

THE INCIDENT SAFETY OFFICER'S CRITICAL ROLE IN RESPONSE OPERATIONS

A Study of the Graniteville Train Wreck and Chlorine Gas Release

Susan M. Smith EdD, MSPH

*The University of Tennessee U.S.A.*¹

Barbara Scott, BS

*The University of Tennessee U.S.A.*²

Key Words:

Chlorine Gas, Train Accident, Technological Disaster, Risk Reduction, Emergency Response

Abstract:

The following paper provides a description of the January 6, 2005 night time train collision in Graniteville, South Carolina in the United States. This collision resulted in the derailment and breach of tanker cars of chlorine and the release of a cloud of chlorine gas. The exposure of industrial workers, residents and emergency responders to toxic levels of the chlorine subsequently resulted in nine fatalities and the treatment of 500 individuals for various levels of exposure to the chlorine gas. The cloud of gas traveled through portions of Graniteville and the Avondale Mills manufacturing facility. An analysis of the critical response actions affecting the safety of emergency workers during the response phase of the Graniteville incident will be provided in this paper. The problems that arise when no site incident safety officer is designated at the beginning of the response phase of a chemical emergency will be outlined. A description of the incident safety officer's role in actions such as the designation of the hot zone and exclusion zone, the establishment of emergency evacuation routes and warning systems, specific standards for exposure monitoring and the development of a site safety plan will be presented. Future actions to reduce the risk to responders during the response and recovering phases of a complex technological disaster such as the one that struck Graniteville will be recommended.

Introduction

On January 6, 2005 early in the morning at 2:40 a.m. a freight train collided with a second stationary train also carrying freight and resulted in the release of chlorine gas and other toxic chemicals. The second train operated by the same national railroad system was on a rail spur or siding. This collision occurred within the town of Graniteville in South Carolina is a town near the Georgia state border. The cause of the wreck was a switch being left open directing

¹ Susan M. Smith Ed.D, M.S.PH., Associate Professor of Safety and Public Health, and Director of the UT Safety Center, The UT Safety Center, 1914 Andy Holt Avenue, Knoxville, TN., 37996-2710.
smsmith@utk.edu (865) 974-1108

²Barbara Scott, BS, A candidate for the Masters in Safety degree with a concentration in Emergency Management from the University of Tennessee

second train onto the same side rail occupied by the first train. If the switch had been properly closed the two trains would have been prevented from traveling on the same track. The train collision occurred in Graniteville a small town of 7,000 residents near the larger town of Aiken South Carolina and 20 km north of the Department of Energy's Savannah River Nuclear Site. (Buckley et.al.2007, Priest et. al. 2006, Hajer, M. et al 2005)

The train collision occurring in the middle of the night resulted in the derailment of tanker cars transporting industrial chemicals including liquefied chlorine being punctured. When a tanker car ruptured deadly chlorine gas was discharged rapidly into the atmosphere and covered low lying areas. of the town. Chlorine gas becomes a dense heavy toxic cloud when it is released from a container such as a tanker car into the atmosphere and because it is heavier than regular air it moved down into the shallow valleys and low areas. The initial discharge of chemicals from ruptured tank cars produced a heavy dense cloud of aerosols and toxic gas. As more chlorine gas was released the chlorine cloud rapidly spread engulfing an adjacent textile mill with 500 employees and moving rapidly into adjacent residential areas of town. Several mill employees who attempted to leave the mill by car and/or call from pay phones near the parking lot to get help directly after the train wreck were over come by fumes and died. Those mill workers who climbed to the top floor of the mill as directed by a fellow worker who understood that most toxic gases were heavier than air survived. (Henry et al. 2005, Buckley et.al.2007, Priest et. al. 2006, Hajer, M. et al 2005)

