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Number 3

Process Safety News

A SIMPLE REAL TWO-PHASE FLOW CORRELATION

By: Hans K. Fauske, D.Sc., Regent Advisor, Fauske & Associates, LLC (FAI)

$$G = \left(\frac{1 - Y}{G_0^2} + \frac{Y}{G_1^2} \right)^{-1/2} \qquad (1)$$

where G (kg m^{-2} s^{-1}) is the two-phase flow rate, and Y is the dimensionless variable ranging from 0 to 1 and G_0 and G_1 are the corresponding asymptotic flow rate limits.

Two-Component Non-Flashing Flow

Such as air-water flows Y represents the gas quality x from 0 to 1 and the corresponding asymptotic limits are

$$G_0 = G_{liquid} \text{ and } G_1 = G_{gas} \qquad (2)$$

Estimated G values in the region between the asymptotic limits are in excellent agreement with experimental data including Safety Relief Valves (SRVs) using available vendor certified all liquid and all gas discharge coefficients (Fauske, 2008).

One-Component Flashing Flow

Such as stagnation steam-water mixtures Y represents the vapor quality x from 0 to 1 and the corresponding asymptotic limits are

$$G_0 = G_{ERM} \text{ and } G_1 = G_{vapor} \qquad (3)$$

Estimated G values in the region between the asymptotic limits are again in excellent agreement with experimental data including SRVs using available vendor certified all vapor discharge coefficient. Eqs. 1 and 3 are considered applicable to top located SRVs ($x > 0$) (Fauske, 2008).

One-Component Non-Equilibrium Flashing Flow

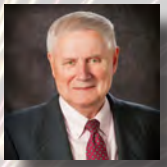
Such as stagnation condition where slight subcooling exist ($x < 0$), a simple length criterion L of the order of 100 mm appears to characterize the residence time requirement for approaching equilibrium flashing flows in ducts, covering wide variations in diameter and stagnation pressure including different fluid properties (Fauske, 2008). In this case Y in Eq. 1 represents the dimensionless length $L^+ = L/100$ ranging from 0 to 1 and the corresponding asymptotic limits are

$$G_0 = G_{liquid} \text{ and } G_1 = G_{ERM} \qquad (4)$$

Again, estimated G values in the region between the asymptotic limits are in excellent agreement with experimental data. As such Eqs. 1 and 4 are considered applicable to bottom located SRVs ($x_0 < 0$) (Fauske, 2008).

References

Hans K. Fauske, 2008, "Two-Phase Flows and Non-Equilibrium Considerations," DIERS Users Group Meeting, Las Vegas, Nevada, April 29, 2008.



Hans K. Fauske is an original founding partner of FAI and currently serves as Regent Advisor

Upcoming Events

- FAI Engineer, Dr. Richard Kwasny, will co-chair and be a presenter at the Thermal Hazards and Process Safety Section at the North American Thermal Analysis Society (NATAS) 43rd Annual Conference at McGill University, August 10-13, Montreal, Quebec
- FAI Engineers will attend the NURETH-16, International Topical Meeting on Nuclear Reactor Thermal Hydraulics, August 30 - September 4, Chicago, IL
- Representatives from FAI will attend the Specialty & Agro Chemicals America Show, September 9–11, Charleston, SC
- FAI Engineers will attend the GLOBAL 2015 21st International Conference & Exhibition: " Nuclear Fuel Cycle for a Low-Carbon Future", September 21-24, 2015, Paris, France
- FAI will exhibit in booth 3969 at the National Safety Council Congress & Expo Atlanta 2015, September 26 - October 2, Atlanta, GA
- FAI presents the Fall 2015 Process Safety Training Courses, October 1 - 2, Burr Ridge, IL
- FAI presents the Fall 2015 Relief System Design Course, October 8 - 9, Burr Ridge, IL

Letter From the President

In a recent conversation I had with Jeff Griffin, Director of Business Development, the subject turned to the increasing need to provide customers with plant services such as seismic analysis of buried piping and cable analysis. Now, many of you are probably reading this and thinking, 'yes, I know Fauske & Associates, LLC (FAI) provides these services, but don't they really fit more in the nuclear area of your business?' The answer is no.

True, the NRC has had strict standards in place for years around maintaining the infrastructure of nuclear facilities to ensure their structural soundness for the long term, or in the event that a severe accident happens. These same standards are applicable in any type of industrial operation or setting.

To quote an observation by Jeff, "Industry in general is aging." It is true, facilities are aging. And, as company's work to retrofit and make use of existing properties instead of building new ones it is especially important to consider their safety by looking at their structural integrity to ensure that they are reliable for ongoing use. Cable and piping failures have on more than one occasion caused safety concerns, even leading to the occurrence of accidents, costly repairs and loss of revenue through plant shutdown scenarios.

At FAI, we have been providing these process safety consulting and testing services for the last 35 years and are now applying the best practices we have learned in the areas of buried piping and cable analysis services to other industries beyond nuclear.

Our engineers are proficient in performing seismic walkdowns to screen for the seismic adequacy of systems, components, and piping. We follow applicable nuclear industry guidelines and alternatively, we developed the FAI seismic screening methodology which we have applied to other industries. This methodology also allows us to analyze underground and buried pipe. Our engineers and contractors who perform these walkdowns regularly undergo various professional seismic training (e.g. training provided by the Seismic Qualification Utility Group – SQUG).

Additionally, FAI offers comprehensive cable analysis using our LIne Resonance Analysis (LIRA®) cable condition monitoring test which provides both an indication of the overall cable health as well as locally degraded areas. It is a Non-Destructive Examination (NDE) tool that does not over-stress the cable, but instead uses a relatively low 5 volt peak-to-peak (Vpp) signal to perform its evaluation. It performs both global and local assessments of the test cable. Importantly, the test cable does not need to be disconnected from its source and testing is completed in minutes. Leaving the cable connected eliminates a potential problem source: the cable termination.

The certifications and experience of our engineers in these areas allow us to assess safety related equipment across all industries. If you need assistance with buried piping or cable analysis, we are happy to assist. Contact me at (630) 887-5224 or kfauske@fauske.com and I will make sure you are connected with the correct engineer to meet your needs.

I hope you are enjoying a wonderful and safe summer,

H. Kristian Fauske
President

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Statement of Purpose:

FAI's "Process Safety News" is intended to be a forum on recent advances in chemical process safety and FAI's current and related offerings in this area. It will address subscriber's concerns regarding issues and practices for relief system design as well as laboratory testing and techniques for process safety management.

