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Public Comment to

US Chemical Safety and Hazards Investigation Board business meeting

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*Summary: The chlorine industry has recently announced that the predicted toxic cloud downwind travel of a large [90-ton] container of chlorine gas will be not 15 miles, as the industry previously stated in several editions of its Pamphlet 74 as late as 2012, but only .2 miles [1184 feet]. [Edition 6, June 2015] The industry has worked hard to make it widely accepted **significantly to adjust downward all our national risk assessment-based emergency response guidelines** for releases from large chlorine containers [and ultimately for many other similarly dangerous TIH containers] based on a newly developed package of theories and assumptions. They aim to modify all relevant federal guidance documents.*

The Chlorine Institute [CI] has led over the last 8-10 years a concerted but very quiet effort to try to lower the perceived risk of onsite worker and adjacent community impacts from potential large container releases of chlorine gas. But recently in June 2015 the Institute abruptly published the latest Edition 6 of its Pamphlet 74, its voluntary but authoritative industry guidance. It dramatically down-sized the industry's own longstanding previous dispersion model-based calculations of downwind travel of small and large chlorine gas container releases. For a 90-ton container, previous versions predicted releases could travel 15 miles downwind, but the latest 2015 version claims that releases would extend only .2 miles [1184 feet]. As one gas scientist exclaimed: "Looks like politics has overtaken science."

Several years ago a talented former longtime Chlorine Institute official landed in the federal DHS/Transportation Security Administration hazardous materials

office. This skillful operative carefully hand-picked and funded a set of gas modeling researchers explicitly chosen as “willing to be skeptical” of the existing gas dispersion science. And this “Gas Modeling Improvements Gang”, with federal funding, patiently coordinated over several years a rich set of communications at annual George Mason University convocations and publications from gas modelers.

The effort’s explicit aims entailed several interlocking stages:

- to “cast doubt” on the existing, broad and relatively consistent dense gas dispersion science consensus shared by practitioners of several well-known dispersion models in use nationwide
- to replace it with an allegedly more accurate model, including several new assumptions, that predict chlorine gas to be much less dangerous than earlier estimated
- to validate the new model with carefully crafted field tests
- and then, most concerning, to re-educate the whole US emergency responder community and re-write all the national guidance documents, especially those with community evacuation guidance for gas emergencies

This group is now working top-down with hand-picked national fire service officials urgently and **significantly to adjust downward** all our national risk assessment-based emergency response guidelines for on-site and off-site releases from large chlorine containers [and ultimately for many other similarly dangerous TIH containers], including the US EPA Risk Management Program guidance and the NOAA CAMEO/OLAHA model for emergency response.

The chlorine industry/DHS team over several years could not wrest any “interim consensus statement” of dramatically lowered chlorine risks from its hand-picked researchers, who often in the GMU conferences heatedly contended that this would cost them “credibility”. The Chlorine Institute board also consistently rejected, moreover, the gas scientists’ appeals for an industry-funded full-scale 90-ton field test release at the special federal test site in Nevada. Previous tests

there had provided vitally important information, if sobering bad news, for other industries field testing their disaster-risk chemicals.

So in June 2015, without waiting any longer for a new formal consensus of their gas researchers, nor for the results of the most recent large-scale 20-ton chlorine release Jack Rabbit II field test in Sept 2016, the chlorine industry threw the dice and quietly published its new Pamphlet 74.

With the basic modeling data unavailable and apparently no independent peer reviews, this stunning chlorine industry attempt at disaster “risk reduction on paper” has in fact risked the consequent serious credibility problems anticipated by its own team of gas researchers.

CSB’s accident investigations have often highlighted the alarming defects in US communities’ emergency response planning and capabilities. So the CSB should be extremely wary of dramatic risk reduction claims that could reduce even further community risk assessment and preparedness.