Nine individuals died as a result of exposure to the toxic chlorine gas which leaked from damaged rail cars and more than 500 individuals were injured. Most of the injured were treated at area hospitals but those who suffered damage to their lungs from exposure were expected to have a permanent impairment. Of the nine individuals who died from toxic gas exposure a majority of the individuals were employees working on the night shift at the textile mill located near the train derailment, and one person was a resident who died when he was trapped in his home and exposed to toxic chlorine gas. (Hart, Ariel, 2005, Buckley et.al.2007)

The evacuation of more than 5,400 local residents to prevent greater exposure of citizens to high levels of toxic gas was initiated as experts from the railroad company arrived on site to determine how to stop the toxic gas from leaking from the damaged derailed cars. It was reported by the media that all community residents were not fully evacuated from the area until 12 hours after the actual train collision occurred. Once evacuated most residents were required to stay away from their homes for at least nine days. These 5000 residents were required to evacuate and local businesses to close not only because of the toxic properties of the chlorine gas that had already ruptured but also because of the threat of additional future ruptures or the failure of fragile patches placed on damaged cars. As residents evacuated emergency workers representing more than 15 local, state and federal agencies and railroad personnel attempted to maintain temporary patches, assess the current level of toxic gas in the air, and transfer toxic chlorine gas under pressure from the damaged railroad tankers to new cars. (Buckley et.al.2007, Priest et. al. 2006, Hajer, M. et al 2005)

The closest local responding agency was the community fire department. This unit's fire department building was inundated by the chlorine gas cloud because the building was located near the textile mill which limited access to local resources. Railroad employees representing the large freight rail company arrived on onsite shortly after the incident and were directly involved in providing onsite response. Railroad employees and subcontractors assessed the level of damage to the rail tanker cars, determined the best method to attempt to patch the damaged cars and designed the best method to remove the remaining toxic chlorine liquid still under pressure without causing further release into the air. The railroad company retained several contractors to respond to different components of this incident. One contractor was retained to patch the damaged car and offload the remaining chlorine to a new rail car. That contractor had retained a subcontractor to provide health and safety, and supervise the decontamination procedures for their operations. Railroad had contracted another firm to

provide health and safety directly for onsite workers employed by the railroad. The railroad had contracted another firm to perform area air quality monitoring and to organize the process of re-entry to previously evacuated areas. Multi-agency response operations are typically managed through a Unified Command Structure (UCS)³. Under the Incident Command System⁴ (ICS), the incident Safety Officer is an important member of the Command Staff, reporting directly to the Incident Commander. The Incident Command System handbook defines the Safety Officer's responsibilities as monitoring and assessing unsafe or hazardous conditions and recommending measures for assuring personnel safety. However, the railroad company did not take on the role of establishing a unified command system at Graniteville and no onsite safety officer was initially designated to coordinate safety procedures for the whole site. (Bowman, 2003, Buckley et.al.2007, Cole, 2000, Belflower et. al., 2005)

Thesis

The rapid designation of a trained incident site safety officer at the beginning of a disaster response operation is critical to ensure that response workers are exposed to the minimum risk. This practice is the most successful method of reducing risk during workers efforts to complete a successful response and recovery operation involving a chemical release, major forest fire or terrorist attack.

Sources of Information

This paper was prepared by the authors using government publications, the published findings of research studies and through a review of public documents such as after action reports focused on the safety and effectiveness of actual emergency response operations for specific emergency response operations in the United States. The direct experience of the authors in the evaluation of emergency response exercises and the authors' direct onsite observation of actual response operations also served as additional sources of information for this paper addressing the role of the incident safety officer.

