JACK RABBIT TRIALS I:

TRAINING VALUE ANALYSIS MEETING

Monday, February 11th – Thursday, February 14th, 2013
Saint Anthony's Parish Hall, Emmitsburg, MD

6/17/13 FINAL REPORT

PREPARED FOR:
National Fire Academy
16825 S Seton Ave
Emmitsburg, MD 21727

PREPARED BY:
Advanced Technical and Educational Consultants, Inc.
2875 Jupiter Park Drive, Suite 500
Jupiter, FL 33458

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Introduction

In April and May of 2010, the Transportation Security Administration (TSA) of the Department of Homeland Security (DHS), in collaboration with the Chemical Security Analysis Center (CSAC), sponsored a series of tests called the Jack Rabbit Trials at Dugway Proving Ground, UT. In the trials, multiple successive releases of 1 ton amounts of chlorine and anhydrous ammonia were performed in various wind and other atmospheric conditions from a standardized release container and within a standardized outside test area.

The purpose of the tests was to study and improve understanding of rapid large-scale releases (60-90 tons) of Compressed Liquefied Gases—specifically toxic inhalation hazard (TIH) gases—from a railcar.

Initial analyses of the trial test results and the recommendations made by subsequent CSAC and TSA strategy conferences on the subject suggest the need for further study to consider re-assessment of planning, preparedness, and response protocols for comparable TIH and other Compressed Liquefied Gas releases. If further study is conducted and if the findings support a re-assessment of current response protocols or a more accurate understanding of the risks and hazards that should be considered during planning, preparedness, and response, then there will also be the need for national communication and training strategies to reach the nation's response community with the new information that has been learned from the tests.

It was also recommended in these initial analyses that there is the clear need for additional tests and study to further refine our understanding of the risks and product behaviors that may be encountered in response to similar large scale TIH and other compressed liquefied gas releases. Plans for these additional tests are currently underway.

Under the guidance of TSA and CSAC, the National Fire Academy (NFA), U.S. Fire Administration (USFA) conducted a meeting of national hazardous materials/TIH/Compressed Liquefied Gas emergency response experts to make recommendations regarding the Jack Rabbit Trials findings. The meeting was held in Emmitsburg, Maryland, on February 11-14, 2013.

The 15 meeting attendees were asked to examine implications of the Jack Rabbit trials on the planning, preparedness and response procedures and guidelines used for handling major TIH and other Compressed Liquefied Gas incidents and releases. The meeting attendees were then asked to recommend national information and communication strategies to best inform the nation's emergency services community about the findings of the trials, including identifying areas impacted in the NFA hazardous materials curriculum as well as identifying training and information materials to be developed and released nationwide. Finally, meeting attendees were asked to recommend areas of further study of such TIH releases and possible supplemental test procedures and measurement approaches to be

considered for inclusion in a second round of Jack Rabbit trials currently planned for March and April 2015 and thereafter.

This is the report of the recommendations made by attendees at that meeting.

1. Review of Jack Rabbit Trials and Findings

In the meeting, a full review of the Jack Rabbit tests and subsequent data analysis was presented by Dr. Shannon Fox and Dr. Joseph Chang. A full account of these presentations is available under separate cover with restricted distribution as Appendix G of this report. Alternative written reports that also provide the full information on the Jack Rabbit tests are also available, again under controlled distribution, from the Department of Homeland Security (DHS) Chemical Security Analysis Center (CSAC), Science and Technology (ST).

The Jack Rabbit test program was conducted at Dugway Proving Ground, UT in April/May 2010, sponsored by DHS TSA, with program oversight provided by the CSAC. The purpose of the tests was to study and improve understanding of rapid large-scale releases (60-90 tons) of pressurized, liquefied toxic inhalation hazard gases from a railcar.

A significant amount of detailed information was gathered in the tests and presented in the meeting. Some of the highlights of the findings that were discussed in the presentations include:

- The highly dramatic visual account of the product behavior during initial release, which is an event stage that is usually not seen by responders.
- The occurrence of a phenomenon of spontaneous energetic releases that is tentatively called Rapid Phase Transitions during the release, which was small explosions in the initial isolation zone area that have not previously been observed.
- The detailed information on the tracking of the release dispersions and downwind concentrations that provided in some cases surprising product behavior information, such as vapor having the potential to disperse against light wind under some conditions or the degree of vertical change in lethal concentrations of chlorine.

Much of the specific findings of importance to responders are detailed below in later sections of this report. In general, initial analyses of test results and the recommendations made by subsequent CSAC and TSA strategy conferences on the subject suggest:

- The need for re-assessment of planning, preparedness, and response protocols for comparable TIH and other Compressed Liquefied Gas releases.

- The need for national communication and training strategies to reach the nation's response community with the new information that has been learned from the tests.

- The need for additional tests and study to further refine our understanding of the risks and product behaviors that may be encountered in response to similar large scale TIH and other Compressed Liquefied Gas releases.

In general, the meeting attendees felt the Jack Rabbit test findings, and the future Jack Rabbit II tests that are currently being planned, were of high importance to the nation's emergency services, and meeting attendees were very supportive of the program. The work of meeting attendees subsequent to this presentation, as documented in this report, was to provide an assessment of the relevance and importance of the specific findings to the nation's emergency response community, to recommend strategies for communicating the findings to the nation's emergency response community, and to provide recommendations for further study in the Jack Rabbit II tests that are being planned to best address the response and safety informational needs of the nation's fire and emergency services.

2. Ramifications of Jack Rabbit Findings for Emergency Preparedness, Planning and Response Communities

Meeting attendees determined that the Jack Rabbit test information of particular importance to the USFA/NFA hazardous materials and incident commander curriculum included:

- The observed spontaneous energetic release events tentatively called Rapid Phase Transitions which may have an impact on responder safety and safe action options, depending on further scientific analysis of cause;
- The extent and length of off-gassing after dispersion from soil and impacted areas and its significance for responder decisions about when it is safe to enter the initial isolation zone;
- The observed plume dispersion information and the clarification of factors affecting dispersion, and the potential impact of this information on responder calculations of downwind areas of exposure and protective action needs;
- The enhanced understanding of dispersion and area contamination supports the need of responders to use a risk-based decision-making process in determining the appropriate strategies and tactics;
- The observed level of reactivity of an oxidizer as it comes into contact with a organic material or other reactive materials, and its impact on responder assessment of risk;
- Because the data in the initial tests was inconclusive regarding isolation zones, the need for careful structuring of the planned additional Jack Rabbit tests in order to achieve more conclusive data regarding the accuracy of the current ERG guidelines that are used by responders to calculate the size of initial isolation zones;
- The confirmation of the current understanding in the response community of the dominant impact of wind and weather on dispersion patterns; and
- The dramatic graphic portrayal of initial release that is rarely seen by responders, which was deemed by meeting attendees to be very important to share in order to reinforce responder understanding of and respect for the scope of risk at such releases.

