

Effective Practices in Rail Transit Accident Investigations

PREPARED BY

K&J Safety Consulting Services

**Center for Urban Transportation Research
(CUTR)
University of South Florida**



**U.S. Department of Transportation
Federal Transit Administration**



NOVEMBER

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NOVEMBER 2021

FTA Report No. 0203

PREPARED BY

K&J Safety and Security Consulting Services 3257
Elcano Lane
Cantonment FL 32533-6876

Center for Urban Transportation Research (CUTR)
University of South Florida
4202 E. Fowler Avenue, CUT100
Tampa FL 33620

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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
NOTE: volumes greater than 1000 L shall be shown in m ³				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C

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Abstract

As part of FTA's effort to promote continuous safety improvement in the public transit industry, these *Effective Practices in Rail Transit Agency Accident Investigations* were developed to provide Rail Transit Agencies with leading transit industry practices for performing investigations. The supporting *Rail Transit Agency Accident Investigations—Background Research* provides a comprehensive examination of each SMS element to broaden the reader's understanding of how each component complements the others. The recommended practices described in this document and emphasized through the background research are not intended to be prescriptive in nature. Each public transit agency is responsible for tailoring its event investigation processes to its unique operating environment, the complexity of the operation, and the transit modes provided. These locally-developed processes should correspond to a transit agency's existing Standard Operating Procedures (SOPs) or emergency plan.

Executive Summary

Background

The Federal Transit Administration's (FTA) adoption of the Safety Management System (SMS) framework elevated the approach to safety in public transit. FTA defines SMS as "... a formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of the transit agency's safety risk mitigation. SMS includes systematic procedures, practices, and policies for managing risks and hazards."¹

Event investigation, which falls under the Safety Assurance (SA) component of SMS, is central to identifying causal or contributing factors in events, including accidents. They are conducted for early detection and identification of hazards, addressing safety concerns in a permanent and effective manner, reducing the agency's exposure to risk, promoting continuous improvement, and elevating the safety of employees and the riding public.

49 Code of Federal Regulations (CFR) § 673.27 requires transit agencies to include the investigation of safety events as part of their safety assurance process in the Public Transportation Agency Safety Plan (PTASP). An investigation evaluates the effectiveness of safety risk control methods and should result in corrective actions to improve those control methods where gaps are identified.

Although other functions in the transit agency may develop information to implement disciplinary action, manage claims, or defend litigation, a safety investigation should be independent of these interests and focused on developing the facts, determining the probable cause, and, most importantly, identifying corrective actions that can prevent future accidents.

Purpose

As part of FTA's effort to promote continuous safety improvement in the rail transit industry, these *Effective Practices in Rail Transit Agency Accident Investigations* were developed to provide rail transit agencies (RTAs) with leading transit industry practices for performing investigations. The supporting *Rail Transit Agency Accident Investigations—Background Research* provides a comprehensive examination of each SMS element to broaden the understanding of how each component complements another. Each RTA is responsible for tailoring its event investigation processes to its unique operating environments, the complexity of the operation, and the mode of transportation provided. These locally-developed processes should correspond to a transit agency's existing Standard Operating Procedures (SOPs) or emergency plan.

¹ *Federal Register*, Vol. 83, No. 139, July 19, 2018. Pg. 34428; 49 CFR Part 673, Public Transportation Agency Safety Plan Final Rule, § 673.5, Definitions.

Document Organization

This document is intended to improve an investigator's analytical and critical thinking skills, which are necessary to accurately identify root causes and contributing factors leading to short-term, intermediate, and long-range Corrective Action Plans (CAPs) to address key findings in accident investigations. These effective practices are based on the background research presented in *Rail Transit Agency Accident Investigations – Background Research*. An expanded SMS presentation and detailed accident investigation processes and methods are included within that technical memorandum.

These effective practices include the following sections and supporting appendices:

- Section 1 presents the accident investigation perspective and includes statutory requirements.
- Section 2 presents the accident scene process.
- Section 3 presents activities that should occur after the on-scene investigation has concluded.
- Section 4 discusses report preparation and the development of CAPs.
- Appendix A provides information on investigation expectations in the event a National Transportation Safety Board (NTSB) investigation process is activated.
- Appendix B lists recommended investigator Go-Bag contents.
- Appendix C includes key points that should be considered when conducting interviews and recommended processes,
- Appendix D includes information on survivor and witness statements and questions for events that result in an injury or fatality.
- Appendix E presents a 72-hour pre-event history checklist to assist in obtaining, in as much detail as possible, information on operator activities in the 72 hours before the event.
- Appendix F discusses the hazard identification component of the Safety Risk Management process and includes analytical tools that can be used to assist in determining cause or contributing factors.
- Appendix G provides a detailed investigation report outline and discusses content.
- Concluding the document are acronyms and abbreviations, traffic investigation terminology, and a glossary of terms.

Section 1

Investigation Perspective

The primary purpose of conducting investigations of undesirable events, including accidents, is to determine the cause so corrective actions can be put in place that prevent future similar events. For the purpose of this guidance document, the terms “event” and “accident” are defined in accordance with 49 Code of Federal Regulations (CFR) § 674.7:

- *Event* – an accident, incident, or occurrence.
- *Accident* – an event that involves any of the following—a loss of life, a report of a serious injury to a person, a collision involving a rail transit vehicle, a runaway train, an evacuation for life safety reasons, or any derailment of a rail transit vehicle, at any location, at any time, whatever the cause.

A Rail Transit Agency (RTA) can use accident investigation outcomes to inform its Safety Management System (SMS) processes. The analyses performed and information obtained through the investigation process can be used to proactively and predictively identify where and when a similar event may occur. It can result in process improvements from lessons learned and the identification of system changes that were made with no change management process, resulting in unintended consequences.