Findings and Discussion

In the initial effort of responders to evacuate over 4,500 mill workers and community residents in the middle of the night and stop the release of chlorine gas spewing from the damaged tank cars at the site of Graniteville Train Derailment, each agency and private response company followed their own safety procedures and requirements. Without the immediate designation of an incident Safety Officer trained in the Incident Command System (ICS) and assigned to coordinate safety procedures for all agencies and private contractors many safety procedures were not uniformly implemented. Without an incident safety officer onsite no site safety plan was developed as part of the overall incident action plan. Unsafe conditions resulted from this lack of overall safety coordination. The lack of the development and adoption and use of a uniform warning system to alert emergency workers when they should evacuate the area was one example of a significant unsafe condition. Many low cost options were available to implement when establishing a functional onsite warning system for Graniteville. One effective low tech warning system used during the 9/11 response phase used in New York that could have been initially implemented at Graniteville under the guidance of an incident safety officer was the use of hand-held air horns "to signal site-wide

³ Unified Command (UC) – The incident response management structure used when there are multi agencies responding to an incident. Each agency can still operate under their own incident structure as a branch or group under the Unified Command. (Cole, 2000)

⁴ Incident Command System (ICS) – The process that has been adopted as the "tool for command, control, and coordination of resources" in emergency response activities nationwide. (Cole, 2000)

emergencies.” (Vincoli, Black, and Burkhammer 24) A further example of problems that arose when no incident safety officer was initially assigned to the first Graniteville response command center location was placed too close to the actual wreck and toxic gas release site. This initial location greatly increased the vulnerability of the entire command center and its response workers and managers to harm from subsequent chlorine gas releases which could have occurred from the still damaged railroad tank cars and once this safety issue was reevaluated the command site was moved farther from the collision location. (Belflower et. al., 2005)

The initial lack of the designation of a qualified site safety officer with training in incident command at the Graniteville disaster site was in violation of federal Occupational Safety and Health Administration Regulations. The United States Occupational Safety and Health Administration regulations requires every agency responding to incidents that involve hazardous materials or chemicals to have both a designated incident commander and a safety officer who are specifically responsible for oversight of the operation and safety of all responders. However in practice the incident commanders do not always appoint a Safety Officer. This oversight may in large part be due to the lack of sufficient and/or available personnel trained specifically as a Safety Officer under the Incident Command System used in emergency response. (Belflower et. al., 2005)

In the case of disasters involving chemical releases, United States Environmental Protection Agency (EPA) has oversight of the response activities and required to closely monitors site safety activities. If at anytime the federal Environmental Protection Agency (EPA) determines that the response activities are not sufficient to protect human health and the environment, a Letter of Federal Interest is presented to the principally responsible party (PRP) locally and the EPA becomes the lead agency in the response. This mechanism also allows EPA to mobilize federal resources to affect the response. During the initial response at Graniteville EPA assisted the local lead agency in setting up a Unified Command structure in which all response agencies and the principal responsible parties were represented. However, the original Unified Command structure did not assigned a Safety Officer to develop the Site Safety Plan and to coordinate the safety activities of all responders under one plan. Initially EPA attempted to fill this need by designating a subcontractor, the United State Coast Guard (USCG), to fill the role of Safety Officer under the now established EPA’s Command Staff. (Cole, 2000)

While performing this role, USCG reported to EPA that each agency and contractor was still operating under their own individual safety plans and reported that there was no continuity concerning safety procedures at the response site. EPA then made the decision to bring in an EPA Safety Officer trained in the Incident Command System to address this important issue (Cole, 2000). On the eleventh day of the response, a sustained high level of chlorine gas was detected by monitors in the hot zone where the unloading operations were underway. Workers in the hot zone assessing this high level thought a breach of a patch fitted to a damaged rail car still containing toxic chlorine gas had occurred. Those workers with knowledge of this change in the level of chlorine gas stopped operations and evacuated the hot zone. However since a coordinated uniform evacuation warning system had not been developed at the beginning of the response, no evacuation alarm was initiated by this evacuating group to warn other workers in the hot zone as well as those working in the adjacent exclusion zone to evacuate. Those workers did not stop work because they received no warning of the change site air quality conditions and if a break had actually occurred rather than some type of wind shift the safety of these response workers would have been put at risk. Once the assignment of a site EPA safety officer trained in Incident Command System was achieved a warning system was established, a site safety plan developed and implemented. The initial command center was also moved further from the chlorine release site to reduce the possibility that the actual command center site itself could be disabled if another toxic

release occurred. The emergency responders at Graniteville were fortunate that the initial lack of warning, evacuation and safety planning for the emergency response work site did not result in the death or injury of responders. (Belflower et. al., 2005)

