

U.S. Fire Administration/Technical Report Series

# Special Report: Rail Emergencies

USFA-TR-094/February 2003



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## **U.S. Fire Administration Fire Investigations Program**

**T**he U.S. Fire Administration develops reports on selected major fires throughout the country. The fires usually involve multiple deaths or a large loss of property. But the primary criterion for deciding to do a report is whether it will result in significant “lessons learned.” In some cases these lessons bring to light new knowledge about fire--the effect of building construction or contents, human behavior in fire, etc. In other cases, the lessons are not new but are serious enough to highlight once again, with yet another fire tragedy report. In some cases, special reports are developed to discuss events, drills, or new technologies which are of interest to the fire service.

The reports are sent to fire magazines and are distributed at National and Regional fire meetings. The International Association of Fire Chiefs assists the USFA in disseminating the findings throughout the fire service. On a continuing basis the reports are available on request from the USFA; announcements of their availability are published widely in fire journals and newsletters.

This body of work provides detailed information on the nature of the fire problem for policymakers who must decide on allocations of resources between fire and other pressing problems, and within the fire service to improve codes and code enforcement, training, public fire education, building technology, and other related areas.

The Fire Administration, which has no regulatory authority, sends an experienced fire investigator into a community after a major incident only after having conferred with the local fire authorities to insure that the assistance and presence of the USFA would be supportive and would in no way interfere with any review of the incident they are themselves conducting. The intent is not to arrive during the event or even immediately after, but rather after the dust settles, so that a complete and objective review of all the important aspects of the incident can be made. Local authorities review the USFA’s report while it is in draft. The USFA investigator or team is available to local authorities should they wish to request technical assistance for their own investigation.

For additional copies of this report write to the U.S. Fire Administration, 16825 South Seton Avenue, Emmitsburg, Maryland 21727. The report is available on the Administration’s Web site at <http://www.usfa.dhs.gov/>



# **Special Report: Rail Emergencies**

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This is Report 094 of the Major Fires Investigation Project conducted by Varley-Campbell and Associates, Inc./TriData Corporation under contract EME-97-CO-0506 to the United States Fire Administration, Federal Emergency Management Agency, and is available from the Website [USFA.gov](http://USFA.gov).



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## **U.S. Fire Administration**

### **Mission Statement**

*As an entity of the Department of Homeland Security, the mission of the USFA is to reduce life and economic losses due to fire and related emergencies, through leadership, advocacy, coordination, and support. We serve the Nation independently, in coordination with other Federal agencies, and in partnership with fire protection and emergency service communities. With a commitment to excellence, we provide public education, training, technology, and data initiatives.*



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# INTRODUCTION

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Few modes of transportation are as safe and familiar to most Americans as that of rail. But when a passenger rail emergency occurs, it can present one of the most challenging types of incidents to emergency responders. Even with safe passenger miles in the millions, accidents can and do occur. They happen in remote areas like the desert, as well as in the most densely populated areas, such as the northeast corridor.

Whether an accident occurs in New York City or a bayou in Alabama, the challenge is significant. Responders may be confronted with a large number of patients who may be severely injured and/or trapped. They may be trapped in heavy debris in remote locations, at elevated or below-grade settings, or in limited access areas. The common denominator among the victims is that they require triage, treatment, transport and possibly, hospitalization.

In two of these accidents, there were fourteen fatalities with hundreds of injuries. One accident alone in Big Bayou Canot in Alabama, resulted in 42 fatalities. Add to these staggering numbers the reality that the specter of domestic terrorism visited the rails in Hyder, AZ, where dozens of people were injured.

The USFA has selected the topic of rail emergencies as the subject of a special report under the Major Fires Investigation Program. The focus of this report will be the planning and response aspects of managing large scale rail emergencies from the standpoint of command and control, with the objective of providing care to the injured.

The purpose of this Special Report is to identify the challenges to strategic planning and tactical operations in the area of rail transportation emergencies and to provide planning suggestions for fire and rescue departments. While this report addresses operations at all types of rail systems; (inter state, inter city, urban commuter, and both privately and publicly operated), the focus is mainly on the emergency response issues pertaining to passenger rail emergencies and the rescue and patient care missions. Hazardous materials are addressed only as a component of response planning. Significant incidents over a 12-year period are reviewed and discussed. The report can serve as a planning resource document for the development of training scenarios, or can be reviewed as basic background research.

USFA wants to share the “lessons learned” from this incidents with the fire service. In the case of rail emergencies, this is especially pertinent because few organizations have direct experience with large-scale rail emergencies. Yet few departments can dismiss the possibility that they may be called upon to respond to this very type of disaster.

The U.S. Fire Administration appreciates the assistance of Mr. Curt Secrest, Rail Branch Chief for Response Preparedness, at the Transportation Security Administration, in serving as a peer reviewer and providing valuable input to this report.

## SUMMARY OF KEY ISSUES

Issue	Comment
Incident Command System	Extensive rail emergencies can present emergency service personnel with formidable operational, jurisdictional, and logistical challenges to overcome. The effective management of such emergencies must begin with a well-defined, and coordinated incident command that can rapidly and accurately assess the situation and quickly identify and acquire the resources necessary to support emergency operations.
Multiple Jurisdictional Operations	Rail emergencies rarely impact a singular jurisdiction, and usually require multi-agency response. The command and control of the incident therefore must be handled through some form of unified command structure. Fire departments can best prepare by adopting mutual aid agreements and common response protocols and by conducting joint training exercises.
Extrication/Physical Hazards	Rail accidents usually pose complicated extrication problems. Mangled rail cars constructed of high tensile steel, high strength Plexiglas and other composite materials may require special heavy rescue equipment to gain access to trapped passengers. Often compounding this problem is the presence of hazardous materials, high voltage electrical hazards, and the threat of fire and explosions.
Search and Rescue	The rescue and treatment of trapped and injured passengers is usually the primary focus of emergency responders during a rail accident. It is imperative that all cars and affected structures be searched and marked to avoid duplication of effort. Coordinating search efforts is one of the primary tasks early in the response.
Patient Triage	There are many methods of triage and emergency responders should be familiar with the protocol followed in their department as well as those in mutual aid areas. The Simple Triage and Rapid Transport (START) system works particularly well during rail emergencies for classifying patients and transporting them to hospitals or to special treatment facilities.
Mass Casualty Medical Caches	Two necessary components for the successful care of the injured are having a sufficient supply of the right medical supplies and being able to get the supplies to the scene of the accident quickly. Oxygen and masks, backboards and splints, trauma dressings, fluids, and other medical supplies will be needed. When possible, personnel with EMS experience who are familiar with medical terminology and practices should be assigned as the medical supply officers.
Transportation	The location and terrain at the emergency scene can have a major impact on the mode of transportation used to get personnel to the accident scene and remove the victims to medical facilities. The rapid influx of rescue and transport vehicles can create traffic problems and delay transporting the injured. Traffic should be coordinated through a staging area until directed to the emergency scene.
Incident Communications	Effective radio communications are often a major problem during major rail emergencies. Communication is most often hampered by incompatible equipment, radio frequencies, and communication protocols. Some of these problems can be addressed through Regional disaster communications planning and equipment purchases along with a common communications protocol.

## SCOPE OF PROBLEM

Over 18,000 fire and rescue departments directly border right of way served by the National Passenger Rail Corporation (Amtrak) covering 25,000 miles of rails. In addition, many urban areas operate rail transit systems. With a potential of occurring anywhere, rail emergencies can present a complex problem for responders. Whether the incident occurs in a remote location or in a densely developed area, access problems at the accident site are generally the norm. Even after the scene is accessed, rescuers are often faced with situations that demand expertise in a number of different emergency management disciplines. Firefighting, delivery of emergency medical services in a mass-casualty situation, confined space rescue, high or low angle rescue, extrication, even underwater operations may be required. Rescuers may be confronted with large numbers of patients ranging from walking wounded to those who are entrapped and require extensive extrication efforts. The accountability of patients, who may number up to 500 per Amtrak train and nearly 1,000 in a city mass transit environment, is particularly complicated and daunting.

Rail emergencies, by their nature, require multi-organizational response. The fire, police, emergency medical system, and the supporting municipal infrastructure will all be involved; as will the affected rail authority. Command issues are compounded when incidents involve several jurisdictions and multiple rail operations. **A strong, well-practiced incident management system capable of adapting to a large-scale unified command effort will be invaluable in planning response to a large-scale rail incident. Moreover, this level of planning applies to other major disaster scenarios of all types; and therefore is worth understanding.**

Responses to rail incidents are generally long-term in nature and require a considerable commitment of resources. The needs for food, fuel, shelter, lighting, communications and all the other basics of long-term incident management are magnified when operating at remote access locations. These incidents are usually high profile and media intensive which incident commanders should anticipate. On-site debriefings for staff as well as critical incident stress counseling will be required. How to manage witnesses, bystanders, and Good Samaritans also needs to be considered in planning the response to rail emergencies, and all major incidents. The assets necessary to control a site with extended perimeters over a large area with multiple access points may be considerable.