Meeting attendees recommended that the best way to assess the significance to responders for specific findings and observations from the Jack Rabbit tests was to array each of the detailed findings against the relevant stages of the General Hazardous Materials Behavior Model (GEBMO). In that way, the significance of each of the findings and observations can be assessed for their relevance to actual response decision-making and for their significance in whether they would necessitate any changes in current responder actions at the scene of a comparable release.

The stages of GEBMO are:

- **Stress**—This stage involves assessment of the types of stress/stresses applied to a container and/or its contents and their potential to cause container failure. Types of stress include thermal, mechanical and chemical stress.
- **Breach**—This stage involves assessment of the potential ways that a container and/or its closures could breach (open-up), such as disintegration, runaway linear cracking, closures opening up, punctures, and splits or tears.
- **Release**—This stage involves assessment of the speed of the release of the contents, such as detonation, violent rupture, rapid relief, and spill or leak.
- **Engulf**—This stage involves assessment of the dispersion pattern that the contents will take to create the engulfed area, such as hemisphere, cloud, plume, cone, stream, pool, and irregular dispersion pattern.
- **Impinge**—This stage involves assessment of the length of contact that exposures and exposed persons will have with the released contents in terms of duration, short term, medium term, and long term.
- **Harm**—This stage involves assessment of the likely harm due to the hazards of the released contents, such as thermal, radiation, asphyxiation, chemical (toxic or corrosive, etiologic, and mechanical.)

Meeting attendees arrayed all the findings from the Jack Rabbit I tests that were explored in the meeting against the relevant stage of the GEBMO model for hazardous materials response and evaluated each observation's significance to current response procedures and protocols. The results of that analysis and informational array are provided in this report in Appendix D.

3. Recommendations for Informing the Nation's Emergency Preparedness, Planning and Response Community

The meeting attendees discussed at length how best to communicate the findings of Jack Rabbit 1 to the nation's fire and emergency services personnel. It was felt that it was very important to reach everyone with the information as quickly as possible, but it was also cautioned that the method of information dissemination and how the message itself is framed will be critical to avoid inadvertently overstating or understating the importance of the findings. For example, it was noted that the highly dramatic effect of the visual images of the release, something rarely seen by responders, may have the potential to overly alarm and to be misinterpreted by less informed audiences, without careful messaging that is targeted correctly for the different audience groups in the emergency services and response community.

After exploring a range of information dissemination options, the meeting attendees recommended the following four step information strategy for reaching the nation's fire and emergency services audiences.

1. **Bulletin to Responders.** An immediate information bulletin should be prepared that is focused directly on the areas of interest of responders. This bulletin should be short, simple, clear and direct in terms of the practical application of the Jack Rabbit findings to response protocols; should state in responder language what has been learned and what is still unclear about risks impacting response operations; and should state clearly whether or not there are any changes to response protocols that are suggested by the findings.

   A draft of the recommended key points for this "bulletin to responders" is in Appendix C, below. In general, the bulletin should emphasize that most of the current recommended actions in the ERG are confirmed and that there are some additional potential risks that will merit further study. Some of the main points recommended by the meeting attendees are:

   - Initial isolation zone of ERG is validated.
   - Wind is validated as the dominate factor affecting dispersion. At low winds, the initial expansion from the release will be in 360 degrees. At moderate to higher winds, the expansion area will be strongly influenced by wind direction.
   - The phenomena of some movement of the vapor upwind in low wind conditions was observed and will require additional study to determine factors affecting response.
   - Responders may need to learn how to consider more complex data regarding conditions in order to better use the ERG to make correct calculations for protective actions downwind. Further

study is recommended to determine how responder assessment of additional factors such as unusual weather patterns or topography features should affect decisions about protective actions downwind.

- The phenomena of spontaneous energetic releases tentatively called Rapid Phase Transitions was observed and will require additional study to determine factors affecting risk assessment and response.

- The phenomena of longer periods of off-gassing in the initial isolation zone area was observed and will require additional study to determine factors affecting risk assessment and response.

It was recommended that this bulletin be released broadly in print and on the internet and disseminated concurrently to the fire press, to the national fire and EMS professional associations, through NFA TRADE networks to state and metropolitan fire training departments, and through USFA and through the IAB to the entire hazardous materials preparedness, planning and response communities.

2. **Fire and Emergency Services Conference Presentations.** In order to avoid the potential for misinformation (especially given the dramatic nature of some of the Jack Rabbit I visual material and given the scientifically complicated nuances in the initial findings at this stage of the program) the meeting attendees recommended that the next level of communication after the bulletin (above) would best be achieved by direct expert presentations on the findings at professional conferences.

   It was felt that the initial bulletin recommended above would reach the rank and file of the emergency services adequately with the initial, simpler information, but that the more technically schooled hazardous materials technician and command audiences would need the more in-depth information and would benefit from the opportunity for the face-to-face technical dialogue with experts that occurs in the hazardous materials conference environment.

   It was recommended that a limited group of hazardous materials response experts be selected to help represent the Jack Rabbit program to the hazardous materials community at appropriate national conferences and response community national meetings. It was recommended that a standardized presentation be prepared that the team would use and that the team be schooled as necessary to ensure consistency in message.

   The meeting attendees recommended that the standardized presentation should be a direct derivative of the program materials presented at the meeting, with the addition of script modifications to properly frame the

findings framed into the standardized hazardous materials behavior model (stress, breach, release, impingement, harm) that is used in the hazardous materials response community.

3. **Internet Information Website.** The meeting attendees strongly recommended that DHS ST CSAC create a publically accessible website on the Jack Rabbit test program that would include both searchable detail on the findings, possible dialogue or chat opportunities for the emergency services community to provide on-going comments and input into the Jack Rabbit program, and also calendars and updates regarding plans for Jack Rabbit II.

   Meeting attendees also noted that the Jack Rabbit program, especially given the plans for Jack Rabbit II, will involve an on-going series of evolving analysis and discovery. A national internet site for exchange and dissemination of information regarding such a dynamic program would allow for continuous growth and the immediate updating of information that is not possible in other information dissemination venues.

   The other audience that would benefit from access to such a site would be other agencies and organizations that could use the site to get informed about the program and possibly to find ways to support, contribute, and otherwise participate or help in the future tests.

4. **Video Program.** Meeting attendees recommended that the fourth step of information outreach be production and national dissemination of a full video on the Jack Rabbit program and findings, targeted to the emergency services but applicable to much broader audiences. It was recognized that such a production would take longer and would not provide the immediate information release of the bulletin and conference presentations described above. But the meeting attendees felt that such a production eventually would become the primary national message channel for informing the public and nation's emergency services community about the findings of the Jack Rabbit program.

   If the internet information website (recommendation above) is established, the meeting attendees felt this would be the correct dissemination vehicle for the video program, both for online viewing on the website and for downloading.

   The meeting attendees began working on a draft script for a possible video production on the Jack Rabbit I tests, targeting the information needs of emergency responders. Drafts of this scripting work are available for separate review on request.