The experience at Graniteville provides a clear example of how critical a role an onsite incident safety officer's role is when a chemical spill is involved in the emergency. The use of multiple agencies and many private contracted responders was not unique to the Graniteville train wreck and is a very common practice in the response phase to large emergencies or disasters in the United States.. During the response to previous large disasters in the United States such as the response to 9/11 it was reported that many agencies and contractors worked during the response stages with little or no prior knowledge or experienced in emergency response procedures. Many responders who worked without coordinated health and safety oversight have experienced subsequent negative impacts on their health. Authors Vincoli, Black, and Burkhammer noted these findings after studying the response to the 9/11 disaster in an article published in *Journal of Professional Safety*. The authors state "No thought was given to personal hygiene – and even less regard was given to the use of personal protective equipment." (Vincoli, Black, and Burkhammer, 2002) These unsafe working conditions were found although the safety, health and environmental team onsite had recommended that "all workers at the site wear, at a minimum, a hard hat, safety glasses, long pants, shirts with sleeves and sturdy shoes (preferably safety shoes). In addition, anyone within 25 feet of the pile or downwind of the site was required to wear respiratory protection."(Vincoli, Black, and Burkhammer, 2002)

The tasks and responsibilities of the designated incident safety officer include:

- The identification of individuals responsible for the site safety and health for each agency and contractor on-site.
- The development of a Site Safety Plan for inclusion in the Incident Action Plan.
- Establish limits for areas to be included in the hot zone and the exclusion zone based on monitoring data and planned response activities.
- Establish criteria that must be achieved before a hot zone or exclusion zone can be reduced in sizes or eliminated.
- Define which personnel have access to a zone and how personnel will be identified at the point of entry.
- Establish a method of tracking the entry and exist of responders into the hot or exclusion zone and insuring that the system is used.
- Establish the role of the incident safety officer in scene control to insure safety of responders and others working near the response site.
- Enforce minimum standards for personal protective equipment and for decontamination of all onsite personnel.
- Establish safety procedures and policies insuring the safety disposal of used personal protective equipment during decontamination.
- When site monitoring indicates possible exposure to contaminants that may require an increase in health monitoring, the safety officer must set the minimum standards for the additional monitoring.
- The incident safety officer must also address the minimum qualifications of workers in the hot zone and exclusion zone and establish a very strict safety policy on the use of volunteer workers rather than employees in the response operation. (Cole, 2002)

While this list represents examples of the duties of the incident safety officer these responsibilities of an assigned incident safety office do not reduce the responsibility of each agency and/or subcontractor to insure the safety of their own response work force. Each contractor and agency must review the site safety plan with all employees and provide the

safety officer with documentation that this training was completed. (Bowman, 2003, Cole, 2000)

The need for the onsite incident safety officer to be assigned promptly and at the beginning of the emergency response was also clearly emphasized by the After Action Report published following the Cedar Fire damaging San Diego California in 2003. The San Diego Fire Department issued an after action report stating that several near misses and violations of accepted safety practices by emergency responders occurred. These safety violations were linked in the report to the fact that an incident safety officer was not appointed until late in the fire response. The lack of availability of a trained and qualified site safety officer was documented in the report focused on lessons learned and corrective actions for the lack of the immediate appointment of a incident safety officer. One of issues stated in the lessons learned part of the after action report was that the “adapt and overcome” attitude of the responders to meet all challenges can influence their judgment of risk vs. benefit and lead them into high risk situations that might be avoided. This “adapt and overcome” attitude can in certain cases endanger the life of the emergency responders themselves. The site incident safety officer can provide a broad prospective of the importance of the safety of emergency responders and provide this ongoing advice directly to the incident commander. The site safety officer can set site specific guidance or parameters for fire crews to allow them to more effectively determine whether crew safety should precipitate a retreat or revision in strategy for a fire in impacting a specific situation. (Bowman, 2003, Cole, 2000) At the present time a majority of the recommendations for a stronger onsite presence of a safety officer needed in a major fire are found in the specific after action reports following a disaster event. No published research or nationwide survey of disaster managers covering this issue was found by the authors.