Inquiries:

FAI's "Process Safety News" is published by
Fauske & Associates, LLC
16W070 83rd Street, Burr Ridge, IL 60527
Toll Free: 877 FAUSKE1, +1-630-323-8750
Fax: +1-630-986-5481
info@fauske.com www.fauske.com

Executive Director

H. Kristian Fauske

Art Director

Sara Peters

Contributors

AnnMarie Fauske
Dr. Hans K. Fauske
Kris Fauske
Ashley Foote
Zach Hachmeister
Lisa Karcz
Amy Paul
Sara Peters
Carol Raines
Elizabeth Raines

Publisher

Fauske & Associates, LLC

THE KOENEN TEST APPARATUS

By: Amy Paul, Mechanical Engineer
Fauske & Associates, LLC

The Flammability Testing and Consulting Services department at Fauske & Associates, LLC (FAI) has increased our testing scope once again! We are now able to offer Koenen Testing. This test is used to measure the sensitivity of a solid or liquid sample to intense heat with varying confinement.

The Koenen Test apparatus at FAI meets the requirements for test methods listed in the United Nations' *Recommendations on the Transport of Dangerous Goods Manual of Tests and Criteria* and the European Parliament's Council on the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). In the UN Manual, the Koenen test methods are Test 1(b), Test 2(b) and Test 8(b), while the test method in REACH is A.14 *Explosive Properties* found in the *Official Journal of the European Union*. Based on the test results from these procedures, shipping classifications can be determined as well as the limiting diameter.

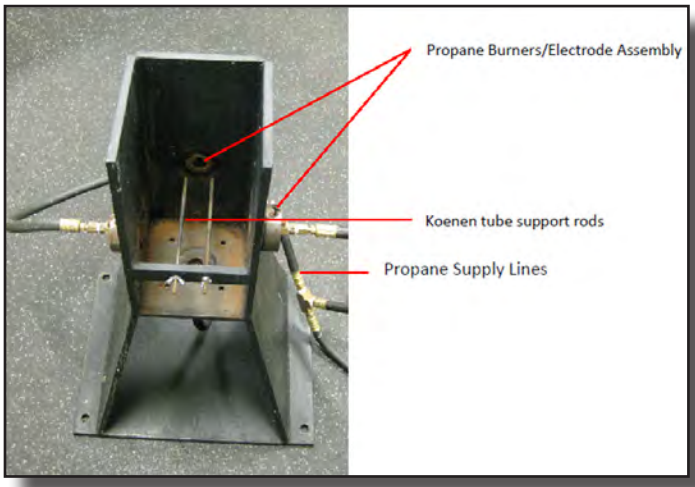

Figure 1: Koenen Test Apparatus

The sample is placed in a non-reusable tube with a reusable collar fitted with a standard orifice plate ranging from a 1 mm diameter up to a 20 mm diameter, through which the decomposition gases are vented. The tube assembly is then placed in the Koenen Test Apparatus, which contains four propane burners housed in a support frame that encloses the test tube on three sides and the bottom. The tube assembly is then exposed to direct heat from the four burners until the tube ruptures or five minutes have expired, whichever comes first. The results of the test are based on how and if the tube ruptures during testing, and at what orifice size.

Figure 2: Tube pre-test

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Possible effects of heating under confinement according to the *Recommendations on the Transport of Dangerous Goods Manual of Tests and Criteria*:

"O": Tube unchanged
"A": Bottom of tube bulged out
"B": Bottom and wall of the tube bulged out
"C": Bottom of tube split
"D": Wall of tube split
"E": Tube split into two fragments
"F": Tube fragmented into three or more mainly large pieces which in some cases may be connected with each other by a narrow strip
"G": Tube fragmented into many mainly small pieces, closing device undamaged
"H": Tube fragmenting into many very small pieces, closing device bulged out or fragmented

Figure 3: Tube that underwent effect "A"

Figure 4: Tube that underwent effect "D"

Figure 5: Tube that underwent effect "E"

Figure 6: Tube that underwent effect "F"

Figure 2 through Figure 6 are pictures of results we typically see at FAI. Tests that result in "O" to "E" effect are regarded as "no explosion" according to the UN standards. UN Division classifications are made based on results with a limiting diameter - the largest diameter of the orifice plate used which results in an explosion.

The REACH method for thermal sensitivity uses the 6.0 mm and 2.0 mm diameter orifice plate. Classifications are based on whether or not an explosion occurs at either of these conditions. This test is part of the *Explosive Properties* test series, which includes tests to determine mechanical sensitivity with respect to both shock and friction.

Contact us at info@fauske.com to learn if this test is right for your needs.

Amy Paul is a mechanical engineer working in the Flammability Testing and Consulting Services Group at FAI

FAUSKE & ASSOCIATES, LLC (FAI) MILESTONES:
A LOOK BACK AT OUR 35 YEAR JOURNEY

1980-1989

35th ANNIVERSARY

1980
DIERS project begins

1980
Fauske & Associates, LLC (FAI) founded by Drs. Hans K. Fauske, Robert E. Henry and Michael A. Grolmes

The Beginning

1981
*Modular Accident Analysis Program (MAAP) Development started

1983
DIERS large-scale blowdown tests (vapor disengagement and flow regimes) conducted

1984
DIERS large-scale chemical runaway reaction testing-pressure relief and effluent control conducted

1984
*MAAP1 released

1984
*MAAP2B released

1985
Vent Sizing Package (VSP™) system introduced

1986
Acquired by Westinghouse Electric Company, LLC

1986
*MAAP 3 released

1987
Direct containment heating experiments conductd

1987
Two-phase Venting ERS Design VSSP Software released

1988
External RPV cooling experiments conducted

1988
*MAAP3B released

1989
Reactive System Screening Tool (RSST™) introduced

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*MAAP is an Electric Power Research Institute (EPRI) owned and licensed computer software

REACTION CALORIMETRY FROM A NEW GRAD'S PERSPECTIVE

By: Elizabeth Raines, Chemical Engineer
Fauske & Associates, LLC

Reaction Calorimetry is the methodical process that analyzes the heat evolution of a new or existing chemical process that is capable of dissecting the individual steps of that process; these studies can be used to determine if those individual steps can be refined in order to optimize them.

As a 2014 Bachelor of Science Chemical Engineering graduate from the University of Illinois in Champaign, Illinois, reaction engineering has always fascinated me. As an eager and excited undergraduate college freshman sitting in my Introduction to Chemical Engineering course, I remember the professor drawing a reactor on the chalkboard and adding in components A and B and having the product C coming out of the reactor. I remember thinking how simple it was that if you know the right recipe you can make something valuable. I have since learned that the process of making that desired product C is far from that simple. Selecting the process temperature and pressure is a significant step and can directly affect the yield and selectivity of the desired product and the rate of the reaction. Additionally, figuring out what type of equipment is needed and how the process needs to be run (such as how the product will need to be separated or handled before and leaving the reactor), is no simple task. Furthermore, these details do not even take into consideration how to optimize the process—make it better, faster, and cheaper, while creating and maintaining an inherently safe design as well as being responsible to our environment by making it "green". Fortunately, I have learned through my education and mentoring I have received here at Fauske & Associates, LLC (FAI), that some of these parameters can be selected through reaction calorimetry studies.