4. Overview of Recommendations for Including Jack Rabbit Findings into USFA/NFA Curriculum and Programs

The meeting attendees assessed the relevance of the information stemming from the Jack Rabbit trials for USFA NFA hazardous materials training, and they concluded that there was important information that should be included in USFA/NFA hazardous materials and emergency services training delivered on campus at Emmitsburg and at regional and State training sites nationally.

Meeting attendees determined that the Jack Rabbit test information of particular importance to the USFA/NFA hazardous materials and incident commander curriculum included:

- The observed spontaneous energetic release events tentatively called Rapid Phase Transitions which may have an impact on responder safety and safe action options, depending on further scientific analysis of cause;
- The extent and length of off-gassing after dispersion from soil and impacted areas and its significance for responder decisions about when it is safe to enter the initial isolation zone;
- The observed plume dispersion information and the clarification of factors affecting dispersion, and the potential impact of this information on responder calculations of downwind areas of exposure and protective action needs;
- The inconclusive data generated regarding isolation zones, which suggested the need for careful structuring of the planned additional Jack Rabbit tests in order to achieve more conclusive data regarding the accuracy current guidelines that are used by responders to calculate the size of isolation zones;
- The observed level of reactivity of an oxidizer as it comes into contact with a organic material or other reactive materials, and its impact on responder assessment of risk;
- The confirmation of the accuracy of the current ERG guidelines that are used by responders to calculate the size of initial isolation zones;
- The confirmation of the current understanding in the response community of the dominant impact of wind and weather on dispersion patterns; and
- The dramatic graphic portrayal of initial release that is rarely seen by responders, which was deemed by meeting attendees to be very

important to share in order to reinforce responder understanding of and respect for the scope of risk at such releases.

Meeting attendees identified five courses in the USFA/NFA Hazardous Materials Curriculum that can meaningfully be updated to include accounts of the Jack Rabbit trials and the findings, as part of the overall outreach effort to disseminate the information to the nation's hazardous materials response and preparedness community. These courses are:

- Hazardous Materials Incident Management (R-243).
- Chemistry for Emergency Response (R-233).
- Hazardous Materials Operating Site Practices (R-229).
- Incident Safety Officer.
- Advanced Life Support for Hazardous Materials Incident Response (R-247).

The committee recommended detailed revisions and additions to each of the courses. These detailed revision recommendations are listed in full in Appendix E of this report. These recommendations for course revisions will be included in upcoming NFA curriculum revision planning and, pending USFA/NFA management approval, will subsequently be entered into the respective course production and revision cycles as part of the authoring of curriculum updates.

As part of FEMA's overall information dissemination effort for the Jack Rabbit findings, USFA and NFA will also brief appropriate Emergency Management Institute (EMI) hazardous materials and integrated emergency management program training officers on the Jack Rabbit findings summarized in this report so that appropriate areas in the EMI curriculum also at the Emmitsburg campus can be updated as well.

5. Recommendations for Further Study in Jack Rabbit II Trials

It was reported in the meeting that planning is underway for conducting a second round of test releases that are to be called Jack Rabbit II. Meeting attendees were asked to additionally recommend areas of study, supplemental data collection strategies and procedures, possible sources for support and for supplemental test equipment, and any other additions to the Jack Rabbit II tests that would help better address the informational needs of the nation's emergency services.

Tentative plans are that the Jack Rabbit II tests will occur over an extended period of time, with a first round of releases in March or April of 2015 and a second round of releases later. The second round of tests may be conducted as much as a year later, perhaps in March or April of 2016. The purpose of the time lapse between tests is two-fold: (1) it will allow time for after effects from the first round of tests to diminish so that they do not create misleading chemical interactions that might contaminate the results of the second round of tests; and (2) it will allow time for sufficient initial analysis of results of the first round of tests to determine if refinements in test conduct and test measurement procedures are needed in the second round of tests.

As currently planned, the first round of Jack Rabbit II tests will include a variety of improvements and expansions of the Jack Rabbit I effort. Some of the enhancements include:

- Providing containment systems for the releases that mimic more closely the tank car or rail car environment than was used in Jack Rabbit I.
- Providing a release system will mimic impingement situation and a non-obstructed immediate release area.
- Conducting larger volume Liquefied Compressed Gas field releases of 5, 10, and 20 tons per release.
- Conducting 24 trials, then in following year as many as 24 trials again. Number of trials is subject to test plan.
- Measuring 11-km downwind dispersion data with vertical sampling for 3-D mass-balance.
- Creating a mock urban testing environment engineered with terrain and building features.
- Collecting comprehensive source term data: two-phase flow, pooling, rainout, retention, and off-gassing.
- Performing comprehensive experimental characterization of RPT phenomenology.
- Conducting additional laboratory testing.

The meeting attendees made a large number of recommendations and suggestions for the Jack Rabbit II tests. The meeting attendee recommendations are listed below.

Study variations in factors affecting dispersion and ground absorption

It would be helpful to responders if the Jack Rabbit II tests could study with greater variety the different factors that impact dispersion. Some suggestions provided by meeting attendees include:

- Explore the impact on dispersion of different weather conditions, possibly by conducting releases in different seasons.
- Explore the impact on dispersion and ground absorption by releasing the products onto different surfaces, such as a variety of soil compositions, railbed materials, asphalt and concrete roadway surfaces.
- Explore the impact on dispersion of different types of breaches (disintegration, runaway linear cracking, closures opening up, punctures, and splits or tears) and different locations on the container (side as well as bottom).
- Explore the impact on dispersion of different Terrain variations, including water surfaces (including absorption of ammonia), slope direction, and sub-level channels.
- Explore the impact of different types of obstructions and gather data on flow changes based upon size and configuration of obstructions.

Study variations in factors affecting response operations

It would be helpful to responders if the Jack Rabbit II tests could study the impact of the TIH and related compressed liquefied gas releases on responder safety and tactical operations considerations. Some suggestions provided by meeting attendees include:

- Explore the impact of the TIH release on personal protective equipment integrity, including assessing the impact on carbon filters (for example, there is some information that at concentrations of chlorine above 10,000 ppm the carbon filters in masks may ignite because of the oxidation strength of chlorine) and possibly using mannequins with measurement instrumentation placed at different areas with different PPE to assess performance during exposures.
- Explore the impact of exposure on response equipment, including degradation of the performance of vehicles, damage to the integrity of hoses and other water supply equipment, and damage to electronic response and

communication equipment (equipment and apparatus may be available for donation for this area of study).

- Explore the viability of sheltering in place/evacuation options, including how long will the atmosphere inside a vehicle be viable, how long does it take to permeate buildings of different construction types, which are better locations within buildings (especially floor level height), and how long will a vehicle used for evacuation be safe for occupants (how long can an evacuation vehicle safely be inside a cloud as it passes through to a safer location).

- Explore the effectiveness of some proposed mitigation and protective action techniques, such as the use of inflatable tents for sheltering in place, the use of film on windows, and the use of master streams to alter direction or dissipate (example: routing the gas around a congested area).