At their discretion, the National Transportation Safety Board (NTSB) “investigates accidents to determine the probable cause, identify safety issues, and devise recommendations to prevent recurrence.”² Appendix A summarizes what to expect if an RTA event is elevated to include an NTSB investigation. American Public Transportation Association (APTA) RT- OP-S-002-02 Rev. 3, Standard for Accident/Incident Notification and Investigation Requirements, defines the purpose of an investigation as “... to gather and assess facts in order to determine cause(s), and to identify corrective measures to prevent recurrence. Accident/incident investigation is not intended to affix blame, or subject people to liability for their actions, or to recommend disciplinary action.”

Although other functions in the transit agency may develop information to implement disciplinary actions, manage claims, or defend litigations, the safety investigation should be independent of these interests and focus on developing the facts, determining the probable cause, and, most importantly, identifying corrective actions that can prevent future accidents.

During the investigation of an undesirable safety event, such as a rail accident, a variety of factual operating information is developed around the circumstances of the event. This information is then compared with the programs, procedures,

² NTSB FY 2018–2022 Strategic Plan.

and practices that should have been in place and followed in the particular event. Investigation findings are noted where there is a gap between what should have happened and what occurred. Gaps are analyzed to determine the probable cause and other factors contributing to the event.

Provided no gaps between existing requirements and actual performance are identified in an accident investigation, the adequacy of agency policies, procedures, and equipment should be assessed. In both safety audits and safety investigations, findings are analyzed and corrective actions are developed to address gaps that are identified.

FTA Regulations

FTA specifies requirements for transit accident investigations in 49 CFR 673.49 CFR § 673.27, which requires transit agencies to include the investigation of safety events as part of their safety assurance process in the Public Transportation Agency Safety Plan (PTASP). An investigation evaluates the effectiveness of safety risk control methods and should result in corrective actions to improve those control methods where gaps are identified. FTA specifies requirements for rail transit accident investigations in 49 CFR § 674.35. The SSOA lays out its method of complying with Part 674 regulations in its program standard. Typically, these require the agency to prepare and submit an accident investigation plan for the SSOA to review and approve.

The regulations require State Safety Oversight Agencies (SSOAs) to “investigate or require an investigation” of accidents. The regulation also states that FTA (the “Administrator”) may conduct an independent investigation or an independent review of the State Safety Oversight (SSO) and agency investigation. Section 674.35 – Investigations, establishes the requirements for these investigations, as follows:

- An SSOA must investigate or require an investigation of an accident and is responsible for the sufficiency and thoroughness of all investigations, whether conducted by the SSOA or RTA. If an SSOA requires an RTA to investigate an accident, the SSOA must conduct an independent review of the RTA's findings of causation. In any instance in which an RTA is conducting its internal investigation of the accident or incident, the SSOA and the RTA must coordinate their investigations in accordance with the SSO program standard and any agreements in effect.
- Within a reasonable time, an SSOA must issue a written report on its investigation of an accident or review of an RTA's accident investigation in accordance with the reporting requirements established by the SSOA. The report must describe the investigation activities; identify the factors that caused or contributed to the accident; and set forth a corrective action plan, as necessary or appropriate. The SSOA must formally adopt the

report of an accident and transmit that report to the RTA for review and concurrence. If the RTA does not concur with an SSOA's report, the SSOA may allow the RTA to submit a written dissent from the report, which may be included in the report, at the discretion of the SSOA.

- All personnel and contractors that conduct investigations on behalf of an SSOA should be trained to perform their functions in accordance with the Public Transportation Safety Certification Training Program.
- The Administrator may conduct an independent investigation of any accident or an independent review of an SSOA's or an RTA's findings of causation of an accident.

The SSOA lays out its method of complying with 49 CFR Part 674 regulations in its program standard. Typically, these require the agency to prepare and submit an accident investigation plan for the SSOA to review and approve; in most cases, the SSOA requires the agency to conduct accident investigations on behalf of the SSOA. The SSOA then independently reviews accident reports submitted to them and either approves or requires additional investigative activities.

Working with SSOA or FTA on Investigations

With delegated investigations, SSOA and FTA personnel may monitor investigative activities and witness interviews, inspections, or re-creations. Agencies should plan to honor such requests and have appropriate procedures written into their accident investigation procedures.

Both SSOA and FTA, under the authority provided in 49 USC § 5329(f), may conduct independent investigations. With independent SSOA or FTA investigations, agencies should plan to coordinate their activities to minimize confusion or miscommunication. Federal and state oversight personnel are expected to comply with agency procedures for roadway access, Roadway Worker Protection (RWP) rules, and Personal Protective Equipment (PPE), as appropriate.

Notifications

All safety events (including “near misses”), no matter how minor they may be perceived, should result in notification to key personnel and management so they can be investigated, assessed, and recorded in line with SMS data collection and analysis requirements. Not all events will require notification and reporting to oversight bodies outside the transit agency, which depends upon SSO program and regulatory notification requirements.

Investigators should acquaint themselves with the specific regulations and requirements for notification applicable to their operations, which may include internal agency processes and procedures, SSO program standards,

or other regulations and requirements. The following information is based on regulations and guidance in effect as of the date of publication of this document; it is not intended to substitute for a careful reading of the current applicable regulations.

SSOAs, FTA, the Federal Railroad Administration (FRA), and the NTSB have established that rail transit events meeting established criteria must be formally reported within specific timelines. Note that rail transit operations on shared-use or shared-corridor alignments may also fall under FRA accident notification requirements.

Notification Contacts	
FTA	TOC-01@dot.gov, (202) 366-1863
SSOA	As specified in state's program standard
NTSB	(800) 424-0201 – National Response Center
FRA	(800) 424-8802 or (800) 424-0201

Notification to FTA

FTA notification requirements are listed 49 CFR Part 674. FTA published a *Two-Hour Accident Notification Guide* and *Two-Hour Accident Notification Quick Reference Checklist*, which can be found on the FTA website at www.transit.gov/regulations-and-guidance/safety/two-hour-accident-notification-guide. The guide and checklist provide more reporting requirement clarity.