After completing internships in both the dust and reaction calorimetry laboratories, I have been fortunate enough to become a full-time employee at FAI. FAI is well known for their more than 35 years of providing quality customized engineering and testing solutions, of which their latest sector of the industry being reaction calorimetry. Reaction calorimetry is a testing and consulting service led at FAI by Dr. Donald Knoechel who has close to 30 years of industry experience creating and improving chemical processes through the use of reaction calorimetry.

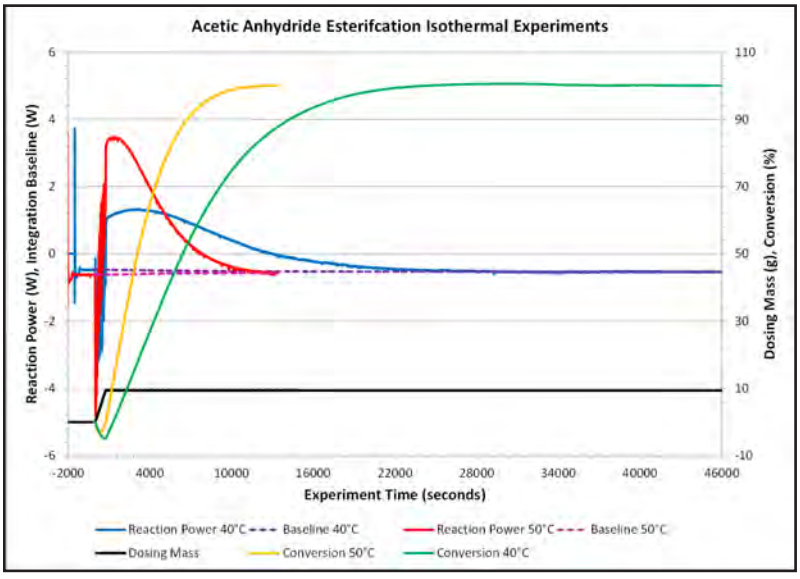
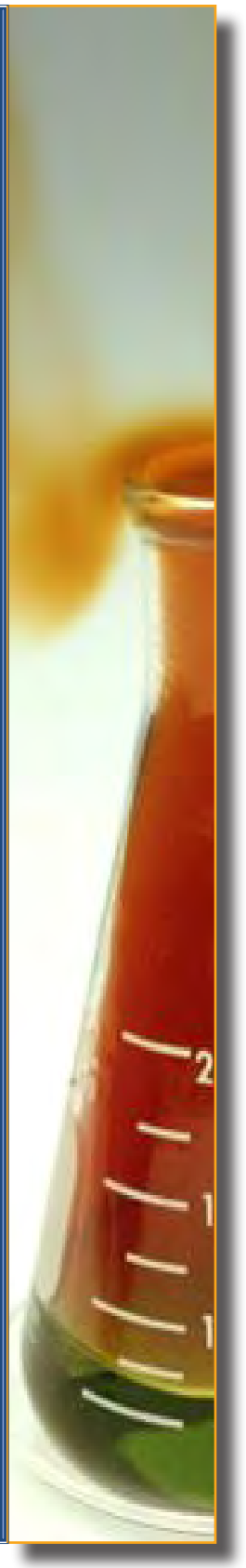


Figure 1

In today's fast paced eco-concious world, there is a real demand to make chemical products faster, cheaper and greener while not compromising on safety. I see calorimetry as a great tool for this type of process optimization. Specifically, optimization with regard to process :

- Safety
- Efficiency
- Sustainability



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A few examples of ways calorimetry can optimize your process with regard to these three parameters are laid out in Table 1.

Table 1, Examples of Process Optimization that can be completed with Calorimetry

Safety	Efficiency	Sustainability
• Testing and consulting to aid in safe process scale up from lab or pilot plant processes • Sizing relief systems for various upset scenarios • Determining ways to eliminate or substitute hazardous solvents or reagents	• Performing kinetic modeling of chemical systems • Testing and enhancing processes for feed rates, temperature pressure, mixing, etc.* • Improving catalytic reactions for catalyst type and loading and process parameters	• Perform testing to determine if the amounts of solvents used can be reduced (particularly if they end up as waste) • Determine if the energy released during a chemical reaction can be utilized elsewhere in the plant (i.e. used to heat water, etc.)

**An example of enhancing a process is shown in Figure 1 where the esterification of acetic anhydride with methanol was completed at two different temperatures (40°C and 50°C). The cost associated with running the process at a higher temperature can be compared to the time saved by finishing the reaction more quickly to determine what approach will be most beneficial to your company.*

We at FAI are problem solvers — if you have a concern about your process whether it be safety related or you are looking for a way to improve your process through optimization or looking for a greener approach, give us a call and we can come up for a tailored solution for you.

The main thing I have learned working in industry is that there is always more to learn. As such, I will be starting graduate school part-time this fall to complete a Master of Sciences in Chemical Engineering at the Illinois Institute of Technology.

Elizabeth Raines is a chemical engineer working in the Thermal Hazards Testing and Consulting Group at FAI