I urge CSB to undertake an inquiry into the likely safety impacts of this industry effort to influence so dramatically the toxic gas disaster risk perceptions of public and emergency responders, and on the certain corporate legal liability impacts. Corporate liability concerns, as esteemed former CSB Member Irv Rosenthal often reminded us, are the single largest incentive for improvements in industrial chemical safety culture and operations.

I hope the Board will:

- Convene a stakeholder Workshop broadly conceived to illuminate the issues and bring to light the underlying technical assumptions of the new gas modeling effort being relied upon
- Intervene in any and all proceedings to prevent misperceptions about the risks of chlorine releases from railcars and other large containers on facility sites, whether for feedstock use or storage

Appendix A: Aims of the Industry-Government Risk Reduction Effort

Chlorine Gas modeling My notes Risk Minz excerpts Hanna 2016 Draft 2 10 19 16

Hanna Field tests JRI Lyme Bay 2016 Atmos Env Notes

<http://www.ceoe.udel.edu/envfluids/assets/pdf/2016ae.pdf>

The Hanna et al. 2016 study was sponsored by the US DHS and the US DOD's Defense Threat Reduction Agency. [cf. Acknowledgments, p. 256]

[Hanna has long been a key expert player in the US chemical industry's use of vapor cloud dispersion models: cf. Hanna, S.R., Drivas, P.J., Chang, J.C., 1996. Guidelines for Use of Vapor Cloud Dispersion Models. AIChE/CCPS, 345 East 47th St., New York, NY, 285 pp with CD]

[In other Hanna articles he gratefully acknowledges the leadership behind the scenes of Jack Aherne, but not mentioning that Aherne is a former top Chlorine Institute staffer serving in the US DHS/Transportation Security Administration hazardous materials office.]

The Hanna et al 2016 article outlines succinctly the main aims shaping what can be seen as an ambitious corporate/government risk minimization effort:

- A. The ostensible justification for funding an extensive study of large releases of chlorine is **to inform the emergency responders [ER] community of expected size and distance of the cloud:**

"Introduction

When large amounts (on the order of 10 tons) of chlorine are released to the atmosphere as a result of railcar accidents or other causes, there is a need to inform emergency responders of the expected magnitude and extent of the hazardous chlorine cloud. Dense gas dispersion models and/or results of field experiments can be used to guide this decision process."

- B. **The Chlorine Institute [CI] board has refused for many years [against advice from its own consultants and some of the GMU conference gas modelers] to conduct a full-scale 90-ton field test of a chlorine tank car release** that could decisively test the emerging GMIG theories and assumptions. As other industries have done at the federal Nevada Test Site's LLNL-directed Liquefied Gaseous Fuels Spill Test Facility [LGFSTF].

The current study proponents never mention the counterpart full-scale field test releases, e.g., that the oil industry funded in 1987 [just post-Bhopal] at \$2 million to assess potential serious HF releases for the 50 US oil refineries using HF for alkylation. They got very bad news! Huge long releases, 5 miles downwind, completely surprising to the Amoco sponsors relying on existing dispersion models. LLNL LGFSTF 1987 Research sponsors at this site also tested ammonia, LNG and the USAF's rocket fuel N2O4.

The current gas modelers paid some early attention to ammonia gas releases, but soon dropped to a single focus on chlorine.

C. The current state of dense gas dispersion research is inadequate.

“Because of the obvious hazards, there have been very few field experiments carried out where the mass of chlorine released was more than about one ton. Model simulations are uncertain because of several physical and chemical complications such as accounting for the time-dependent two phase chlorine releases with significant rainout of aerosol drops, the dense gas slumping, the evaporation effects, and the chemical reactions and deposition.”

D. Hanna had found that previously used dense gas models are fairly consistent with each other, one might say stubbornly reporting downwind chlorine gas cloud distances to 20 pp out to about 7-11 miles, but when Hanna et al [2008] [disingenuously] pretended to apply the 6 models to the three recent real world railcar release accidents, they note a serious “discrepancy” between predictions and observed realities of the three accidents.