Notification to SSOA

Title 49 CFR § 674.27 requires the SSOA to establish accident notification requirements that should specify time limits, notification methods, and information requirements. Investigators should familiarize themselves with the notification and reporting requirements in the program standard applicable to their state. In any instance in which an RTA must notify the FRA of an accident as defined by 49 CFR 225.5 (i.e., shared use of the general railroad system trackage or corridors), the RTA must also notify the SSOA and FTA of the accident within the same time frame as required by the FRA.

Notification to FRA

FRA has established reporting and recordkeeping requirements for accidents and injuries. Whereas rail transit operations do not fall under these regulations, in the case of shared-use/shared-corridor operations, waiver agreements may require reporting of specified transit events. Investigators dealing with shared-use/shared-corridor operations should familiarize themselves with the specific reporting requirements (if any) in the waiver agreement(s) applicable to their operation; 49 CFR § 225.9 requires telephonic reporting of the following events to FRA:

- Certain deaths or injuries:
 - Death of a rail passenger or a railroad employee
 - Death of an employee of a contractor to a railroad performing work for the railroad on property owned, leased, or maintained by the contracting railroad
 - Death or injury of five or more persons
- Certain train accidents or train incidents:
 - Train accident that results in serious injury to two or more train crewmembers or passengers requiring their admission to a hospital
 - Train accident resulting in evacuation of a passenger train
 - Fatality resulting from a train accident or train incident at a highway-rail grade crossing when death occurs within 24 hours of the accident/incident
 - Train accident resulting in damage (based on preliminary gross estimate) of \$150,000 or more to railroad and nonrailroad property
- Train accidents on or fouling passenger service mail lines involving a collision or derailment on a main line used for scheduled passenger service

Notification to NTSB

Title 49 CFR § 840.3 requires notification to NTSB no later than two hours after an accident that results in:

- Passenger or employee fatality or serious injury to two or more crewmembers or passengers requiring admission to a hospital
- Evacuation of a passenger train
- Damage to a tank car or container resulting in the release of hazardous materials or involving evacuation of the public
- Fatality at a grade crossing

Title 49 CFR § 840.3 requires notification to NTSB no later than four hours after an accident that does not include the circumstances listed above, but results in:

- Damage (based on a preliminary gross estimate) of \$150,000 or more for repairs or current replacement cost to railroad and non-railroad property
- Damage of \$25,000 or more to a passenger train and railroad and non-railroad property

NTSB investigations are infrequent for rail transit systems; however, it is important to be familiar with and understand what will occur in the event a rail transit accident is the subject of an investigation; see Appendix A, “What to Expect: NTSB Investigations.”

Investigation Plan and Procedures

RTA investigation plans and procedures must conform with the requirements in SSO program standard. Title 49 CFR § 674.27 (a) (7) – Investigation states that the SSO program standard must identify thresholds for accidents that require the RTA to investigate. Also, the program standard must address how the SSOA will oversee an RTA's internal investigation, the role of the SSOA in supporting any investigation conducted or findings and recommendations made by the NTSB or FTA, and procedures for protecting the confidentiality of the investigation reports. It also includes the roles and responsibilities of RTA personnel, contractors, or others involved in the accident review process, including the composition and organization of inter-departmental investigation teams and the criteria or thresholds for their deployment.

Significant or complex investigations may require the assembly of an investigation team or committee. Typically, internal support for the investigative process includes agency Subject Matter Experts (SMEs) in specific areas that may include:

- Car equipment (mechanical)
- Track/infrastructure/power
- Signals/communication
- Power
- Transportation
- Safety and security
- Operating rules, procedures, practices, bulletins
- Training
- Human factors (medical, hours of service, training)
- Survival factors
- External expertise may also be required from vendors, manufacturers, or consultants

Investigator Qualifications

Essential knowledge, skills, and abilities for investigators include:

- Knowledge of system operations
- Knowledge of accident investigation methods and requirements
- Understanding of equipment and subsystem functionality (track, vehicles, signals, power, communications)
- Ability to read and understand procedures and drawings
- Knowledge of agency rules, procedures, and processes in place to prevent accidents

- Knowledge of local and state rules.
- Understanding of SMS and system safety principles
- Knowledge of incident scene management and Incident Command System/ National (ICS/NIMS)
- Interviewing skills
- Skills related to documenting an accident scene (photography, sketching, measurement, evidence)
- People skills

Title 49 CFR Part 672 establishes minimum training for personnel who conduct safety audits and examinations of public transportation systems operated by public transportation agencies and those who are directly responsible for safety oversight of public transportation agencies. The agency's lead investigator and SSOA investigators would fall under this requirement; depending on the other investigator's role in the organization, they may or may not fall under this definition. Nonetheless, the training curriculum provides a good background for anyone involved in rail transit investigations. The required curriculum includes the following:

- SMS Awareness - e-learning delivery (all required participants) (1-hour course)
- Safety Assurance - e-learning delivery (all required participants) (2-hour course)
- SMS Principles for Transit (all required participants) (20 hours)
- SMS Principles for SSO Programs (FTA/SSOA/contractor support personnel only) (16 hours)
- Transit Safety and Security Program (TSSP) curriculum, minus Transit System Security (TSS) course, (all required participants – credit provided if participant has Course Completion Certificate of previous TSSP courses)
- Rail System Safety (36 hours)
- Effectively Managing Transit Emergencies (32 hours)
- Rail Incident Investigation (36 hours)

Title 49 CFR 672, Appendix A provides a list of technical training plan elements for SSOA personnel who oversee transit operations, which is also a good benchmark for internal investigator training.