FAUSKE & ASSOCIATES, LLC (FAI) AWARDS "STEP UP" HONORS TO EMPLOYEES

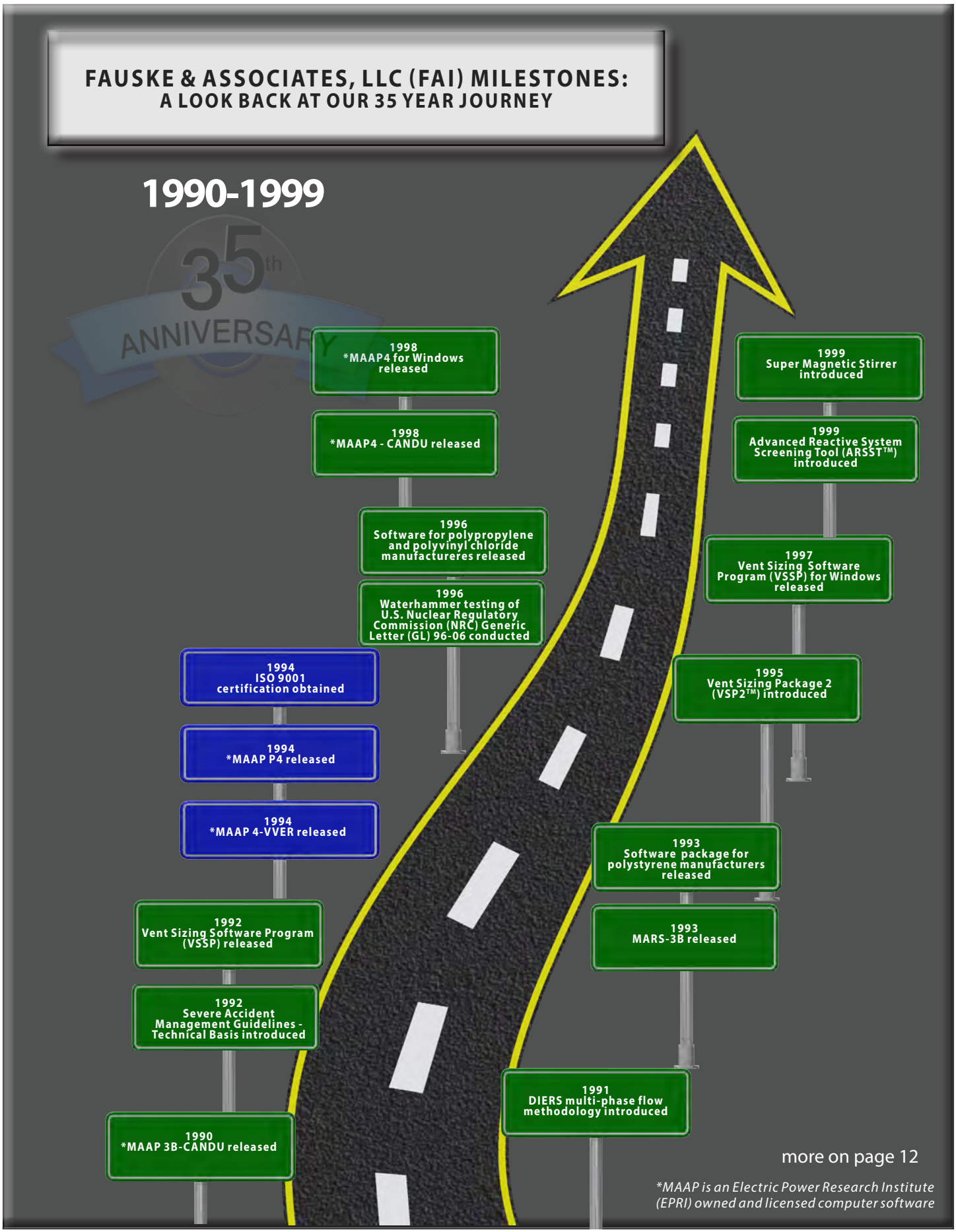
STEP UP FAUSKE

Four Fauske & Associates, LLC (FAI) employees were awarded "Step Up" honors in July. Each was nominated by fellow employees for work above and beyond their normal daily responsibilities

Congratulations to Joe Kalebich, Amy Paul, Jane Luciano and Jim Burelbach (left to right) for "Stepping Up" and leading by example.

FAUSKE & ASSOCIATES, LLC (FAI) MILESTONES:
A LOOK BACK AT OUR 35 YEAR JOURNEY

1990-1999



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SEISMIC ASSESSMENT OF TANKS BY RESPONSE SPECTRUM ANALYSIS (RSA)

By: Ashley Foote, Mechanical Engineer
Fauske & Associates, LLC

Overview

Response Spectrum Analysis (RSA) is a method used to estimate the peak response of a structure due to base motion. RSA is commonly used to determine the effect of earthquakes on various structures. In the past, Fauske & Associates, LLC (FAI) has used the RSA approach to verify the seismic adequacy of various tanks; one example is a large water tank made of reinforced concrete. Though the addition of water to the system may seem straightforward, it adds complexity to the calculation. The tank was partially filled meaning that the effects of water sloshing during an earthquake must be taken into account in addition to the movement of the structure itself.

Both the Seismic Qualification Utility Group (SQUG) and the American Petroleum Institute (API) provide methodologies to analytically verify the seismic capability of many nuclear plant components, including vertical flat bottom metal tanks. The screening criteria and simplified hand calculations in both methodologies provide simple and conservative means of addressing the complex dynamic fluid-structure interaction analysis. To analytically perform the analysis, many assumptions and simplifications of geometry must be made. The engineer performing the analysis must determine if the simplifications are acceptable or if another analysis method must be used. In the cases where the analytical methods cannot be used or where the component fails screening criteria, finite element analysis (FEA) is a good alternative. This is particularly true for concrete tanks that are not covered by the SQUG or API methodologies.

Seismic Analysis of a Tank

To determine whether the tank is seismically adequate, the demand of the earthquake must be compared to the capacity of the water tank. The geometric and material properties of both the tank and the expected earthquake are needed to calculate the capacity of the water tank. Figure 1 shows a typical reinforced concrete water tank; it is cylindrical and rests flat on a concrete base. The peak ground acceleration (PGA) is used to calculate the seismic demand that would be placed on the tank during an earthquake. When considering the capacity of the tank multiple failure modes are considered such as the buckling strength and the overturning moment. Once both the capacity and the demand are calculated for each of the failure modes the demand-to-capacity ratios (DCRs) can be used to determine the tanks ability to withstand the given seismic event. If the DCR is greater than 1, the tank does not pass for that failure mode. In order for the tank to be considered seismically adequate it must pass for each of the failure modes.

For the purposes of seismic verification, the response spectra are predicted using seismic data from the areas surrounding the tank in question. The seismic ground response spectrum for this tank can be seen in Figure 2.

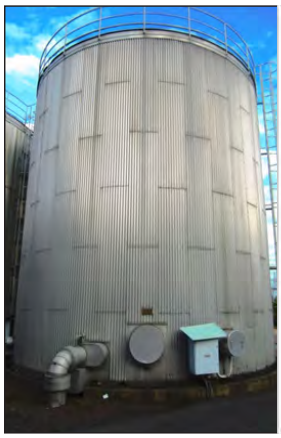

Figure 1

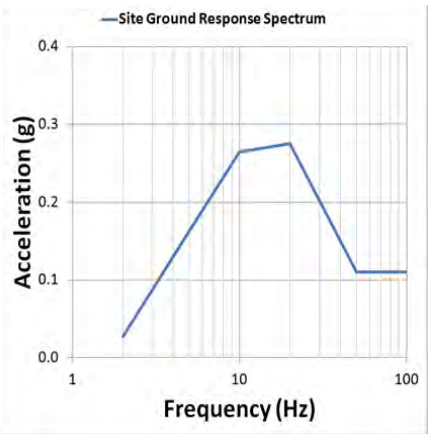

Figure 2

SQUG provides a method to analyze the seismic qualities of vertical tanks in their Generic Implementation Procedure (GIP). These guidelines are applicable to vertical tanks that have large cylindrical geometries. Many of the parameters that are relevant to the tank analysis can be calculated using equations found in the GIP such as this one for sloshing mode frequency, F_s:

$$F_s = \frac{1}{2\pi}\sqrt{\frac{1.84G}{R}\tanh\left(\frac{1.84H}{R}\right)}$$

Where G is the acceleration of gravity (9.81m/s^2), H is the height of the water in the tank, and R is the radius of the tank. The GIP assumes that the tank is made of steel, carbon steel, or aluminum and that the tank is resting flat on the ground or on a concrete slab. For the case of the tank seen in Figure 1, it is resting flat on the ground; however it is made of reinforced concrete meaning that not all of the GIP equations are applicable. This would also be true if the tank was resting above grade (or above ground) on feet.