Study the impact of releases on urban environments

It would be helpful to responders and to community emergency preparedness efforts if the Jack Rabbit II tests could better identify community infrastructure features that are particularly vulnerable to damage and degradation from a release of TIH or other compressed liquefied gases. Some suggestions provided by meeting attendees to be considered in the construction of a mock urban environment for this area of study include:

- Measure the impact of exposure to bridge construction, railroad ties, telephone poles, and other combustible public infrastructure elements.

- Measure the impact of exposure on electronic communication cables and equipment, computer system components, and electronic and power grid materials such as electrical insulators and transformers.

- Measure the impact of exposure on private dwelling construction, including plywood structures, asphalt shingles, outdoor pools, etc.

- Measure the impact of exposure on agricultural and farming environments, including crop degradation and soil damage.

- Measure the impact on vehicles, including engine damage, electric vehicle motor and battery damage, and permeable component damage.

- Measure the impact of exposure and absorption on underground sewers, pipeways, tunnels, and subways.

Recommendations for sampling and measurement instruments

Meeting attendees recommended that a comprehensive and aggressive data collection effort be made in Jack Rabbit II tests in order to effectively measure the different factors discussed above. Attendees urged the use of a wide variety of

instruments, including draeger vacutainers as well as tubes, the use of point sampling at different altitudes, the use of quadrocopters and Go pro cameras.

Appendix A:
Recommended Key Points for Bulletin to Responders

Meeting attendees discussed at length how best to communicate the findings of the Jack Rabbit tests to the nation's emergency response community.

As preamble to the findings, the bulletin should provide a brief, definitive explanation of the program. It should:

- Formally announce that Jack Rabbit occurred.
- Explain that the ERG and other resources have been based on empirical knowledge, and that Jack Rabbit has the goal of providing responders with real scientific analysis of the behaviors of the materials released.
- Explain that the studies will be ongoing and that a second round of tests is already being planned.
- Summarize the key findings of significance to responders.
- Provide directions for responders and others to get more information.

After much discussion, meeting attendees distilled the range of issues and findings into a few key points that should be initially highlighted for responders. They are:

- Initial isolation zone of ERG is validated.
- Wind is validated as the dominate factor affecting dispersion. At low wind, the initial expansion from the release will be in 360 degrees. At moderate to higher winds, the expansion area will be strongly influenced by wind direction.
- The phenomena of some movement of the vapor upwind in low wind conditions was observed and will require additional study to determine factors affecting response.
- ERG calculations for protective actions downwind may need additional critical data, and further study will be required to determine how additional factors such as how topography conditions in urban, suburban, and rural areas influence plume dispersion and behavior.
- The spontaneous energetic release phenomena tentatively called Rapid Phase Transitions was observed and will require additional study to determine factors affecting risk assessment and response.

- The phenomena of longer periods of off-gassing in the initial isolation zone area was observed and will require additional study to determine factors affecting risk assessment and response.

Some additional concepts recommended by the meeting attendees that will have resonance with the emergency response community center on grouping the information around the three ideas of:

1. Keep doing what you've been trained to do.
2. What you already know in general will be refined and better understood in further studies.
3. There are some possible new phenomena that may need your attention. "Stay tuned" as more studies are done.

An alternative array of the information that was suggested by meeting attendees divided the material into what we already know and what is new. A draft of that array is below.

(1) Validation of what responders already know:

- Initial isolation zone, consistent with ERG.
- 360 initial dispersion (can move upwind, uphill).
- Vapor density, Venturi effect of the jet is the primary driver of initial flow.
- Low wind speeds and stability can result in extended persistence.
- Terrain/obstacle trapping.

(2) The new phenomena that may be of concern:

- Rapid Phase Transitions. The meeting attendees recommended consideration of alternative labels in the bulletin to responders, such as "spontaneous energetic release." In any case, it is recommended that the uncertainty of the mechanism for this phenomenon be clearly acknowledged in the bulletin.
- Vertical concentration gradient, with the caution that it may not apply to other materials besides Chlorine.
- Off-gassing.

Additional contextual information that was discussed in the meeting and that would be of importance in communications to responders includes:

- The testing was done on two specific products because they represent 75% of the transported TIH and other Compressed Liquefied Gas hazards. Make it clear why these two are the current focus.
- Share references of incidents showing the localization of fatalities in the 250-500m range.

Appendix B:
Translation of Jack Rabbit Phenomena and Findings into the National Hazardous Materials GEBMO Model

1. STRESS: First stage of GEBMO Model

This stage involves assessment of the types of stress/stresses applied to a container and/or its contents and their potential to cause container failure. Types of stress include thermal, mechanical and chemical stress.

JACK RABBIT FINDINGS RELATED TO STRESS

The Jack Rabbit tests used a simple hole breach model that implies mechanical stress, but there was no direct exploration of stress issues in the tests. This should be considered for future study.

2. BREACH: Second stage of GEBMO Model

This stage involves assessment of the potential ways that a container and/or its closures could breach (open-up), such as disintegration, runaway linear cracking, closures opening up, punctures, and splits or tears.

JACK RABBIT FINDINGS RELATED TO BREACH

The standardized breach used in the tests was a small hole in the bottom of the container. The same breach mechanism was used in all the tests intentionally for research consistency, and there was no exploration in the tests of product behavior differences for different breach types.

Breach variations should be considered for further study. In addition to variations in breach type, further study should also consider variations in hole location and orientation (such as top or higher in relation to liquid space, versus bottom that was used in the tests) which can have an impact on release and dispersion characteristics, especially if large quantities of the product remain in the container because of hole location.

Presentation note: To demonstrate examples of other commonly encountered breaches in presentations about the tests, presenters should consider using existing pictures of incidents that are very similar in scope, such as the puncture at MacDona vs. the fracture at Graniteville.

3. RELEASE: Third stage of GEBMO Model

This stage involves assessment of the speed of the release of the contents, such as detonation, violent rupture, rapid relief, and spill or leak.

JACK RABBIT FINDINGS RELATED TO RELEASE

The release rate was standardized in the tests because the release rate was determined by the standardized breach mechanism that was used in all the releases. In an actual emergency, release rates can vary dramatically

depending upon container breach variations, which can range from pin hole with an extremely slow release to catastrophic damage with full and immediate discharge of the material.

For responders, it is important to be able to anticipate the differences in dispersion patterns that might result from different release rates and release conditions, and to correctly evaluate the safety of performing initial rescue and containment operations when release rates are such that some of the product may still be in the container or still releasing. For this reason, variations in release rate should be considered for study in future Jack Rabbit II tests.

Other factors may impact the release rate beyond the type of breach. For example, location of the breach is an important factor to consider. A hole on the side of a container may allow product below the level of the hole to remain in the container. Another characteristic impacting release rate in the release of TIH and other compressed liquefied gases is the phenomenon of auto-refrigeration when the gas is released, which can cause flash freezing in the area of the breach and a glaze of chlorine-water hydrates. Variations in the phenomenon of auto-refrigeration based upon breach variations should be considered for study in future Jack Rabbit II tests.