In addition to the Public Transportation Safety Certification Training Program curriculum, there are several additional types of training investigators should consider. Potential courses of value to investigators include:

- Agency operating rules
- Agency roadway worker protection

- Agency maintenance training courses
- Agency bloodborne pathogens training
- Agency hazardous materials awareness
- Advanced Rail Incident Investigation-Transportation Safety Institute (TSI)
- Rail Nomenclature (TSI-on-line)
- Fatigue and Sleep Apnea Awareness (TSI-on-line)
- Curbing Transit Employee Distracted Driving (TSI-on-line)
- Transit Safety and Security Audit (TSI)
- Introduction to the Incident Command System, ICS 100 (Federal Emergency Management Agency [FEMA] On-line)
- NTSB Accident Investigation Orientation (RPH-301-NTSB Training Center)
- Forensic photography (various commercial vendors)
- Interviewing skills (various commercial vendors)
- Root cause analysis (various commercial vendors)

Investigators should take every opportunity to undertake self-directed training by spending time with agency technicians, operators, controllers, and other personnel to better understand system operations and maintenance. This also allows an investigator to establish good interpersonal relationships with key staff.

Section 2

Accident Scene

Agency Emergency Response

The agency's response to incidents should be established in advance in an existing Standard Operating Procedure (SOP) or emergency plan. Typically, the agency's control center is responsible for notifying appropriate personnel and activate the response, including notifying investigators. This is where the agencies' program of training, exercises, and debriefs with emergency responders pay dividends.

It is essential that agency responders are aware of the priorities – rescue and public safety followed by preservation of evidence. Emphasis should be placed on preserving the integrity of data recorders, signal cases, and vehicle control compartments.

Inter-Agency Coordination/ICS

Multiple agencies may be involved in an accident response, particularly a significant mass casualty event. The Incident Command System (ICS) is a standardized, on-scene, all-hazard incident management concept (see Figure 2-1). ICS allows its users to adopt an integrated organizational structure to match the complexities and demands of single or multiple incidents without being hindered by jurisdictional boundaries. ICS is part of the National Incident Management System (NIMS) and has as its primary purposes:



Source: istockphoto.com

- Safety of responders and others
- Achievement of tactical objectives
- Efficient use of resources
- Communication and coordination between responding agencies

The ICS structure presented in Figure 1 also provides the roles and responsibilities of those involved in incident command.



FEMA offers free online training on ICS. Various transit specific emergency management documents are available on FTA's website at www.transit.dot.gov/regulations-and-guidance/safety/publications.

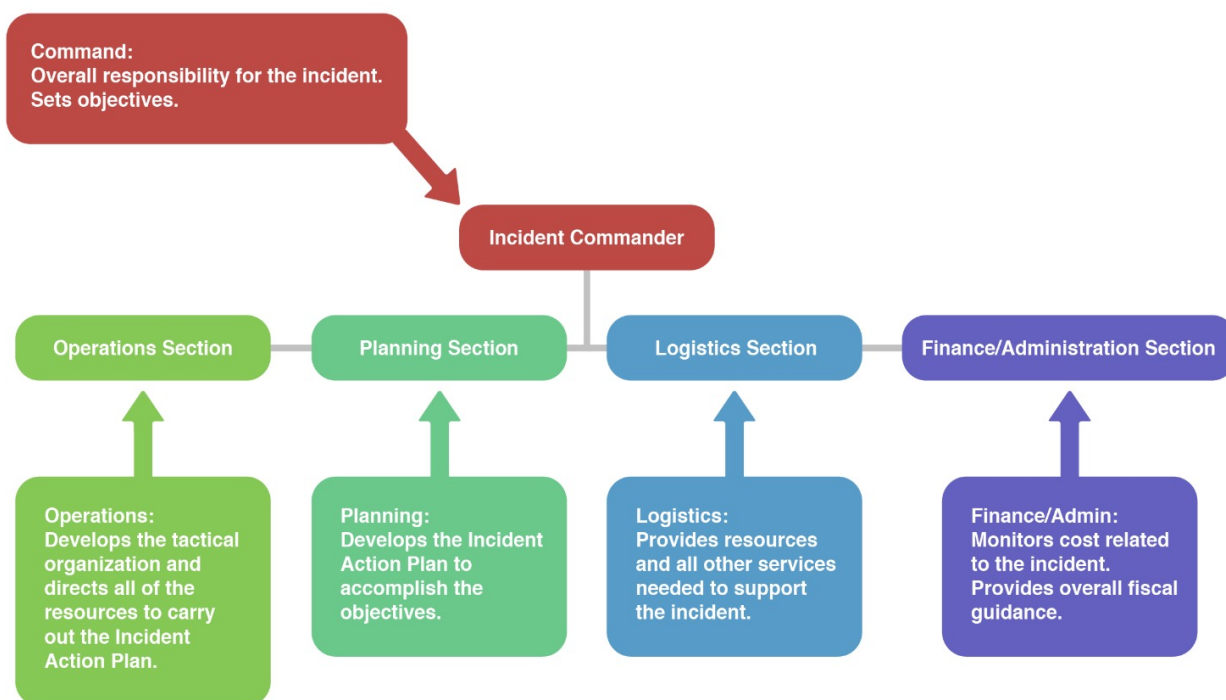


Figure 2-1 Incident Command System (ICS) Structure

Source: TSI

Typically, the first transit employee on the scene (often a train operator) is the initial Incident Commander (IC). The IC position may transition to a more experienced agency employee until the responders arrive. When ICS is established by the response agency, the agency becomes part of the ICS and supports the IC.

Although the following FRA regulations do not apply to most rail transit systems, they do provide a useful model on coordination with emergency response agencies:

- Title 49 CFR § 239.101(5) – Establishing and maintaining a working relationship with emergency responders through training, exercises, and planning.
- Title 49 CFR § 239.103 – periodic full-scale simulations
- Title 49 CFR § 239.105 – debriefing and critique after each actual event and large-scale simulation
- Title 49 CFR § 239.105 (c) – purpose of debriefing and critique.

Scene Safety

The first stop for investigators should be the IC, who will often be with the fire department or police. For accidents entirely on agency property (such as a yard) and with no fire or injuries necessitating a response, the IC will be an agency employee. Before entering the scene, investigators should perform a hazard scan and participate in a safety briefing with the IC. Among the potential hazards that should be evaluated are:

- Traction power electrical status
- Unstable equipment
- Damaged catenary under tension
- Movement on adjacent tracks
- Repair/re-railing equipment and activities
- Biohazards
- Haz-mat spills

Investigators need to request that the IC provide a representative with communication capabilities with the IC that can accompany them during the investigation.