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Similarly to SQUG, API provides a methodology called API-650 Appendix E which applies to welded oil storage tanks. The API-650 standard is applicable to vertical, cylindrical, above-ground tanks of various sizes and capacities. The API-650 provides a step by step methodology that is used in a similar manner as the GIP. It is the responsibility of the engineer to determine which standard is applicable to the tank in question, but if both standards can be used it increases the confidence of the results.

For the tank seen in Figure 1, a numerical model was built with a commercial FEA software package. The model was designed using the geometry and material properties of the tank. Boundary conditions were then added to account for the anchorage of the tank and the amount of water inside the tank using values such as the sloshing frequency calculated using the equation from the GIP. The seismic data is then incorporated into the model allowing the code to calculate the internal forces by reflecting the dynamic properties of the tank found by superimposing contributions of each of the modes of vibration of the tank. Figure 3 shows an example of the first horizontal mode of vibration calculated before sloshing is taken into account. Similarly, the code uses the seismic response spectra to calculate the resulting displacements of the tank, an example of these results can be seen in Figure 4.

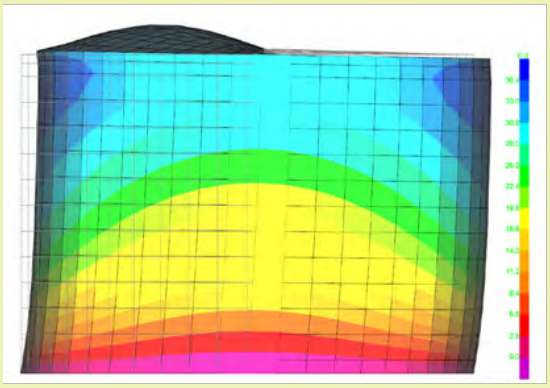


Figure 3

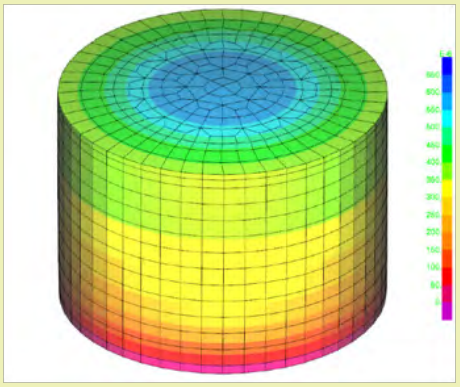


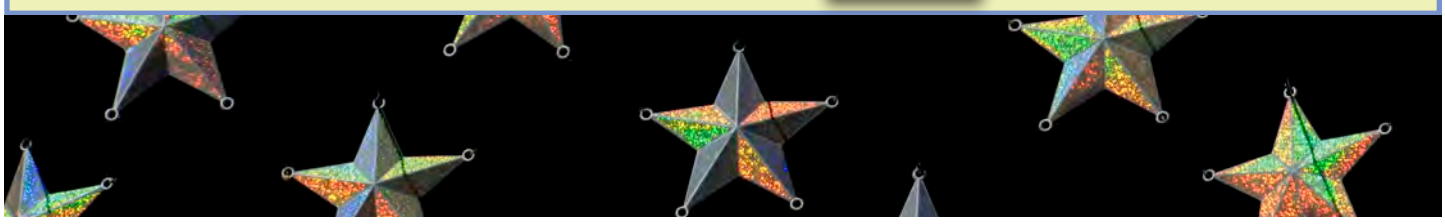
Figure 4

Various loads applied to the tank such as the weight of the roof, the hoop stresses in the tank walls, and the bending moments in the tank can be determined with the tank model. Once the analysis is complete, the DCR for each tank component can be calculated (for example, wall to foundation connection, hoop force in the wall, bending moment in the roof slab, etc.). These ratios can be analyzed to determine the overall adequacy and the limiting components of the tank. The results of the GIP, the API-650, and the FEA model can be compared to increase the confidence of the model.

Conclusion

Response Spectrum Analysis (RSA) can be used to verify the seismic adequacy of various nuclear plant components including vertical water tanks. The analysis can be performed by both analytical and FEA methods. Once both the demand and capacity of the tank are calculated, they can be compared to determine whether the tank can withstand the predicted seismic event and which components are most likely to fail. For this particular tank, it was found that the seismic capacity exceeded the seismic demand resulting in adequate seismic design.

Ashley Foote is a mechanical engineer working in the Structural Services & Vibration Group at FAI



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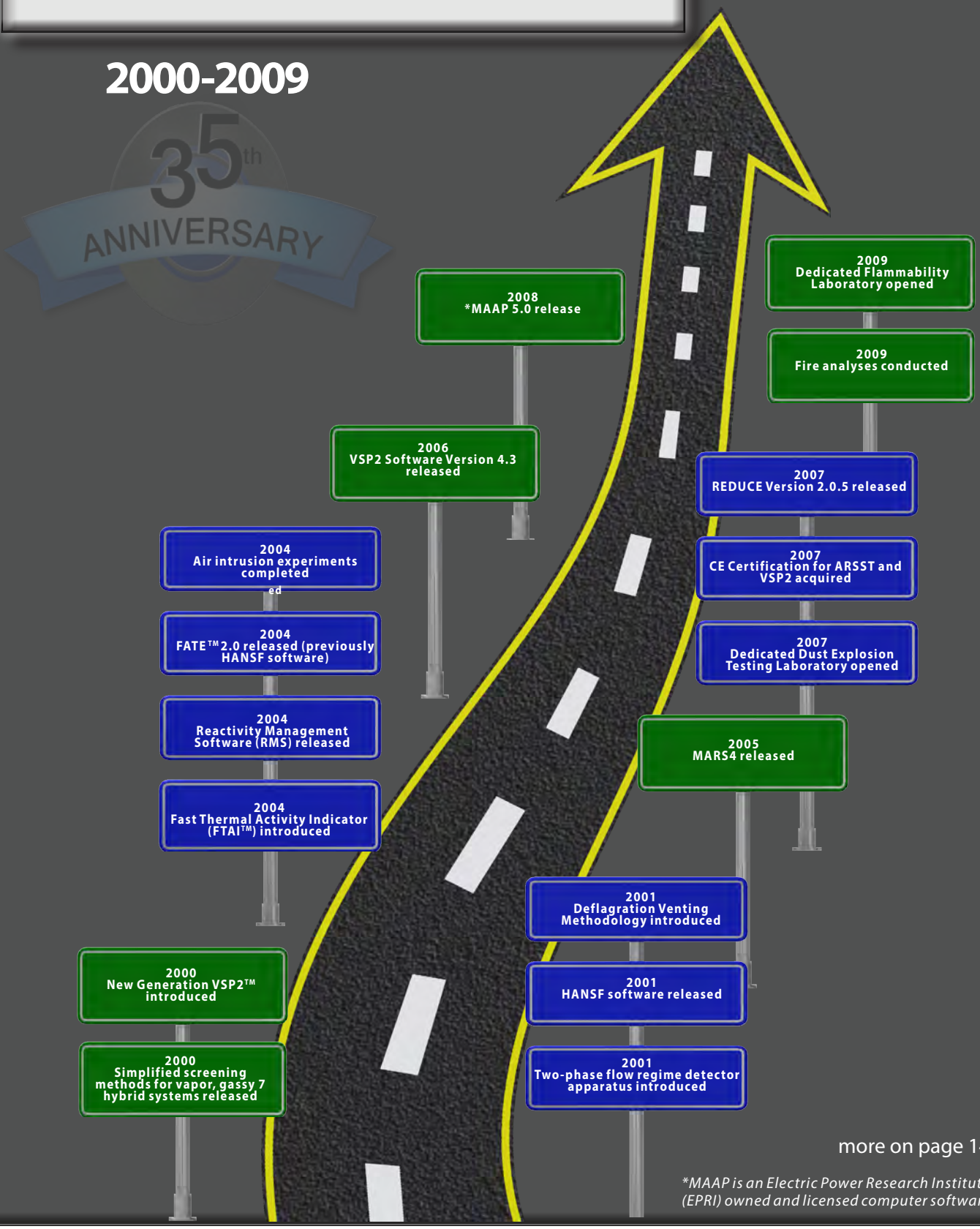
A LOOK BACK AT OUR 35 YEAR JOURNEY

