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MTI MINETA TRANSPORTATION INSTITUTE

Managerial Personnel Respond: Augment the Emergency Operations Center for Extreme Events

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MINETA TRANSPORTATION INSTITUTE

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REPORT 2415.10

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16. Abstract

Railroads have been managing normal emergencies for more than 150 years. They have plans and equipment, such as snow sheds and fire trains, to respond to normal emergencies. As the average temperature on Earth rises, more frequent and more extreme weather-related emergencies are placing new demands on railroads, which operate in an open and unprotected environment. Preparing an emergency operations center for the railroad, and preparing to join a regional response to wildfires, hurricanes, tornadoes, floods and other extreme events is good risk management.

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INTRODUCTION

North American railroads have over 140,000 miles of track spanning the continent. They have been dealing with normal emergencies—events that recur without serious long- term consequences—for over 150 years. They have playbooks and systems in place to mitigate the likelihood of occurrence or the damage to railroad property. They have response plans to manage normal emergencies when they occur, using railroad resources and coordinating with local first responders. However, a new normal is being created by changes in global temperatures, and new complexities have been created by interdisciplinary dependencies.

The Intergovernmental Panel on Climate Change (IPCC) published the First Assessment Report in 1990 that evaluated the impacts of climate change on weather (IPCC, 1990). Since that time four more assessments have been completed showing the impacts of greenhouse gas emissions and global warming on issues like sea level rise and storm intensities (IPCC, 2014), which impact railroad operations.

As global warming progresses the strength of storms, sea level rise, and wildfire risk are all increasing, potentially impacting railroad infrastructure in ways that normal emergencies have not done in the past. New adaptation measures, including emergency response coordination strategies, will be needed to keep the trains moving.

Former Federal Emergency Management Agency (FEMA) Director James Lee Witt has provided the key steps for disaster resilience:

1. “Developing comprehensive emergency response frameworks that are regularly updated, tested, and aligned with evolving threats.

2. Establishing dedicated contingency or ‘rainy day’ funds to maintain financial flexibility and ensure rapid mobilization of resources during crises.

3. Investing in training and capacity-building to empower teams with the skills and confidence to respond effectively under pressure.

4. Fostering cross-sector collaboration to strengthen coordination and resource-sharing across jurisdictions and industries.

5. Leveraging data and technology to enhance early warning systems, risk assessments, and real-time decision-making.” (J.L. Witt, personal communication, May 22, 2025).

Preparing emergency management strategies for weather-related emergencies addresses three of these issues. The emergency response frameworks (Incident Command System) enable railroads to assemble resources and personnel (Address the Problem: Emergency Plan for Extreme Events), while using data and technology (THIRA) to inform the types of normal emergencies and extreme events that will be planned for. This guide focuses on the importance of cross-sector collaboration (Augment the Emergency Operations Center for Extreme Events), considering which agencies will be part of response and recovery for critical events, and how the railroad can organize its resources to benefit from multi-jurisdictional and interdisciplinary participation. Railroads may use physical or virtual emergency management facilities, from a repurposed conference room to a technology-informed sophisticated emergency operations center.

This guide begins with an overview of normal emergencies unrelated to weather, seasonal and cyclical weather-related emergencies, and weather-related extreme events. In each case a brief description of the likely incident response is provided, noting the use of the Incident Command System (ICS) for organizing the various agencies. The guide ends with some considerations for enhancing an existing emergency management strategy to support the emergency plans for extreme events that are becoming more widespread as a result of rising global average temperatures and related weather phenomena.

NORMAL EMERGENCIES

Normal emergencies may be related to natural causes, technological failures, and human actions, including greenhouse gas emissions. The threat and hazard inventory and risk assessment (THIRA) process allows a railroad to evaluate the geographic and social conditions near its tracks and estimate the likely emergencies that may occur near its route segments (Edwards and Goodrich, 2024). Table 1 lists normal emergencies that railroads anticipate, and for which a response is planned. For example, Norfolk Southern has published a *Railroad Emergency Response Planning Guide* (2018) with a focus on hazardous materials accidents.

Table 1. Threats and Hazards by Category: Normal Emergencies

Natural	***Technological***	***Human-Caused***
Drought	Aviation accident	Active shooter
Earthquake	Dam failure	Armed assault
Epidemic/pandemic	Derailment	Biological attack
Floods	Hazardous materials release	Chemical attack
Heat wave, sustained	Landslide	Collision
Hurricane/monsoon	Levee failure	Cyberattack against data
Sea level rise	Pipeline accident	Explosive attack
Space weather	Radiological accident	Improvised explosive device (IED) attack
Tornado	Train accident	Nuclear terrorism
Wildland interface fire	Transportation accident	Physical attack on system
Winter storms	Urban conflagration	Radiological attack
	Utility disruption	Trespass/Suicide Death
	Pipeline accident	

Source: Department of Homeland Security, 2015, p. 4-5.

NORMAL EMERGENCIES UNRELATED TO WEATHER

Many of the most common normal emergencies are unrelated to weather or climate change. Collisions between trains and other vehicles occur about 1,600 times per year. Most happen at grade crossings, and many result in deaths and severe injuries, and disruption of rail service. Although rail companies and government transportation departments install warning devices and barriers, motorists, bicyclists, and pedestrians make bad decisions about obeying the warnings and end up in accidents (National Highway Safety Administration, n.d.).

Trespasser deaths are another type of normal emergency that disrupts rail operations and devastates train crews. In 2023 there were 715 trespasser deaths, and in 2024 there were 821 people who died while trespassing on rail property (National Safety Council, 2025). Some deaths are accidental and some are suicides. The Federal Railroad Administration has publications for railroads and local governments to try to prevent railroad-related deaths, such as the *Trespass and Suicide Prevention Handbook* (Federal Railroad Administration, 2025). The International Union of Railways (UIC) has published posters and a video in multiple languages, called “Stay Off the Tracks: Safe Decisions Every Time,” to emphasize the importance of safe decision-making at railroad crossings (UIC, 2025).

Collision events and trespasser deaths draw the local community fire department responders to the scene for rescue and lifesaving services. Law enforcement personnel direct traffic and investigate the accident scene. The railroad conductor is responsible for finding any bodies or other remains and preserving the evidence until the coroner arrives (Trent Bachman, personnel communication, May 13, 2025). This represents a collaboration between local first responders and rail personnel, usually involving just a few dozen people. In many jurisdictions the Incident Command System (ICS) will be used to coordinate the work of the various agencies (Edwards and Goodrich, 2025).

Derailments are another common normal emergency, not usually related to weather, with an average of 3 per day or 1,000 per year (Hernandez, 2023). Most occur in the rail yard and cause little disruption. Rerailing is relatively rapid and routine. The most common causes of derailments are human error and track failures (Hernandez, 2023). However, some derailments are caused by wheel bearings catching fire and can lead to multiple cars leaving the tracks, often with hazardous materials being released from tank cars in the consist. The 2023 Norfolk Southern derailment in East Palestine, Ohio, was an example of a very severe emergency, but unrelated to weather (National Transportation Safety Board, 2024).

Figure 1. Rail consist with hazardous materials tank cars

Source: F. Edwards

Hazardous materials accidents and spills are another common normal emergency that are thoroughly planned for. Tank cars, shown in Figure 1, are designed to resist spilling their loads when accidents occur, but older tank cars may fail in a serious derailment or collision. In 2022 there were 337 hazardous materials leaks and spills on the railroad, but only 32 were classified as serious (Fraser and Abdollah, 2023). The Pipeline and Hazardous Materials Safety Administration has created a guide to managing normal emergencies involving hazardous materials leaks and spills using the Incident Command System (US DOT, 2018).

Unless the derailment leads to a hazardous materials spill, or to a serious injury or death to railroad personnel, there is generally no need for local first responders to be involved in the resolution of the event. The most serious events may rise to the level of extreme events with multiple jurisdictions and professions being involved in the response and recovery efforts and the use of ICS to coordinate the work.

If a normal emergency requires a response by local law enforcement or fire personnel, the railroad will usually be represented in the field by the conductor, who will serve as the subject matter expert for the public safety Incident Commander (IC). The conductor will be able to explain the railroad operations involved in the normal emergency, and coordinate with the railroad dispatch center to ensure that the rail operations are managed for the safety of everyone involved in the event. When the emergency site is cleared, the conductor will notify the dispatch center that normal operations can resume.

NORMAL EMERGENCIES RELATED TO WEATHER

Seasonal and cyclical weather is also considered in railroad planning for normal emergencies. Adaptation steps like raising bridges, enlarging culverts, and reinforcing buildings are taken to minimize the impact of regional weather-related threats like storms, floods, and high winds. For example, Union Pacific has a guide called *How to Prepare for Hurricanes* (2020) that gives specific guidance for railroad measures before the storm and after landfall.

High heat is a weather-related event that is being exacerbated by the rising levels of greenhouse gasses (IPCC, 2014). Railroad tracks are laid with the rail at the highest average temperature for that portion of the route (J. Moller, personal communication, April 14, 2025). Traditionally the rails were secured with wooden ties and iron spikes, then allowed to cool in place. Track buckling, also called sun kinks, as shown in Figure 2, occurs when the rail is subjected to higher-than-expected temperatures, causing the rail to expand and deform against the ties and spikes.

Figure 2. Buckled rail (sun kink) from extreme heat

Source: National Oceanic and Atmospheric Administration, 2017.

Sun kinks cause an average of 50 derailments per year, at a cost of about $1 million in loss and damage per event in 2014 dollars (Magill, 2014). A 2019 study found that delays caused by sun kinks in track could lead to $103 billion in railroad operating losses by 2100 (Chinowski, et al.). A recent study by the International Union of Railways (UIC) in Europe found that high heat creates thermal expansion and higher stress on the rail structure, amplifying the stress from heavy rail traffic. Reduced nighttime cooling maintains these higher stresses for a longer period (Blanco and Diaz, 2025).