Safety investigators should model appropriate behavior and dress. While on scene, investigators must wear clothing and Personal Protective Equipment (PPE) appropriate to the accident scene and agency protocols. At a minimum, this means long pants, safety footwear, eye protection, hard hat, work gloves, and a reflective outer vest that meets agency requirements. Additional PPE may be required depending on the conditions at each accident scene.



News media often stage cameras to record activities at accident scenes. The investigator should be aware that the behavior and appearance of investigators and other personnel may make the news. (*Note:* The media might have video equipment that might not appear to be in use [video cameras pointed to the ground]; however, they may still be recording audio.) Also, if the NTSB is investigating, only an NTSB representative may talk to the media.



Experienced investigators maintain a “go bag” with PPE and investigative tools that are routinely needed (see Investigator “Go Bag” contents list in Appendix B). Keep in mind that gauges, electric meters, measurement devices, and publications maintained as part of a go-bag should be kept up to date and calibrated. Users should be appropriately trained and qualified. For investigators who do not routinely use a track gauge, electrical meter, or similar device, it is often better to have an experienced technician take the measurements while an investigator observes.

Exposure Potential – Bloodborne Pathogens

Rail transit accident investigators have the potential for exposure to bloodborne pathogens, including Hepatitis B Virus (HBV) and Human Immunodeficiency Virus (HIV). While on scene, investigators should assume that blood and other bodily fluids may be present and should use “universal precautions.” That means to treat blood and bodily fluids as if they are infectious for HIV, HBV, and other bloodborne pathogens and to take appropriate precautions. Rail transit accident investigators should receive initial and recurrent training on bloodborne pathogens as specified in applicable Occupational Safety and Health Administration (OSHA) regulations. The training is required to cover information on the HBV vaccine, which employers should provide at no charge if requested (see 29 CFR § 1910.1030).

Exposure Potential – Hazardous Materials

Rail transit accident investigators have the potential for exposure to hazardous materials, particularly on systems that interface with highway vehicles. These materials may include automotive fluids (gasoline, diesel fuel, hydraulic fluid, antifreeze) as well as a wide variety of chemicals transported by commercial motor carriers. Depending on the operational characteristics of the rail transit system and risk profile, some level of hazardous materials awareness training for investigators is appropriate. For example, NTSB rail accident investigators who respond to transit, freight, and passenger train accidents complete the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) initial training with annual 8-hour refreshers. Some online courses are commercially available. Rail transit investigators should be provided with an appropriate level of hazardous materials training based on the operational characteristics and risk of exposure they may encounter (see 29 CFR § 1910.120).

Documenting and Managing the Accident Scene

A key element of scene management is the preservation of factual evidence. However, during the initial emergency response phase, rescue, recovery, and public safety will be the priorities over preservation of evidence. Rail transit investigators should contact the IC as soon as possible to coordinate the needs of the investigation with the needs of immediate response. The goal of preserving, securing, and documenting the history of pieces of evidence is to protect the condition and integrity of evidence collected during an investigation.

Chain of Custody

Chain of custody documents the movement and location of evidence and the history of persons and entities who had it in their custody from the time it is obtained until its final disposition.

Evidence Collection/Retention

Investigators should have an evidence control plan along with the appropriate chain-of-custody forms and containers. For agencies with dedicated transit law enforcement, these organizations will have established evidence control procedures and storage rooms that can be of help. If vehicles or larger components such as switch machines need to be preserved, a secure storage location in a yard or other fenced facility is needed, ideally with access control.

Typical investigative actions to collect and preserve evidence include:

- Meeting with the IC to outline investigative needs.
- Collecting extensive photo and video scene documentation that allows the viewer to link specific shots of evidentiary items to be linked to the overall scene map.
- Field sketching with sufficient detail to show spatial relationship of collected items to the overall scene.
- Photographing collected evidence *in situ* before collection.
- Tagging or bagging evidence items and completing a chain-of-custody form for each item.
- Maintaining physical control of collected items until transferred to another custodian (storing items in a locked vehicle only accessible by the investigator satisfies this element).
- Tagging larger items (for example, a switch point, switch machine, rail vehicle) and completing a chain-of-custody form. Control should be transferred to the manager responsible for moving the item to a secure location after reaching an understanding on the secure storage requirements.
- Delivering smaller items under the investigator's control to the designated custodian (for example, agency's police department).
- In cases in which the investigator will be the custodian, bagged or tagged items can be stored in a secure location such as a locked storeroom, locked office, or locked cabinet with controlled access.

Event Recorder, Data Logger, Supervisory Control and Data Acquisition (SCADA), Camera System Analysis

Many rail transit systems have extensive data recording systems that provide invaluable information to the investigator. Data recorders may be installed on vehicles, wayside signal houses, control rooms, grade crossing warning equipment cabinets, and in the control center SCADA systems, but may only be stored for a limited time period before being overwritten. Agencies may record Train-to-Wayside Communications (TWC), which include Automatic Train Control (ATC), track, and auxiliary equipment commands, signals, and

messages. Control Center and tower communications may be recorded allowing for later event transcripts. Camera systems may be on vehicles or in stations or other locations, and the investigator may need to coordinate with the agency security/police division to retrieve data. Vehicle audio capture devices may also be installed. Onboard electronic data recorders are required in FRA-regulated environments and are becoming more common onboard rail transit vehicles. Transit agency and private business and residence surveillance cameras may be installed adjacent to the scene. In addition, cellphone videos or photos taken by bystanders may provide valuable evidence. Gaining access to surveillance or personal cell phone data may require local law enforcement assistance.