2000-2009

35th ANNIVERSARY



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Fauske & Associates, LLC
Connected to the Community

FAUSKE & ASSOCIATES, LLC (FAI) SUPPORTS LOCAL KIWANIS CHARITY GOLF OUTING

On May 22, 2015, FAI showed their support for the Willowbrook/Burr Ridge Illinois Kiwanis at their Annual Golf Outing.

FAI sponsored a hole and a foursome of FAI employees including from left to right: Kris Fauske, President; Gabe Wood, Manager, Thermal Hazards Testing & Consulting; Zach Hachmeister, Director of Operations, and Ken Kurko, Director, Thermal Hazards Testing & Consulting participated in the outing, taking first place honors.

Willowbrook/Burr Ridge Kiwanis
Annual Golf Outing - 2015

KIWANIS INTERNATIONAL
SERVING THE CHILDREN OF THE WORLD

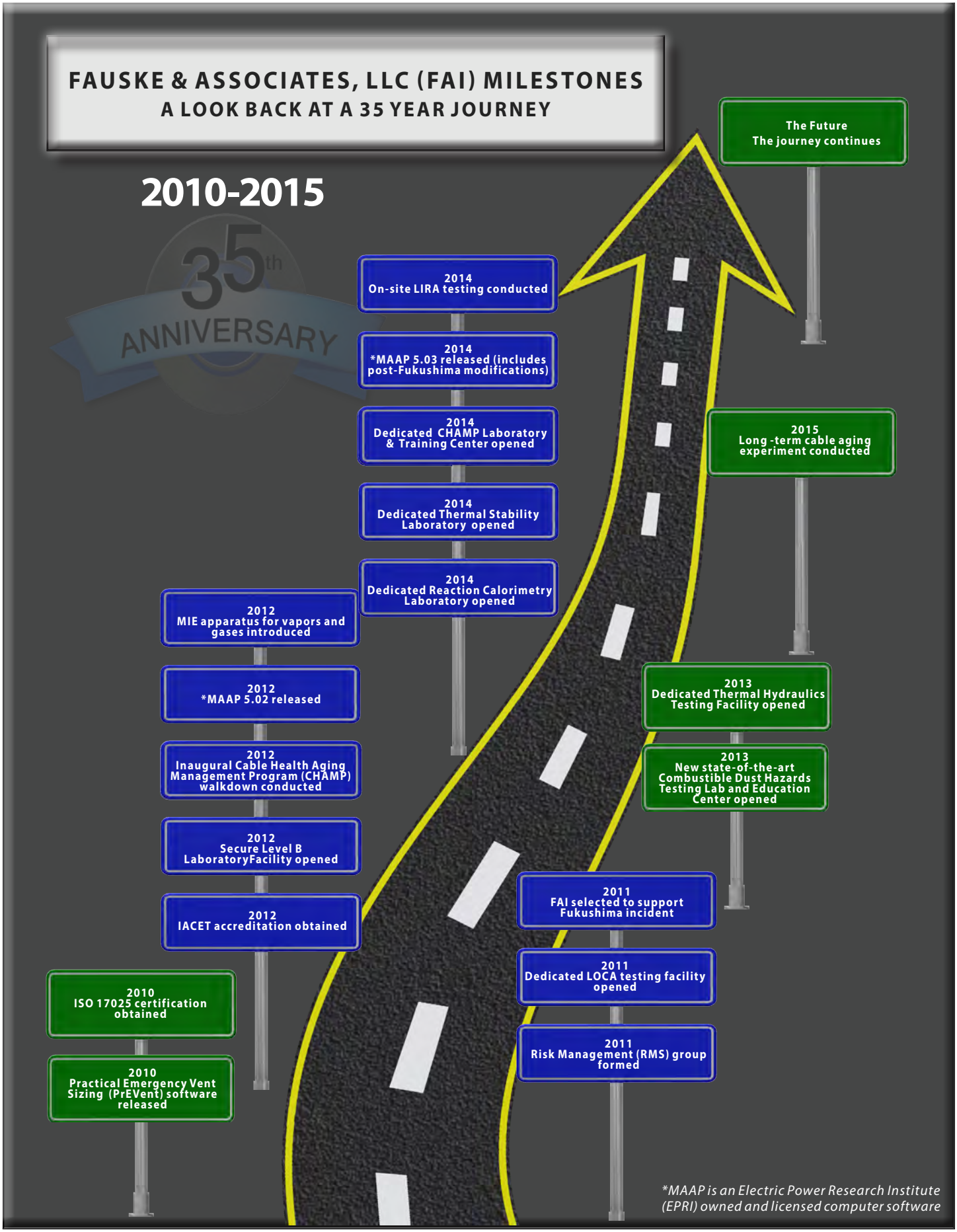
FAUSKE & ASSOCIATES, LLC (FAI) CONGRATULATES THE CLARENDON HILLS HEAT ON THEIR WINNING SEASON AND USED BASEBALL EQUIPMENT DRIVE

Congratulations to the Clarendon Hills Heat baseball team from Clarendon Hills, IL for winning the West Suburban Baseball League (WSBL) championship on June 30th. FAI is a team sponsor and Kris Fauske, President of FAI, is head coach. FAI is also supporting the team's collaboration with the Burr Ridge/Willowbrook Kiwanis organization to collect gently used baseball equipment for distribution to underprivileged children (in the area) at their 2015 Summerslam 9U Tournament being held July 17-19.