*“Hanna et al. (2008) showed that the predictions of six widely-used dense gas models agreed fairly well with each other (all within a factor of plus and minus three at any given downwind distance out to 20 km) for three major chlorine railcar accidents (Festus, Macdona and Graniteville). However, no chlorine concentration data were available at these sites, and a **discrepancy** existed because, although the predicted concentrations indicated significant health effects at distances out to 10 km, there were casualties only in the near field.”*

E. Ongoing US gas modeling research has been therefore investigating every plausible significant factor [deposition, etc.] that could indicate that chlorine is not as dangerous downwind as previous models and widely-distributed guidance documents have suggested:

*“As mentioned above, there are several possible causes for the discrepancies, and **they are the subject of current research**. Thus the Jack Rabbit I (JR I) field experiment was conducted in 2010, with one and two ton releases of pressurized liquefied chlorine, and concentration measurements out to distances of 500 m (Fox and Storwold, 2011). Hanna et al. (2012) and Bauer (2013) analyzed the JR I concentration observations and Hearn et al. (2013) analyzed the deposition observations.*

F. [There is no significant peer review apparent or ongoing of the major research reports from this coordinated gas modeling effort.] In general this field of research is very sparse.

G. Even though gas scientists have often expressed a need for a full scale railroad tank car release [90 tons], in part because of scientists’ expressed doubts about the scalability of results from smaller field tests to predict the behavior of large dense gas releases, the project planned nothing that large:

“The Jack Rabbit II (JR II) field experiment is planned for 2015-2016 with larger releases of chlorine (as much as 10 tons).”

Later decision was to release 20 tons in JR II. [Sept 2016]

- H. **The gas modelers group did a really wide search for additional field experimentation that might shed light on the dangers of chlorine gas dispersion .** Given its documented history of use as a war gas in WW I and its very widespread transportation through US cities for decades, and despite the no doubt heartfelt concern for the well-being of first responders on the part of Western industrial researchers, the **only research** the modelers could locate was from the UK military Chemical Defense Establishment’s **Lime Bay naval tests in 1927**, and it was **unsatisfactory** in many respects for comparison with current research protocols and standards:

“ To aid in planning the siting of JR II concentration monitors, a search was initiated for additional chlorine field observations for very large mass releases. The major additional chlorine field experiment resource in the literature is the Lyme Bay (LB), England, data archive (Wheatley et al., 1988).

The Lyme Bay releases were over water vs. land, and with poor sampling collection done by passing submarines and only 20% accurate, etc....

Nonetheless, **the modelers wrestled these two data sets into another comparative study** [not comparing models this time, only reported dispersion results, and **over-reaching even farther to pretend to be providing useful data sets** for future analysts to use:

“The current paper focuses on the combined analysis of the two field data sets.” [Jack Rabbit I and Lime Bay]

p. 254 “ ... the current analysis focusses on the observations at LB and JR I. There have been several dense gas dispersion models previously applied to the two databases (e.g., see Wheatley et al., 1988 and Ziomas et al., 1989 for LB, and Hanna et al., 2012 and Bauer, 2013 for JR I) but no models will be evaluated here. Our primary objective is to use the field experiment observations to estimate the downwind chlorine concentrations expected during the JR II field experiment, where the release masses will be 5-10 tons and the sampler arcs will extend from 25 m to 11 km. Another objective is to provide a table of LB and JR I data that is sufficient to be used by others to develop and evaluate models.”