Another aspect of rail incident management is the two-fold issue of safe scene control and preservation of evidence. In a worst case scenario, an accident may be caused by a terrorist, and may involve the placement of secondary devices intended to further harm the passengers or rescuers. Responders must always be on the alert for this possibility, and take steps to protect themselves. The Safety Officer should size-up the real and potential hazards for responders and ensure that the incident commander is cognizant of these. At the same time, the integrity of the scene should be protected as much as possible in case a crime is involved. And whether the rail incident is accidental or not, as much evidence as possible should be preserved anyway for the National Transportation Safety Board's (NTSB) post-accident investigation. While rescuer self-protection and patient care are always the primary priorities, the importance of the accident investigation can not be overlooked.

## COMMAND AND CONTROL

Effective command and control of rail emergencies begins with accurately defining and quantifying the situation--and then communicating these details quickly. The resources needed to provide medical care, treat, transport and support operations should be deployed through a clearly designated incident command system.

One of the biggest difficulties can be confirming the exact location of the rail accident. Unless the incident occurs in a well populated area, the location of the site may be hard to describe precisely. The case studies in this report provide numerous examples of where inconclusive or inaccurate location information was reported at first, thus delaying response.

Another issue is the terminology used in reporting an incident. Rail personnel may utilize terminology, such as milepost numbers, that is very familiar to them. But, unless fire and rescue responders are conversant with these markers, milepost numbers may be of little use to them. Some incidents have been reported by using local landmarks, e.g., "The Dupont siding", or "The landfill road". However, if the responders are unfamiliar with the landmark, then this information may not be helpful either. Responders should always confirm that they understand the location.

The likelihood of multiple-jurisdictional response raises a variety of command and control issues. Due to the limited access of railway right-of-ways, the access to an incident may be from a jurisdiction other than the one where the incident occurred or on private property. There may be legal problems beyond the tactical considerations of equipment compatibility, common radio frequencies, and terminology. Medical control rules, such as authorizations to administer controlled substances and other protocols and procedures, can vary between jurisdictions, especially if the incident borders state lines.

Rail incidents require multi agency response. The most likely agencies to be involved in responding to a rail incident are: emergency management, law enforcement, fire, emergency medical, hospitals, public transportation, rail, adjacent impacted occupancies, utilities, industry, and Federal and State transportation authorities. Advance command and control planning should be seriously considered by all agencies that would be affected by a train disaster in their community.

### Command Post Operations/Locations

The proper location, staffing, and operation of the command post are central to the safe and effective management of any incident. The complexities and life safety issues of a railway emergency demand especially well structured coordination, command, and control. Fire departments generally are viewed as the authority having jurisdiction in rail incidents. In many locations, the fire department is the only major response stakeholder with incident command procedures and the experience in implementing those procedures.

The use of a mobile command unit is ideally applied at rail incidents. The question becomes one of how large and well-equipped the unit needs to be to handle the incident. Most fire department command units are not large enough to accommodate the full complement of an expanded command structure. However, many law enforcement agencies have large well-equipped command units. What should be avoided is a situation where multiple mobile command posts are employed because these can cause confusion. It is a good practice is to have one location from which strategic decisions are made and communicated by the leaders of the primary response agencies. This is especially critical if radio interoperability is a problem. The public information spokesperson should be assigned to the Central Command Post.

## **TACTICAL CONSIDERATIONS**

### **Accountability of Victims**

A unique challenge in rail emergencies is identifying and accounting for all the passengers on board. Passenger trains are much more dynamic as far as occupancy than most other modes of travel. Accountability of passengers in public transportation ranges from very highly screened and closely managed (such as air travel), to the literally hundreds of non-reserved passengers in a commuter train. Even a moderately full, unreserved inter-city train will carry hundreds of “anonymous” passengers.

In contrast to the passenger lists of airlines and the manifest of hazardous material cargoes, the closest accountability a non-reserved passenger train will have is the conductor’s estimate. The availability of that information is dependent upon whether the conductor is among the seriously injured or killed. In a commuter rail incident, exact accountability may be a next to impossible task. Uninjured passengers and many categorized as “walking wounded” will leave the scene, making it difficult to know how many were affected by the incident, or how to account for their whereabouts if anxious family members call. Also victims may be rendered unconscious, and unless they have identification on their person, may only be known as “passenger x” for hours, or longer.

### **Logistical Support**

The sheer number of people involved, coupled with the need for specialized heavy equipment, automatically creates a requirement for a large logistics support network. Medical supplies, patient transport vehicles, communications devices (radios, cellular phones, and batteries), fuel for the vehicles working on site, and food, are among the relief necessities. Electrical power for lights at the scene and stationary communications gear are needed to support a long-term incident.

Even if the incident has no complicated extrication and rescue situations, a major transportation incident automatically becomes the subject of an intense investigation. The investigation may become a criminal investigation in which case the complexity and media scrutiny increase dramatically.

### **Convergence**

A common problem to most major disasters is the convergence of well-intentioned individuals and organizations that respond on self-initiative, or who are requested via a blanket “all-call”. These resources range from the very useful (as were the volunteers in Hyder, Arizona) to those that can substantially hamper operations and impede progress. Large-scale incidents, such as train wrecks, require a significant commitment of trained personnel, but even the experienced, specialized resources must be coordinated. Incident commanders should anticipate that a variety of individuals will congregate at the site, requested or not, and should plan accordingly. Managing a large influx of people and equipment until they can best be utilized requires that assembly points and staging areas be designated and that perimeters be maintained. The position of staging officer is one that should be filled early. Included with the instructions for staging should be policies on site security and the management of unrequested responders, sightseers, and the media.

### **Media Considerations**

Incident commanders can expect a media onslaught at major rail emergencies. These incidents attract both print and electronic media seeking to collect details of the disaster as quickly as possible.

The news media can serve several useful purposes. News helicopters, for example, can be used to give the command staff an airborne view, provided that a mutually acceptable agreement is worked out among all media organizations that avoids favoring one news organization over another. It would also be necessary to ensure that the helicopter does not disrupt the incident scene. The media can assist too by broadcasting toll-free, hotline numbers where relatives can call for information. This takes some of the demand for passenger information off the shoulders of the command staff.

Unfortunately, incidents of such high visibility can attract unscrupulous people. Personnel should insist on credentials from persons purporting to be media representatives, just as they would from those claiming to be physicians or other emergency workers handling perimeter security (usually law enforcement officers).

## **Access/Mobility**

As noted previously, rail emergencies can be among the most difficult for responders to access, even when the crash itself is easy to find. The crash in Secaucus, NJ, challenged responders because the right of way channeled through swampy, undeveloped areas, and because there was a raised rail bed as well as ties and ballast which interfered with the free passage of emergency vehicles. Also, fences and other physical barriers usually are maintained along rail corridors for security purposes. These can further complicate access to a crash site. In the Chase, MD and Silver Spring, MD incidents, the raised railbed presented problems for the responders in terms of accessing the cars. In the case of the Silver Spring incident, firefighters were required to hand stretch attack hoselines of 600 feet in length through back yards and up the elevated roadbed in an urban area. The adaptation and use of leader lines and equipment generally suited for high rise firefighting allowed the crews to attack and extinguish the fires at this crash.

Access to a rail incident may require vehicles that are designed for off-road operation. The incident in rural Hyder, AZ required off-road type vehicles to travel over 20 miles; conventional sedans could not be used. Helicopters may be needed to traverse difficult terrain, but they are always subject to the limitations of weather and visual flight rules. In the Alabama incident, access to the wreck was possible only via boat, and then, by rescue train. Rail incidents often require creative solutions to access the scene.

## **Physical Hazards**

Next to earthquakes, rail incidents cause the most treacherous working surfaces and create great potential for injuries of all types. The cars may be juxtaposed at any angle, with jagged protruding edges, possibly at concealed locations. Metal that has been subject to the forces of a rail accident may sheer off into razor sharp edges. The side or top of a rail car was not intended to be a working surface. Any slip from the top of a rail car means a ten foot or more drop onto a usually hard and uneven surface. Ties and rail ballast threaten foot, ankle, and knee injuries. Even non-life threatening injuries such as strains and sprains are problematic because the injured responder requires treatment and possibly transport, thus drawing away resources needed to treat the rail passenger casualties.

Electrical hazards are present at any rail incident, more so if the rail system is powered by electricity. Catenary wires (11,000 volts) are equipped with automatic safety devices, but responders can never take de-energizing of electrical power for granted. Rapid transit or local light rail systems usually get power from third rail pickups which have the potential for 600 volts with high amperage, direct current. It is absolutely imperative that all emergency service organizations with **ANY** potential of



being dispatched to an incident involving an electrical powered rail system, become very familiar with the operating characteristics of the power system and the emergency operating procedures. If responders do not know the characteristics and emergency operating procedures, they must rely upon the local jurisdiction or transportation personnel for information and directions.

Responders may encounter high capacity train batteries with accompanying high voltage if the batteries are intact. Special caution is needed if the case is split open because the sulfuric acid and lead in the batteries can cause severe local burns or inflict the potential for long-term health damage. An explosion hazard may also exist if any batteries have suffered extensive damage or been exposed to high heat. Concentration of hydrogen gas may have escaped into the surrounding atmosphere. Sparks or other forms of an ignition source may ignite the gas and air mixture resulting in an explosion.