The Clarendon Hills Heat is an organization that seeks to develop integrity, leadership, citizenship and teamwork in their players through the vehicle of the great game of baseball. The Heat emphasize having fun on the field while stressing the importance of class and sportsmanship on and off the field -- both in victory and in defeat, along with giving back to their community in exchange for their generous support.

Way to go Clarendon Hills Heat!

Heat
Clarendon Hills


FAUSKE & ASSOCIATES, LLC (FAI) MILESTONES
A LOOK BACK AT A 35 YEAR JOURNEY
2010-2015
35th ANNIVERSARY
The Future
The journey continues
2014
On-site LIRA testing conducted
2014
*MAAP 5.03 released (includes post-Fukushima modifications)
2014
Dedicated CHAMP Laboratory & Training Center opened
2014
Dedicated Thermal Stability Laboratory opened
2014
Dedicated Reaction Calorimetry Laboratory opened
2015
Long -term cable aging experiment conducted
2013
Dedicated Thermal Hydraulics Testing Facility opened
2013
New state-of-the-art Combustible Dust Hazards Testing Lab and Education Center opened
2012
MIE apparatus for vapors and gases introduced
2012
*MAAP 5.02 released
2012
Inaugural Cable Health Aging Management Program (CHAMP) walkdown conducted
2012
Secure Level B LaboratoryFacility opened
2012
IACET accreditation obtained
2011
FAI selected to support Fukushima incident
2011
Dedicated LOCA testing facility opened
2011
Risk Management (RMS) group formed
2010
ISO 17025 certification obtained
2010
Practical Emergency Vent Sizing (PrEVent) software released
*MAAP is an Electric Power Research Institute (EPRI) owned and licensed computer software

Fall 2015 Process Safety Training Courses
Thursday, October 1 - Friday, October 2, 2015

Fauske & Associates, LLC (FAI), presents two individual process safety courses, designed to identify hazards and control strategies that allow for explosion and fire hazard risk mitigation in the process industries. Each course may be attended individually.

Topics to be covered:
- Flammability and electrostatic hazards
- Prevention and protection practices for dust explosion hazards, including OSHA Combustible Dust National Emphasis Program

CEUs: 0.6 per course

Who should attend?
FAI designed these introductory courses for personnel including – but not limited to – chemists, engineers, technicians and operational staff in R&D, process development, kilo, pilot and full-scale production in the chemical, petrochemical, food, cosmetic, detergent, plastic, paper, agrochemicals and pharmaceutical industries.

Technological/ Education Requirements:
There are no technological requirements for this introductory course. Grade 12 or higher education and 2-3 years professional experience are required.

Day 1 – Thursday, October 1
8 am - 4 pm

Introduction to Understanding and Controlling Flammability Hazards

Description
This course will enable engineers and process safety personnel to identify hazards of conducting processes with combustible and flammable liquids and gases. A review of common flammable and electrostatic principles will be discussed using theory and case reviews.

Scheduled Agenda
- Introduction – Basic Theory and Definitions
- Review of Significant Incidents
- Conditions for Fire and Explosion
- Small-Scale Tests
- Theoretical Calculations (Predictions)
- Ignition Factors, Including Electrostatics
- Explosion Control
- Case Studies
- Daily Learning Assessment
- Questions and Answers
- Course Evaluation Instructions

Learning Outcomes
After completing this introductory course, participants will be able to describe and define the fundamental principles of flammability and electrostatic hazards in various industry settings, including:

- Defining what constitutes flammability and electrostatic hazards
- Identifying and mitigating conditions that create such hazards
- Interpreting and reporting on such hazards

CEU Credit Eligibility: FAI is an an IACET (International Association for Continuing Education & Training) Authorized Provider. In order to be eligible for CEU credit (0.6 per course), attendees must be present for the duration of the course, score 85% or higher on the course assessment and complete the course evaluation.

Privacy: Fauske & Associates, LLC has a written policy to ensure privacy and confidentiality of participant training records and information. Training records will only be released with the expressed written permission of the participant. The participant record will be released to the participant or designated third party within 14 business days of the request.

Please direct instructor or course related questions to: Lisa Karcz: karcz@fauske.com, (630) 887-5232, Fax: (630) 986-5481

Prices: $495.00 per day or $990.00 for both days
Hotel accommodations and travel expenses are the responsibility of the participant
Fees include continental breakfast, lunch and afternoon refreshments for each day of attendance.

Location:
Fauske & Associates, LLC
16W070 83rd Street
Burr Ridge, IL 60527
(630) 323-8750

Fall 2015 Process Safety Training Courses
Thursday, October 1 - Friday, October 2, 2015

Fauske & Associates, LLC (FAI), presents two individual process safety courses, designed to identify hazards and control strategies that allow for explosion and fire hazard risk mitigation in the process industries. Each course may be attended individually.

Topics to be covered:
- Flammability and electrostatic hazards
- Prevention and protection practices for dust explosion hazards, including OSHA Combustible Dust National Emphasis Program

CEUs: 0.6 per course

Who should attend?
FAI designed these introductory courses for personnel including – but not limited to – chemists, engineers, technicians and operational staff in R&D, process development, kilo, pilot and full-scale production in the chemical, petrochemical, food, cosmetic, detergent, plastic, paper, agrochemicals and pharmaceutical industries.

Technological/ Education Requirements:
There are no technological requirements for this introductory course. Grade 12 or higher education and 2-3 years professional experience are required.

Day 2 – Friday, October 2
8 am - 4 pm

Introduction to Dust Explosion Hazards, Prevention and Protection Practices

Description
This course will ensure all participants are aware of important issues associated with OSHA's Combustible Dust National Emphasis Program, NFPA 654 and other relevant standards and codes. A logical approach to characterizing a powder's hazardous dust properties will be presented, as well as a description of various techniques used to control and/or avoid dust explosions in a safe and compliant manner.

Scheduled Agenda
- Introduction
- Review of Recent Dust Explosions
- Fundamentals of Dust Explosions
- How to Comply With NFPA Codes and OSHA's Program on Combustible Dust Compliance
- Protection Options
- Daily Learning Assessment
- Questions and Answers
- Course Evaluation Instructions

Outcomes
After completing this introductory course, participants will be able to identify potential dust hazards and how to utilize appropriate test methods to determine levels of potential hazards; as well as apply appropriate mitigation techniques to prevent combustible dust hazards, including:

- Identifying hazard levels
- Determining appropriate methodology for hazard characterization
- Ascertaining process application and hazard mitigation

CEU Credit Eligibility: FAI is an an IACET (International Association for Continuing Education & Training) Authorized Provider. In order to be eligible for CEU credit (0.6 per course), attendees must be present for the duration of the course, score 85% or higher on the course assessment and complete the course evaluation.

