Testimony of Neal Langerman, Ph.D.

CEO & Principal Scientist

Advanced Chemical Safety

7563 Convoy Court
San Diego, CA 92111

Representing

The American Chemical Society

Prepared for Submission to the

Committee on Homeland Security
U.S. House of Representatives

June 16, 2009

The Chemical Facility Antiterrorism Act of 2009

Good morning. My name is Dr. Neal Langerman. I am a Ph.D. chemist and I have more than 30 years of experience in the field of chemical safety. I helped establish and run my first consulting firm, Chemical Safety Associates, in 1980 and am now the Principal Scientist and CEO of Advanced Chemical Safety, Inc., which I founded and have led since 1997. In that role, I provide training to industrial clients in all areas related to chemical management and consulting on chemical, safety, and regulatory issues.

I have authored numerous manuals, peer-reviewed publications, and reports and led seminars, workshops, and meeting symposia on topics related to chemical safety, and serve on the editorial board of the Journal of Chemical Health & Safety.

I have also worked on these issues for 20 years through my professional organization, the American Chemical Society (ACS). I am a past Chair and now the Treasurer of ACS's Division of Chemical Health and Safety and serve as a consultant to the ACS Committee on Chemical Safety.

The American Chemical Society is a scientific society of chemists and chemical engineers. It was created in 1876 and today is the world's largest scientific society with a membership of more than 154,000. It also has the distinction of having a national charter of incorporation passed by Congress in 1937 and signed by President Franklin Delano Roosevelt.

I'm here to share some of the thoughts ACS has developed on the use of Inherently Safer Technologies[i] and on the regulation of research labs.[ii]

Inherently safer industrial technologies for the production, transport, and use of industrial and agricultural chemicals, pharmaceuticals, and both commodity and advanced materials is vital to homeland security, including the protection of the public and of critical infrastructure. Achieving these goals requires research, development, and technology investments to help secure the nation's chemical infrastructure and safeguard against the consequences of a terrorist attack.

For many years, ACS has encouraged the federal government to take a leading role in developing technology. In particular, ACS has long advocated federal support of green chemistry research & development as a means to develop safer technologies. ACS has also been concerned about the role that regulations play in slowing down innovation, particularly in laboratory settings, when regulations intended for industrial settings are inappropriately applied.

While many industrial processes and sectors use various definitions of inherently safer technologies, the term collectively captures a group of processes and technologies that improve safety by greatly reducing or eliminating hazards through a permanent and inseparable element of the process. Thus, safety is built into the process from the outset, not added on, and hazards are reduced or eliminated, not simply controlled. This is not a new or recent idea. In fact, industries have applied this concept for many decades.

Many organizations involved in the chemical, pharmaceutical, and related process industries have strongly advocated and advanced inherent safety, supporting the work of professional societies and academic institutions, utilizing the concept in training chemists and engineers, and incorporating it into internal process safety management programs. Inherent safety is a well recognized engineering process concept that is based on the belief that a hazard can be moderated or eliminated, thereby reducing risk and possibly removing the risk altogether.

There is a rich literature addressing the technical aspects of IST. The publications of Dennis Hendershot[iii], for example, discuss methods of implementation as well as limitations and circumstances wherein IST may not produce the safest design. Many of the publications of the Center for Chemical Process Safety, such as "Inherently Safer Chemical Processes: A Life Cycle Approach, 2nd Edition" discuss design and operations considerations for reducing the risks associated with chemical processes. These publications and many others show that inherently safer systems and technologies can make adverse events less likely and (when an event occurs) less severe. They also show that other important factors must be taken into consideration.

IST may include engineering changes, material substitution or quantity reduction, and is only one of many approaches that may be employed to achieve risk reduction. A successful approach to changing technology in this area comes through an application of system safety analysis that extends from the top to the bottom of the organization. Designing safer systems also includes safer practices and an organizational prejudice toward safety.

Ideally, an IST approach is integrated into the original design and engineering of a process to lower operational risk. This is best done at the initial conceptual design stage, but can also be achieved by modifying existing technology. The distinction must be noted, as much of the emphasis of the Chemical Facility Antiterrorism Act of 2009 is aimed at existing facilities – some constructed several decades ago.

The chemical enterprise has considerable experience in developing and implementing inherently safer systems and welcomes creative approaches for encouraging additional IST research and development. Several recent industry association security codes require member companies to conduct vulnerability assessments of their facilities as a condition of continued membership. These codes recommend consideration of inherently safer and more secure technologies, especially during facility design, redesign, or modernization.