## **Extrication**

Rail accidents can pose very complicated extrication problems for rescuers. Due to high speeds in transit, the heaviness of the equipment, and the massive structures which rail cars may impact, virtually any entrapment configuration is possible. Compounding that situation is the strength and resistance of the materials involved: high strength Plexiglas, high tensile steel, and aluminum and composite materials are the norm. The paradox of rail accidents is that access to the rail cars via windows may be accomplished with the simplest of tools--a screwdriver and simple prying apparatus. When telescoping, accordion, or rollover crash configurations compromise the cars, even the heaviest-duty rescue equipment carried by most fire and rescue departments may be of limited value. Portable hydraulic tools and saws may have little use in rail car crashes. While such tools may be good choices for close-in rescue and removal of seats, flooring, or light interior finishes, heavier capacity torches and lifting equipment will almost certainly be required. Capacities of 110 tons are standard in the industry for removing rail cars. To stabilize telescoped or stacked cars will require such heavy equipment.

Another problem with extrication equipment is the access needed to move the equipment into place and use it. Heavy capacity cranes and winches that are mounted on rail cars require clear track and right of way in which to operate. Mobile equipment requires space to operate and a firm anchor point for set-up.

## **Environmental Factors**

Every emergency operation is subject to the challenges presented by the weather. Few incidents can be so negatively influenced by weather conditions as rail emergencies. A crash or derailment places the passengers into whatever environment exists outside the protection of the rail cars. Incidents researched for this report have occurred in near freezing weather, torrential downpours, in complete darkness, and in scorching heat with high humidity. Even a somewhat minor derailment can be turned into a serious challenge by the influence of the weather. In Bowie, Maryland, in 1970, ambient temperatures were over 100 degrees with high humidity typical of the area. An incident in Boise, ID occurred at 12:30 A.M. where the temperature was 28 degrees. Each of these incidents involved well over a hundred persons with injuries of all types. In addition to caring for the accident-related injuries, responders must anticipate treating and caring for the heat or cold-related injuries and the exacerbating effects of thermal extremes on the injured.

## **Search and Rescue**

In a rail emergency, locating all crew and passengers and treating the injured is of utmost importance. In the case of the Big Bayou Canot, many of the victims were trapped underwater and primary search of all cars by conventional fire and rescue units was impossible. In a case in Elsmere, England, due to the proximity of a toxic gas cloud, the primary search was completed by teams of firefighters wearing full SCBA. In both cases, the search consisted of car to car searches by teams of firefighters. Far more complicated and dangerous searches may be involved when victims are hidden or obscured by the wreckage that entraps them. The challenge to commanders is to assure that all cars and affected structures are searched without duplication of effort. As areas are searched they should be marked and recorded. In some cases, the incident commander may want to establish separate sectors in the cars where victims are present.

## **Suppression Operations**

Rail emergencies will require a major commitment of resources by the fire department. Fire and rescue personnel are needed to perform search and rescue, triage, and medical treatment. Fire suppression operations are also often required.

In the case of Ft. Lauderdale, FL, the train struck a loaded flammable liquid carrier with ensuing fire. The crash in Silver Spring, MD is noteworthy because the first arriving fire companies not only encountered a large-scale train emergency with many injured people, but a severe fire with trapped passengers.

## **Hazardous Materials**

The issue of hazardous materials is present in passenger train emergencies even if no bulk hazardous cargo per se is being carried. In a case in England, a mail train collided with tank cars containing carbon dioxide. While not aggressively toxic, carbon dioxide can kill by oxygen deprivation (it did affect several rescuers.) The potential of a fully loaded passenger train with exposure to a suffocating chemical is very real. With shared track beds and adjacent rail lines and siding in which the most toxic, flammable, and reactive chemicals are shipped side by side with rail passengers, rescuers must always be alert and consider the potential of hazardous materials when planning for or responding to a report of a rail emergency.

Passenger trains carry common hazardous materials in the form of locomotive fuel, battery banks (with substantial quantities of acid and lead), and potential blood borne pathogens from restroom facilities. Another hazardous materials consideration is the propane tanks that supply the switch mechanism heaters on the rail bed. In a crash, these may be seriously damaged, leaking, or on fire. Such tanks may “only” contain a few hundred gallons, but certainly provide sufficient LP gas to cause a lethal explosion. An insidious hazardous material potential to responders at train wreck emergencies is the presence of underground pipelines sharing the right-of-way with rail lines.

Finally, if the crash is the result of criminal intent, there may be secondary devices, such as bombs, in place. First responders will not necessarily know what caused the incident at the time they arrive on scene, but should be cognizant of this potential threat to their safety.

## **CASUALTY MANAGEMENT**

### **Access/Egress**

In addition to the problems associated with overall access to the site, getting to individual casualties in entrapment situations present difficulties as well. Tons of rail equipment and debris may separate emergency medical responders from victims in need of care. Responders must be mindful first of their own safety in their haste to locate and access trapped passengers. In the irregular compartmentation typical of rail incidents, intact passenger areas may be immediately adjacent to areas of gross damage and mangled heavy equipment. Rescuers may be able to hear trapped victims, but reaching them may require an extended rescue effort. In the Chase incident, one of the trapped passengers had to be abandoned temporarily because unstable rail cars began to shift and medical personnel were ordered to evacuate.

In rail emergencies, the casualties may be in underground tracks or subway tunnels, in stations, on overpasses, or even in water. Rescuers should carefully evaluate the need to evacuate passengers taking into account several factors. The first is the safety of the immediate environment. Do they need to be moved because of imminent danger due to structural instability, or to external factors such as fire, smoke, or chemical exposure? Another consideration is the nature and seriousness of their injuries. Do the victims need to be moved for treatment of their injuries? In many cases if the car is upright and stable and the injured are medically able to remain for longer periods of time, (and no fire or hazardous material is threatening the area exposing the car) a good choice may be to leave them in the car. This is an especially wise decision if people could be exposed to more harm if they are moved than if they are directed to stay in place. “Psychological” first aid is appropriate, however, and incident managers should communicate by assigning a responder with a radio in cars where the passengers are retained. To control panic, passengers need to be reassured about their safety, the status of evacuation actions, and the reasons behind “protect in place” decisions.

Depending on how severe the injuries are, it may be necessary to move casualties to an area of secondary triage and/or treatment. Communication again is vital. The responders in the cars need to know what decisions have been made about where to move the more severely injured. Many times the injured are moved to just outside the rail cars, but remain close to the wreckage. Triage or treatment areas should be far enough away to be in a safe area, but close enough to permit rapid removal of non-ambulatory cases. When passengers are evacuated from a rail car (or any other rescue situation) their egress and physical security should be managed and their whereabouts accounted for and reported.

### **Types of Injuries**

Studies and actual experience suggest some commonalities in rail accident injuries. In most rail incidents, the greatest percentages of injuries will fall either at the low end--to the “walking wounded”--or to the high end--serious life-threatening or mortal, injuries. Rescuers can expect a large number of painful, yet non-life-threatening injuries. Sprains, bruises, lacerations, and contusions can account for sometimes hundreds of injuries. The strain on medical resources often is not so much the degree of injury, but the magnitude of the numbers injured who, while not in immediate danger, must be accounted for, triaged, treated, and transported. A smaller number of injuries will likely be critical or mortal. Among these are passengers and crew who become victims of serious trauma such as crushing, flail, amputation, evisceration, or even decapitation. In cases of severe and prolonged

entrapment, rescuers can anticipate the effects of crush injury syndrome. In entrapment scenarios, rescuers should anticipate the potential threat caused by the entrapment. In Big Bayou, over 40 passengers were drowned. In Silver Spring, eight succumbed to burn injuries while trapped.

## Triage

Second only to command and control of the overall incident site, triage is the key to efficient and life-saving casualty management. Many different means and methods of triage are taught and accepted, and fire and rescue responders should be familiar with the method followed in their particular area as well as in their mutual aid area. Regardless of the method, all triage systems have the same objective: to sort and prioritize the patients according to the severity, survivability, and treatability of their injuries.

Triage is a skill that should be practiced on routine incidents and during mass casualty incident drills. The time to learn and hone mass casualty triage skills and identify response deficiencies is not at the time of a major incident. Mistakes will occur, but responders should have a working knowledge and familiarity with the principles and terminology of their particular triage system.

The location of primary triage will usually be dictated by the incident. With rail emergencies, secondary triage may be indicated due to the number of patients and the distances involved. Below grade incidents such as the Boston wreck and the New York subway incident are examples. Most triage systems build a secondary triage in conjunction with the treatment phase.

Triage systems will classify the injuries into four general categories:

- 1) **mortal**--life threatening - if untreated within an hour, the patient will likely die,
- 2) **severe**--not immediately life-threatening but if untreated, the patient will move in the life threatening category,
- 3) **moderate**--must be treated at a medical facility, but not life threatening, and
- 4) **light**--"walking wounded", cuts contusions, bruises, checkup.