- I. The summary by Hanna et al [2016] of the earlier small-scale releases in the Jack Rabbit I field tests was **candid in outlining [perhaps] all the ways those tests were designed to minimize the downwind travel of the chlorine gas releases:**

2.2. Jack Rabbit I

One or two tons of pressurized liquefied chlorine were released at about 7 am on each of five JR I trial days in summer 2010 at Dugway Proving Ground, Utah, USA. The experiment is described

by Fox and Storwold (2011), and three journal articles have been published on the JR I data analysis (Hanna et al., 2012; Hearn et al., 2013; and Bauer, 2013). The Hanna et al. (2012) article focusses on the concentration observations used in the current paper. JR I was intended to address worst case conditions related to pressurized liquefied chlorine releases from railcars and trucks. **Thus the hole in the tank was at the bottom and the release system was designed so that no flashing occurred before the chlorine exited the hole. The initial jet pointed downwards and a terrain depression (2 m deep with radius 25 m) surrounded the release, so as to minimize initial transport and dispersion away from the source.** The field experiments took place **at dawn**, when the ambient atmosphere was still stable, **again minimizing ambient dispersion.** Once the chlorine cloud was transported or dispersed out of the initial depression, though, its subsequent transport and dispersion was over a flat desert surface. Real-time fast response chlorine concentration samplers were located on arcs at distances 25, 50, 100, 300, and 500 m from the source. The 25 m arc was at the top of the edge of the depression. Because limited numbers of samplers were available, the samplers were sparse at the farther arcs (100 and beyond).

For the current analysis, the four chlorine trials (numbers 5, 6, 7, and 8) with 2 ton releases are used. Trial 2, with one ton released, was called a “pilot trial” and is not used in the current analysis. It was intended primarily to test the samplers and other instrumentation and improve the methodology for later trials. The peak (max) one-min averaged concentrations on several JR I downwind arcs (25, 50, 100, 300, 500 m) are used for comparison with Lyme Bay. The wind speed used in our analysis was measured at a height of 2 m. **The chlorine release occurred at a hole in the bottom of the tank, about 1 m above ground (e.g., see Fig. 1, where the release took place during a low wind (0.6 m/s) speed period and hence the dense momentum jet spreads out nearly uniformly in all directions).**” [p. 253]

p. 255 The JR I field experiments were carried out with downward pointing flashing jets and an artificially built depression. Thus the near-field cloud transport and dispersion are influenced by this unique scenario. The effects of the initial scenario are likely less important after the cloud passes the 50 m sampling arc in JR I. For larger distances, the main effect of the depression is to increase the time duration of the release (and thus reduce the effective continuous release rate Q). The LB observations extend out to 2900 m.

[p. 255-256] All of the LB and JR I experiments took place in the daytime (either early morning or the middle of the day). At night, due to the ambient vertical turbulence suppression, the vertical dispersion would be further constrained. **But due to the very hazardous conditions associated with chlorine releases, the experiment planners avoid nighttime releases.**

J. The Hanna et al. 2016 report ends [again, disingenuously] with a confidence-building assertion of “striking agreement”:

“The LB experiments are the only previous chlorine field experiments that we have discovered where the releases were the same magnitude as planned for JR II (5e20 tons). Although the

1927 LB observations **lack information** regarding the release conditions and other details, at this time there is no one to ask about the missing information. Moving ships are not the best platforms to measure concentration distributions, and deposition of chlorine to the sea surface is not measured or accounted for. Nonetheless, there is **striking agreement between the LB and JR I chlorine field experiments at far different locations and separated by 83 years in time.**" [p. 255]

[See the highly relevant 2005 observations from prominent NOAA scientist Bruce Hicks (retired) on the standards of urban dispersion modeling research:

"1 Introduction

There are many computer models that purport to describe dispersion in urban areas. Many of these yield displays that suggest confidence in the outputs that is not easily reconciled with the realities involved. With few exceptions, data to verify the accuracy of forecasts are not available. In those cases where data are available, the agreement between model predictions and reality can sometimes be poor (see Gryning and Lyck, [2]; Draxler, [1]). Often, confidence is generated on the basis of comparisons against data obtained in experiments usually conducted elsewhere, and often in circumstances selected to satisfy requirements of the models. In other words, the models are often tested in situations such that there is a good chance that there will be success. The chances that the circumstances of field tests mirror the circumstances of an actual event are slim. Hence, there is a credibility gap that needs to be addressed.