Investigators need to become familiar with the various types of electronic data recorders, audio capture devices, train-to-wayside communications, facility security cameras, and cameras located within the vehicles and throughout the transit system(s) they may be called out to investigate. Investigators should recognize that due to the age of some legacy equipment, there may not be any recording capabilities; older railcars, for example, will exhibit these limitations. If a delay in downloading data may result in data loss, the various recorder(s) should be downloaded and documented on-scene or properly secured for later data retrieval. If power is secured to the train, it may be necessary to pull the boxes and connect to another appropriate power source in the shop or on a powered train. If a box is removed, record the serial number, the unit should be properly tagged to hold it for accident investigation purposes and to ensure that the unit has the chain-of-custody.

Prior to downloads, the recorder system time should be compared against an accurate clock (ATC clock, control center, or cellphone time) for later time synchronization. The actual car number should be noted and compared against the recorder car number in case the recorder system car number was not reset during a maintenance change-out. Some event recorders do not account for wheel wear, thereby requiring wheel diameter measurement (on the axle with the recorder speed sensor) to calculate actual vehicle speeds and distances between stations. Agencies need to have written protocols in place for the protection, download, analysis, and retention of data generated by such systems.

Forward-facing video from same day previous trains may be useful and should be ordered in a timely way to avoid losing data. The general rule for electronic data at risk of being overwritten is that it is better to have it and not need it than the other way around.

Investigators need to familiarize themselves with these systems and the protocols for download and analysis and should practice obtaining information in a low-pressure, non-accident environment. Some systems will require the assistance of technicians or vehicle engineers to obtain and explain the data.

Investigators should engage key personnel in advance to facilitate downloads and analysis when needed. Agency personnel may be able to provide an initial “hot-read” of the data prior issuing the formal report which may assist other investigation functions. Many agencies rely on their respective SME investigators to produce vehicle, track, and signals investigation reports which are later fused to make final determinations about root and causal factors.

Photographs, Videos, Sketches, and Measurements

Appendix B provides extensive instruction and pointers for documenting the scene through photographs and field sketches. In general terms. Some investigators wear a “Go Pro” type device, so they are always recording on-scene. A measuring tape or other measuring device can be deployed while filming to assist in capturing relative scale of objects/evidence. It is better to have images and not need them. For evidence control purposes, unwanted images should not be deleted. Video recorders may also capture sound, so investigators should be aware of what is said during shooting.



Source: Pixabay

Before collecting small pieces of evidence, the point of rest, orientation, and location relative to the overall scene (including location description in accordance with the most recently issued NTD Safety and Security Reporting Manual³) should be photo-documented. Unique identifiers on equipment and components such as serial numbers or model identification should be captured. Rail vehicles and maintenance equipment may have stenciling at various locations on (or under) the equipment that should be captured.

Agencies may find it beneficial to have a drone operator/photographer on staff or under contract to record aerial images of a scene. An alternative is to ask for images from law enforcement or media who may have overflown the scene.

It is important to capture things that will change, such as rail markings, track and switch conditions, signal relay positions, operator control handles, and cab breaker positions, starting at a distance and moving in closer. If documenting a vehicle, signal case, or another unique component, an image of the identification number (car number, license plate, signal number, part number, asset number) should be captured before and after taking the more detailed shots to enable linking a close-up easily to the unique item. Adding an annotation to a picture or component will assist in capturing the intent or significance of the evidence when reviewing it at a later time. Additionally, a written log of key evidence helps organize the material that will need to be reviewed and analyzed.

³ <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/ntd/146986/2020-ntd-safety-and-security-policy-manualv1-1.pdf>.

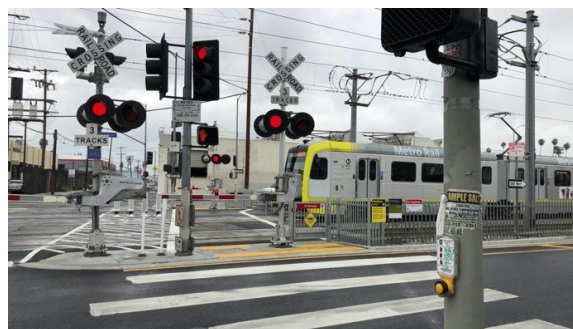
In a derailment event, as many images and measurements as possible should be taken before the derailed vehicle is moved. Handheld or portable wheel gauges can be used at the scene to capture wheel readings, such as flange width and depth, wheel circumference and wheel back to back measurements; however, a more detailed inspection of the train wheels should be performed in a shop environment and, if necessary, specialized testing devices should be used to capture wheel profiles and document anomalies. The area traversed before the point of derailment (POD) is of particular interest, as are the stationing markers along the right-of-way (ROW) ahead of and throughout the derailment area, beyond the POD to the location of the rail vehicle's final resting location and resulting property damage. It will be necessary to take additional photographs and measurements after the derailed vehicle is removed once the track structure is accessible. Post derailment track measurements are taken at stations of fixed distance (at 15.5-ft intervals, for example), and wear, gauge of track, cross-level, and super-elevation should be recorded. Conditions of ties, fasteners, rail wear and other track components, including Special Track work (crossing frogs, switch points, stock rails, rail braces, track rods, housetops), and rail lubrication devices are also should be recorded. Photos of conditions at each station can be useful.

Sketches should be marked as “not to scale” and show a North arrow. Measurements should be from a fixed object that will not change, such as a stationing marker, the edge of a platform, or a traction power pole. Some vital measurements include point of impact, point of derailment, position of rest, and orientation of individual cars.

If multiple people are taking measurements, there are often natural discrepancies, particularly over long distances. Agreement on the numbers to be officially recorded should be reached, with remeasuring if necessary. The goal with scene documentation is to have measurements and relative positions accurately recorded so the investigator theoretically can put everything back in the same place after it has been removed. Many agencies use this information to model equipment behavior during post incident activities or to provide detailed illustrations in the final report.