In 2012 the Federal Railroad Administration (FRA) issued a safety advisory on continuous welded rail (CWR) buckling from high heat that was published in the *Federal Register*. It recommended inspections for conditions that could lead to buckling. The advisory emphasized the importance of employee training on conditions that could lead to track buckling, and of frequent inspections of tracks in critical areas at fixed structures or where buckling has occurred in the past. The guide suggests that speed restrictions should be used during periods of high heat to minimize the likelihood of derailments, especially in populated areas.

Snow storms are common in many parts of the United States, especially in areas with alpine weather conditions. While tracks provide a more stable operating environment than roads, railroads still have to plan for heavy snow storms. Steel rails can be impacted by freezing temperatures and covered by snow drifts, and air brake hoses can freeze. Special sensors alert train operators to track damage, such as splitting from freezing temperatures

(Union Pacific, 2022a). In some areas with heavy snow, the railroads have historically built snow sheds where trains can shelter until storms have passed (BNSF, 2021).

Union Pacific (UP) begins planning in fall by activating special equipment to clear its routes (Union Pacific, 2022a). For example, UP maintains a special snow removal train set at its Dunsmuir station just south of Mount Shasta in California, as shown in Figures 3 and 4, that can use cool air to blow snow from the tracks and right of way along the mountain routes. For heavier snow build-up, bulldozers, Jordan spreaders, and rotary snow plows with spinning blades are used (Association of American Railroads, n.d.). Heaters keep switches from freezing. Special locomotives with air brake dryers, heated headlights, and automatic systems to keep locomotives warm even when they are powered down all help to keep the trains moving even in winter weather. An extra engine may be added to the consist to maintain air pressure for the brakes during freezing weather. “Blizzard busses” are cabooses with extra winter supplies that can provide shelter for train crews. “Snow busses” are locomotives that run across tracks every few hours to keep them open (Union Pacific, 2022a).

Figure 3. Union Pacific snow removal train, Dunsmuir, California.

Source: F. Edwards

Figure 4. Union Pacific snow removal train, Dunsmuir, California.

Source: F. Edwards

Railroads might also use private weather forecasters to inform them of the need for advanced planning when storms are expected. Dispatchers can then reroute trains to avoid blizzards. Union Pacific (UP) has a 24-hour Weather Command Center, which watches for conditions that might cause damage, and construction engineers and maintenance staff who are ready to repair storm damage to signals, switches, and other critical equipment (Union Pacific, 2022a). UP also offers its customers a Winter Weather Action Plan (Union Pacific, 2022b).

The outcome of heavy precipitation may be flooding, mudslides and landslides. Railroads have historical records of areas where these conditions typically exist, and strengthen the infrastructure in those locations to be resilient to storm conditions. When a flood is anticipated, they may stage loaded rail cars on bridges to weigh them down. Engineering activities like building levees and seawalls are proactive efforts to protect the railroad right of way. "Water can weaken bridges, wash away ballast, and damage signaling systems" (Association of American Railroads, n.d., n.p.). After flooding, drones and ground penetrating radar are used to assess damage to railroad bridges, rail yards, and track conditions to support the rapid restoration of facilities and services (Association of American Railroads, n.d.).

Wildfires are another weather-related event that can impact railroad operations. They used to be considered seasonal, but now such fires can happen more frequently in many environments. For example, in California wildfire risk is almost year-round, with two of the most disastrous events—the Pacific Palisades Fire and the Eden Fire—occurring in the Los Angeles County area in January, 2025 (Laschinsky and Nichols, 2025). Railroad weather monitoring centers track low humidity and high wind conditions that can lead to rapid spread of wildfires, whether caused by arson, electricity transmission equipment, or lightning strikes. For example, in August of 2020 over 12,000 lightning strikes within seven days ignited wildfires all over northern California, including two of the three largest fires in state history up to that time (Linton, 2020). High heat makes lightning strikes more likely, often resulting in damage to electrical systems or setting off wildfires (Kim, 2025). Railroads respond by rerouting trains around wildfires, and relocating personnel and equipment away from the fires, when possible (Association of American Railroads, n.d.).

Railroads also proactively prepare for wildfires. Both Union Pacific and BNSF have fire trains that carry water and fire retardant to the site of wildfires near the tracks. The trains can fight fires up to 30 feet from the track, and can cover bridges, switches, and other vulnerable infrastructure with fire retardant to lessen damage if the fire burns over railroad property (Franz, 2023; BNSF, 2019).

Figure 5. BNSF Fire Train assisting CalFire in Lassen County, 2022.

Source: CalFire Incident Management Team 3.

Figure 6. BNSF Fire Train with CalFire personnel

Source: Incident Management Team 3, CalFire

The BNSF firefighting train that was deployed to help Cal Fire in Lassen County in January of 2022 consisted of "two locomotives, one fire suppression car, two water tenders and a caboose...with firefighting nozzles and 56,000 gallons of water or fire retardant" (CalFire, 2022), as shown in Figures 5 and 6. A team of CalFire hazardous materials specialists sprayed fire retardant over the smoldering rail ties and valuable infrastructure like bridges and trackside sensors. They also sprayed vegetation adjacent to the tracks to create a firefighter safety zone. This is an example of how railroads and public safety personnel collaborate during normal emergencies.

EMERGENCY MANAGEMENT FOR NORMAL EMERGENCIES

In a large wildfire like the fire in Lassen County, California, the fire would be fought by multiple mutual aid fire departments using the ICS, as mandated by Homeland Security Presidential Directive 5 (HSPD-5) (Bush, 2003). They would establish a large incident command post, perhaps also including federal firefighting assets like the Department of Forestry. When the railroad provides an asset to assist with firefighting, a railroad representative would be part of the Operations Section, managing the deployment and use of the railroad's equipment. In a small wildfire, or in the early stages of fighting a wildfire, the railroad representative might serve as a subject matter expert in the Planning/ Intelligence Section at the Incident Command Post, advising on railroad resources that might be offered for firefighting, like a fire train, if it were located in the area.

Figure 7. Emergency operations center, Amtrak South Station, Boston
Source: F. Edwards

During normal emergencies, the railroad might open its own emergency management center where it could coordinate the work of the crews responding to the emergency and those managing the recovery from the event, as shown in Figure 7. Management personnel representing construction, engineering, maintenance-of-way, and rail operations would collaborate to resolve the normal emergency and resume operations as quickly as possible. Railroads have their own systems for managing such events, often based on the role of the day-to-day department operations in resolving the issue. A small emergency operations center might be established, or representatives might collaborate in a conference room as depicted in Figure 7, or through phone calls or video conferences using technology like Zoom or Microsoft Teams.

EXTREME EVENTS

As the IPCC has predicted, weather-related natural hazards are accelerating in frequency and intensity as the average temperature on Earth warms (IPCC, 2014). Events that were formerly seasonal and cyclical have in some instances become more frequent, of longer duration, or more intense. Table 2 lists the weather-related events that have been impacted by the rise in average temperatures.

Table 2. Threats and Hazards by Category: Extreme Events

Natural	Technological
Drought	Derailment—sun kinks
Floods	Landslides
Heat wave, sustained	Levee failures
Hurricane/monsoon	Urban conflagrations
Sea level rise	Utility disruption - electricity
Storm Surge	
Tornado	
Wildland interface fire	
Winter storms	

Source: IPCC, 2014

HIGH AND SUSTAINED HEAT

A 2024 *New York Times* article stated, “The dated U.S. rail infrastructure is struggling to stay operational as climate change accelerates and intense heat waves, downpours, and high winds become more frequent” (Kim, 2024). This quote was the result of Amtrak Northeast corridor delays in June 2024, related to high temperatures that damaged the electrical system, putting 150 miles of track out of service. In addition, the heat has the potential to create sun kinks that require slower train operating speeds for safety (Kim, 2024).

National Weather Service predictions for the summer of 2025 show that many areas of the country will have increased temperatures. The Washington Post published a map showing that the Midwest and Pacific Northwest would have temperatures well above normal, while the southwest, northeast, and Middle Atlantic regions would be above normal. Only the southeast, Gulf Coast and Pacific Coast would be at normal temperature levels (Jewell and Ross, 2025). These conditions are likely to lead to droughts in Florida and the mid-Atlantic states, and more intense wildfires, which have already been seen in Minnesota in May. One scientist noted that summers are getting hotter and wildfire seasons are getting longer (Holthaus, 2025).

While track buckling and sun kinks are planned for as normal emergencies by railroads, the developing high and sustained heat conditions are likely to impact new areas. Places that traditionally have high temperatures are seeing new highs set, and more high heat days. In Phoenix, 2024 was a record-breaking summer. They had 113 consecutive days of temperatures above 100 degrees, and a total of 120 summer days above 100 degrees (Thomson, 2024). Las Vegas experienced 112 days above 100 degrees in the summer of 2024. It also set a record for the hottest day at 120 degrees on July 7. Critically important to rail operations was the very warm average low of 84.8 degrees (Zoltec, 2024), meaning that even when the sun set, the rails could not cool off completely. Even traditionally cooler places like Seattle saw an unusually hot summer in 2024, with record-breaking highs of 98 degrees at SeaTac airport and 100 degrees in Olympia.

Rails are installed at the average high temperature for the area. As average daily temperatures rise across the US the stress on the rails increases. Sun kinks become more likely. Railroads have developed proactive measures to monitor rail conditions in high heat areas. They have adjusted the rail neutral temperatures (RNT) for installations as average temperatures rise. Tracks are now installed with fasteners and ballast is firm. Raising the RNT to levels for traditionally cooler areas to those currently used in the Mojave Desert is one method for hardening the infrastructure against heat damage (Kim, 2025).