Triage decisions can be among the most difficult ever made by firefighters and emergency medical responders. Responders are guided by the basic tenet of disaster medicine "to do the most for the many". Local triage and treatment protocols should be practiced and treat/no treat conditions should be very familiar to responders. The Simple Triage and Rapid Transport (START) system works particularly well at rail incidents because most injuries are light or moderate, and the rest tend to be at the opposite end of the spectrum.

## Treatment

The treatment sector must be closely coordinated with triage. One of the key early decisions is where to locate the treatment area--its proximity to triage and the level of treatment to be rendered. At a minimum, the injured parties should at least be stabilized and "packaged" for transport to definitive medical care. Such packaging may consist of applying cervical collars, and immobilizing with half and full backboards or stokes baskets. Other treatment equipment will include splints, dressings, bandages, blankets, intravenous sets and fluids, and oxygen therapy equipment.

Close coordination and communication should be maintained in the treatment area. The treatment officer must maintain the proper level of resources (supplies and a sufficient number of trained peo-

ple) as well as maintain communication with the incident managers regarding significant changes in patient status, e.g., the number requiring care.

While treatment supplies may be included as a task in the logistics sector of the command structure, some departments designate a medical supplies officer. A trained medical care provider will be able to anticipate needs more quickly and will be familiar with EMS terminology and practices. The location of the medical supply cache should ideally be close to the treatment area and separate from the overall supply staging areas. Accountability of all equipment and supplies, especially controlled appliances, controlled medications, and fluids, should be anticipated and addressed in assignments.

## **Disposition**

The disposition function has different labels in incident management systems, but basically covers the responsibility of routing injured people to the proper medical care facility. Many factors must be balanced to assure that the victims are properly and safely transferred to treatment facilities. Depending on the severity and type of some injuries the patients may need to be transported not to the closest hospital, but to a special facility, e.g.; a trauma center, burn unit, or hospital offering orthopedic specialties. The capabilities and specialties of the hospitals must be factored into decisions about what types of injuries are transported to which facilities. Sometimes the closest hospital can only stabilize the patient's condition until a specialized level of care can be arranged at a different treatment facility. To avoid overtaxing one hospital, the injured should be distributed among various hospitals in the area. Generally, the least severely injured are transported last and farthest facility.

The need for an effective communication officer is especially critical at the disposition position. The officer in this function will need to interface with the triage/treatment group, the hospital network, and the incident commander. Requests for resources, status updates, and patient conditions, should flow quickly and reliably among the "need to know" positions in the chain of command. The disposition officer may need to communicate with multiple treatment areas and with several medical care facilities as well as transport providers.

## **Transport**

In some incident management structures, the same person is placed in charge of both the disposition and transport functions. While this centralizes the routing (movement) function into one sector, a large-scale incident may overwhelm this position. A major problem that often is encountered in highly visible mass casualty incidents is the rapid influx of all sorts of vehicles. Such was the problem at the Columbine High School massacre where over 1,000 locked public safety vehicles clogged the streets near the school. Traffic should be managed and vehicles held at assembly or staging points until they are mission assigned and directed into and out of the treatment area. Undirected vehicles quickly produce bottlenecks that can choke the flow of authorized vehicles trying to access or leave the scene.

The transport officer must be assertive and vigilant to assure that traffic control is maintained. Transport vehicles are routed in with the idea that they must also be routed out and there will be many others to follow. Rail accidents in remote locations will also challenge the disposition and transport officer. Only rough-terrain vehicles such as four-wheel drive or high ground clearance units should be assigned if the terrain prohibits conventional vehicles.

Air transport may play a major role in the disposition of casualties. Landing Zones (LZs) should be remote from the transport/pick-up areas, due to the disturbance of rotor downwash. Enough

resources (personnel for carrying and at least one firefighting unit for standby) should be assigned at the landing zones.

Another function sometimes delegated to disposition is cross checking the numbers assigned to injured individuals. Rather than using the victims' name, triage tags are assigned using a number, and are checked accordingly. The accountability of patients should flow from the Incident Commander to medical control to disposition and back from the medical care facilities. Under no circumstances should victims' names ever be transmitted over non-secure radio frequencies. Even cellular telephones, while much more secure, are subject to scanners and hackers and should be avoided for sensitive traffic.

## **Incident Communications**

Communications problems have been identified in every incident researched for this report as well as in the critiques of similar drills and exercises. In some instances, the problem is with the physical radios. Most, however, center around the challenges posed by multiple jurisdictions and multiple public safety agencies needing to communicate, but being hampered by different equipment, radio frequencies, protocols, and so forth. Also, the radio discipline required in an emergency incident has sometimes proven to be lacking. Groups who have not worked together before are often brought together in response to a rail incident. The lack of familiarity and limited joint response experience among different groups can create misunderstandings and communications failures.

Even those response organizations and individuals who are accustomed to field operations may use terms different for the same thing, and critical information may not be passed on accurately or acknowledged. The USFA Report, *Firefighter Communications* discusses these problems at length. Some of the parties involved may not be familiar with emergency management jargon, terms, and communications practices.

## **Radios**

Although portable radios have become much more reliable, the rugged environment of a railway accident can challenge their ability to withstand heavy use. As issue with radios is batteries. A significant number of the proper type of batteries at the proper level of charge will be required for sustained operations. Most mobile command vehicles carry battery banks and chargers, however, many times at the early stages of an incident, radios and batteries are found to be in short supply. For long-term incidents, especially in colder weather, a constant supply of fully-charged batteries for portable radios is necessary to support effective operations.

## **Channels**

Another concern with radios is channel availability. The availability of non-repeating channels for on-site operations is needed as well as the capability of repeater channels for longer distance operations. In remote or non-urban environments, the lack of repeating channels hampers long distance communications. This impacts requests for assistance and information flow, especially to and from the medical facilities. Cellular telephone and satellite-based communication links are well suited for these operations, but then channel security is an issue. Also, in a crowded urban area, cell phone channels may be saturated, especially in situations where the media's presence is significant.

## **PLANNING CONSIDERATIONS**

It is important that emergency responders understand the issues and complexities associated with rail emergencies and the mass casualty potential. The scope and magnitude of a rail emergency can quickly overwhelm the available resources and capacity of the local emergency services to effectively respond to the demands of such disasters. The following planning considerations offer a list of fundamental tactical emergency service organizations will likely confront if they respond to a rail accident:

### **Pre-Plan/Drills**

1. Rail incidents should be covered in the disaster/emergency management plan.
2. Include rail incidents in the medical disaster plan.
3. Ensure that all key stakeholders are familiar with and have had a chance to contribute to the plan.
4. Exercise and revise the rail incident annex periodically.

### **Locations of track; right-of-way, operators**

1. Locate the rail lines; Amtrak, light rail, urban mass transit, and commuter. Include those to which the department may be called to respond on an assist, especially if operating an advanced life support unit or other specialized unit such as Hazmat, heavy rescue or technical rescue, light /air unit, mobile command vehicle, tanker.
2. Identify the right-of-way owners. Including their names, phone and page numbers, and second-in-command.
3. Find out what policies and procedures the right-of-way owner has in place, and attach them to the rail incident annex.
4. List the rail companies that operate equipment on the rail line(s) within your jurisdiction.
5. Ensure that the National Response Center (NRC) (1 800 424-8802) is contacted to report an event.

Note: The NRC will contact the Federal Railroad Administration (FRA) and the National Transportation Safety Board (NTSB) to report the incident.

### **Access points/landmarks, mileposts, and maps**

1. Identify and map the access points to the right of way, bridges in your response area. Below grade areas, stairs, shafts, tunnels.
2. Include in the description and the map landmarks that correspond to access points.
3. List the milepost markers which indicate access points and where railroad mileposts are located in your response area.
4. Check that you have an easily understood map of the right-of-way and track area.
5. Determine whether these maps should be carried on response equipment.
6. Conduct training using the map.

## **Electric cut-offs, controls**

1. Identify where the power cut-offs are, what they control, and how they operate.

## **Access to specialized resources**

1. Maintain a list of heavy (rail equipment grade) equipment operators.
2. Include the names and number of heavy road construction and grading equipment operators.
3. Find out where to obtain a large supply of portable lights and electric generators.
4. List suppliers of mobile food and shelters.

## **Unified Command System**

As the sophistication of incident command grows, the concept of unified command fits very well to a rail incident scenario. Briefly summarized, the Unified Command System (UCS) builds upon the incident command system and is an organized set of procedures, each of which assigns areas of responsibility to various positions or groups of people for tactical, functional, or geographic divisions or sectors. Typically, the “Incident Commander” is the senior response officer from the authority having jurisdiction (AHJ). In some types of incidents, the AHJ is very clear; the fire chief if it is a fire, the police chief or sheriff if it is primarily a law enforcement incident, like a sniper with hostages, a civil disturbance, etc. In other words, like earthquakes, train or plane crashes, hurricanes, and bombs and explosions both public safety organizations may be equally taxed and responsible for different aspects of the emergency. Within the command structure provisions need to be made for liaison with outside agencies that can support the lead agencies. In a bombing, for example, WMD detectors, heavy excavation equipment, search and rescue canines and others are needed to support the command post.