The proposed legislation adds a strong requirement for implementing something like Inherently Safer Technologies at facilities covered under the Chemical Facility Antiterrorism Act. However, application of IST is a complex and nuanced process. Professionals, in a real-world context, need to apply these principles and processes where appropriate. This can perhaps be appreciated through some examples.

Inherently Safer Design

It is generally thought that designing a unit to achieve the maximum inherent safety is straightforward. The design team is typically guided by the strategies of "minimize", "substitute", "moderate", and "simplify" and chooses the design which provides the best balance of process safety with production efficiency. This approach seems reasonable when one considers the meaning of the four terms. "Minimize" refers to reducing the quantities of hazardous substances to the lowest practical amount, consistent with production requirements. "Substitute" refers to using a less hazardous material. "Moderate" refers to using safer conditions, such as lower temperature or pressure. And, "simplify" refers to designing the process to reduce the potential for human and operating errors and making the unit by design more tolerant of upset conditions.

A case study recently published in the peer-reviewed *Journal of Hazardous Materials* illustrated the complexity of achieving a reasonable balance of safety and efficiency in its discussion[iv] of modifications to an existing boiler.

The facility was working to meet new environmental regulations that required the reduction of nitrogen oxides (NOx) air pollutants emitted from the boiler. A design team chose the technology to clean-up the emissions: a reactor that used ammonia gas to reduce the NOx. The initial design proposed bringing liquid ammonia approximately 600 ft through a 2 inch pipe to a vaporizer which would convert the liquid ammonia to its gaseous form. The gas would then be injected into the reactor, reducing the NOx into simple nitrogen and water vapor. Due to process safety concerns related to piping the liquid ammonia over 600 feet, the design was reviewed using the strategies of inherently safer design/technologies.

"Substitute" and "moderate" strategies were investigated to lower the overall risk. The design team proposed to replace the liquid ammonia, which is toxic if inhaled, with a less hazardous solution of ammonium hydroxide in water.

However, as the formal hazard and safety review proceeded, it was determined that the ammonium hydroxide in water option had the potential to release 7900 lbs of ammonia while the liquid ammonia process would only release 530 lbs. Further, the liquid ammonia process provided better overall operating efficiency. The design team ultimately selected liquid ammonia as the lower risk, inherently safer process, even though the initial consideration suggested this was not the "safer" alternative.

This example illustrates that deciding among several designs requires evaluating a variety of metrics, including volume of hazardous materials, area affected by and frequencies of releases, consequence and severity of releases, and the life-cycle costs. This particular review of the design options for inherently safer characteristics was conducted as part of the company's process hazard analysis. It met "management of change" requirements of OSHA's Process Safety Management standard, in which "contemplated changes to a process must be evaluated to fully assess their impact on employee safety and health."[v] However, it was not driven by the OSHA requirements.

Minimization of Hazardous Materials[vi]

While my last example illustrated the complexity of decisions about inherent safety, the next example should showcase its benefits.

A facility brought in a design team to study the replacement of a large aging bromine gas storage tank with smaller bromine cylinders. The design team was instructed to evaluate the overall hazards associated with bulk storage versus the smaller cylinders, which require increased frequency of transportation. After review, the design team recommended that the cylinders option be implemented. The existing tank had a capacity of 100 cubic feet (19,000 lbs) and was refilled once every couple of months from a 15,000 lb highway tanker. The transfer from the tanker to the storage tank was done outside, using low pressure nitrogen to drive the liquid. The bulk tank was inside a containment building, protected with a caustic scrubber.

The proposed replacement used the "minimize" strategy of IST. Two 16 cubic foot (3100 lb) cylinders of bromine, the size of helium cylinders used to fill balloons in grocery stores and parties, would replace the 1000 cubic foot tank. This would reduce the overall quantity of bromine onsite by 67%. It would require the truck to deliver a single 16 cu ft. cylinder about once per month. In addition, the quantity change resulted in the facility no longer being regulated under the U.S. EPA Risk Management Program.

The design team performed both "consequence analysis" and a "quantitative risk assessment". The results of these studies clearly supported the reduced risk approach, and the decision was made to switch to the smaller cylinders.

Unintended Consequences

Finally, I want to offer a word of caution about unintended consequences of some of the measures that may be considered in these discussions.

The draft wording of the Chemical Facility Anti-Terrorism Standards (CFATS) regulations under the 2006 law unintentionally captured most research and academic laboratories into the Top Screen process. Had this wording remained in force, much effort would have been expended by both DHS and the research community which would not have enhanced security. In cooperation with a number of organizations, including ACS, a task force worked with DHS to modify the Appendix A list and thereby reduce the number of research institutions which were required to file a Top Screen report.