To avoid derailments caused by sun kinks, the freight railroads that own most of the rail infrastructure in the US set lower speed limits as temperatures rise, causing impacts to schedules for both freight rail and Amtrak. When the temperature of the steel tracks reaches 128F degrees, the speed limit is lowered to 100 mph. At 135F degrees they go to 80 mph. These temperatures can be reached with an ambient temperature of 95 degrees or higher (Kim, 2025).

In 2025 the UIC published a new guide for railroads coping with high temperatures, recognizing that this is an international challenge. They note that heat impacts go beyond rails, and impact bridges, communications systems, and signaling systems. UIC recommends using reinforced concrete sleepers to maintain better track geometry, and use rail expansion joints to accommodate heat-related expansion. Operational changes may be needed to limit heavy rail traffic during the hottest hours of the day (Blanco and Diaz, 2025).

SUMMER STORMS

Summer storms will also be more frequent and more intense as the climate warms. Thunder storms, tropical storms, hurricanes, and tornadoes will be more frequent and more intense. The North American monsoon in the west will bring some drought relief but contribute to flooding and mudslides. But the high plains and West will experience drought conditions that contribute fuel to wildfire season. The start of the monsoon also brings more lightning strikes that ignite wildfires. “Northern and eastern portions of the Gulf Coast and the Carolinas are at a higher-than-average risk of direct impacts this season” (Lada, 2025).

The Association of American Railroads (AAR) notes that water weakens bridges, washes away ballast, and damages electronics like signals and sensors. Railroads work to improve drainage and install culverts that accommodate the new higher water flows. The weather monitoring centers will notify railroad operations when relocations of trains are necessary. Personnel and equipment may be moved to high ground, and train routing may change to move the consists out of the storm's path, using their disaster response plans for storms and hurricanes (Association of American Railroads, n.d.).

The challenge comes when weather-related emergencies occur in unexpected places or with unusual intensity. Storms in the Appalachian Mountains have led to culverts becoming overwhelmed, leading to community flooding (Timms and Gadd, 2022; Sutton, 2022). Hurricane Helene battered communities in the Blue Ridge Mountains that had never experienced hurricanes before, washing away 60 miles of CSX track and a critical bridge. The repairs led to a lawsuit (Whetstone, 2024; Wadhwani, 2024) and months of rerouting for freight, adding to time and cost.

In 2025 UIC released another report, on railroads dealing with intense storms. They made suggestions for adaptation strategies. After determining the vulnerability of rail segments, they list raising the track, enhancing drainage, waterproofing critical rolling stock, installing pumps to remove water from tracks and tunnels, and installing water-resistant braking systems, among dozens of possible steps (Diaz and Blanco, 2025). The AAR recommends having a 24/7 weather watch conducted in the traffic control center to permit the quickest preparedness and response activities. Response may include staging critical assets, re-routing shipments, and moving sensitive rolling stock from high-risk areas (Association of American Railroads, n.d.).

TORNADOES

Tornadoes often accompany summer storms, hurricanes or even wildfires. They are difficult to predict. The National Weather Service noted that 2025 had more tornadoes than usual, with 1,000 by May 27. Dan Chavas, an earth scientist from Purdue University, noted that "tornado alley" has now expanded to everything east of the Rocky Mountains and west of the Appalachians, and tornado season has become all year. The much warmer waters of the Gulf of Mexico account for much of the energy behind the tornado swarms. These data show new characteristics such as a shift farther east, earlier in the year, and more clustered outbreaks (Chavas, 2025).

The only protection against tornadoes is a safe room designed to withstand the intense winds. Since railroads operate in the open, they have to plan in advance to recover from the inevitable tornado damage to infrastructure and vegetation, and the impacts on their routes.

Figure 8. Destroyed house in Bucks County, Pennsylvania

Source: F. Edwards

Figure 9. Destroyed mid-summer vegetation in Bucks County, Pennsylvania

Source: F. Edwards

As shown in Figures 8 and 9, in July, 2021 Bucks County, Pennsylvania, a suburb of Philadelphia, experienced an EF-3 tornado with winds up to 140 mph. It destroyed modern suburban homes, and damaged a row of town houses, the police station, stands of trees, the Faulkner car dealership, and cell phone towers. This is an area far outside of “tornado alley” that has rarely experienced tornadoes before. In 1896 a similar EF-3 tornado ran through the area with 200 mph winds and threw the Penn Valley train station onto the railroad tracks, just missing an express train traveling to New York City (Robertson, 2021).

Cities have reported significant high wind damage from toppling billboards (Junaidi and Yasin, 2025), which could be removed from rail rights-of-way and roofs of buildings like railroad stations or yard structures. John T. Grey of the AAR listed railroads’ post-tornado roles as, “Railroads know that the quicker they can safely restore service, the quicker affected communities can obtain food, water, and other necessities; that supplies needed for rebuilding can be brought in; that debris can be removed; and that rail customers can return their operations to normal” (Association of American Railroads, 2017).

In a March 14, 2025 tornado event BNSF lost a telecommunications tower that left 40 miles of track in Missouri without communications. An investigation revealed that the tower had been toppled by the tornado. Train traffic had been halted by power problems and trees downed by the storm in that stretch of track, so the loss of communications was not an immediately dangerous emergency. However, a cell on wheels (COW) was brought from Denver to temporarily restore communications. The telecom team created a new 80-foot tower, and integrated it into the network, restoring communications within 36 hours. This rapid response was possible because of pre-disaster planning that enabled crews from various sectors to collaborate to move the COW from Denver to Missouri, construct the tower, and integrate the communications system (BNSF, 2025).

HURRICANES

One of the accelerating extreme events that directly impacts railroads is hurricanes. Hurricanes have typically made landfall along the Atlantic or Gulf coasts, losing speed as they traveled away from the warm water. Although Tropical Storm Sandy made final landfall further north than usual in New Jersey, the areas that experienced storm surge, intense winds, and extreme rainfall were generally within 100 miles of the coast. Maine, Massachusetts, Rhode Island, and New Hampshire saw storm surge and high winds that damaged ports and property. The tropical storm then merged with a winter storm and traveled to Pennsylvania, Ohio, and Tennessee with damaging winds and intense rain. Tennessee and West Virginia got up to a foot of snow in an early and unseasonal storm. New York City and the New Jersey coast were notably impacted by this hurricane (Moraski, 2012).

New York City

New York City experienced the full force of Hurricane Sandy on October 29, 2012. The wind and rain lasted for 48 hours, destroying 300 homes and killing 44 residents (New York City Recovery, n.d.). Flooded utility equipment left much of the city in darkness. In a place where many people live and work in high rise buildings, the loss of electricity means more than using candles and flashlights. The loss of power to elevators makes many buildings inaccessible to all residents, and the elderly and people with disabilities may lack access to even low-rise buildings. In many high-rise buildings, the water is pumped up to the roof and then gravity fed to residences, so loss of power also means loss of water and sanitation (William Ciaccio, New York City Transit, personal communication, June 12, 2015).

Storm surge destroyed homes and marinas along the Atlantic coast of the Borough of Queens, notably in the Rockaways. The Long Island Railroad and New York City Subway line that serve the Rockaways suffered track damage from storm surge and flooding, as shown in Figure 10, including undermining some track beds along the coast. The Rockaways had to be served by a bus bridge for weeks (Moraski, 2012). “Sandy’s storm surge dumped debris over the tracks, washed out the right of way, weakened the embankment and destroyed hundreds of feet of the A Line mainline connection between Howard Beach and the Rockaway Peninsula” (Sneider, 2016, n.p.).

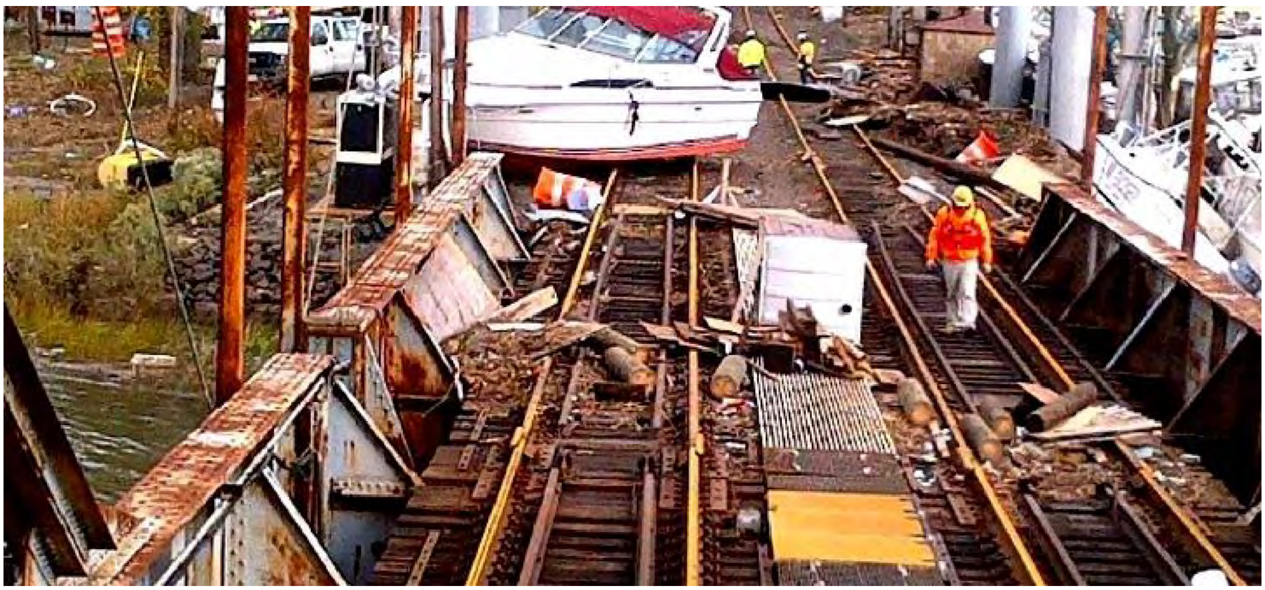

Figure 10. Track damage in Queens after Hurricane Sandy

Source: Metropolitan Transit Authority

As shown in Figure 11, the New York City subway trains experienced flooding with salt water in nine of the system’s 14 tunnels and many stations, damaging its electricity-based infrastructure. Restoration work included waterproofing and relocating some sensitive signaling equipment to a higher location. Tunnels that were 100 years old had never experienced this level of storm surge (Sneider, 2016). The Coney Island subway yard that flooded was a mile from the coast (Gibbens, 2022).