The matter is of immediate concern because of the recognized vulnerability of cities and urban areas to attacks using hazardous gases and biological agents..."

"Urban Dispersion for the 21st Century" in © 2005 WIT Press Transactions on The Built Environment, Vol 82, www.witpress.com, ISSN 1743-3509 (on-line) Safety and Security Engineering 555

<http://www.witpress.com/elibrary/wit-transactions-on-the-built-environment/82/15166>

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Chlorine Observed concentrations JR I Lyme Bay 1927 field tests url authors 2016 Atmos Env
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Highlights: Chlorine concentrations observed during two field experiments with releases of several tons are analyzed. The 1927 Lyme Bay and the 2010 Jack Rabbit I field experiments are

studied. Normalized concentrations Cu/Q decrease with distance as x1.5 to 200 m and as x2 from 200 m to 3 km. Results can be used to evaluate models and plan future field experiments.

<http://www.ceoe.udel.edu/envfluids/assets/pdf/2016ae.pdf>

Appendix B: How the Gas Modeling Improvement Gang Worked

Background: A pressurized chlorine container, if punctured, releases its contents within three minutes, forming a dense, cold deadly gas cloud 550 times bigger than the container. The dense gas cloud will clump downwind or down slope, or both, depending on the wind direction and strength, etc.

To predict such impacts, several competing dense gas models with differing assumptions and biases have long been employed by federal agencies. [cf. quote from “DCNet/URBANet” report Bruce Hicks 2006] A spending-averse Congress has long been frustrated in deciding which to fund and long sought some coordination and consistency. One problem is entrenched bias – it seems common knowledge that open-air field testing is designed to get results validating the model being “tested.” So the overall gas modeling research field has long had a major credibility problem:

DCNet/URBANet excerpt here: Bruce Hicks, NOAA 1/14/2006 ??????????

WIT Transactions on the Built Environment, Vol 82, 2005

<http://www.witpress.com/elibrary/wit-transactions-on-the-built-environment/82/15166>

Urban dispersion for the 21st century

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Abstract The threat of a terrorist attack using gaseous or biological agents has changed the focus of urban dispersion research programs... [T]here is an emerging parallel thrust to optimize the use of existing data and to provide forecasts based heavily on data assimilation... Within an urban canopy (i.e. in the street canyons) the complexity of transport through the air is such that an accurate prediction of concentrations at any specific place and time is unlikely, regardless of the proximity of accurate meteorological data. Some options are reviewed, as are currently being tested in Washington D.C. and in New York City.

Keywords: urban dispersion, emergency response,

- 1 Introduction There are many computer models that purport to describe dispersion in urban areas. Many of these yield displays that suggest confidence in the outputs that is not easily reconciled with the realities involved. With few exceptions, data to verify the accuracy of forecasts are not available. In those cases where data are available, the*

*agreement between model predictions and reality can sometimes be poor (see Gryning and Lyck, [2]; Draxler, [1]). Often, confidence is generated on the basis of comparisons against data obtained in experiments usually conducted elsewhere, **and often in circumstances selected to satisfy requirements of the models. In other words, the models are often tested in situations such that there is a good chance that there will be success.** The chances that the circumstances of field tests mirror the circumstances of an actual event are slim. Hence, **there is a credibility gap that needs to be addressed.** The matter is of immediate concern because of the recognized vulnerability of cities and urban areas to attacks using hazardous gases and biological agents...” [pp. 555-556]*

“Gas modeling is an art. Like all artists, gas modelers fall in love with their models.” --- modeling guru

A relatively consistent set of dense gas dispersion models has been in use by US agencies and companies for several years, and federal emergency response guidance has reflected their results, specifically that a chlorine release could extend many miles. Despite two federal post-Bhopal disaster Community Right To Know laws, the at-risk publics near major hazard chemical facilities have effectively never been vividly informed about the risks.