Grade Crossings/ Intersections

The position and condition of pavement markings, warning signs, and any special pedestrian enhancements (swing gates, pedestrian gates, Z approaches) should be documented, as should the



Source: TTCI

functionality of traffic signals, signage, and warning devices, if possible. The rail vehicle should be examined for equipment anomalies and damage prior to being released. The right-of-way (ROW) should also be inspected for damage and debris that can result in a secondary event. During the post-on-scene phase, the investigator will be comparing scene conditions to as-built drawings, regulatory orders, and other criteria. If conditions permit, it is helpful to record a video from a motor vehicle driver/pedestrian perspective approaching the crossing/intersection in the same manner as during the event.

Witness Statements

Police or transit agency personnel should try to get as many witness statements as possible while on the scene, along with contact information. As passengers often are anxious to leave the scene, at a minimum, contact information for later follow up should be obtained. Investigators may need to schedule follow up interviews depending on the nature of the event.

Weather and Environment

The first investigators to arrive on the scene should make notes on their observations of the weather and environment at the scene:

- Did weather conditions affect visibility?
- Did weather conditions affect vehicle wheel friction?
- Is it dark (after sunset or in a tunnel)?
- Is artificial lighting present? Are all lights lit?
- Is any unusual noise (such as ventilation fans) or high ambient noise conditions present?
- Is there anything in the environment that may have created a distraction?
- What was the direction of travel and time of the accident?

Local airports often will have a weather station and data on temperature, precipitation, and wind, which can be obtained at or near the time of the event. Information on times of sunset and sunrise can also be obtained. [The National Oceanic and Atmospheric Administration](#) (NOAA) also is a source for weather conditions at the time of an event.

Working with Law Enforcement

Local law enforcement agencies have independent authority at traffic accidents and criminal events and will lead their investigation. Investigators need to forge cooperative working relationships with these local authorities, preferably in advance of the accident. Agencies with their own police department or contracting with a local police department for dedicated personnel often have an easier time investigating. Relationships can be forged through meetings, training, drills, and tabletop exercises.

Law enforcement traffic investigations focus on which party broke the law (who gets the citation). In severe accidents, law enforcement may conduct a criminal investigation of agency employees or the agency itself. In some instances, the operator is judged not “at fault” by law enforcement, but the agency’s internal investigation will find the accident to have been preventable. (*Note: An accident could be rated as non-preventable on the part of an employee by the RTA but still have organizational*



Source: Pixabay

implications that need to be addressed to prevent similar future accidents or that require the agency to analyze identified hazards, evaluate safety risk, and implement proactive or preventive action. The agency safety investigation is more focused on system and organizational issues and prevention than on fault.)

Points of Contact

Business cards or contact information of people from other departments and outside agencies should be obtained. An investigator will invariably have additional questions for them or need documentation or further information.

Recovery Activities

Prior to resuming regular passenger service, subject matter experts (SMEs) should ensure that it is safe to do so or put mitigations in place to safeguard train movement. For example, it may be necessary to implement a temporary speed restriction on a segment of track with significant defects until permanent repairs are executed. If significant damage is inflicted on the signal system, a manual or absolute signal block operation will be required to resume train service. Additionally, rail vehicles involved in an incident should be thoroughly inspected prior to movement to ensure they not compromised and operated at reduced speeds to a repair facility.

Agencies typically have existing test criteria that are used on a routine basis in preventive maintenance activities or when subsystems or components are placed into service or replaced. For example, if signal system performance needs to be validated, it may require a simple series of track circuit shunt tests; however, following a more complex event, the functional verification of an entire interlocking may be required. These tasks typically will be performed prior to restoring passenger service.

Most investigators will usually need to rely on technical staff to perform many of the tests, but they should witness test performance and outcome. Any test not already covered by an internal maintenance procedure should have a written test plan developed and reviewed by agency technical and investigative staff.

Section 3

Post On-Scene Investigation

Fact-Finding Phase

Post on-scene activities include desk reviews of documentation, follow-up interviews, tests, and re-creations, described as the “fact-finding” phase of an investigation.

Timeline

A timeline forms the basis of laying out the accident sequence and helps to put precipitating events in order; therefore, early on, investigators should begin creating a timeline of events relevant to the accident. This starts at the beginning of the accident trip or employee shift. However, investigators should also review and include operating cautions, special or temporary orders, procedures, and instructions that might have been in effect on the day of the accident. As much detail as possible should be developed around events relevant to the accident. Inputs for the timeline include vehicle and signal system event recorder data, video recordings, interviews, SCADA data, and control center logs.

Effective Investigation Practice

Once a “good” time is established for an event, for example, using a vehicle event recorder, forward-facing video, and/or signal system data that all show entering an interlocking track circuit, other recorders and their data can be synced. Investigators should plan to budget enough time for this effort.

Recorded Data

Recorded data are a crucial source for a complete timeline and for understanding the event. Synchronizing the times from multiple data recorders is an important step to ensure accuracy. Standalone cameras and data recorders typically have autonomous internal clocks. Over time, the clocks can deviate from the original time setting, and some equipment may have had clocks initially set inaccurately or to a different time zone. Aligning date/time stamps across various data sets to actual time can be a challenge. SCADA time is usually tied into an accurate clock, but this should be verified.

Video images can provide valuable data to the survival factors investigation on where individuals were located and the injury mechanisms involved. Forward-facing video provides valuable information on the moments leading up to the accident and the conditions of track, structures, signals, and environment.

Effective Investigation Practice

In an accident in which the track, signals, power, or other infrastructure may play a role, forward-facing video from previous trains that operated over the territory just before the event can be very valuable to review. Where relevant information is developed, it should be added to the timeline.

Inward (operator) facing video is becoming more common and has been recommended to the transit industry by the NTSB. APTA issued Recommended Practice RT-OP-RP-024-19, Crash and Fire Protected Inward and Outward Facing Audio and Image Recorders in Rail Transit Operating Compartments. Inward-facing video can provide the investigator with valuable information on operator actions, vigilance, and distractions that may have been factors in an accident.