Figure 11. New York City Subway flooded tracks after Hurricane Sandy
Source: New York City Transit

New Jersey

One major transportation connection between New York and New Jersey is the Port Authority Trans Hudson (PATH) train system that carries thousands of commuters every day. Superstorm Sandy flooded the PATH tunnel. The PATH station in Hoboken, the first stop in New Jersey on westbound trains, was flooded with a mix of river water, rain, and sewage (Halbfinger, 2012).

The beachfront of Atlantic City received a direct hit from Superstorm Sandy. Part of the boardwalk was ripped away. Farther north the iconic roller coaster in Seaside was torn from its moorings and washed into the ocean (Halbfinger, 2012). The storm did $36 billion in damage to New Jersey, killed 12 people, and sent a storm surge of four to five feet across the barrier islands and coastal communities (6ABC digital staff, 2023).

New Jersey Transit's Rail Operations Center was flooded, damaging the emergency power supplies and the operating system's computer. Trees knocked over by the winds took down railroad signal wires. Rail washouts occurred on the Atlantic City Rail Line and North Jersey Coast Line. The railroads' Morgan Drawbridge in South Amboy was damaged by collisions with boats and a trailer (NJ Transit, 2012).

The locations and levels of damage were a surprise to the agencies serving the state. Previous storm surge had not reached these levels, meaning that the damage has been limited to the immediate coast. In Hurricane Sandy the 80 mph winds drove 14-foot waves onto the coast. The Nature Conservancy's study shows that healthy marshes protected parts of the coast from severe damage. They have been restoring marshes and wetlands along the coast to develop some protection from future storms (The Nature Conservancy, 2022).

Figure 12. House being raised in Long Island, New York
Source: F. Edwards

Figure 13. New construction to post-Sandy building code in Ocean City, New Jersey
Source: F. Edwards

National Geographic notes that, “Warming temperatures are making hurricanes stronger, rainier, and more likely to strike farther north” (Gibbens, 2022, n.p.). Sea levels in the New York metropolitan area have risen nine inches since 1950. Property buy-outs and building elevations, as shown in Figures 12 and 13, have created new resilience along the Atlantic coast (Gibbens, 2022).

Wildfires

Rising temperatures and droughts have combined to increase the number of wildfires in the US. The National Interagency Coordination Center, a firefighting organization, reported that 2024 saw a significant increase in wildfires across the US, to 64,897 events, compared to 56,580 in 2023. In 2024 1,888 of these were designated as large wildfires. Although Idaho, Washington, Oregon, California, and Arizona had the most fires, most states had some notable wildfires during 2024. Some of these fires have had direct impacts on railroad property.

In 2021 UP noted that there were 80 large fires burning in 13 states. UP had its route between Roseville, California, and Portland, Oregon, closed by the Lava Fire burning the critical Dry Canyon Bridge near Redding. That same year the Dixie fire destroyed UP infrastructure that interrupted the supply chain (Lester, 2021a), even though UP crews and Cal Fire personnel used the water trains to spray track and apply thermal gel to structures (Lester, 2021b). The Dixie fire, which burned 900,000 acres, also damaged BNSF infrastructure, taking out two bridges and leading to the collapse of a tunnel, closing the Gateway Subdivision that connects Northern California to Oregon for almost three months (Lassen, 2022). BNSF and Cal Fire personnel used the BNSF fire trains to protect critical railroad infrastructure (Lester, 2021b). More than 30 assets were saved, “including bridges, signal infrastructure, and telecom infrastructure” (Lassen, 2022, n.p.).

These are just a few examples of the kinds of damage that railroads experience from wildfires. Rising average temperatures and stronger winds increase the number and severity of wildfires. Railroads take proactive preventive measures like installing concrete ties and spraying fire retardant on flammable equipment. However, as railroad systems cross the continent, they are impacted by wildfire activity in many states.

CONSIDERATIONS FOR RAILROAD EMERGENCY MANAGEMENT FOR EXTREME EVENTS

Railroads have an emergency management plan base for normal emergencies, both weather related and non-weather related. In many cases the events can be managed remotely by a relatively small team of experienced personnel. Extreme events create two major challenges to those plans: the need to coordinate with many more agencies and the need to source information from additional experts. These challenges may require not only extended plans but also new operational spaces.

MORE EXPERTS AND INFORMATION

Railroad emergency management staff have extensive experience dealing with their own personnel to end service disruptions and repair railroad equipment. Railroad staff may be drawn from maintenance-of-way, signals, communications, construction, and engineering departments. Supplies and materials are stored in strategic locations to support the requirements of responding to normal emergencies. The organizational memory of previous events provides a platform for developing response strategies for extreme events.

Weather forecasting has become a critical part of the emergency management of extreme events. The National Weather Service has local weather forecast offices that issue daily reports on temperature, precipitation, and wind conditions. They forecast extreme events like the likelihood of tornadoes and straight-line wind events. They follow the development of hurricanes, and estimate the probability of landfall for specific areas, and the intensity of the storm. This information is important as preparedness and response operations are developed. Past experience suggests that the railroad's emergency management staff could benefit from being placed on the local weather forecast office's distribution list for daily emailed bulletins to enable the development of situational awareness for weather along the sector's routes.

Weather-related emergencies are growing in size, impacting large swaths of railroad rights-of-way. Several sections of railroad track may be involved in the same or concurrent events. The extreme event response staff may include personnel from multiple districts who may not be accustomed to working together. Using ICS, which is familiar to first responders, will make it easier for strangers to work together toward the common goal of restoring service to customers.

In many areas the railroad may have its own police department. In an emergency they would manage the questioning of railroad personnel about an event on railroad property or involving railroad personnel. In some areas a local sheriff's department may have an agreement with the railroad to be able to question the engineer and conductor about events on railroad property.

In addition to railroads' personnel, an extreme event will require cooperation with local first responders. Professional and volunteer fire departments will be working to stop the spread of the fire and the further loss of property. In some cases, lives may be at stake and environmental damage to sensitive areas may have to be prevented. This requires establishing a system where railroad and fire department concerns are addressed collaboratively. The law enforcement agencies will have a role in traffic management, event investigation, and evidence protection of the rail property in the community. They may also be seeking the responsible party, and collecting evidence that may lead to a criminal or civil action. Including a local law enforcement representative in the emergency operations center ensures that railroad actions do not conflict with law enforcement needs.

Larger events make mapping more challenging. Railroads have geographic information system (GIS) resources that can create maps to assist with cross-jurisdiction collaboration. For example, in a flood event there may be multiple cities and counties involved, and in some cases multiple states and tribes. All of these entities have to be considered in a response plan so that the actions of one group do not interfere with the actions of another group, as both work toward resolution of the emergency. GIS-based mapping helps to visualize the various jurisdictions, topography, land features like rivers, and dense forests.

Maps can also show high density populations and critical facilities like hospitals, nursing homes, and day care centers, whose proximity to the event may impact the strategies that can be used to mitigate it. For example, while fire retardant is an important tool for firefighting in wildland areas, the US Environmental Protection Agency (EPA) has concerns about whether it is safe for unprotected people—those without self-contained breathing apparatus—to be exposed to the products of combustion from the retardant. There are also concerns about ingesting these materials (Spanne, 2021). Knowing where sensitive receptors might be could help manage an evacuation away from the fire zone, or protect sensitive environments from aerial spraying or spraying from the fire train over water courses.

Coordination with the US and state-level EPA staff continues to be important as clean-up and recovery progress. After Hurricane Helene the CSX staff trying to reopen their undermined track thought that they could mine the adjacent river for the lost ballast and rocks. However, that river was an environmentally and economically sensitive area, which led to a law suit that would have been avoided if environmental protection agencies had been included early in the recovery planning (Whetstone, 2024).

Railroads have extensive logistics support capabilities. Traditionally they have provided immediate relief supplies to post-emergency communities, brought additional first responders to the scene, and hauled out downed trees and other debris. These roles remain important, but additional roles have become critical. Several rail companies have created fire trains that move water and fire retardant to wildfire areas. Tank cars of fuel can be brought to locations that have lost electricity and can no longer pump fuel for first responders from underground storage tanks. Locomotives can also be used as generators for emergency situations, a World War II era function that can be resumed with the proper planning (Jeff Moller, personal communication, April 22, 2025). All kinds of relief supplies can be delivered by rail once the right-of-way has been surveyed and repaired.

In an extreme weather-related event, it is unlikely that the railroad would be the organizing entity for the emergency response. Law enforcement, fire, and political jurisdictions' staff like planners and logistics managers will take the lead, using the HSPD-5 mandated ICS. To benefit from collaborative planning, the railroad staff needs to be in contact with local first responders, local utility providers, and community representatives. In a small localized event, collaboration can be accomplished through the creation of internet-based video calls or through in-person discussions at railroad facilities. In larger extreme events, railroad staff will benefit through joining the larger ICS incident command post (ICP) or emergency operations center (EOC) that local entities establish.