After 9/11, the US military and the new huge Department of Homeland Security funded gas dispersion modeling research to understand the risks of toxic gas releases into the 35 or so High Threat Urban Areas, which also got many millions to beef up their counter-terrorism preparedness. Some field tests involved releasing tracer gases in New York City and Washington D.C. Well-recognized problems included the complexity of urban gas release flows, e.g., through “urban street canyons” and higher overflows over buildings, and the large and pervasive uncertainties in the dispersion science.

The informal national group that might be tagged the “Gas Modeling Improvements Gang” participated in a skillfully-coordinated, under-the-radar industry-government research effort, which even won in 2015 an award for Technology Transfer [from government to industry]. Focused through a newly-established and well-funded US DHS Chemical Security Analysis Center at Aberdeen MD, the effort borrowed the legitimacy and the clout of two federal agencies who had their own reasons for wanting to minimize the risks of chlorine gas releases. The effort stimulated gas dispersion theories and field testing from US DHS and US DOD, and secured for their hand-picked researchers perhaps the largest single US pot of gas research funding ever, \$1 million-plus in DHS appropriations from Congress. [total yet to be learned]

The effort adopted the early mantra that it needed to “get the science first”, even before doing small-scale carefully crafted field gas dispersion “testing” at military facilities. Their publications hyped admittedly very skimpy actual historical chlorine accident release data [a total sample of three releases] to attempt systematically and explicitly to “cast doubt” by asserting “discrepancies” and “gaps” in the longstanding older set of relatively consistent gas dispersion models and to assert that new theories and assumptions were required. They

challenged the whole existing set of toxic gas national emergency response guidance documents as “unrealistic” and “over-conservative”.

The congenial researcher group was funded for work explicitly and studiously incorporating every conceivable risk-minimizing factor along the whole gas dispersion chain of calculations, for example, “mist pool” formation and chlorine “deposition and reactivity” factors which could reduce the downwind reach of a toxic chlorine cloud.

Even the Dugway Proving Ground set of small-to large Jack Rabbit I and II field tests in 2010 and again in 2015-2016 seem deliberately designed to minimize downwind dispersion [for example, usually directing the escaping jet of chlorine straight down into a very big hole in the ground or onto a concrete pad -- not downwind or downslope]. Their chosen test conditions are not likely to be encountered in any number of potential and much more serious real-world chlorine container releases [whether rural or urban, whether by accident or terrorism].

The military researchers even considered lowering the widely accepted standard of public protection from chlorine gas exposure – not to protect the most vulnerable in the population, but some more robust “average” population.

Appendix C: The key political context: Enormous corporate liability concerns

The underlying and wider context of this recent Chlorine Institute risk-reduction-on-paper effort is that **the chlorine industry every day gambles with the safety of at-risk chlorine facility site workers and nearby citizens**. OSHA right to know and US EPA’s Risk Management Program regulations force industry to provide information to at risk workers and citizens, but do not grant any Right to Act to communities to force industry to reduce even the highest onsite disaster risks.

The railroad producers, users and carriers of the industry’s chlorine **90-ton containers** [first loaded and then unloaded on fixed facility sites] make a similar risky gamble. And the last-named sector even testifies in Congress periodically [the American Association of Railroads] that when they route their most hazardous chemical cargoes through major cities, they are risking massive casualties and so “betting the railroad”, and with pitifully inadequate catastrophic insurance of only \$1-1.5 Billion. One may guess that the fixed facility shippers and receivers/users of chlorine gas containers also have deplorably inadequate insurance.

The chlorine industry in the 21st Century could see that **other risk-imposing industries had succeeded for decades [cf. Doubt Is Their Product, 2008]** in continuing to sell massive amounts of deadly products such as nicotine, asbestos and climate-damaging hydrocarbons by hiring a

small number of scientists to “cast doubt” on existing science demonstrating serious harms. The US Manufacturing Chemists Association [later re-named the American Chemistry Council] had begun spending in the mid-1970s some \$3-5 million to fund scientists and even more in public relations work into the 1990s to defeat the emerging scientific consensus that chlorine [from CFCs] was damaging the ozone layer. [as recounted in the Merchants of Doubt (2010), pp. 70-71, 112-118, 233].