4. ENGULF: Fourth stage of GEBMO Model

This stage involves assessment of the dispersion pattern that the contents will take to create the engulfed area, such as hemisphere, cloud, plume, cone, stream, pool, and irregular dispersion pattern.

JACK RABBIT FINDINGS RELATED TO ENGULF

The standardization of breach and release rate and the standardized physical terrain location in the tests limited their effect on dispersion and provided good illustration of the effect of weather and ambient conditions on dispersion patterns. In the tests, wind was the dominant factor, followed by temperature and humidity variations.

In low wind conditions, the dispersion was relatively uniform in all directions, and the release created a very dramatic circular expanding dispersion cloud that was relatively slow to fully disperse.

In tests during higher wind conditions the dispersion followed wind direction and material dispersed much more quickly downwind.

The limited terrain differences and obstacles present in the tests had very minor impact on the dispersion pattern, but nonetheless suggested that terrain and obstacles can have an important effect, and that material flow interaction with different terrain feathers should be further studied and examined.

There were observations of significant vertical differences in the concentration profile within the dispersion cloud, with concentrations lessening as measurements moved upward. These vertical differences in concentration can present important safety and hazard condition information for responders and need to be studied much more fully in subsequent tests.

Finally, there were inconclusive findings regarding the consistency of downwind dispersions in the tests with the dispersion estimates and calculations commonly used in the response field. It is possible that current procedures responders use are fine, or it is possible that responders may need to learn how to consider more complex data regarding conditions in order to better use the ERG to make correct calculations for protective actions downwind. Further study is recommended to determine how responder assessment of additional factors such as unusual weather patterns or topography features should affect decisions about protective actions downwind.

5. IMPINGE: Fifth stage of GEBMO Model

This stage involves assessment of the length of contact that exposures and exposed persons will have with the released contents in terms of duration, short term, medium term, and long term.

JACK RABBIT FINDINGS RELEATED TO IMPINGE

The Jack Rabbit I tests provided important observations about the length of contact that exposures and exposed persons might have with TIH and other compressed liquefied gases after a release of the form and type used in the tests. These included important observations of the persistence in chemicals in the area and soil after the initial cloud dispersion that have the potential for impact on responder decision-making and operations.

Notable ammonia bubbling and off-gassing of permeated/absorbed chemical was observed for a considerable time after the vapor cloud was dispersed, especially in the releases that occurred in low wind conditions where the cloud was resident in the area for a longer period of time. This is an important consideration for responders entering the area for operations after dispersion of the cloud, because disturbing the soil can result in releasing permeated gas, and can potentially result in a secondary cloud evolution. In addition, the spontaneous releases tentatively called Rapid Phase Transitions that were observed may present further risks after the initial cloud dispersion. Further study should be conducted in the Jack Rabbit II tests of degree of absorption and subsequent release of chemicals in different soils and conditions with an effort to measure the variations sufficiently to provide more informed reference for future responder decision-making regarding the safety of entering the release area.

6. HARM: Sixth stage of GEBMO Model

This stage involves assessment of the likely harm due to the hazards of the released contents, such as thermal, radiation, asphyxiation, chemical (toxic or corrosive, etiologic, and mechanical).

JACK RABBIT FINDINGS RELATED TO HARM

The Jack Rabbit I tests measured the dispersion and engulfing of the ammonia and chlorine releases conducted in the tests, but did not measure the impact of the release or evaluate potential damage to life and property stemming from contact with the released material. There may be opportunities in the Jack Rabbit II tests that are being planned to perform some useful studies in this area.

TIH and other Compressed, liquefied gas hazards have known hazards and dangerous physical properties. In addition to the primary hazard classifications, many will also have specific additional hazards beyond liquefied gas general hazards (i.e., explosive, flammable, corrosive, etc.).

Most of these hazards have been extensively studied and measured and may not merit further examination in the Jack Rabbit II tests. But there are some variations in harm and hazard that should be explored in the future Jack Rabbit II tests. These areas include measuring the impact of contact with the released material on equipment, vehicles, building materials, and facilities, measuring the variations in toxic load and dosages in downwind dispersion areas, and measuring the potential that the vapor cloud may be super-cooled below boiling point (as low as minus 70 degrees centigrade) and the effects (flash freezing, cloud density, etc).

Appendix C:
Detailed Recommendations for Inclusion of Jack Rabbit Findings into USFA/NFA Curriculum and Programs

The committee identified five courses in the USFA/NFA Hazardous Materials Curriculum that can meaningfully be updated to include accounts of the Jack Rabbit trials and the findings, as part of the overall outreach effort to disseminate the information to the nation's hazardous materials response and preparedness community. These courses are:

- Hazardous Materials Incident Management (R-243).
- Chemistry for Emergency Response (R-233).
- Hazardous Materials Operating Site Practices (R-229).
- Incident Safety Officer.
- Advanced Life Support for Hazardous Materials Incident Response (R-247).

The committee recommended detailed revisions and additions to each of the courses, as listed below. These recommendations for course revisions will be included in upcoming NFA curriculum planning and subsequently, pending USFA/NFA management approval, entered into the course production and revision cycles. As part of this information dissemination effort, NFA will also brief appropriate Emergency Management Institute (EMI) hazardous materials and integrated emergency management program training officers on the Jack Rabbit findings summarized in this report so that appropriate areas in the EMI curriculum can be updated as well.

Hazardous Materials Incident Management (HMIM)

The best fit is in unit 3, in the area of decision-making. There is an area that discusses risk-based response, specifically the facts, science and circumstance of the incident.

An option would also be to introduce the course with the information, but there is already an introduction scenario.

Recommendation is that it be conducted as a discussion-based activity at the end of the chapter, outlining that even the best science is still not 100 percent accurate. The situation may change during the incident, and the Incident Commander must continue to look at data and continually update their situational awareness as more information becomes available.

Incident Safety Officer

Unit 5 appears to be the best place because that unit has a hazardous materials component and terrorist attacks.

Slides 5-19, 5-22, 5-23

Safety at selected incident sites; the current course speaks to uphill and upwind. This would be a place to mention that under specific wind conditions the hazardous cloud could move uphill and upwind. It could be changed to Haz Mat/WMD for the title and add at terrorism.

Components to include would be:

Spontaneous energetic releases or Rapid Phase Transitions

Off-Gassing

Plume dispersion piece/initial zones may not be safe

The current accepted tactics and strategies may not be appropriate under unique conditions. The safety officer's job is to be aware of those specific hazards.

Chemistry for Emergency Response

Best fit is in Unit 8, Physical and Chemical Properties.

Discussion would be based around the science and specifically what is happening. The spontaneous energetic releases, or Rapid Phase Transitions, are a great part of the discussion as well as the compressed gas phenomena. Also a great part of the discussion would be the reactivity of the oxidizer as it comes into contact with an organic material or other reactive materials.