FACILITIES FOR COLLABORATION

The Facility: In Your Own Office

As in normal emergencies, extreme events may be managed through internet-based video conferencing. Systems like Zoom and Microsoft Teams are used in routine business management and are therefore familiar to many participants. The disadvantage is that in an extreme emergency two barriers arise to their use. First, loss of electricity leads to loss of internet service, and power loss is a hallmark of extreme events, whether tornadoes, floods, high heat, or wildfires. Hurricanes can lead to power loss across multiple states. Second, phone service is also typically lost during extreme events. Cell phone towers are vulnerable to the same extreme events as electric power. Many agencies rely on voice over IP (VOIP), an internet-based phone system that requires electricity to operate. Making a plan based on remote connections for managing the extreme event may be unsuccessful in many weather-related extreme events.

The System: In Your Own Office

The small group in an office setting will probably be fewer than ten, with most representing railroad departments. Participants will make their own notes, and an administrative assistant to one of the railroad representatives can make the official log of decisions and agreements. This person can transcribe the decisions and agreements and circulate them to the participants for certifying, either through signature or emailed agreement. These decisions and agreements become the basis for executing response and recovery activities.

The Facility: In a Railroad Emergency Operations Center

A second strategy for collaboration is face-to-face in a railroad facility like the emergency operations center (EOC) at Amtrak in Boston depicted earlier in Figure 7. A conference room allows participants to discuss options and make plans. This works well for events requiring just a few railroad representatives and local first responders. Extreme events that are localized, like tornado strikes and lightning strikes, may be successfully managed with a relatively small team.

The railroad EOC should have supplies and equipment cached in the room or nearby so it can be set up quickly. Laptop computers with railroad software and power supplies will be needed for each position. Cell phone chargers and power banks, electric extension cords, paper and pencils, table tents, and markers are all needed for efficient operation of the discussions, especially if many of the participants are strangers to each other. A printer and copy machine should be in the room or nearby. White boards/wipe-off boards, dry erase markers, and erasers are needed to track information as it comes to the EOC. These boards, along with paper maps, will help to create the common operating picture—the understanding of the event as it unfolds—for everyone in the room.

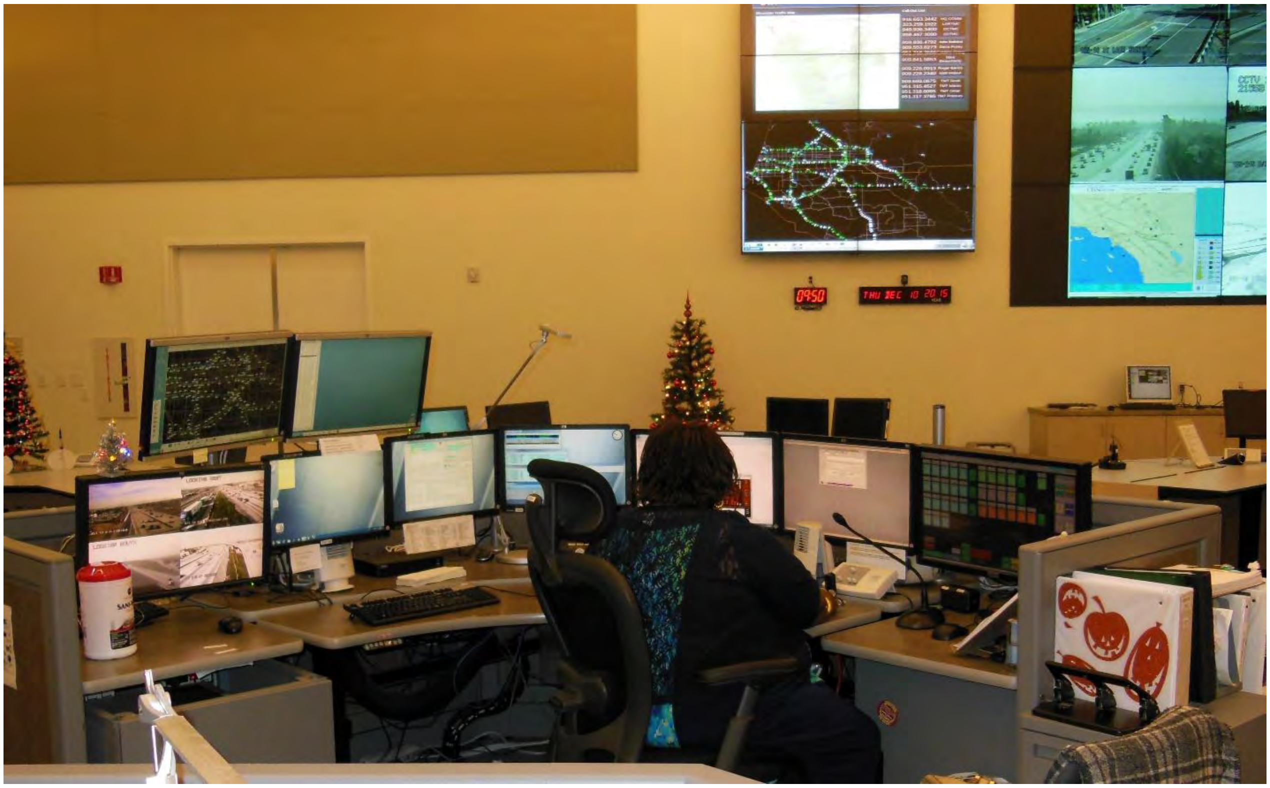

Figure 14. Law Enforcement dispatcher

Source: F. Edwards

The law enforcement and fire personnel may have radios that connect them to their headquarters. As shown in Figure 14, dispatchers at the agency's communications center will relay developing information regarding the progress of damage assessment, rescues, and road conditions to their personnel in the railroad EOC, and they can add this information to the white boards and maps to update the common operating picture.

However, once utilities, local government representatives, and non-profit agencies become part of the planning team for extreme event resolution, a much larger facility will be needed, called an Incident Command Post (ICP) established by the primary organizing agency, usually not the railroad.

The System: In A Railroad Emergency Operations Center

The purpose of the railroad EOC is to manage the extreme emergency at its lowest level to simplify decision making and resource allocations. Depending on the number of people participating in the extreme event management, the system for organizing the individuals can be based on day-to-day titles or can use ICS to match the first responders in the field.

Some agencies like to maintain their day-to-day titles for simplicity. This can avoid the need for new nomenclature, especially if people already know each other. The most senior person in the railroad hierarchy who is present will generally become the leader/convener for discussions. Representatives of railroad entities like maintenance-of-way, construction, engineering, signals, communications, and others will organize informally for discussions based on their organizational relationships. The senior railroad person's administrative assistant will usually be the note-taker, and record topics of discussion and decisions, which may be made by consensus, majority vote, or by the most senior railroad person present, depending on whose resources are being allocated.

Non-railroad personnel may also participate in the railroad EOC. Law enforcement and fire personnel will represent their professions' needs. Utility company representatives will be present to coordinate restoration of power with the railroad's signals and communications activities. A non-profit like the American Red Cross might be present to coordinate the delivery of relief supplies through the railroad.

Disagreements between railroad and non-railroad staff will have to be resolved through negotiation, or be based on the decision of the owner of the resource in question. For example, if the railroad wants to run the fire train with fire department personnel aboard, the fire department representative would have to agree to the participation, unless there is a pre-existing agreement. Issues related to railroad property—damage assessment, debris removal, repairs—will normally be under the control of the railroad, although the order of operations may be altered to meet the needs of first responders or community concerns. For example, the railroad might remove downed trees from a segment of track first that opens access to essential community facilities, and then clear the rest of its right-of-way.

Even when a larger ICP or EOC is established, the railroad may need its own EOC to support its Agency Representative to the larger EOC/ICP, and to organize its own internal response. It can be any size or shape based on the organization's needs. It should be located in a weather-resistant building with emergency power and personnel support supplies. Ideally the location should be unknown to the public and secure. It needs reliable communication resources like radio, telephones, and internet.

The railroad EOC would supervise internal damage assessment, risk management, debris removal, and railroad facility repairs. It coordinates the fulfillment of any resource requests agreed to by the Agency Rep at the EOC or ICP. It collects information about weather conditions, and its infrastructure, like buildings, bridges, and levees. It also tracks community conditions that would impact the railroad, like highway bridges and road closures.

The Facility: The Incident Command Post

In a regional extreme event, a much larger facility will be needed for collaboration among all impacted jurisdictions and disciplines. The railroad is both a major land owner and a major resource base whose participation is essential, but generally not the lead agency for a weather-related extreme event. Federal emergency management doctrine says that "all disasters are local" (Pittman, 2011, n.p.), which means that the jurisdiction where the extreme event is first experienced becomes the lead agency for the event in that state. The political jurisdiction of first impact will establish an Incident Command Post (ICP) in a safe and convenient facility, like a high school gym or fairground building. Figure 15 depicts an ICP organized around the Incident Command System, with each Section having its own table.

Figure 15. EOC by ICS roles

Source: F. Edwards

Some larger jurisdictions, like counties or regional agencies, may have permanently established emergency operations centers that support a 24-hour response capability. These facilities may be resource rich, with a “mission control” set-up focused on informational screens. Figure 16 shows a regional transportation emergency operations center that can be used to host the ICP during extreme events.

Figure 16. Mission Control-style, Permanent Transportation EOC
Source: F. Edwards

Regardless of the style selected, the public agency ICP facility will be organized using the ICS, and the railroad may have several roles. The ICP will have a check-in section where everyone registers, gets a vest or other visible identification, and gets a briefing on the event up to that time. Each person is then assigned to a supervisor who will give the person specific duties. The person proceeds to the supervisor and goes to work.