ACS endorses regulations targeted specifically to research laboratories in academia, government and industry, rather than regulations that accidentally capture labs in rules developed for industrial settings. In applying regulations designed to address large-scale industrial operations to smaller laboratories, disproportionate environmental regulatory burdens are inappropriately placed on many academic, commercial, and government laboratories. By applying an industrial regulatory scheme to laboratories, unintended, ineffective, and inappropriate burdens are placed on these facilities, thus slowing U.S. innovation.

Unfortunately, substantive issues remain unresolved. For instance, the screening threshold for nitric acid, a very common laboratory reagent, requires that a campus with fewer than 50 bottles of the acid distributed among more than 1000 teaching and research laboratories scattered across a campus must file a Top Screen report, and possibly be required to implement the same security vulnerability reviews and procedures as that of a major chemical facility. The security vulnerability tools and procedures applicable to a chemical manufacturing facility are not well-suited to an academic campus. A performance model similar to OSHA's "Laboratory Standard" would be better.

These illustrations are only a few examples among many which demonstrate several issues for this Committee to consider. First, existing process safety engineering programs, performed under both regulatory and corporate umbrellas, are adequate to invoke and implement an IST approach when appropriate. Second, the implementation of one or more IST strategies at a particular process unit may or may not result in enhanced security. The only justification for implementing a technology must be in solid engineering and science. Third, the law must provide sufficient flexibility to both the DHS and the regulated community to enhance security in an efficient and effective manner.

ACS has consistently supported research and development initiatives that promote advancements in inherent safety and risk reduction. For example, ACS is a strong supporter of the Green Chemistry Research and Development Act, which has been passed by the House in the last three Congresses and is expected to be considered in the Senate this year. The Act seeks to promote green chemistry by authorizing a coordinated green chemistry research and development program at the National Science Foundation, the Department of Energy, and other agencies. Such a program would enhance green engineering, which is the practical application of green chemistry to develop simpler, more cost-efficient, and generally safer and environmentally benign processes. It also recognizes that the elimination of all hazardous industrial materials and processes is not currently feasible, but that methods to minimize the risks associated with their use can be employed.

Policy Recommendations

- ACS supports increased attention on safer technologies and believes the focus should be on a broad portfolio of timely and effective methods of reducing risk and mitigating potential damage.

The portfolio of risk reduction methods and tools should include IST and other inherent safety techniques. However, when risk analyses require replacing or significantly modifying current process technologies, considerable effort must be expended to develop, scale-up, test and install new, safer processes. Great care must be taken to ensure that the new processes do not result in inferior products or create unrecognized health, safety, or environmental impacts.

While scientists and engineers have made great strides in understanding the impacts of industrial processes and products over the past several decades, there is still no guaranteed formula for developing inherently safer production processes. In the future, chemical and related industries will benefit greatly from increased educational and professional development and training of scientists and engineers in the disciplines of green chemistry and engineering, risk analysis, and industrial ecology.

- ACS supports involvement of federal agencies in researching and facilitating the advancement of safer technologies.

Several federal agencies, including but not limited to the Environmental Protection Agency (EPA), Department of Homeland Security (DHS), the Occupational Safety and Health Administration (OSHA), actively work with the manufacturing sector to promote safer and more secure facilities. These agencies, through their collaborations and oversight of the manufacturing sector, have a keen understanding of private-sector efforts being developed and implemented to further the advancement of safer and more secure facilities. ACS believes that these agencies should support and encourage research and development – both in the public and private sector – to foster cost-effective, inherently safer chemistries and chemical processes. ACS also believes that these agencies, in collaboration with other appropriate agencies should evaluate, and where appropriate, make recommendations on potential incentives and disincentives that would best encourage the private sector to advance continued improvement in their safety and security performance. The National Research Council has made similar recommendations[vii] , stating, among other recommendations, that:

- "DHS should support research and development to foster cost-effective, inherently safer chemistries and chemical processes," and;

- "DHS should support research to determine the combinations of incentives and disincentives that would best encourage the private sector to invest in safety and security. This will require research to identify the nature of the interdependencies and weak links in the supply chain and consideration of public-private partnerships to encourage voluntary adoption of protective measures by the weakest links in the chain."

In the long term, both the public and industry will benefit from the discovery of economically viable, inherently safer technologies. The benefits to the public of safer technology are obvious. For industry, moving towards a safer industrial model will lead to lower insurance and risk costs while ensuring the safety of customers and employees and protecting investors from excessive risk. ACS also supports examination of the potential of public-private partnerships to encourage voluntary adoption of protective measures.