Recommend that it be conducted as an activity. There are three activities in this unit; one of the activities could be replaced. Liquefied gas should be part of the discussion.

Hazardous Materials Operating Site Practices

Possible areas were considered for inclusion of the material in this course: Unit 2, Unit 4, Unit 8 or Unit 10.

The group felt that one consideration for the material would be in Unit 4, activity 4.1 is Physical Properties/Rapid Assessment Rapid Hazard. This existing activity could be replaced.

Protective Action Criteria is a term that should be used instead of Initial and Secondary Public Protection Actions. There should be a review of how the terms are used in Unit 8 and 10.

Recommend that the material is best placed at the end of the isolation section lecture of Chapter 8, before activity 8.1.

Recommend that the terms also be standardized to reflect verbiage used in the Emergency Response Guide, i.e., Initial Public Protection, and Secondary Public Protection be replaced with Protective Action Criteria or the verbiage out of the ERG.

Advanced Life Support for Response to Hazardous Materials Incidents

The best fit for this course is in Unit 7. This is the Inorganic Non-Salts unit where things like Ammonia and Hydrogen Fluoride are discussed. Although it is not a perfect fit, it is the appropriate place to discuss the toxicity of these gases. Need to add a discussion on how gases are liquefied for shipment and the hazards of liquefied gases.

Since this course is currently under revision, it is the group's recommendation that the new information from Jack Rabbit should be utilized in writing the new course.

Appendix D:
Meeting Agenda and Work Schedules

Agenda

Background

The Jack Rabbit test program was conducted at Dugway Proving Ground, UT, in April/May 2010, sponsored by DHS TSA, with program oversight provided by the Chemical Security Analysis Center. The purpose of the tests was to study and improve understanding of rapid large-scale releases (60-90 tons) of pressurized, liquefied toxic inhalation hazard gases from a railcar.

Initial analyses of test results and the recommendations made by subsequent CSAC and TSA strategy conferences on the subject suggest the need for re-assessment of planning, preparedness, and response protocols for comparable TIH and other Compressed Liquefied Gas releases, the need for national communication and training strategies to reach the nation's response community with the new information that has been learned from the tests, as well as the possible need for additional tests and study to further refine our understanding of the risks and product behaviors that may be encountered in response to similar large scale TIH and other Compressed Liquefied Gas releases.

Meeting Goals

1. Review Project Jack Rabbit I field test results and the analysis of the field test results.
2. Assess possible ramifications of the test and test results on current planning, preparedness and response protocols for large scale TIH and other Compressed Liquefied Gas releases.
3. Develop national communication and training strategies to best reach the nation's emergency preparedness, planning and response communities with the new information, including specific recommendations as appropriate for NFA and other federal hazardous materials training partners. These strategies should be consistent with the strategic communication priorities previously developed by CSAC and TSA for this program.
4. Develop recommendations for consideration regarding the further tests and study that might be needed to refine our understanding of TIH and other Compressed Liquefied Gas large-scale releases and to develop revised response and planning protocols and procedures.

Meeting Work Schedule

Day / Time	Agenda Topic
Day 1, Mon., Feb. 11	
9:00 am	Wayne Yoder, NFA Hazardous Materials Training Specialist presents a brief orientation to Project Jack Rabbit and the reason for this meeting.
9:10 am	Participant Introductions
9:15 am	Shannon Fox, PhD presents an overview of the Jack Rabbit project and the Jack Rabbit 1 field tests.
11:30 am	Lunch
1:00 pm	Dr. Joseph Chang presents an overview of Jack Rabbit 1 field test methods and quantitative results.
2:00 pm	Break
2:15 pm – 4:00 pm	All participants discuss ramifications of Jack Rabbit 1 field test results for emergency preparedness, planning, and response protocols.
Day 2, Tues., Feb. 12	
9:00 am	All participants discuss communication strategies for reaching the nation's emergency preparedness, planning, and response communities.
10:30 am	The group conducts a focused discussion to distill Jack Rabbit 1 field test findings into a discrete list of implications relevant to emergency preparedness, planning, and response protocols.
12:00 pm	Lunch
1:00 pm	All participants develop a list of possible venues and associated points of contact for distribution of a consistent, standardized set of information on Jack Rabbit I findings via the hazardous materials conference circuit.
2:30 – 4:00 pm	All participants develop a list of recommendations for experimental methods and areas for further study in Jack Rabbit II trials.

Day / Time	Agenda Topic
Day 3, Wed., Feb. 13	
9:00 am	Breakout Sessions Group 1 reviews NFA's courses within the hazardous materials curriculum to identify locations within course content where insertion of Jack Rabbit information would be appropriate. Group 2 conducts an open discussion to review and refine the recommendations for experimental methods and areas for further study in the Jack Rabbit II trials. This discussion also served to debrief participants who were absent on Day 2 of the meeting and to provide the opportunity to solicit their input.
12:00 pm	Lunch
1:00 pm – 4:00 pm	Breakout Sessions (continued) Group 1 develops a draft storyboard for the video. Group 2 further refines the plan for controlled distribution of a standardized message to the hazardous materials response community.
Day 4, Thurs., Feb. 14	
9:00 am	Groups 1 and 2 report out on breakout session outcomes.
11:00 am	Meeting adjourns

Appendix E:
Meeting Participants

Andy Byrnes	Utah Valley University	byrnesan@uvu.edu
Dr. Joseph Chang	HSSAI	joseph.chang@hsi.dhs.gov
Rick Edinger	Chesterfield Fire Rescue	edingerr2u@hotmail.com
Shannon Fox, Ph.D.	DHS/ST/CSAC	shannon.fox@st.dhs.gov
Susan Hernandez	DHS/FEMA/USFA/NFA	susan.hernandez@fema.dhs.gov
Shelly Kent	ATEC, Inc	skent@atec-md.us
William Lewis	ATEC, Inc	blewis@atec-md.us
Mark A. Maday	Union Pacific RR	mmaday@up.com
Dave Mathew	ATEC, Inc	dmatthew32@aol.com
Jack McCartt	ATEC, Inc	jmccartt@atecflorida.us
Greg Noll	Hildebrand & Noll Associates / South Central (PA) Rgional Task Force	ggnoll@me.com
Frank Reiner	The Chlorine Institute	freiner@cl2.com
William Schoonover	DOT	william.schoonover@dot.gov
Charles Wright	Union Pacific RR - Retired	cjw19@cox.net
Wayne Yoder	DHS/FEMA/USFA/NFA	wayne.yoder@fema.dhs.gov

Brief Resume Summaries of Meeting Attendees

The following brief summaries of the background of the meeting attendees are provided in this report because of requests from readers who wished to be apprised of the technical and expertise backgrounds of the participants. It should be noted that the recommendations in this report are additive, not consensus, and it is important to acknowledge that these brief resume summaries are NOT intended to suggest that the parties or organizations represented concur with all of the additive recommendations and observations in this report.