Privacy: Fauske & Associates, LLC has a written policy to ensure privacy and confidentiality of participant training records and information. Training records will only be released with the expressed written permission of the participant. The participant record will be released to the participant or designated third party within 14 business days of the request.

Please direct instructor or course related questions to: Lisa Karcz: karcz@fauske.com, (630) 887-5232, Fax: (630) 986-5481

Prices: $495.00 per day or $990.00 for both days
Hotel accommodations and travel expenses are the responsibility of the participant
Fees include continental breakfast, lunch and afternoon refreshments for each day of attendance.

Location:
Fauske & Associates, LLC
16W070 83rd Street
Burr Ridge, IL 60527
(630) 323-8750

SPRING 2015 PROCESS SAFETY TRAINING COURSES

Introduction to Understanding and Controlling Flammability Hazards – Thursday, October 1, 8 am - 4 pm
Introduction to Dust Explosion Hazards, Prevention and Protection Practices – Friday, October 2, 8 am - 4 pm

REGISTRATION FORM

Course Location:
Fauske & Associates, LLC
16w070 83rd Street
Burr Ridge, IL 60527
(630) 323-8750

Trainer/Host:
Fauske & Associates, LLC
16w070 83rd Street
Burr Ridge, IL 60527
(630) 323-8750

First Name: _____ Last Name: _____

Company Name: _____ Position: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone: _____ Cell: _____ Fax: _____

Email: _____

Price:
$495.00 per day or
$990.00 for both days

Fee includes continental breakfast, lunch and afternoon refreshments for each day of attendance.
All fees must be received prior to course commencement.
We accept Visa, Mastercard, American Express, purchase order or company check.

Payment Method: _____Visa _____ Mastercard _____AmEx _____ Purchase Order _____ Company Check

Name on Account: _____

Account Number: _____Expiration Date: _____

Signature authorizing Fauske & Associates, LLC, to charge credit card:

_____

Please select which day(s) you will be attending:

☐ Day 1: Thursday, October 1 - *Introduction to Understanding and Controlling Flammability Hazards*
☐ Day 2: Friday, October 2 - *Introduction to Dust Explosion Hazards, Prevention and Protection Practices*

Hotel accommodations* and travel expenses are the responsibility of the participant

***A list of area hotels will be provided upon receipt of completed registration form**

Cancellation Policy: Cancellations will be accepted up to September 21, 2015

Contact Lisa Karcz: karcz@fauske.com, (630) 887-5232, Fax: (630) 986-5481

FAUSKE & ASSOCIATES, LLC
WORLD LEADER IN NUCLEAR AND CHEMICAL PROCESS SAFETY

www.fauske.com

FAUSKE & ASSOCIATES, LLC
World Leader in Nuclear and Chemical Process Safety

Fall 2015 Relief Systems Design Course

Thursday, October 8 - Friday, October 9, 2015

Location/Host:

Fauske & Associates, LLC
16W070 83rd Street
Burr Ridge, IL 60527
(630) 323-8750

Course Description

Unlike other emergency vent sizing courses, this curriculum highlights "hand" calculation methods; capable of giving safe – but not overly conservative – relief system designs, with an emphasis on reactive systems and the role of two-phase flow.

Benchmarking of these methods will be illustrated with incidents and available plant data. Utilization of methods and equations will be demonstrated through practical design examples; covering condensed phase (vapor, gassy and hybrid systems), as well as gas phase (gas and dust deflagrations) reactions.

Featured Speaker

Hans K. Fauske, D.Sc., Emeritus President and Regent Advisor of Fauske & Associates, LLC, served as the principal investigator and leader of the DIERS research project team. He is widely known for having developed a simple and cost-effective approach to relief system sizing, including reactive systems and two-phase flow considerations.

Curriculum

Methodology Overview
- DIERS
- API
- ASME
- NFPA

Vent Sizing Models
- Condensed Phase Reactions (Vapor, Gassy and Hybrid Systems)
- Vapor Phase Reactions (Gas and Dust Deflagrations)

Capacity Certification of Pressure Relief Valves in Two-Phase Flow
- Sizing PRV Nozzles
- Sizing Inlet Piping (3% Rule)
- Sizing Outlet Piping (10% Rule)

Runaway Reaction Classification
- Condensed Phase Reactions & Adiabatic Calorimetry
- Vapor Phase Reactions

Single and Two-Phase Flow Overview
- Vessel Behavior and Flow Regimes
- Vessel Blowdown and Vent Line Behavior
- Subcritical and Critical Two-Phase Flows

Special Topics and Examples
- Non-Reactive Fire Sizing Models for Foamy and Non-Foamy Systems
- Discharge Reaction Forces
- Effluent Control / Containment Considerations

Learning Outcomes

After completing this course, attendees will:
- Understand the up-to-date DIERS vent sizing methodologies and models, as well as the role of single and two-phase flow in venting behavior
- Perform vent size calculations using the correct models and methodologies
- Apply adiabatic calorimetry data
- Be able to use hands-on techniques and "rules of thumb" to ensure that realistic vessel and vent size conditions are specified

Price: $1,500.00 USD

- Fees must be received prior to course commencement
- Hotel accommodations and travel expenses are the responsibility of the participant
- Fees include course notes, continental breakfast and lunch for each day of attendance

Fall 2015 Relief Systems Design Course

Thursday, October 8 - Friday, October 9, 2015
8 am - 4 pm

REGISTRATION FORM

Course Location/Host:
Fauske & Associates, LLC
16W070 83rd Street
Burr Ridge, IL 60527
(630) 323-8750

First Name: _____ Last Name: _____

Company Name: _____ Position: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone: _____ Cell: _____ Fax: _____

Email: _____

Price:
$1,500.00 USD

- Fee includes course notes, continental breakfast and lunch for each day of attendance
- All fees must be received prior to course commencement
- We accept Visa, Mastercard, American Express, purchase order or company check

Payment Method: _____ Visa _____ Mastercard _____ AmEx _____ Purchase Order _____ Company Check

Name on Account: _____

Account Number: _____ Expiration Date: _____

Signature authorizing Fauske & Associates, LLC, to charge credit card:

_____

Hotel accommodations* and travel expenses are the responsibility of the participant

***A list of area hotels will be provided upon receipt of completed registration form**

Cancellation Policy: Cancellations will be accepted up to September 28, 2015
Contact Lisa Karcz: karcz@fauske.com, (630) 887-5232, Fax: (630) 986-5481

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