Conclusion

In conclusion, the existing regulatory structure, under the U.S. EPA Risk Management Program and the U.S. OSHA Process Safety Management standard, provide strong incentives to examine and implement IST. These programs work in natural conjunction with Homeland Security's mandate to enhance infrastructure security. The provisions of the Chemical Facility Antiterrorism Act of 2006 provide a sufficient legislative framework for this purpose.
The most effective steps to further infrastructure protections will likely include incentives, rather than new regulations. Tools that the government could and should invoke to this end include the following:

- Grants in support of research by universities, industry, and government to develop inherently safer and environmentally benign processes and technologies, renewable energy, fuels, and chemical feedstocks, and other research needs
- Tax incentives that encourage private investment in research and development of inherently safer technologies and processes.
- Tax incentives and patent subsidies that allow safer technologies to compete in the market, particularly when their up-front costs and risks are higher than for conventional technologies.
- Guaranteed preferential government purchasing of safer and more sustainable technologies.
- Award programs, such as the Presidential Green Chemistry Challenge Awards, that recognize businesses that incorporate sustainability and safety principles into their overall goals and objectives. Such recognition will help foster replication by others in industry.

The ACS believes that support for research guided by the principles of sustainability, green chemistry, and green engineering, combined with industrial incentives for the adoption of safer technologies and new regulatory strategies that promote safer products and processes, will be instrumental in meeting the challenges of enhancing national and homeland security, protecting human health and the environment, and strengthening the economy.

I would like to thank the Committee for the opportunity to share these thoughts here today, and I am ready to answer any questions Committee members may have. Thank you.

Testimony of Neal Langerman, Ph.D. before the House Homeland Security Committee on The Chemical Facility Antiterrorism Act of 2009. June 16, 2009.

---

i The official American Chemical Society Position Statement on Inherently Safer Technology for Chemical and Related Industrial Process Operations is presented in Attachment 1.

ii The official American Chemical Society Position Statement on Regulation of Laboratory Waste is presented in Attachment 2.

iii Hendershot, D. C. (2008). "Incorporating Inherent Safety into Process Hazard Studies." *1st Latin American Process Safety Conference and Exhibition*, May 27-29, 2008, Buenos Aires, Argentina.

Amyotte, P. R., A. U. Goraya, D. C. Hendershot, and F. I. Khan (2007). "Incorporation of Inherent Safety Principles in Process Safety Management." *Process Safety Progress* **26**, 4 (December), 333-346.

Hendershot, D. C. (2007). "Rethink Your Approach to Process Safety." *Chemical Processing* **70**, 9 (September), 36-40.

Hendershot, D. C. (2006). "An Overview of Inherently Safer Design." *Process Safety Progress* **25**, 2 (June), 98-107.

Hendershot, D. C., J. A. Sussman, G. E. Winkler, and G. L. Dill (2006). "Implementing Inherently Safer Design in an Existing Plant." *Process Safety Progress* **25**, 1 (March), 52-57.

Hendershot, D. C., and J. P. Gupta (2004). "Inherently Safer Design." Lees' Loss Prevention in the Process Industries, 3rd Edition. ed. M. S. Mannan, 32/1-32/24. Oxford, UK: Butterworth-Heinemann.

Hendershot, D. C. (2004). "Engineering Design for Safety: Inherently Safer Design." *Annual Ramazzini Days 2004, International Scientific Conference, Preventing Chemical Accidents: Lessons Learned Since the Bhopal Disaster in 1984*, October 28-29, 2004, Session IV: Advances in Preparation. Carpi, Italy: Collegium Ramazzini.

Hendershot, D. C. (2004). "Inherently Safer Design." Accident Precursor Analysis and Management: Reducing Technological Risk Through Diligence, ed. J. R. Phimister, V. M. Bier, and H. C. Kunreuther, 103-117. Washington, DC: The National Academies Press.

iv Study, K. (2007), "A real-life example of choosing an inherently safer process option", J. Hazardous Materials, 142, 771-775.

v "Process Safety Management." U.S. Department of Labor, Occupational Safety and Health Administration. OSHA 3132. 2000, 22.

vi Hendershot, D. C., J. A. Sussman, G. E. Winkler, and G. L. Dill (2006). "Implementing Inherently Safer Design in an Existing Plant." *Process Safety Progress* **25**, 1 (March), 52-57.

vii "Terrorism and the Chemical Infrastructure: Protecting People and Reducing Vulnerabilities", (2006), The National Academic Press.