In a rail incident, the number of potential Incident Commanders grows with the complexity of the incident. Because the fire department is the primary emergency response agency for most non-law enforcement emergencies, the fire department will usually take a lead role in train emergencies. However, the number of entities having legitimate interest in the command structure is significant. The emergency medical care providers operate under medical authority granted to them by the local medical control organization. Therefore, even fire department paramedics operate under the authority to “practice” under the supervision of the medical system. The right-of-way operator as well as the train equipment operator have very key roles in the unified command structure, police, mutual aid fire and rescue departments, heavy equipment operators, logistics providers, all have roles in the unified command structure.

Following a rail incident, first responders should locate the train crew to obtain a copy of the train manifest. The manifest will allow incident command to locate and readily identify any hazardous material cars that may be involved in the accident. A representative from the railroad involved should come to the command post to serve as a liaison between first responders and contractors hired to clean the wreckage.

It is important for fire departments to decide in advance what stakeholder organizations will be permitted to operate at the command post. Part of the planning should include security for the command post, and the identification of any mobile incident command vehicles along with their capabilities (emergency generator, interview space, communications, look-ups), fax equipment, lights, etc.



## CASE STUDIES

Few incidents could be as diverse in geographic location and environment as the major rail incidents portrayed in this section. They are, however, similar in terms of problems with identifying the accident locations, access, and casualties. Some of the victims were trapped, and required complex packaging and removal procedures. Each incident summary contributes an important aspect of the study of rail emergencies. The map below shows where the incidents occur.

**Locations of Case Study Rail Emergencies**



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## **Case Study Number One**

### **Chase, Maryland--January 4, 1987**

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On January 4, 1987, a collision occurred between an Amtrak Colonial passenger train #94 and three Conrail locomotives. The twelve car Amtrak train carrying 616 passengers and crew collided with a string of Conrail locomotives being shuttled to a rail yard after the Conrail unit ran through a switch and signal. The collision resulted in a force that according to one source "was like 340 pounds of TNT." The Amtrak train was traveling at least 60 mph at the time of the crash. At least one caller to the emergency dispatch center reported an "explosion."

The area is a low-density suburban area north east of Baltimore in the fire and rescue response jurisdiction of Baltimore County, Maryland. Amtrak and Conrail share the rail line. The right of way runs through the neighborhood, but direct access is limited due to grading and fencing.

The first arriving unit--an engine from a Baltimore County fire station within a mile and a half of the collision scene--reported smoke showing as they left the station. This information plus the 9-1-1 calls reporting "hundreds of injuries" caused dispatchers to augment the response with additional medical and firefighting forces. The first alarm consisted of four engines, a ladder truck, one medic unit, three EMS supervisors, two heavy rescue units, and the Hazmat team and Battalion Chief.

A full medical group (four medic unit, one EMS supervisor, one Battalion Chief, and one engine company) was added by dispatch and this was supplemented by the request for two more medical groups by the first responding EMS supervisor.

The first arriving company found the entire passenger train derailed. There were nine cars in an upright position. Three cars were stacked at odd angles one upon another on top of one of the Amtrak engines. One Amtrak locomotive and one Conrail locomotive were totally demolished. The remaining two Conrail locomotives were upright and situated further north of the scene. Over 150 passengers had already exited the train and were walking about the track area and the neighborhood. The overhead 11,000-volt DC wires for the catenary system were lying about and fire crews were uncertain as to their status. A large body of fire fed by spilled #2 diesel fuel greeted responders, and endangered two passenger cars as well as private dwellings nearby. A second, smaller body of fire was discovered underneath the forward passenger cars that were stacked at precarious angles.

The first arriving officer made the following requests and performed the accompanying actions:

- Requested Amtrak to shut down all power and rail traffic;
- Directed an engine to establish water supply;
- Directed other engines to advance handlines to protect trapped passengers;
- Directed second alarm units to respond to the other side of the incident from the first engine and concentrate on search and rescue actions; and
- Established "Amtrak Command," calling for a second alarm.

When the Battalion Chief arrived, the first-in officer relayed command and briefed him on conditions and actions being taken. The BC determined that the EMS supervisor had established medical command, and then began to set up sectors. Sector I was the Command Post and Sector 2 covered the rear nine passenger cars, which did not involve rescue problems.

Shortly thereafter, and in accordance with the Baltimore County Fire Department (BCFD) Emergency Plan, the dispatch center activated “Major Medic Command Mode” and then “Major Command Mode.” These conditions are implemented when pre-determined levels of resources are committed.

Within 16 minutes of dispatch of alarm, the Command Center had been established at the site, the site was sectorized, and medical command had been established with disaster-level response put into effect by the county fire department.

At this point, rescue operations consisted of treating and removing those passengers not trapped or seriously injured, and controlling the fire to allow for close search and rescue efforts. As the fire was knocked down, trapped passengers were located, several of whom were deceased. As the fires were brought under control, it became apparent that the rescue effort for the passengers who were still alive and trapped would be a long, resource-intensive process.

The rescue effort to reach, treat in place, and remove the patients was long and arduous. Following is a summary of the major actions/lessons learned and recommendations from the BCFD, Maryland Institute of Emergency Medical Services (MIEMS) and the National Transportation Safety Board (NTSB).

The incident required four fire department command and control sectors with one of those subdivided in the extrication area of the cars. The sectors were:

- Sector 1      Command Post
- Sector 2      Upright Cars (later redesignated “Staging” after passengers were evacuated. Staging retained the designation of Sector 2 when it was relocated to a nearby elementary school)
- Sector 3      Street Access Side served as personnel and equipment pool area and support to Sector 4 after rescue, firefighting and fuel spill control operations were completed.
- Sector 4      Telescoped and overturned car area (later subdivided into 4A and 4B, scene of extended extrication and rescue operations in heavily damaged cars)
- Sector 5      Hazardous Material Control

There were a total of seven medical sectors (including the medical examiner)

1. Primary triage/treatment/transportation near command post
2. Medical staging; in front of BCFD FS# 54
3. Primary triage/treatment/transportation, west side (alternate of Sector 1)
4. Extrication (A-west side, B-east side)
5. Secondary triage/treatment/transportation-inside BCFD FS #54
6. Aeromedical staging area-nearby elementary school
7. Clearing station, nearby elementary schools medical examiner’s station.

In excess of 400 victims were assessed at secondary triage, 177 were transported to 11 hospitals and 22 were admitted. A total of 37 fire and rescue department vehicles, and 7 private ambulances transported the casualties. Seven of the injured were transported via private or police vehicles, and

28 were transported by aeromedical transport. Sixteen of the passengers were fatally injured; one expired after being transported to a medical facility.

There were a number of lessons that were learned from this incident:

- Training in incident command procedures and triage/treatment practices is essential to effectively manage such major incidents. Early recognition of the size and scope by the first responding companies supported by an emergency medical system well-versed in mass casualty incidents' played a major role in the management of this incident.
- Sectoring the incident from the beginning gained a level of control over the scene.
- There was tremendous confusion and concern among the passengers escaping the wreck. They surrounded first-in units, and some passengers removed equipment from the fire department vehicles. This hampered early rescue efforts and caused additional stress for all involved.
- Communications between sectors, EMS and Suppression, and all functions was hampered due to the limited number of radios and channels. This was especially true of "Med" channels (1), which confined the flow of casualty information from the site to triage and then to the hospitals.
- All sector officers; control zones and triage areas should be properly identified and marked with vests, tape/signs and flags respectively for greater visibility.
- Working crews, such as extrication, should not be relieved as a unit because of the loss of continuity in extended operations. If this is not possible, an officer or senior technician should be left to provide background information and coordination of efforts.
- Conventional rescue tools typical to fire department operations lack the capacity needed to work with rail equipment. While useful in common entrapment situations, standard extrication tools are of little value when applied to rail cars, truck assemblies, and other heavy components typical of rail equipment.

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## **Case Study Number Two**

### **Silver Spring, Maryland--February 16, 1996**

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At approximately 5:39 P.M. on February 16, 1996, an eastbound Maryland Rail Commuter (MARC) train (#286), collided with a westbound Amtrak passenger train (#29), the Capitol Limited, just north of Washington, D.C. The collision occurred during a storm that dropped 10 inches of snow on the Washington area. The MARC train was a push-pull commuter train consisting of the locomotive unit at the rear (or pushing). The engineer operated the controls pushing two passenger cars and a passenger coach with cab controls in the lead. The train had a crew of three and 20 passengers. The Amtrak train (#229), consisted of two-locomotives and 15 cars operated by a crew of 17 and carrying 164 passengers.

The MARC cab car struck the side of the second Amtrak locomotive as it was crossing over from one main track to another. Upon impact, the fuel tanks of the Amtrak locomotive ruptured and sprayed finely vaporized fuel into the passenger compartment of the MARC coach. Ignition was

almost immediate from one of many suspected sources. The MARC engineer was killed by blunt force trauma in an unsurvivable impact. The remaining crew and passengers survived the immediate impact, but were trapped by the fire. Eight of the passengers were unable to escape and succumbed to the effects of the fire.