Andy Byrnes retired after 21 years of service as a Special Operations Battalion Chief from the Orem Utah Fire Department. He was also a sworn Law Enforcement Officer for 18 years and a certified Paramedic for 16 years. He is currently an Assistant Professor and Instructional Designer for Utah Valley University (UVU), Emergency Services Department/Institute of Emergency Services and Homeland Security – Utah Fire and Rescue Academy in Provo, Utah. He has led development teams in the reorganization and rewriting of the new Apparatus Driver Operator – Pumper and Aerial courses for the Academy. He has also led the development of the new Hazardous Materials Awareness, Basic Operations, WMD Operations, Hazmat Technician, Building Construction, and Fire Officer I & II courses. He is the curriculum designer and lead instructor for the Incident Command Training Center (CTC) at the Institute featuring virtual and simulated incident management and command training scenarios. As an Assistant Professor, Andy is the Director of the Recruit Candidate Academy program for entry level firefighters. He is an experienced Emergency Services Instructor working for local, state, and national Fire/EMS and Law Enforcement organizations to include the Office of Domestic Preparedness, the National Fire Academy in Emmitsburg, Maryland, and the FBI Academy in Quantico, Virginia. He is also a consultant/instructor for the Defense Threat Reduction Agency, Counter Proliferation Programs; WMD Response; Crime Scene Operations; Border Protection; and Multi-national exercises in nine Eastern European and former Soviet bloc countries. He has taught Hazardous Materials Operations courses in Singapore and has been a keynote speaker at the Saudi Arabian Fire Protection Engineering conference in Dhahran, Saudi Arabia. He has reviewed and contributed to several textbooks related to Hazardous Materials/WMD response, and he is a frequent course reviewer and subject matter expert in the areas of Hazmat and Firefighting Leadership and Management. Andy is a graduate of the National Fire Academy's Executive Fire Officer Program. He holds an Associate degree in Fire Science, a Bachelors degree in Public Emergency Services Management and a Master's Degree in Instructional Technology from Utah State University.

Rick Edinger is an assistant fire chief with Chesterfield County Fire and Emergency Medical Services (CFEMS), a metro-sized all-hazards department in central Virginia. Chief Edinger is a hazardous materials technician and is a member of the CFEMS Hazardous Incident Team. He currently serves as the vice-chairman of the International Association of Fire Chiefs (IAFC) Hazardous Materials Committee and

represents the committee on the Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents (NFPA 472). He also serves as president of the Virginia Association of Hazardous Materials Response Specialists. Chief Edinger holds a Bachelor of Science degree in fire science technology and is a graduate of the National Fire Academy's Executive Fire Officer Program.

Susan M. Hernandez, Instructional Systems Specialist, National Fire Academy, Response Section. Responsibilities include directing course development and revision projects, guidance to program managers for educational and instructional design planning and concepts. Other responsibilities include project management for education and training activities that affect training developments, research in advanced technologies and techniques affecting the changing environment of training design and delivery and evaluation/assessments for ongoing training activities. Education: B.A. in English/History; certification in Secondary Education with concentration in French Literature and linguistics; M.Ed. in Educational Psychology with psychometrics certification. Employment history: Teacher of K-12 students enrolled in the Home-Bound Education program for physically and emotionally disabled students of Fauquier County, Virginia; Behavioral Science Specialist, with the Army ADAPC program (Active Duty, various locations); Administrative Assistant to the Dean of Peter's Creek/Chugiach extension campus, University of Alaska, Anchorage; Department of Defense ASVAB Test Specialist for the District of Columbia Region; Education Specialist with the Field training and Coordination Division and the Support Systems Branch of the Emergency Management Institute, FEMA.

William Lewis is an instructional designer and curriculum analyst for ATEC. Mr. Lewis is a retired federal officer after 35 years with the National Fire Academy and Emergency Management Institute, FEMA. His work experience includes over 15 years as the senior training advisor and national co-chair of the Training Committee for the National Response Team with a special lead role in federal hazardous materials, WMD, and NIMS ICS curriculum management, concurrent with over 25 years experience as an instructional designer, supervisor and administrator developing courses and supervising staff responsible for developing over 100 courses for the National Fire Academy and the Emergency Management Institute, and also concurrent with over 15 years performing senior policy and training advisory roles for the U.S. Fire Administration, the previous FEMA Office of Training, and other FEMA offices involved in NFA and EMI curriculum. Awards include several CineEagle awards for federal training films, the IAFC Level A award for career federal work in hazmat/WMD training, the Dept. of Agriculture career training award for the design and implementation of NFA's national field training curriculum, and a number of art director awards for private sector training films and commercials.

Mark A. Maday is Manager – Hazardous Materials Management, for Union Pacific Railroad. His present responsibilities for Union Pacific include DOT/FRA/PHMSA

hazardous material regulation compliance, development and implementation of hazardous materials training programs, and hazmat/incident response. Mark also currently serves on the Association of American Railroads (AAR) Hazmat Committee and Non Accidental Release (NAR) Committee and chairs several task forces for those committees. Additionally, he also serves on the Renewable Fuels Association (RFA) Safety Committee and has been appointed to the Nebraska State Emergency Response Commission (SERC). Prior to taking his current position with Union Pacific, Mark served as a Manager – Hazmat-Field from November 2003 until October 2009 covering UP's Chicago Territory. That territory consisted of the states of Illinois, Wisconsin, Minnesota, and Northern and Eastern Iowa. Prior to joining Union Pacific in 2003, he worked for Del Monte Foods as Transportation Manager – Central States Distribution from 1996 – 2002. Prior to joining Del Monte, he was a Captain in the US Army/US Army Reserve with qualifications in Nuclear, Biological, and Chemical warfare, and Logistics. He is certified as a technician-level hazardous material emergency responder and holds a B.A. degree from Northeastern Illinois University.

David Matthew has 27 years of fire service experience in Kansas and most recently in California. Matthew earned a Master degree in Security Studies from the Naval Postgraduate School. He earned a Bachelor's Degree in General Studies from Wichita State University (WSU). He graduated from the National Fire Academy (NFA) Executive Fire Officer Program (EFOP) and has attained the Chief Fire Officer (CFO) designation from the Center for Public Safety Excellence (CSPE). He completed the Incident Command, Hazardous Materials, and Instructional Methodology curriculum at the NFA as part of over 5,000 hours of training. Matthew has delivered over 5,000 hours of training to responders in 34 different states and three countries. He is a current instructor and developer for the Incident Management and HazMat/WMD curriculum. Course development activities include complete HazMat Technician courses for state agencies and specific modules in numerous other courses. Matthew serves as a Subject Matter Expert (SME) for the Department of Homeland Security (DHS) conducting course reviews. In addition, he participates as a developer and evaluator for major exercises including Urban Shield 2012.