The initial lack of a safety officer responsible for the site following both the toxic release in Graniteville South Carolina and the Cedar Bluff Fire near San Diego, California resulted in onsite operations that lacked many of the common safety procedures recommended to protect emergency responders. Although the responders in both cases representing local, state and federal response agencies were all highly trained in either hazardous chemical or wildfire response and Incident Command structure the needs for specific site safety coordination were not implemented. Without the immediate designation and subsequent supervision of an onsite safety officer for the response site the aspects of safety that require onsite coordination between agencies or crews may not occur. The lack of development and implementation of a coordinated a site wide specific safety plan and no person whose sole job was to insure coordinated safety allowed the lack of a coordinated site safety response to introduce unnecessary high risk to responders. (Bowman , 2003, Cole, 2000)

When a site safety officer is not appointed the individuals responsible for the management of the emergency response are making the assumption that all emergency responders will act in a safe manner and not endanger themselves or their fellow responders. During emergency operations even the best trained responders or incident commanders can fail to focus on the over all safety of the responders when he or she is also managing all major components of a critical incident response. (Davis and Walters, 2005)

Summary

State and federal response agencies in the United States have conducted training in Incident Command Structure (ICS) as directed by the Department of Homeland Security, for many of the federal personnel involved in emergency response. Only a portion of those trained have experience in the field of site safety management. Not all local agencies and private response contractors are proficient or have had sufficient practice using the processes and procedures of the ICS structure. Most responders are not trained as professional safety managers. Emergency responders are generally well trained to perform their assignments in a safe

manner, but unique situations arise during emergency operations that require additional risk analysis. (Bowman, 2003)

The number and type of agencies involved in a response can also increase the risk to responders. When responders are working with representatives from many state and federal agencies and/or contractors who have a different level of safety awareness the risk to emergency responders can be amplified. A site safety officer trained in incident command structure should always be appointed at the very beginning of a response operation to insure the site safety plan and safety procedures for emergency responders are uniformly implemented. Emergency planners, managers and responders must take actions to insure that a well qualified incident safety officer is promptly appointed to all major response operations involving chemical releases, explosive or flammable materials. Further more, additional policies, resources and training programs must be implemented at the local, state and federal levels in the United States to insure that those responsible for emergency response operations have access to capable incident safety officers. For these changes to be implemented decision makers must 1) understand the importance of rapidly assigning an onsite incident safety officer to work directly under the site commander 2) recognize the specific safety procedures that the incident safety officer should immediately implement at the site and 3) insure that agencies have the resources needed to increase the number and availability of individuals trained as incident safety officers.

Until all agencies and private companies participating in multi-agency responses have implemented ICS training as directed in the National Response Plan, the federal and state agencies will be called upon to provide resources to fill the incident Safety Officer role under the Unified Command structure. This role is best filled by someone who has experience working with contractors in the field and has completed ICS 420 Safety Officer training.

References

Buckley, R. L., Hunter C., Addis, R. and M. J. Parker, Modeling Dispersion from Toxic Gas Release aft a Train Collision in Graniteville, SC, *The Journal of Air and Waste Management Association*, Volume 57 (March 2007) pp 268-278.

Davis, Brian A., and T. Danielle Walters. Coping with catastrophe: the first 24 hours. *Risk Management*. 52.7 (July 2005): 44(5).

Hajer, Marilyn and M. Walsh. Coping With Community Trauma, *Public Management*, Volume 87 i4, (May 2005) p. 4.

Hart, Ariel, National Briefing- South Carolina: Request for Aid After Train Crash, *New York Times*, January 13, 2005.

