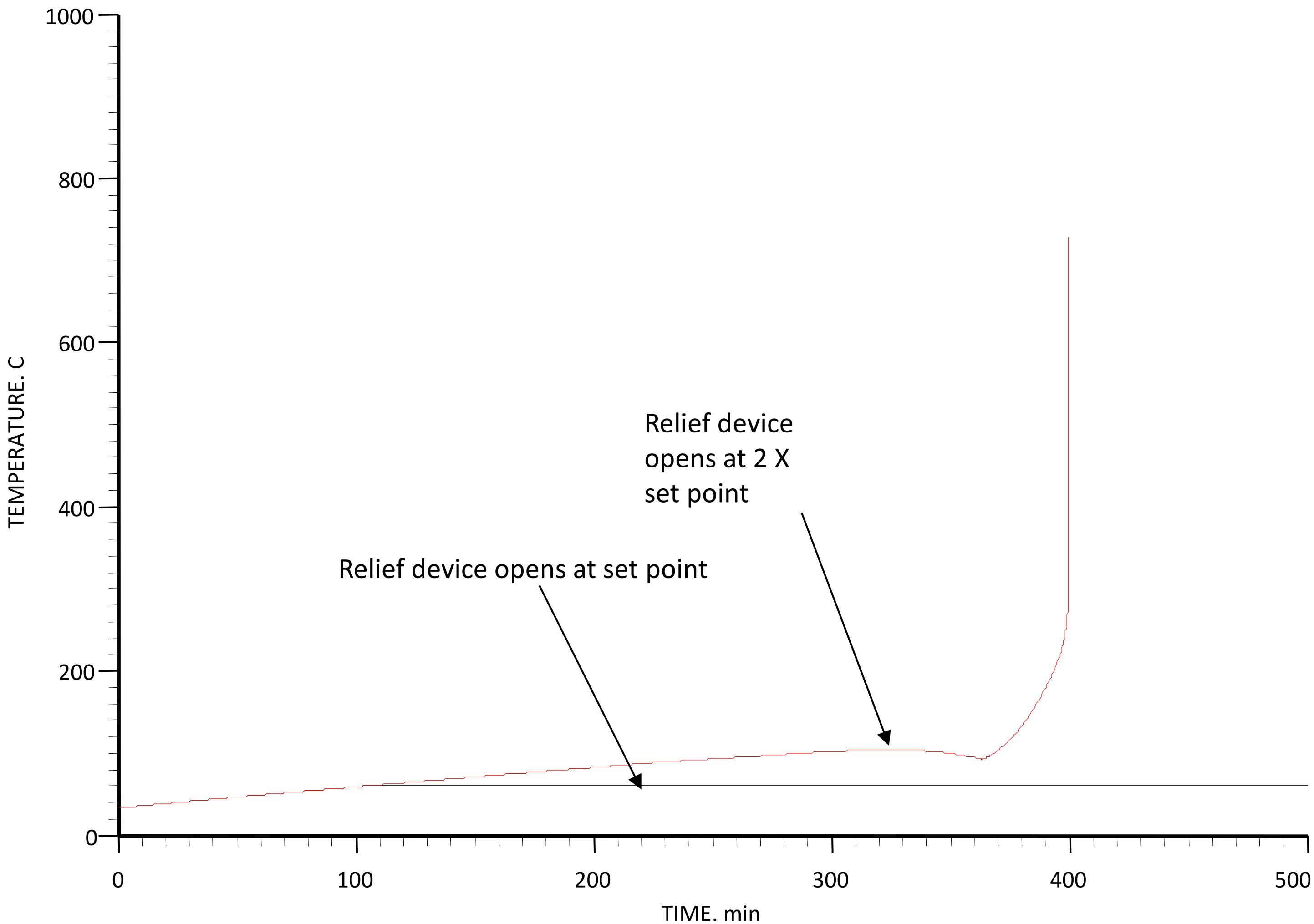


Source: SuperChems Expert

Reaction systems require a higher level of care and documentation

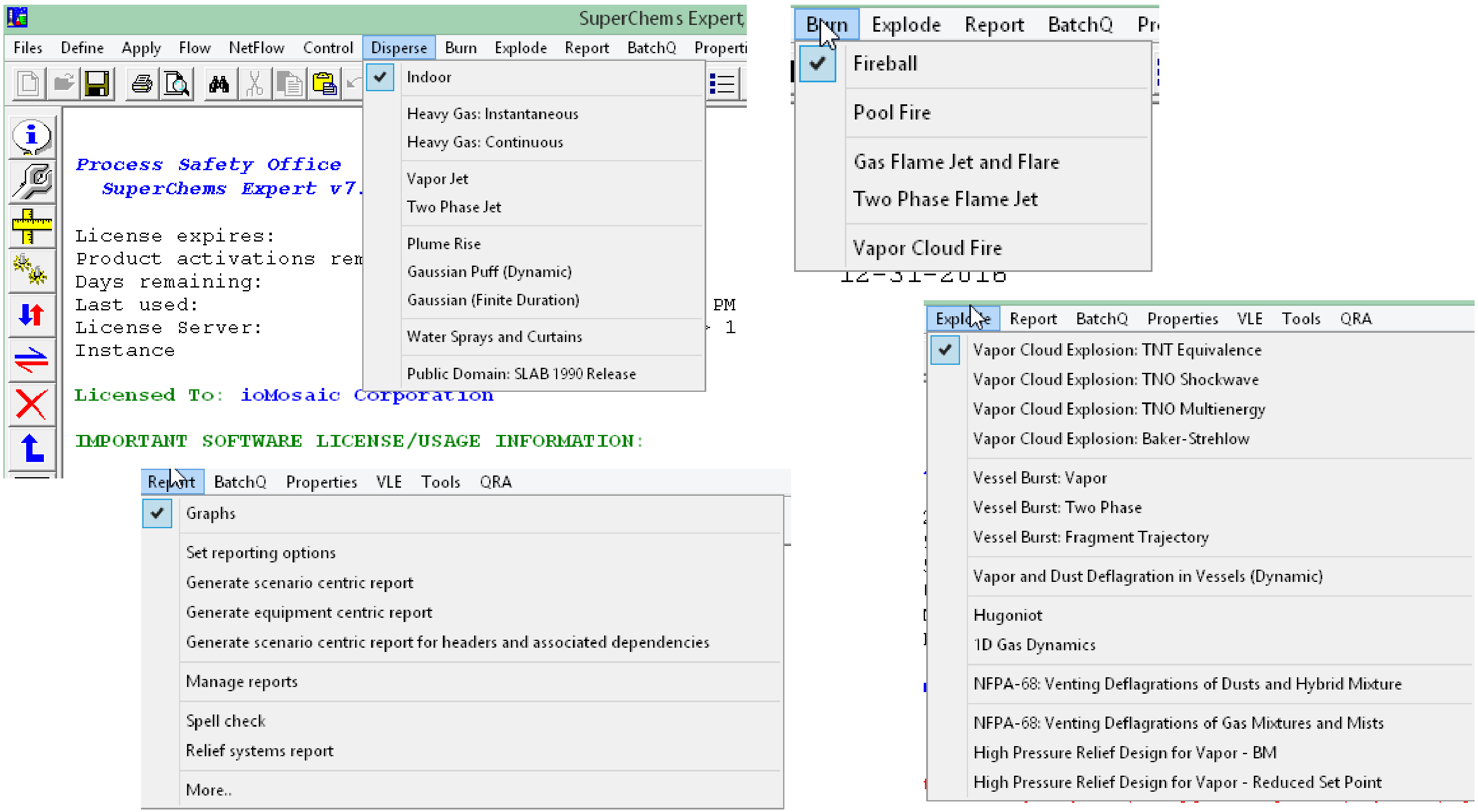
- Reaction systems characterization
- Scenarios leading to runaway reactions
- Two-phase flow
- Dispersion and/or effluent handling of reaction products

Reaction systems require a higher level of care and documentation



Source: SuperChems Expert

In addition to flow models, relief and flare systems tools need to consider a myriad of consequence models in order to meet the new expanding RAGAGEP requirements



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Through innovation and dedication to continual improvement, ioMosaic has become a leading provider of integrated process safety and risk management solutions. ioMosaic has expertise in a wide variety of areas, including pressure relief systems design, process safety management, expert litigation support, laboratory services, training, and software development.

ioMosaic is an integrated process safety and risk management consulting firm focused on helping you manage and reduce episodic risk. Because when safety, efficiency, and compliance are improved, you can sleep better at night. Our over 40 years of industry expertise allow us the flexibility, resources and capabilities to determine what you need to reduce and manage episodic risk, maintain compliance and prevent injuries and catastrophic incidents.

Our mission is to help you protect your people, your plant, your profits, and our planet.

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