Jack McCartt has over 25 years of Fire and EMS service experience in Tennessee and Florida. He rose through the ranks to Deputy Fire Chief at Boca Raton Fire Rescue Services, Boca Raton, FL. He later served in the position of Fire Chief for the Dania Beach Rescue Service, Dania, FL. While working as a Firefighter in Palm Beach County, Chief McCartt served as the Fire Academy Director of South Technical Education Center, Fire Academy as well as instructing many programs throughout the State of Florida and across the United States. During his tenure at Boca Raton Fire Rescue he co-developed the Palm Beach County Haz Mat Technician Program. Since retiring from the fire service Chief McCartt serves as the government program coordinator for Advanced Technical and Educational Consultants, Inc. He has developed and instructed courses for the USFA/National Fire Academy, along with the Department of Defense, Department of Justice and the Department of Energy,

with most course design, development and delivery in the Hazardous Material/Terrorism/EMS curriculum area. He has also developed and delivered over one hundred Fire Assessment Centers. Chief McCartt is currently a Florida certified Firefighter, Fire Officer, Paramedic, Fire Instructor III and Fire Inspector. He holds a Bachelor of Health Sciences from Nova University, Ft. Lauderdale, FL.

Gregory G. Noll has forty-two years experience in emergency response and occupational safety and health. During his career, he has served as the Hazardous Materials Coordinator for the Prince George's County (Maryland) Fire Department, as Fire and Safety Associate with the American Petroleum Institute in Washington, D.C., as a faculty member for the Iowa State University, Fire Service Institute, and as a career firefighter with the Reading, PA Fire Department. Mr. Noll is presently a senior partner with Hildebrand and Noll Associates, Inc., a consulting firm specializing in operations security, incident and crisis management and hazardous materials emergency response, management and training issues. In addition, he is Program Manager for the South Central Task Force, an eight-county regional Pennsylvania task force covering a population of 2 million and is responsible for the day-to-day management of the task force. Mr. Noll also serves as the senior Hazmat Manager for PA Task Force-1, one of the 28 federal urban search and rescue teams, and responded to both the World Trade Center attack and the Hurricane Katrina disaster. A Certified Safety Professional (CSP), Certified Emergency Manager (CEM) and an experienced educator, Mr. Noll has served as a college instructor and as an adjunct faculty member for the National Fire Academy and the FBI HazMat Response Unit. He has served as a panelist on several national teleconferences in the hazardous materials and emergency management field, as well as an on-camera narrator for over 30 hazmat training videos, and has testified at OSHA public hearings on hazardous materials and emergency response issues. In 2010, Greg and Mike Hildebrand were the recipients of the California Continuing Challenge William Patterson Lifetime Achievement Award for their "lifetime" of commitment and sacrifice in creating and promoting innovations and achievements in the hazardous materials response and training community. In 2011, Greg was honored by the International Association of Fire Chiefs (IAFC) as the recipient of the John M. Eversole Lifetime Achievement Award for his leadership and contributions to further and enhance the hazardous materials emergency response profession. He recently retired after twenty-nine years of service with the U.S. Air Force Reserve, and has served as a subject matter expert for various DOD hazardous materials and counter-terrorism response training programs. He is the co-author of nine hazardous materials textbooks, including *Hazardous Materials: Managing the Incident* (4^{th} edition), and has published over fifty journal articles on fire service and hazardous materials related subjects. Mr. Noll serves on a number of several national committees, including as chairperson for the NFPA Technical Committee on Hazardous Materials/WMD Response Personnel (NFPA 472), as a member of the IAFC Hazardous Materials Committee, as State and Local Co-Chair for the InterAgency Board (IAB) for Equipment Standardization and Interoperability – Training and Exercise Subgroup, and the Editorial Advisory Board for *Fire Engineering*

magazine and the Fire Department Instructors Conference. Mr. Noll has an M.P.A., Public Administration, Iowa State University; B.S., Business Administration, Kutztown University of Pennsylvania; A.A., Fire Science, Prince George's College, Largo, Maryland.

Frank Reiner has been President of the Chlorine Institute since June of 2010. In this role he is responsible for day-to-day operations in all of the Institute's areas of activity. The Institute's activities are focused on improving safety and security performance in production, distribution and use of chlor-alkali chemicals. Frank joined the Chlorine Institute as Vice President of Transportation and Emergency Preparedness in October, 2005. He was responsible for facilitating Institute task groups by working to meet the challenges to chlorine transportation and promoting effective emergency preparedness. He has represented the Institute as a member of several industry groups including the Association of American Railroads Tank Car Committee, the Federal Railroad Administration Rail Safety Advisory Committee, and the Next Generation Rail Tank Car Project External Advisory Panel. Prior to joining the Institute, Frank was employed by Union Tank Car Company as Director, Shop Operations. Frank began his career in the rail industry at Union Tank Car in 1989 as a project engineer focusing on stress analysis. He held various technical positions including Chief Product Engineer at Union Tank Car prior to joining UTLX's Shop Operations group in 2001. Frank has a Bachelor of Civil Engineering Degree from the Illinois Institute of Technology and a Master of Science in Management from Purdue University and is a registered professional engineer.

Charles J. Wright retired from the Union Pacific Railroad Omaha, NE in 2009 as the Manager, Hazardous Material Training. He was employed by Union Pacific since 1979. During this time he developed, implemented, and administered hazardous materials training programs (regulatory and response oriented) for employees and local emergency response personnel; consulted with regulatory and response agencies on hazardous material issues; and responded to rail emergencies involving hazardous materials. He worked with National Fire Academy to develop Recognizing and Identifying Hazardous Materials and Hazardous Materials Incident Response programs. He earned his Bachelor of Science in Education at the University of Maryland, College Park, MD Emphasis: Education for Industry, Fire Protection Engineering, and Business Administration. In 1978 he earned his Master of Science in Education: Emphasis Industrial Technology, Curriculum Development, and Educational Technology. He is a life member of the National Fire Protection Association since 1960, and from 1989 to present he has served on the FNPA Technical committee on Hazardous Materials Response Personnel.

Wayne Yoder is a Training Specialist/Program Manager for the Hazardous Materials/Weapons of Mass Destruction and Responder Health and Safety programs at the National Fire Academy (NFA). The NFA is an element of the United States Fire Administration (USFA)/FEMA/DHS. Wayne is a member of the NFPA Hazardous Materials Response Personnel Technical Committee overseeing NFPA 472 and 473.

Wayne is also a member of the ASTM E54 Homeland Security Committee. Wayne has been involved with the Target Capability and NIMS Resource Typing and Credentialing development effort associated with HSPD 5 and HSPD 8 implementation. Wayne is a member of the Interagency Board for Equipment Standardization and Interoperability where he currently serves as the Federal Co-chair of the Training and Exercise Subgroup. He is a member of the National Response Team Training Subcommittee. Wayne has over 35 years of Fire, EMS, and Special Operations experience at all levels. He coordinated development and management the Delray Beach Fire and Rescue Department's Hazardous Materials and Special Operations Response Program. Wayne retired with over 21 years of service with the Delray Beach Fire Rescue Department, Florida, when he moved to serve the Nation's citizens at the USFA.