The industries were enabled by post-Reagan politics and ill-conceived media notions of “balanced” coverage in staving off disaster prevention regulations, and keeping the public in the dark. The US chemical industry, after the 1984 Bhopal India toxic gas disaster raised public and official alarm and liability stakes, reacted strongly and largely successfully to undermine the Community Right To Know laws that Congress enacted in 1986 and 1990. They deployed from the Public Relations Department of the Chemical Manufacturers Association [later re-named the American Chemistry Council] a \$10 million/year public relations campaign called “Responsible Care” in nearly totally successful efforts to ward off real regulatory mandates for accident prevention and Inherently Safer Technologies.

Especially after the alarming 9/11 attacks in 2001, and because chlorine was known historically since World War I to be an effective war gas, the industrial use of which has many safer alternatives, **the chlorine gas industry was vulnerable to attacks in court battles and political struggles.** In many public forums, media reports and legal cases, safety advocates [including this author] highlighted the Chlorine Institute’s own longstanding Pamphlet 74 predictions of potential chlorine gas cloud release impacts miles downwind.

The industry’s avowals throughout the Gas Modeling Improvements Gang efforts that they have had at heart only the public safety interest in provision of “accurate” information to communities and emergency responders is belied by its hugely impactful refusal to support the necessity of widespread adoption of safer alternative chemicals – nevertheless, scores of US chlorine-using facilities have switched to widely available safer chemicals. [cite Orum reports for CAP]. And the industry has strongly **opposed efforts to put safe distances between even its largest 90-ton containers and at-risk High Threat Urban Areas -- in the contexts of chlorine producer and user facility siting and shipper/carrier re-routing battles** against at-risk major cities. Finally, the industry has never accepted any responsibility for providing adequate emergency response capabilities, having offloaded that burden for many decades to localities.

Appendix D: An Important and Relevant Analogy for CSB

CSB may be aware of an important situation analogous to the chlorine industry modeling effort discussed here, namely the current controversies about the ongoing US federal agency approval

processes for the siting of four newly proposed LNG export terminals that pose major hazard risks to workers and nearby communities.

Independent gas scientists from the US and the UK have strongly challenged PHMSA for utilizing consultants' proprietary new gas dispersion models which the scientists assert:

- a. Are likely to **under-predict** both onsite and offsite consequence impacts of potential Vapor Cloud Explosion accidents with **heavy hydrocarbons stored along with methane** in large quantities in the proposed export facilities
- b. As **proprietary** gas models are not accessible to independent researchers for needed evaluation and validation of the agencies' assessments and approvals
- c. **Lack therefore the needed peer reviews** to determine the models' accuracy and adequacy for the task of site approvals
- d. Are very complex and difficult for all but a few specialists to evaluate, so deny to the public any real **transparency** regarding the adequacy of the federal siting approval processes

PHMSA has been pushed successfully by the US and UK gas scientists into holding recent national stakeholder Workshops on the issues they raised with the agency. Four massive Vapor Cloud Explosion accidents, including in Buncefield UK and in Puerto Rico have prompted re-assessment of gas science estimations of the potential consequences from accidental or terrorist-caused releases in major petrochemical storage facilities.

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Explosive LNG issues grab PHMSA's attention [jenny Mandel](#), E&E reporter

EnergyWire: Tuesday, June 7, 2016 <http://www.eenews.net/stories/1060038378>

Jerry Havens Distinguished Professor of Chemical Engineering University of Arkansas

James Venart Professor Emeritus of Mechanical Engineering University of New Brunswick

Regarding the Jordan Cove Export Terminal Draft Environmental Impact Statement

Docket No. CP13-483 January 14, 2015

UNITED STATES LNG TERMINAL SAFE-SITING POLICY IS FAULTY