At 17:42 hours, the 9-1-1 center began receiving many telephone calls reporting a train accident. The reports gave conflicting location information and different descriptions of the type of train. The dispatching center decided to send the assignment for a passenger train collision with the location at the rear of a nearby high-rise building, which is a familiar landmark for responders. The first fire unit on the scene reported two separate fires, one at the front of the train and one at the rear. A second alarm was requested and a report of injured victims was also transmitted.

The first unit attacked the fire in the MARC passenger cars, and assisting units were directed to the Amtrak locomotive, which was about 400 feet from the MARC fire. Deep snow, the limited access railbed, and uphill grading hampered access to the first locomotive. Firefighters utilized leader lines to advance long handlines to attack the fires. Access to the interior of the MARC car was only possible from an adjacent passenger car, which was used to confine and knock down the bulk of the fire.

The Incident Commander established command and placed all EMS communications on a separate radio channel. He directed assisting units to stage at a nearby intersection. Ambulatory passengers, many of them injured, were assisted by residents of the nearby high rise building who led the passengers into the shelter of their building. This location became the initial triage and treatment site. Public buses were routed to take injured passengers to nearby schools for temporary shelter.

Area hospitals were notified of the incident and placed on disaster alert status. Injuries ranged from minor abrasions to major fractures and respiratory burns. A total of 26 passengers and crewmembers required transport to hospitals. Eleven people died and 11 were injured on the MARC train. Eight of the deaths were due to fatal smoke and soot inhalation. The Amtrak train had no fatalities, but 15 injuries.

There are several issues important to note with regard to this accident:

- The exact location and extent of the incident was difficult to determine, as access was limited and difficult.
- Patient triage was difficult because local residents on both sides of the track gathered ambulatory patients and uninjured passengers into their homes. Responders had to go door-to-door to account for all the passengers.
- The county disaster plan, while supported by a well-organized incident command system, lacked provisions for coordination and communication with the rail operators and exact procedures for rail passenger emergencies.
- Rescue tools were unable to breach the MARC cars.
- The collision between the commuter rail and the Amtrak locomotive on the main track resulted in extreme damage to the commuter rail equipment, directly affecting survivability and rescue options.
- Communications were intense and some sensitive information was compromised over emergency radios and cellular telephones.
  - There was a lack of communication and coordination between the track owner (CSX), Amtrak, and MARC due to a lack of emergency planning by the stakeholders.

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## **Case Study Number Three**

### **Mobile, Alabama--September 22, 1993**

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On September 22, 1993 at approximately 3:00 A.M., Amtrak Train #2, The Sunset Limited, with 220 people on board, derailed on a bridge which crosses the 300 foot wide Big Bayou Canot in a delta area of wide creeks, cays, and swamps in the Mobile River area, northeast of Mobile near Chickasaw, Alabama.<sup>1</sup> A displaced girder span (38 inches to the west) caused the derailment. The misalignment had occurred when, 10 minutes before the Sunset Limited passed over the bridge, a tugboat shoving barges crashed into the bridge under heavy fog conditions.

The impact of the lead locomotive into the protruding girders, at 72 miles per hour, caused the derailment of all cars. The lead locomotive became buried in 46 feet of mud and the portion protruding above the embankment burned; so did the second locomotive, a baggage car, and a dorm-coach.

The conductor issued a “mayday” call over the railroad radio and was overheard by other rail equipment in the area. Calls were relayed to the train dispatch center in Jacksonville, Florida and to the Mobile, Alabama police department. Locating the crash was difficult due to the fact that all train operations personnel were killed in the crash and no one else knew the exact location of the train. For about 18 minutes, until 03:20 hours, confusion ensued as the area’s 9-1-1 operators attempted to determine the exact location of the accident site.

At 03:20 hours, a response was dispatched for the Mobile Fire Department consisting of a fireboat, three engines, a truck, rescue unit, a District Chief, and Medical Shift commander. The Coast Guard, area police and fire departments, and the Mobile County Emergency Management Agency were also notified at that time.

While enroute, the medical supervisor alerted the nearest Level I trauma center, the University of South Alabama Medical Center, in addition to pre-alerting aeromedical, private ambulances, and off-duty paramedics. (The EMS shift supervisor gave orders to first-arriving units to NOT perform CPR, endotracheal intubation, or aggressive advanced cardiac life support in anticipation of the potential for a large number of injured passengers.)

The first arriving unit was the Mobile Fire Department fireboat, which was slowed due to the same heavy fog conditions that caused the precipitating towboat accident. The fireboat confirmed the location of the crash and the fire conditions.

The crash site was very unsafe. The water is 20 feet deep, the rail bed is elevated and footing was unsure. Ties and rails and other obstacles presented physical hazards to rescuers. The only light, other than flashlights, was from the fire that burned in the rail cars and fuel tank. Daytime temperatures reached the mid-nineties with high humidity, a heat exhaustion hazard for rescuers.

The foggy conditions, darkness, and inherently confusing nature of the river and its tributaries complicated response and rescue. A diving team from the U.S. Marine Corps and divers from the State Bridge Inspections Diving Team arrived to conduct a methodical underwater search and to recover

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<sup>1</sup> See the U.S. Fire Administration’s Technical Rescue Incident Report, *The Derailment of the Sunset Limited, September 22, 1993*.

bodies from the submerged cars. The water in the bayou was dark brown and visibility inside the train cars was less than 12 inches. Debris and tight spaces made the environment that much more hazardous. Some of the divers used “Kirby-Morgan” helmets that have a tether which delivers surface-supplied breathing air, acts as a safety line, and enables communications with personnel on the surface.

After determining that there were no survivors among the passengers who were submerged, (actually, twenty-eight people had been pulled from the water by two private towboats), the Mobile fireboat, “Ramona Doyle”, commenced to extinguish the fires.

Response personnel were unable to locate a good road access and the District Chief established command at a nearby paper mill. That site was chosen because it was the only location near the crash site that offered road and rail-based access to the crash site. A “rescue train” was assembled consisting of the first-in crews and all of the easily portable rescue equipment from their vehicles. The task force leader organized the three-car train into a treatment area: the dining car, which had tables and could then be used as treatment platform; the middle car which carried the supplies; and a third car for the “walking wounded.” The task force leader used the 30-minute travel time to organize the effort and it was of great benefit.

The rescue train task force arrived at 5:20 A.M. and performed primary search of the area. Once the primary search had been completed, the task force leader sent the train back with 125 patients (lightly injured) and emergency medical personnel. Once the train left, secondary search was performed and no further passengers were located.

The rescue train transported the wounded to the paper mill command post area and other injured passengers were transported to the south side of the river via private towboats. The triage/treatment/and transport operation was managed from the paper mill property and by 8:00 A.M. had transported the last patient. Mobile County EMS personnel triaged, treated, and transported all of the 28 survivors on the west side of the river by 8:30 A.M. At this point, the operation reverted to recovery of remains and assisting National Transportation Safety Board and Federal Railroad Administration personnel in the investigation.

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## **Case Study Number Four**

### **Hyder, Arizona—October 9, 1995**

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On October 9, 1995, at 1:40 A.M., the Amtrak train “Sunset Limited”, enroute from Miami to Los Angeles, derailed as it passed over a bridge crossing a dry creek wash approximately 60 miles southwest of Phoenix, Arizona. The area where the derailment occurred has been described by all concerned as “remote” and was accessible only by helicopter or four-wheel drive vehicles. The inaccessibility of the location and sheer number of injured presented severe challenges to rescue personnel.

The 12-car train, carrying 248 passengers, (mostly senior citizens), and 20 crew members was traveling at around 55 mph when the five cars following the locomotive, sleeping cars, dining car and crew dormitory car, derailed. One Amtrak sleeper car attendant was killed on impact, and nearly 100 people were injured in the crash. The accident was the result of sabotage; both passengers and

responders discovered evidence of tampering on the track. The criminal aspect of the scene did not affect emergency medical and rescue operations, except that barrier tape was set up, and a member of the sheriffs posse stood watch.

There was initial misinformation and confusion as to the exact location of the incident. The train employee who reported the derailment gave a milepost marker for the railroad that did not coordinate with milepost markers on the roadway. This placed the perceived location far to the west of the actual incident. Reporting calls circulated for about 20 minutes between the Department of Public Safety, Phoenix Police Department, and Maricopa and Mojave County Sheriffs' office trying to identify exactly where the derailment was. Sheriffs deputies, who patrol the area where the derailment occurred, finally pinpointed the location shortly after 2:00 A.M.

When the Town of Buckley's police dispatcher received a call from one of the Sheriffs departments, details were sketchy. Based on the description of the number of potential injuries the dispatcher conferred with the local fire chief and decided to call for ambulances, helicopters, and fire personnel.

When it became clear that four-wheel drive vehicles would be needed to reach the area, supplies were off-loaded from fire equipment to private vehicles, and helicopters were placed on stand by. Local paramedics arrived in their own four-wheel drive vehicles and started evaluating patients. Shortly thereafter, three aeromedical helicopters arrived. One, from Samaritan AirEvac, carried an experienced flight nurse who had served 12 years as a paramedic. The nurse set up the basic incident command structure. He had to deviate from normal procedures due to the small amount of resources and the large number of patients.