Henry, C., Belflower, A., Drociuk, D., Gibson, J. J., Harris, R., Horton, D. K., Rossiter, S., Orr, M., Safay, B., Forrester, T., Wright, S., Wenck, M. A., Public Health Consequences from Hazardous Substances Acutely Released During Rail Transit -- South Carolina, 2005; Selected States, 1999-2004; *Morbidity & Mortality Weekly Report*; Vol. 54 Issue 3, (January 2005), p64-67

Mitchell, Clifford S. MS, MD, MPH; Gochfeld, Michael MD, PhD; Shubert, Jan MA, MSW; Kipen, Howard MD, MPH; Moline, Jacqueline MD, MSc; Langlieb, Alan MD, MPH, MBA; Everly, George S. Jr PhD; Udasin, Iris MD; Wartenberg, Daniel PhD; Paulson, Glenn PhD, Surveillance of Workers Responding Under the National Response Plan; *Journal of Occupational and Environmental Medicine*, Volume 49(8), August 2007, pp 922-927

Young, Bob, Augusta Mayor will keep pushing for haz mat notice from railroads. *Emergency Preparedness News*. 29.12 (June 21, 2005): 96.

Bowman, Jeff, Ghio, August, Jarman, Tracy, Frazier, Jeff, Peake, Perry, Handley, Jon, Steadman, Robert, Oates, Samuel, Morgan, Monica, Chew, Chett, Nunez, Pat, Harris, Susan, City of San Diego Fire- Rescue Department Cedar Fire 2003 After Action Report, <http://www.sandiego.gov/fireandems/pdf/afteraction03.pdf>

Cole, Dana, The Incident Command System: A 25-year Evaluation by California Practitioners, February 2000, An unpublished paper submitted as an applied research project submitted to the National fire Academy as part of the Executive Fire Officer Program by Dana Cole, Assistant chief, California Department of Forestry and Fire Protection, St. Helena, California <http://www.usfa.dhs.gov/pdf/efop/efo31023.pdf>

Jackson, Brian A., Baker, John C., Ridgely, M. Susan, Bartis, James T., Linn, Herbert I., Protecting Emergency Responders, *Safety Management in Disaster and Terrorism, Response*, Volume 3, DHHS (NIOSH) Publication No. 2004-144 RAND Publication No. MG-170, 2004, pp 1-119.

[Mitzel, Bill](#), *Emergency Preparedness & Response. Professional Safety*; Jun2007, Vol. 52 Issue 6, pp60-65.

Priest, S. H., J.J. Leu, S. Duhe, T. Klipstine and D. Fisher, Disaster Coverage Does Little To Promote Call for Change, *Newspaper Research Journal*, Volume 27, No. 3, (Summer 2006) pp. 52-65.

Vincoli, Jeffrey W.; Black, Norman H.; Burkhammer, Stewart C. [SH&E at Ground Zero](#). *Professional Safety*, May2002, Vol. 47 Issue 5, p21.

Author Biography

Dr. Susan M. Smith

Dr. Smith is the Director of the UT Safety Center and the Coordinator of the Graduate Safety Program UT Safety at the University of Tennessee. Prior to accepting her current position, Dr. Smith completed a successful 20-year career working with rural communities on the complex issues of disaster mitigation, environmental protection, emergency management and environmental health. She teaches graduate courses in emergency management, accident prevention and environmental health. Dr. Smith's research areas include emergency evacuation and warning systems for special populations. She has served as a controller, evaluator and/or developer for Homeland Security and Emergency Response full scale exercises and table top training programs implemented to train local and state level responders located in the southeastern United States.

Ms. Barbara Scott, BS

Ms. Scott is a candidate for the Masters in Safety degree with a concentration in Emergency Management from the University of Tennessee. Ms. Scott has over twenty years of safety, environmental and occupational health professional experience at the state and federal level in the United States. She also has extensive experience serving as the incident safety officer for emergency response operations in the southeastern United States.