The public agency ICP is organized around the ICS roles. These will be clearly marked with signage to guide people around the facility. Everyone in the room will have a specific assignment under ICS, with each person having one supervisor.

The System: Incident Command Post

The Incident Command System (ICS), as shown in Figure 17, has five sections: Incident Command, Operations Section, Planning/Intelligence Section, Logistics Section, and Finance/Administration Section. These five are called the general staff. The Incident Commander (IC) has three command staff officers who support him or her. They are the Safety Officer, the Public Information Officer and the Logistics Officer. The work stations for each of these sections and positions will be clearly marked in the ICP.[1]

1. A detailed explanation of the Incident Command System in a railroad context is available in Edwards and Goodrich, (2025a), Field Personnel Respond: Incident Command System (ICS) for Extreme Events on the Railroad, https://transweb.sjsu.edu/research/2415.2-ICS-Extreme-Events, a part of this FRA-sponsored series.

Figure 17. Incident Command System Organizational Chart
Source: Edwards and Goodrich, 2025

The Operations Chief (Ops Chief) is responsible for all operations to carry out the goals of the Incident Action Plan (IAP), which is approved by the IC. All agencies involved in resolving the incident report to the Ops Chief, including the Law Enforcement Branch, the Coroner unit, the Fire and Rescue Branch, the Hazardous Materials Unit, the Medical Triage, Treatment and Transport Unit, the Construction and Engineering Branch, and other similar activities, as needed to resolve the event.

The Ops Chief is the connection to the field activities and speaks directly to the Incident Commander in the field to collect information on the progress of the field response. This information is shared with the General Staff and Command Staff at the Action Planning Meetings held on a schedule. At these meetings the Section Chiefs advise the IC on goals for the coming Action Planning Period, and the IC approves the IAP for the next Action Planning Period.

The Planning/Intelligence Chief (P/I Chief) is responsible for check-in and check-out for all ICS personnel. The P/I Chief tracks personnel assignments, develops all required ICS forms to document the event, and plans for demobilization. This person is supported by a staff that carries out documentation roles, including making GIS maps.

The Logistics Chief (Logs Chief) is responsible for providing the supplies and equipment needed by the Operations Section to fulfill the IAP. This includes using resources belonging to the participating agencies, using existing contracts to obtain needed resources, and using open purchase orders to obtain supplies. The Logs Chief is also responsible for the Human Resources Unit, the Facilities Unit, the Transportation Unit, and other supporting organizations.

The Finance/Administration Chief (F/A Chief) manages the finances of the event. The F/A Chief ensures that budgetary decisions are made by the supervising organization to fund personnel overtime and unplanned expenses related to the event. The F/A Chief oversees the Contracts Unit that purchases new types of supplies and equipment, the Risk Management Unit that manages insurance claims and dealings with responsible parties, the Timekeeping Unit that tracks personnel costs, and other groups that are spending unbudgeted funds.

The IC will be in overall charge of the response to the extreme event. The IC is supported by a Safety Officer who ensures that all work is carried out safely, and that the fire code for facility capacity is maintained. The Safety Officer is also responsible for the mental health and well-being of the participants in the extreme event resolution, such as regular meals, appropriate breaks, establishing work schedules and rest areas.

The Public Information Officer is the only person authorized to speak to the media and anyone not part of the ICS structure. This person collects information from all the ICS sections and prepares media handouts and briefings so the community is aware of progress in managing the extreme event. In a multiagency event that includes multiple public agencies, and especially if federal agencies are involved, a Joint Information Center (JIC) will be created to develop media releases in concert, so all the entities "speak with one voice."

The Liaison Officer is the link to the outside organizations, not part of the initial response. This would include utilities, businesses like railroads and non-profit organizations. This person ensures that offers of assistance are given to the right section, and that collaborative work is facilitated. A representative from an outside agency may start at the Liaison Officer area but be moved to Planning/Intelligence as a Subject Matter Expert, or to Operations or Logistics when the offer of assistance is ready to be integrated into the overall response.

It is rare that a railroad would have to establish an ICP in an extreme event, since it is likely that multiple political jurisdictions would be impacted, and one of those would take the lead. The primary role for the railroad will generally be as an Agency Representative, initially to the Liaison Officer. A senior management leader from the railroad will normally represent the company as Agency Representative, someone authorized to offer assistance and the use of resources, and participate in discussions toward the resolution of the event. This builds on the railroads' normal emergency responses, helping with equipment and resources.

Once the railroad's offer of assistance has been accepted within the ICS structure, the railroad's Agency Representative may be assigned to the Ops Chief if equipment is being offered, the P/I Chief if technical assistance like GIS mapping is being offered, or the Logs Chief if supporting materials or supplies are being offered. The Agency Representative will then have a new supervisor assigned from the relevant Section, will get a new identification badge for the new Section, and move to that area to collaborate with that Section's personnel.

During the extreme event the railroad may maintain its own EOC to manage the railroad's internal activities. The railroad may be independently engaging in internal damage assessment, risk management, debris removal, and repairs. The Agency Representative will provide information from the ICP regarding the goals for their next operational period, the railroad's assets that are engaged in the larger community response, and the overall progress of the response. The Agency Representative will also relay relevant railroad progress information to the IC and the Action Planning Meeting, for inclusion in the Action Planning Period report.

At the end of the event, the Agency Representative will complete all assigned tasks, complete all forms, go through the demobilization process, and return any loaned equipment. The Agency Representative can also retrieve any unused supplies or equipment that the railroad provided. At this time the railroad can prepare a bill with a list of all the resources given or used under the direction of the IC, and their cost, so the primary agency can submit the expenses for possible reimbursement from state and federal agencies. The bill can be submitted to the F/I Section Chief for inclusion in the extreme event's overall expenses.

CONCLUSION

Railroads have more than 150 years' experience responding to normal emergencies. They have internal systems for managing and recovering from normal emergencies. As the global climate warms, the number and type of extreme events are increasing, creating new challenges for rail operations. In this environment the railroad is confronted with greater internal and external demands for the use of its resources in response and recovery. Floods, hurricanes, and wildfires are just a few of the extreme events proliferating in the open environment where rail operates. Developing an emergency management facility that can support railroad staff in managing extreme events is an important preparedness step for the new normal.

CASE STUDIES

Case studies of real events help to illustrate the various options for emergency management that can be used by railroads to manage normal emergencies or extreme events.

CASE STUDY 1. NORMAL EMERGENCY: EXCESSIVE SPEED LEADS TO DEATH ON AMTRAK

The Facts

On May 12, 2015, Amtrak train 188 traveling from Washington, DC, to New York City derailed in a Philadelphia neighborhood, killing eight and injuring almost 200 people. One car was destroyed and three rolled onto their sides. The train was carrying 245 passengers, and 185 were transported to area hospitals (6ABC Digital Staff, 2025). The engineer sustained a concussion and the conductor had a fractured skull (Nussbaum, 2015).

In 2022 the engineer, Brian Bostian, was found not guilty of any charges related to his operation of the train. The speed limit in the curve was 50 mph, but the train was traveling 106 mph when it could not hold the curve and derailed. During the event, the engineer was distracted by a 6-minute radio conversation between the dispatcher and a South East Pennsylvania Transportation Authority (SEPTA) train engineer about shots or rocks hitting a local SEPTA train in the area. The train had made an emergency stop, and the engineer had glass in his face (6ABC Digital Staff, 2025). Bostian lost “situational awareness” because of the SEPTA report, and thought that he had passed the curve and was in the next section of track with a 110-mph limit (Moghe, 2022).

The Emergency Management Response

At the site of the derailment, the Philadelphia police and fire departments responded to care for and transport the injured. They established an Incident Command Post at the scene, where the Philadelphia Fire Department was the Incident Commander (IC). Railroad personnel from Amtrak’s nearby 30th Street Station responded to participate in the Incident Command Post. Senior management personnel from Amtrak’s South Station in Boston also responded to the event, as well as emergency response teams from Seattle, Oakland, and Los Angeles (Trent Bachman, personal communication, May 12, 2025).

Because of the size of the event, Amtrak used its National Operations Center in Wilmington, Delaware, about 30 miles away, to coordinate the overall incident, including Philadelphia responders and Amtrak management staff. They coordinated from there with other railroads that shared the impacted track and would have operations changed due to the track blockage.

The Senior Operations Manager in charge of Amtrak’s Wilmington Operations Center determined which railroads would be impacted and what the schedule would have to be. He handled freight railroad responses to coordinate system usage. Managers of individual segments of the Amtrak system would make local adjustments. Segments for the Northeast Corridor included Boston to Stamford, Connecticut, Stamford to New York City, mid-Atlantic, and Washington, DC (Trent Bachman, personal communication, May 12, 2025).