The triage function was combined with treatment, and as more responders arrived, greater attention was given to the treatment phase. Another problem was the shortage of triage tags. The crews responded by using 3 inch tape to record vitals and other patient information and stuck it on the head of each patient. Another area of improvisation was the use of the many spare pillows, blankets, and mattresses carried on the train. These were used to good advantage to keep the patients warm and stable.

The disaster situation was complicated by the fact that passengers had been pulled through the train windows by the on-board crews and were lying on the sides (now tops) of the rail cars. This exposed the passengers, many of them elderly, to the cold desert night air. Hypothermia and falls became a major concern. Passengers who were able to walk were directed to adjacent cars, partially upright, that afforded a short descent to the ground. Ladders were also required for a part of this operation, which increased the danger of fall injuries. Passengers were directed to self-help as much as possible, and many assisted the paramedics in treating others.

The triage area was set up in the dry creek wash bed and patients were classified as to Priority Level 1, 2, or 3. Patients were immobilized with spine boards, cervical collars, and half-backboards.

The decision was made to airlift only the Priority I patients directly to hospitals. Others were air-shuttled to collection points or secondary triage about seven miles from the wreck. The Level I patients consisted of those who were suffering extremity fractures, head and spine injuries, intra-abdominal trauma, and altered levels of consciousness. One patient suffered a heart attack and others were affected by cardiac-related chest pains and asthma attacks.

EMS personnel on scene packaged and flew out 120 patients--12 Level 1 and approximately 40 Level 2's and 3's. Walking wounded rounded out the numbers. A call was placed to Luke Air Force



base hospital, a small base operation, requesting medical assistance. Five physicians and 10 EMTs responded in two ambulances and a staff car with as much medical supplies and water as they could carry. One of the doctors was placed at the triage area and another at the collection area prioritizing helicopter transport and destinations. One of the physicians was requested at the crash site.

A total of 46 ambulances, 15 fire vehicles, and 10 privately owned four-wheel drive vehicles assisted. Eight non-medical helicopters from State and county agencies, Army, Marines, and National Guard assisted a dozen civilian aeromedical helicopters. Eleven of the patients were received at Luke Army hospital (not a trauma center), because civilian hospitals could not accept the heavier military helicopters. Fuel support for the helicopters had to be improvised and was solved by enlisting a local cropdusting operation that opened up their landing area for the choppers to land and re-fuel.

Communications was a major problem. Different agencies and frequencies, the lack of a repeater-based system, and rugged terrain made long-range communication impossible. A satellite cell phone system was available from the Phoenix units, but the news media soon tied up all the cell sites.

While responders did an excellent job of coping with the situation, this incident highlights the importance of the basic incident management practices and supplies needed to safely and efficiently manage an incident of this magnitude. The remoteness of the crash site necessitated improvisation in many areas.

The lack of simple items such as triage tags and zone markings; and the lack of practiced procedures or unified radio communications complicated patient care. For example, confusion arose in the flow of patients from the initial triage area to the treatment and transport zones. Some patients were classified more than once, and others received an inordinate amount of time and attention in relation to the scope of their injuries. This in no way reflects on the professionalism and abilities of the responders, but reinforces the need for clear scene management practices.

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## **Case Study Number Five**

### **Lugoff, South Carolina--July 31, 1991**

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On July 31, 1991, at 5:01 A.M., Amtrak train (#82), the Silver Star, derailed on CSX tracks near Lugoff, South Carolina. In addition to the eight fatalities, there were 12 passengers with serious injuries, and 12 crewmembers and 53 passengers who sustained minor injuries. Altogether, 22 crewmembers and 407 passengers were on board.

Emergency response was delayed due to confusion about where the incident occurred. Communications problems, both procedural and equipment-based, also delayed coordination with CSX and Amtrak. It was not until 5:12 A.M.--eleven minutes after the derailment -- that the CSX dispatcher contacted the Kershaw County EMS dispatcher and reported a train "derailed right out of Lugoff, headed toward Camden". When he asked for a phone number, the dispatcher was given an incorrect number. After attempting to contact the CSX dispatcher, Kershaw County EMS dispatched two deputies at 5:18 A.M. The deputies searched local road crossings and found nothing. Then, a report was heard on the countywide radio from a nearby plant that there was a train on the "Dupont siding". EMS responded to that site at 5:33 A.M.

Despite the delay in notification, medical response was timely. At 5:40 A.M., an EMS supervisor and three ambulances arrived and commenced triage. A command post and medical treatment area was immediately established near the last coach. A staging area for emergency vehicles and evacuation buses was identified at the Dupont parking lot. At 5:50 A.M. the EMS supervisor notified the Kershaw County Medical Hospital to expect a high number of patients. The hospital activated its disaster plan and called in 100 employees and volunteers. One doctor went to the disaster site. In addition to Kershaw County Medical, two hospitals in Columbia also received patients. By 9:00 A.M. all injured passengers had been taken to hospitals. The passenger evacuation continued until 11:15 when the last passengers were bussed out. At noon, the emergency preparedness director turned the site over to CSX.

CSX had held hazardous materials drills within the CSX division. However, CSX or Amtrak had performed no other types of simulated disaster drills with the local fire departments.

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## **Case Study Number Six**

### **Near Essex Junction, Vermont--July 7, 1984**

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At 6:50 A.M. on July 7, 1984, train # 60 enroute to Washington, DC from Montreal, Quebec derailed while passing over a washed out section of gravel embankment under the Central Vermont Railway near Essex Junction, VT. Two locomotive units and the forward seven of 13 cars (two locomotives, one baggage car, two sleeping cars, two food service cars, and eight coaches) derailed and were heavily damaged. The washout was caused by a prolonged period of extremely heavy local downpours that destroyed the railroad support embankment. Of the 294 persons on board, five people died, 29 presented with serious injuries, and 260 had minor or no injuries.

The derailment was reported by a nearby citizen who reported hearing a loud noise and seeing smoke rising from the area. The Essex Police dispatched two squad cars to investigate. At 6:59 A.M., the police monitored citizen band radio traffic which was reporting a train derailment, and EPD dispatched rescue, heavy rescue, and fire department units to the scene. The first response person on the scene was an emergency control technician from the nearby IBM plant. He was unable to access the scene completely, but after walking to the site, he made a radio report to the IBM base station. The station relayed the information, the exact location, and a situation report to emergency responders. By 8:15 A.M., the mass casualty plan was activated, bringing 19 fire department and 19 rescue units to the scene. State officials were on the scene to direct emergency response at 8:00 A.M.

The Vermont National Guard was assembled at the nearby Williston Armory for annual summer maneuvers. In addition to the availability of helicopters, VGuard units provided bulldozers, cranes, lighting, personnel and other equipment to the scene. The Vermont State Police established a command post at 9:00 A.M. and established controlled access to the crash site.

Initial rescue efforts were hampered by the limited access to the site. A road leading to the nearby landfill was the only access to the crash scene. The closest point was uphill and over three fourths of a mile from the dirt/gravel landfill road.

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## **Case Study Number Seven**

### **Near Intercession City, Florida--November 30, 1993**

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On November 30, 1993, Amtrak train (#88), the Silver Meteor, carrying 89 passengers in seven cars, collided with an oversized tractor trailer combination at a privately maintained grade crossing. The locomotive and the first four cars derailed. Six people sustained serious injuries and 53 people suffered minor injuries.

The first call was received at the Osceola County Communications Center at 12:45 P.M. and eight fire and rescue units responded. The Osceola County responding Battalion Chief assumed incident command and established a command post and triage area when he arrived on the scene. He radioed for area hospitals to activate their disaster plans and requested medical evacuation helicopters. The Incident Commander directed responders in their efforts to extricate crewmembers from entrapment in the locomotive and to conduct primary and secondary search of each rail car to locate, triage, and tag patients. There was no fire.

Responders had evacuated all passengers from the train by 1:37 P.M. By 3:15 P.M., response personnel had transported 59 injured to area hospitals. The response included 25 paramedics, 29 emergency medical technicians and 18 firefighters. While the response went smoothly, a troubling aspect of the incident was the location of two underground high-pressure pipelines in the right-of-way on each side of the tracks. Emergency personnel either did not see (due to accident debris) or did not recognize the pipeline markers. The map marking these pipelines had been placed in the Battalion Chiefs car without his knowledge and no one else on the scene or in the EOC knew of the existence and location of the pipelines.

The pipeline owner/operator notified the rail bed owner (CSX) of the pipeline, and it was only by chance that an off-duty pipeline employee brought this to the attention of the terminal operator. Instead of immediately notifying the rail line or the responders, the pipeline operators sent a crew to the scene. It was not until 3:00 PM that the operator notified the Incident Commander about the pipelines. The pipeline operator did not advise any cautionary action until a manager arrived on the site at 5:40 P.M.

At that time, it was suggested that the removal and recovery crews not operate heavy machinery over or near the pipelines because of the possibility of fire or explosion.

A similar derailment with buried pipeline in a railroad right-of-way in San Bernardino, CA, resulted in heavy equipment damaging the pipeline which ruptured 13 days later and caused a fire that killed two, injured 19, and destroyed 11 homes.