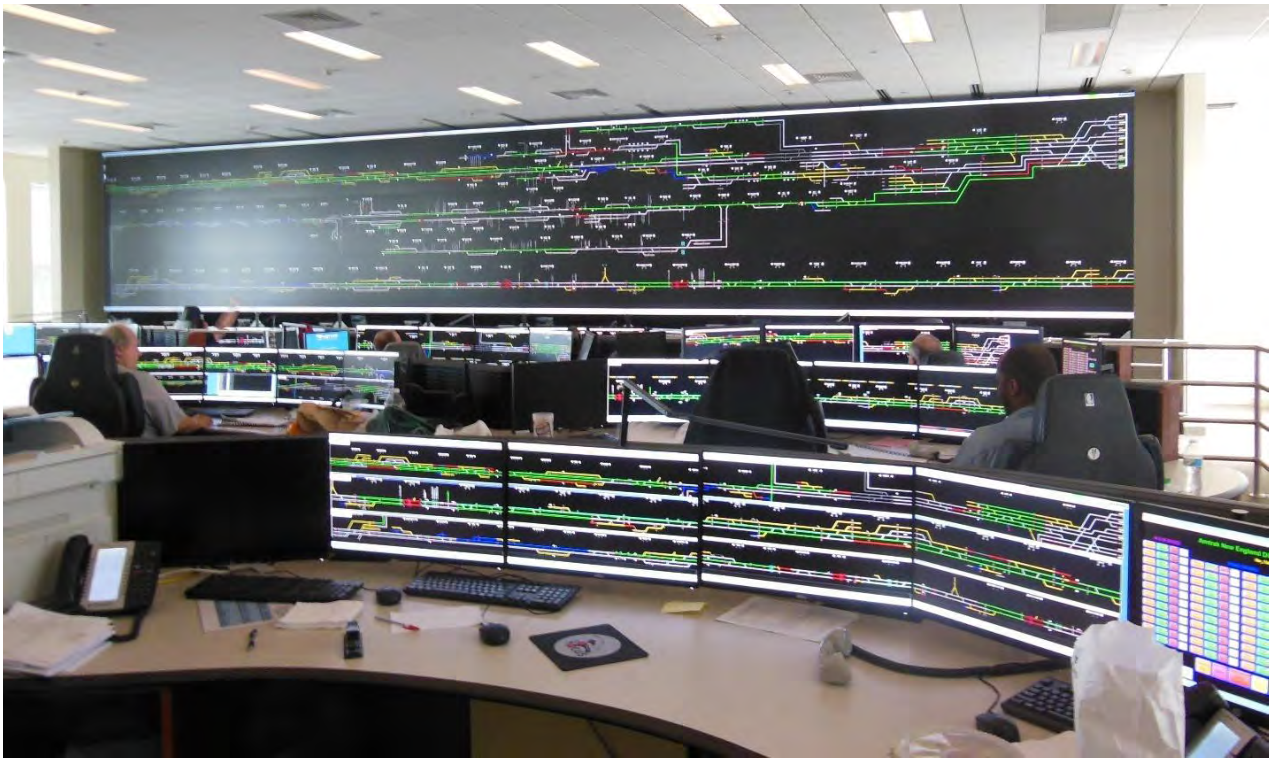

Figure 18. Amtrak Boston movement office
Source: F. Edwards

The Amtrak Northeast Corridor sections then opened local conference rooms. The movement office that monitors train movements every day, 24-hours per day, as shown in Figure 18, was notified of the accident and began managing routes. Representatives included regional transit agencies sharing the Amtrak facilities, Amtrak's high speed ACELA mechanical leads, maintenance-of-way staff, and signaling operations, all collaborating to manage the system while the emergency was being resolved (Trent Bachman, personal communication, May 12, 2025).

The section of track where the accident occurred was not yet equipped with positive train control (PTC), a GPS, wireless radio signal and computer-based system that overrides excessive speed and slows or stops the train.[2] The National Transportation Safety Board (NTSB) noted that if the system had been operational, the accident could not have occurred. Amtrak CEO Joe Boardman said that the PTC would be installed on the whole Northeast Corridor by the end of 2015 (Shoichet and Sanchez, 2015). One cause for delay in installing the system was that the Federal Communications Commission (FCC) could not find an available radio frequency for the system to operate on in the congested Northeast Corridor (Rod Diridon, personal communication, May 15, 2015). By August 13, 2020, all 898 route miles of Amtrak service had PTC systems installed (Toll, 2022).

2. For a more complete description of Positive Train Control see Edwards and Goodrich (2025b, December), Climate Change-Related Threats to Railroads: Implications for Threat, Hazard and Risk Assessment, Public Organization Review, in press.

CASE STUDY 2. NORMAL EMERGENCY: RESPONSE TO A COLLISION

The Facts

Rail accidents often involve improperly operated non-rail vehicles. In rural south San Jose, California, a five-car passenger Caltrain collided with a Coca Cola delivery truck on August 31, 1999 at 6:25 am. The heavily loaded truck got stuck on the Union Pacific track's grade crossing at Richmond Avenue when its stabilizer legs caught on the track, and the truck could not be removed in time to prevent the train from colliding with it (Wilson, 1999).

As soon as he realized that he was stuck, the driver removed the cab from the trailer to prevent it from whipping around when it was struck. He called the number on the warning sign crossbar, but he got no answer, then he called 9-1-1, but the truck was struck before they could answer.

The engineer saw the trailer on the track in the distance as he was traveling at 79 mph. He was able to engage the emergency stopping process to slow his speed, but the short distance to the truck did not allow the train to stop entirely. It takes about one mile to stop a loaded train. The engineer and the conductor were slightly injured during the impact, along with 37 passengers, of whom 12 were taken to hospitals and 25 were treated at the scene (Wilson, 1999).

The Emergency Response

The accident occurred in a rural area of San Jose where the train track runs closely parallel to a major local highway that is heavily used for commuting into Silicon Valley. The 9-1-1 center dispatched a third alarm of San Jose Fire Department (SJFD) (a battalion chief, three engines, two trucks, the hazardous materials unit, and Med-30 chief paramedic) to manage the injured passengers, the hazardous materials spills, and to assist with accident investigation and potential fire suppression. Various fluids were leaking from the train and trailer that had to be contained and prevented from going down the storm drain.

The SJFD battalion chief assumed Incident Command and established ICS, had one firefighter lay sand bags to protect the storm drain, and firefighter/emergency medical technicians deliver patient care for the 37 injured passengers and two railroad employees. SJFD IC appointed the first due engine's captain as the Safety Officer, established the Operations Section with the second due engine's captain as the Operations Chief, and a Medical Branch with the Med-30 chief paramedic as the director, overseeing the continuation of the medical care. The engines brought three firefighter/EMTs and three firefighter paramedics, and the trucks brought six fire fighter/paramedics. They delivered medical triage, expedient treatment, and coordinated with the 9-1-1 ambulances for transport for the injured to St. Louise Hospital in Gilroy. The Caltrain conductor was medically cleared and remained at the scene to communicate with the railroad. The SJFD hazardous materials response team captain joined the Operations Section as the Hazardous Materials Branch to oversee mitigation of the leaks and coordinate with the railroad's privately contracted clean-up company when they arrived.

The SJFD IC established a Plans Section with the third due engine's captain as section chief to chart the progress of the event and record all actions on the required ICS forms. He maintained the status board and tracked the incident action plan as the SJFD IC filled out the ICS structure. The SJFD IC declared the first operational period to be two hours to allow for information collection, medical care and clearance for the two injured rail employees, and scene management.

Once medically cleared, the railroad conductor joined the Planning/Intelligence Section as a subject matter expert to ensure clear communications with the railroad regarding the closing of the track to all rail traffic, and the timely removal and replacement of the damaged engine. The uninjured truck driver joined the Planning/Intelligence Section as a subject matter expert and contacted his dispatch center to request a tow truck and replacement trailer for the heavily loaded truck. The only way to remove it from the high point on the railroad track was to unload the remaining cargo into a different vehicle. He also requested a clean-up company to remove the scattered cans and bottles. This would clear the grade crossing and allow the Union Pacific track to be inspected and reopened. This was critical to the railroad, as it is a single track at that point, and serves both Caltrain's and Amtrak's passenger services and one of the busiest freight corridors in the U.S.

The SJFD's first due engine's engineer was appointed Logistics Chief to arrange for potable water, food, and a port-a-john for the crew working on scene. He also ordered the SJFD's light unit and fuel for evening operations, if needed for extended clean-up. The SJFD IC appointed the SJFD's public information officer (PIO) as the PIO for the accident scene, and requested that the PIO notify the media of a briefing at the scene in one hour, in time for broadcast on radio stations during the morning commute. One goal of the briefing was to ask drivers to take alternate routes or delay their commute. Due to morning rush hour commute patterns, the PIO requested mutual aid from the nearby fire department for their field briefing podium and sound system, as it could arrive more quickly.

Bottles and cans of soda were scattered around the entire area, including all lanes of traffic. The conductor contacted Union Pacific's control center and requested an investigator and a tow engine for the damaged engine and a replacement engine for the train. The IC requested law enforcement support from the San Jose Police Department to direct road traffic around the accident scene, and coordinate with the clean-up company. They were established as the Law Enforcement Branch within the Operations Section of the ICS, and the SJPD sergeant was appointed Law Enforcement Branch Director.

The Law Enforcement Branch Director requested support from the San Jose Transportation Department to provide barricades, delineators, and electric messaging signs to help with traffic control. The police and transportation staff designed a traffic pattern to relieve congestion during the commute, and reported the plan to the Operations Section Chief for approval. The approved plan was added to the Incident Action Plan. It included having the Law Enforcement Section notify all law enforcement agencies in the county, and the California Highway Patrol (CHP), of the accident and detour plan, as it was likely to impact their patrol areas on the local freeway system, including SR-101, SR-85, SR-87, I-280, and I-880/SR 17. As access to the freeways was slowed by secondary traffic impacts from the closed highway, local streets throughout the county might be impacted by commuters changing their routes. The Law Enforcement Branch Director also requested the California Department of Transportation (Caltrans) to use their highway signs and highway emergency radio network channel to notify the traveling public of the accident and detours.

While the morning commute was slowed, few additional accidents were attributed to the collision event because of effective public notification, and collaboration between the SJPD, local law enforcement agencies, San Jose Transportation, CHP, and Caltrans. The railroad conductor knowing ICS made for a smooth collaboration between the railroad company and the Incident Command, speeding emergency response. The engine was towed north to a siding for further inspection, and a replacement engine had the train moving again before noon, and train service restored.

This real event is an example of the value of the incident command system, allowing cross-profession collaboration to save lives, protect the environment, and restore essential services, while minimizing impact on the unaffected community. It is important to note that rural volunteer departments may have little ICS capability, and rural sheriffs may be far away. Therefore, the railroad crew of two might become the beginning of an incident command system and a notification system to protect railroad property, and manage emergency aspects of the event, like human injuries, wildlife injuries, and environmental impacts. When an event occurs in a remote area, the ability to notify the railroad's coordination center and the state's notification center enables a more robust incident command to be established by state resources, all the while operating within the National Incident Management System (NIMS).

CASE STUDY 3: HURRICANE HELENE STRIKES IN THE BLUE RIDGE MOUNTAINS

The Facts

Hurricane Helene made landfall on September 26, 2025, in the Big Bend area of Florida as a Category 4 storm. Unlike most hurricanes it tracked north, away from the coast, and crossed into Georgia, the Carolinas, and Tennessee. By September 27 it was in North Carolina. More than 20 inches of rain fell in the Appalachian Mountains, killing more people from fresh water flooding than from storm surge along the coast. As it traveled at 30 mph, the storm was 400 miles across and blanketed a large inland area with high winds and heavy rains, unusual for the Blue Ridge Mountains. The warmer Atlantic Ocean that it travelled over created these conditions, allowing the air to hold more moisture, which then creates more destructive storms (Mock, 2024).

Historically most hurricane deaths are the result of storm surge along the coast. Helene carried heavy precipitation into the Blue Ridge Mountains, adding 20" of rain to already full mountain creeks and rivers that then overflowed their banks. Rivers in this mountainous area tend to run westward into Tennessee, where during this storm rain was more moderate but riverine flooding was substantial. Flooding and mudslides inundated mountain communities, accompanied by high winds that knocked over trees, blocking roads and taking down power and communications lines (Fortin, Nostrant, Taft and Underwood, 2025). Helene proved to be the third most deadly hurricane in US history, after only Katrina

(2005) and Camille (1969), with over 250 deaths in seven states, 123 of them in North Carolina (Gabriel and Byrne, 2024).

Humans were not the only victims of the deadly hurricane. The railroad industry suffered damage to its infrastructure as the rail routes ran through the mountains in Tennessee and North Carolina. Blue Ridge Southern, a short line railroad, Norfolk Southern and CSX's rail properties were damaged (Stradling, 2025), including track wash outs and bridge destruction.

The Norfolk Southern track was washed away along the Swannanoa, Pigeon, and French Broad Rivers in the Blue Ridge subdivision. The line between Ashville, North Carolina, and Newport, Tennessee, was unusable for months, with 13 miles of track having to be rebuilt (Stradling, 2025).

The Emergency Response

In the immediate aftermath of the storm, crews worked in more than 1,000 locations without commercial power, clearing over 15,000 downed trees. Mountainous terrain made damage assessment very difficult, especially in the section between Ashville and Black Mountain, "where much of the track has been completely destroyed" (Oberholtz, 2024, n.p.).

The Norfolk Southern's East Tennessee Salisbury-Morristown line had over 21,000 feet of track washed out. More track suffered scour and slides, and bridges were damaged. The link to Tennessee was not restored until May, 2025, and work on the connection between Asheville and the rest of North Carolina was just beginning. The bridge over the Pigeon River in Newport, Tennessee, was completed in March, 2025 (Stradling, 2025).

"Gov. Roy Cooper called Helene 'one of the worst storms in modern history for parts of western North Carolina'" (Erden, et al., 2024, n.p.). CSX lost the TN/NC State Line bridge in the Chestoa Recreation Area, and the rails were undermined in Old Fort, North Carolina, along Mill Street. Early reports of the Nolichucky River said it reached record levels and flooded the area at the gorge (Erden, Kim, Shao and White, 2024), taking out a CSX bridge and 60 miles of track (Sneider, 2025).

While all of the losses were devastating, the undermining of the track by the Nolichucky River led to a lawsuit (Whetstone, 2024a). The circumstances demonstrate the importance of having environmental protection agencies and local government representatives participate in formal clean-up and recovery decisions, such as ICS Incident Action Planning, to avoid misunderstandings about how the clean-up will be managed.

The CSX tracks ran along the river bank for two and a half miles (Casey, 2024), and were undermined by the Nolichucky River flooding as they ran along the 8-mile gorge. To accomplish recovery, the ballast had to be replaced and the bank had to be shored up. Railroad construction leaders had informal conversations with federal regulators on September 30, and virtual meetings with the US Army Corps of Engineers (US ACE) about how they would source the needed stone material. Since their ballast had fallen into the river, the CSX staff thought they could pull it out and put it back under the tracks.

The river was also clogged with debris from the destroyed track and from fallen trees that CSX also planned to remove. The positive conversations with the US ACE about an emergency clean-up order led CSX to begin work without waiting for an official letter from US ACE, which is in charge of all navigable waterways in the nation. Later, “agencies have since issued authorizations and determinations approving the work and allowing it to proceed” (Whetstone, 2024a, n.p.). CSX was not a party to the lawsuit because the litigators recognized that they were engaged in permitted activity (Myers, 2024).

While the clean-up was underway, the Southern Environmental Law Center sued the US ACE, the Forest Service and the Fish and Wildlife Service on behalf of local environmental groups, American Rivers and American Whitewater, asking the court to stop CSX’s reconstruction methods, which it claims violate the Endangered Species Act and the Clean Water Act. It turns out that the gorge is a popular white water rafting site that is the main economic engine of the area, bringing in $18 million and supporting 200 jobs (Myers, 2024). The local county commissioner stated that she was unaware of the use of river rock to carry out the CSX repairs. CSX was accused of mining rock from the river and disrupting the rapids that are essential to the whitewater rafting sport. The suit alleges that removing rocks from the river would also cause future flooding downstream and could impact water quality. The groups allege that CSX should have imported rock from a quarry instead of mining the river. CSX pointed out that access to the quarry was unavailable for months after Hurricane Helene due to road damage (Whetstone, 2024a), but that quarry rock was used once it was available (Whetstone, 2024b).

In December the US ACE sent CSX a letter directing the railroad to stop work until it obtains “proper permissions,” claiming that the work is “potentially unauthorized” for the fill activity. The argument turns on whether CSX is engaged in maintenance of its right-of-way, which would not require a permit, but “maintenance does not include modification that changes the character, scope or size of the original fill design” (Casey, 2024, n.p.). In addition, the Tennessee Department of Environment and Conservation, Division of Water Resources also sent a violation letter to CSX regarding the excavation of rock and dirt from the river (Wadhwani, 2024). The CSX spokesperson said that the railroad is trying to work with all parties and comply with environmental laws (Whetstone, 2024b).

In April, 2025 CSX and the three federal agencies filed a motion to dismiss the lawsuit. They cited the nationwide permit for maintenance and emergency work. “The Clean Water Act provides an exemption from the Section 404 permit requirement ‘for the purpose of maintenance, including emergency reconstruction of recently damaged parts, of currently serviceable structures such as dams, levees, groins, riprap, breakwaters, causeways, and bridge abutments or approaches, and transportation structures’” (Smith, 2025, n.p.). The outcome of the lawsuit is still uncertain.

ACRONYMS AND GLOSSARY

AAR	Association of American Railroads
ACELA	Amtrak's high-speed train that runs on the Northeast Corridor track
Amtrak	The American heavy rail passenger service railroad
BNSF	Burlington Northern Santa Fe Railroad, a class 1 railroad
Cal Fire	California Department of Forestry and Fire Protection's firefighting division
Caltrans	California Transportation Department, maintains all federal and state roads in California, as well as overseeing other transportation systems in the state
CHP	California Highway Patrol
Class 1 Railroad	One of seven heavy rail companies that hauls freight in the US and Canada
CSX	A Class 1 railroad
CWR	Continuous welded rail, a method of installing train track
DOT	Department of Transportation
EF-3	Enhanced Fujita Scale, system for measuring tornadoes; EF-3 has 136 mph to 165 mph winds
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FRA	Federal Railroad Administration
GIS	Geographical Information System
GPS	Global Positioning System
HSPD-5	Homeland Security Presidential Directive-5
I	Designates that a road is an Interstate, such as I-95
IAP	Incident Action Plan
IC	Incident Commander
ICP	Incident Command Post
ICS	Incident Command System
IPCC	International Panel on Climate Change

JIC	Joint Information Center, a public affairs collaboration of many agencies during a disaster
mph	Miles per hour
n.d.	No date
NJ Transit	New Jersey Transit
NIMS	National Incident Management System, part of the HSPD-5 mandate, a holistic system for managing emergencies
Northeast Corridor	The portion of Amtrak’s route that runs from Boston to Washington, DC
n.p.	No page, typically found in quotations from internet sources
NTSB	National Transportation Safety Board
PATH	Port Authority Trans Hudson, a commuter train from New Jersey to New York City
PIO	Public Information Officer, part of the ICS
PTC	Positive Train Control
RNT	Rail neutral temperatures, the temperature at which railroad track is installed—rail is heated to the average high temperature for the area before installation to avoid sun kinks at high ambient temperatures
SEPTA	Southeast Pennsylvania Transportation Authority, a bus, trolley, subway, and train transportation system for commuters in the Philadelphia metropolitan area
SJFD	San Jose Fire Department, the fire service for California’s third largest city
SR	Designates that a road is a State Route in California
THIRA	Threat and Hazard Inventory and Risk Assessment
UIC	International Union of Railroads (Paris)
UP	Union Pacific, a class 1 railroad
US	United States of America
VOIP	Voice Over Internet Protocol, a type of telephone system

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