The NTSB documented the need for better communication between the pipeline operators, the rail line and the emergency responders. The local emergency management organizations were directed to "establish procedures for prompt notifications to all involved parties including public safety officials, following a transportation accident and establish comprehensive plans for monitoring and maintaining protective control measures during wreck clearing operations."

The NTSB also concluded that the emergency responder failed to determine and assess the risks posed by the potentially hazardous pipeline at the accident site. A breach in the hazardous liquid pipeline during rescue or wreckage recovery operations would have resulted in the release of a highly flammable product, which could have caused serious burn injuries and/or property damage.

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## **Case Study Number Eight**

### **Ft. Lauderdale, Florida--March 17, 1993**

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On March 17, 1993, Amtrak train (#91), the Silver Star, with a locomotive and 11 cars, struck a fully loaded (8,500-gallon) gasoline tanker at a grade crossing. The tank was punctured and fire ensued immediately engulfing the truck and nine other vehicles. The tank truck driver and five occupants of the stopped vehicles suffered fatal burns. Nineteen people on the train, (11 passengers and eight crewmembers) were injured, but did not require hospitalization.

The Broward County Fire Department was notified at 3:14 P.M. and the first units arrived on the scene at 3:25 P.M. A command post was set up within 100 yards of the collision site and the fire was under control at 4:07 P.M. The response, which derived from four different jurisdictions, was timely and effective.

This incident highlights the potential danger of motor carrier tanks of highly flammable cargo being routed on road if that cross railroad tracks. The fact that the tank truck spun away from the train upon intact, and sprayed most of the flammable liquid away from the train cars, prevented many serious burn injuries to the passengers. The rapid knockdown of the fire was also instrumental in preventing further injuries to the passengers.

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## **Case Study Number Nine**

### **Fox River Grove, Illinois--October 25, 1995**

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On October 25, 1995, at 7:10 A.M., a Northeast Illinois Regional Commuter Rail Corporation (METRA) train struck the left rear of a school bus at a highway-rail crossing in Fox River Grove, IL. The bus had stopped for a red light with the rear of the bus extending over the track and into the path of the oncoming train. Of the 35 school bus passengers, seven sustained fatal injuries, 24 were seriously injured, and four were uninjured. The school bus driver received minor injuries and the three-train crew members and the estimated 120 passengers were uninjured.

The Fox River Grove Police Chief made the first call via his portable radio, after witnessing the collision. The Fox River Grove Fire Department was called at 7:13 A.M. and responded at 7:18 A.M. with an ambulance, pumper, four EMTs, and two paramedics. The Fox River Grove Assistant Fire Chief responded as well and set up incident command with himself as Incident Commander. He requested a third alarm under the Mutual Aid Box Alarm System. Triage areas were established on both sides of the school bus. Twenty ambulances from 18 fire departments as well as two helicopters transported 32 injured passengers to area hospitals. The local hospital activated its disaster plan as well and dispatched a physician to the scene at 7:27 A.M.

An estimated 90 fire and rescue response personnel and the county coroners office responded. The triage officer and a paramedic directed the treatment and transportation of victims. In less than 90 minutes from the time of the collision, all of the seriously injured passengers had been transported to one of seven hospitals. Among the issues in this incident are the high visibility and media coverage, which drew many undispached resources and curiosity-seekers. The nature of the injuries and age of the victims necessitated extensive on-site and follow up incident stress debriefings.

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## **Case Study Number Ten**

### **Union Square Station, New York City--August 28, 1991**

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On August 28, 1991, a 10-car subway train derailed at a crossover as it entered the Union Square Station at approximately 12:12 A.M. The lead car left the tracks and impacted the crash walls between the tracks of the local and express lines. A concrete and steel pillar sheared the lead car diagonally, with half folding over the crash walls and the other half continuing another 250 feet down the local track.

The next car also struck the collision wall and bisected the car near its midpoint. These two cars were destroyed and the next three cars were substantially damaged. Passengers were trapped in awkward positions and hard-to-reach locations by the shearing action of the impact.

Transit Police officers responded almost immediately and radio notification was made at 12:16 A.M. New York City Fire Department (FDNY), Emergency Medical Service (EMS), and New York City Police Department (NYPD) units were dispatched and responded immediately. Among the first to arrive were six units of the FDNY at 12:24 A.M. As the actual number of injuries increased beyond initial estimates, EMS operations managers held over personnel from the off-going shift and began staffing reserve ambulances. EMS also coordinated with NYPD to clear a traffic pattern as a staging area for arriving ambulances in the street above the station.

Eventually, 48 basic life support units, 17 advanced life support units, five volunteer ambulances, five rescue squads, and three medical supply units responded, in addition to numerous engine and ladder companies.

EMS and FDNY response personnel established a triage area on the Union Square Station platform with the field treatment area located at the street level. Both in the intact train cars and on the platform, seriously injured passengers were prepared for immediate transfer by ambulance to 13 area hospitals, three of which were trauma centers. The EMS personnel escorted the less severely injured passengers onto Transit Authority buses, which drove them to hospitals farther from the incident area. EMS Special Operations Division moved its field command/communications vehicle into the area and set up a command post at the Union Square east subway entrance.

The proximity of the derailment to the station platform facilitated evacuation of the injured but extrication, rescue, treatment, and transport of the injured still required extensive resources. During the first hour, five trapped passengers were extricated and taken to an emergency treatment area. During the next two hours, the rescuers concentrated on the additional passengers trapped in the debris. Emergency response personnel worked under conditions of extreme heat and poor ventilation. Because radio signals could not be sent past line of sight, a preplanned relay system with firefighters posted at prescribed intervals was used to transmit radio messages. Verbal communications and hand signals were also used to relay messages from the track to the platform to the street.

Despite the below grade locations and large number of passengers, the majority of the injured passengers were at, or in the process of being transferred to, a medical facility within two hours of the accident. The last passenger, who had been pinned under the wreckage of the second car, was rescued by 3:15 A.M. The five fatalities died almost instantly from blunt-force trauma or exanguination from amputation. Of the estimated 216 passengers on board, 121 were transported to hospitals and 16 were admitted. The total transported included 24 response personnel who suffered heat-related injuries or minor bruises or cuts.

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## **Case Study Number Eleven**

### **Stockton, California--December 19, 1989**

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On December 19, 1989, Amtrak train (#708) consisting of one locomotive and five passenger cars carrying seven crewmembers and 150 passengers, struck a tractor-trailer at a highway grade crossing near Stockton, California. The collision caused the derailment of all cars and the locomotive.

The locomotive detached from the rest of the cars and came to rest on its side; one passenger car rolled on its side as well. The California Highway Patrol (CHP) area communications center received the first call from a resident near the scene at 9:38 A.M. They dispatched personnel and requested assistance from the Stockton Police Department. The Highway Patrol assumed overall command of the incident site.

The Stockton Police received a 9-1-1 call as well and transferred the call to the Stockton Fire Department who also notified the San Joaquin County Communications Center. Fire units were dispatched at 9:40 A.M. The accident occurred in the first due area of the Colledgeville Volunteer Fire Department who were the first responders on the scene at 9:58 A.M.

When the Stockton fire units arrived, they established a joint incident command system for suppression and rescue activities with the CHP assigned the role of incident command. Fire units were greeted with a fuel-fed fire in the locomotive, caused by leaking tanks. Several thousand gallons of fuel leaked out and pooled in a depression under the locomotive, making final extinguishment difficult. Firefighters needed about 2-1/2 hours with NEFF to fully extinguish the deep-seated fire.

The emergency medical and rescue activities were completed utilizing ambulance paramedics and cross-trained firefighter/EMTs. Initial triage was performed at the train site. The uninjured and slightly injured were taken to a nearby building for further triage and identification. Because this was an unmanifested train, a complete passenger list was unavailable.

The more seriously injured were taken to five area hospitals. Both the City of Stockton and San Joaquin County disaster plans were activated. Eventually, nine fire departments and eleven ambulances responded to the incident.

Response agencies that were involved collaborated on an after action critique. They noted problem areas involving training and a limited experience in the Incident Command System (ICS), a lack of availability of ICS position vests, and radio incompatibility. The first issues were either resolved or recognized as an area needing improvement. The critique resulted in the decision by the County Office of Emergency Services to implement the State OES California OnScene Coordination frequency (CALCORD) for use by all county agencies. This frequency enables fire, police, emergency service personnel, and other affected agencies to have a common VHF frequency for communication during the incident.

## **CONCLUSION**

Rail emergencies are among the most challenging incidents facing fire departments. However, since rail emergencies do not occur frequently, if at all, in every jurisdiction, planning and joint training for these scenarios are anything but common. Given the case study information derived from incidents such as those profiled in this report, it is evident that departments should consider what types of equipment, medical supplies, and means of transport would be required should a disaster on the rails occur. Command issues need to be discussed jointly with other first responder agencies and among neighboring jurisdictions. Should a rail emergency occur, departments will be glad that they invested some time in planning for such an event, because the possibility of a mass casualty incident with tactical challenges faces the fire service in every corner of the United States.