Vehicle event recorders are increasingly common on rail transit vehicles. FRA regulations contained in 49 CFR § 229.135 require event recorders on locomotives. These regulations do not apply to most transit operations. The Institute of Electrical and Electronics Engineers (IEEE) issued the Standard for Rail Transit Vehicle Event Recorder, IEEE 1482.1-1999, and APTA issued a recommended practice for periodic maintenance and inspection of event recorders.⁴



Source: NTSB

Event recorders provide time and distance traveled and information on speed, braking, throttle, horn, and other operational parameters. In a collision or derailment scenario, the last few seconds of recorded data can become corrupted or inaccurate because of collision damage or the wheel providing speed/distance inputs being off the rail. Further, specific system data (ATC, propulsion, brake, etc.) may be captured in separate data acquisition modules which could be useful to augment event data recorder (EDR) data.

If recorder speed data is based on wheel rotation, a wheel diameter measurement at the time of download is needed for the best accuracy. This activity is typically performed in a shop environment during post-incident activities. The point of rest of the rail vehicle following the accident is an essential measurement for calculating the location of vehicle data points approaching the accident location.

SCADA system recorded data will provide information on the various wayside systems and subsystems monitored. Potential SCADA data to review may include but is not limited to:

- Track circuit occupancy/non-occupancy
- Track switch position
- Signal indications
- Traction power status including breaker positions
- Alarms
- Ventilation fan status
- Controller inputs

⁴ On-Board Recording Equipment Periodic Inspection and Maintenance, APTA RT-VIM-RP-015-03, Rev. 2, June 8, 2003.

Most agencies record radio and telephone communications to/from the control center. In some cases, radio communication between field units is also recorded. Review and analysis of these communications help determine the event sequence timeline and may provide valuable information about communication flow and decisions and actions that were made leading up to, during, and after the accident. As with other data sources, the time stamp needs to be verified for accuracy and synchronized with other recorded data. Investigators may find it helpful to have critical communications transcribed.

Document Reviews

Document reviews can be a daunting task; documents are selected by investigators based on the circumstances of the accident, as with an audit. Examiners should evaluate what the document says should be done and what was done. Discrepancies or “gaps” need some analysis to determine their relevance. The focus should be on documentation of procedures and policies that were intended to prevent the type of accident under investigation. For example, if operating rules violations were involved, training, rules and procedures, management oversight, and compliance monitoring would be key areas of documentation to review. Figure 3-1 provides examples of documents that may be reviewed during this activity. FTA has produced a compendium of transit safety standards that contains potential external standards investigators can use as benchmarks.⁵

Transportation Department	Track Department	Signal Department	Mechanical (Vehicle) Department
<ul style="list-style-type: none"> Train operating documents <ul style="list-style-type: none"> consist/run ID schedule/paddle bulletins or written instructions to operators Operational rules/procedures Operating rule book <ul style="list-style-type: none"> SOP book train operator manual troubleshooting guide Operational testing records Transportation occurrence reports Supervisor reports Operator statement 	<ul style="list-style-type: none"> Track charts Track inspection records/reports Track repair records Track rehabilitation history Track geometry vehicle reports Rail defect detection inspections Structures inspection and repair history Joint switch inspection records Detailed damage estimates 	<ul style="list-style-type: none"> Signal drawings - track circuit length, IJ and wayside signal locations Signal inspection records/reports Signal repair records Signal upgrade history Signal system design documents Signal system data downloads Joint switch inspection records Detailed damage estimates 	<ul style="list-style-type: none"> Vehicle histories <ul style="list-style-type: none"> acquisition date initial certification rehab/rebuild information Fleet modifications Vehicle inspection records/reports Post-event testing and inspection reports Vehicle repair records Event data recorder downloads Forward-facing and cab video downloads Interior security videos Detailed damage estimates

Figure 3-1 Example Documents to Review

Source: K&J and CUTR

⁵ <https://www.transit.dot.gov/regulations-and-guidance/safety/compendium-transit-safety-standards>.

Management Oversight and Rules Compliance

Operating rules are instructions to personnel covering train operations and maintenance activities on the ROW. Operating rules include the agency rulebook and other associated manuals, SOPs, bulletins, and operating documents (train orders or equivalent) issued to train operators. Investigators should become familiar with the requirements in these rules and procedures.

It is not enough to have rules in place. Systems need to have quality control/assurance programs to be sure rules are understood and complied with. As Ben Franklin said, “A little neglect may breed much mischief.” Without management oversight, levels of compliance and uniform application of rules, there will be “drift.” In an SMS environment, this is called practical drift, and an agency process should be in place to measure the drift, control it, and bring it back in line with the agency's expected performance standards. Rules compliance monitoring programs provide this function.

FRA has requirements for programs of operational tests and inspections (49 CFR § 217.9) that require railroads to “conduct operational tests and inspections to determine the extent of compliance with its code of operating rules, timetables, and timetable special instructions.” Further, railroads should analyze program results and address trends. Rail transit systems do not fall under these FRA regulations. However, they provide an excellent benchmark to assess the adequacy of agency programs.

FTA regulations at 49 CFR Part 674 are based on the SMS approach. A key element (one of the four components) of SMS is safety assurance that includes rules compliance audits. Title 49 CFR § 674.27(b) (1) requires that an agency's safety plan include provisions to “monitor its system for compliance with, and sufficiency of, the agency's procedures for operations and maintenance.”

Effective Investigation Practice

Questions document reviews should answer:

- What is the relevance to the accident sequence?
- What obstacles need to be addressed to bring practices into conformance?
- Are the rail agency's current practices effective in identifying and addressing latest conditions and active failures that have the potential to result in the accident?



Key Points on rule assessments:

- Determine if established practices were followed.
- If not, determine why, i.e., distraction, inadequate oversight, lack of training, cumbersome procedures, practical drift.
- If procedure/practice was followed, determine if it is effective.

APTA published a standard on rules compliance (APTA-RT-OP-S-11-10) for rail transit systems. This voluntary (unless adopted by state regulation), consensus-based standard requires, among other things, defining rules to be evaluated and operating positions affected, cycles, determining the frequency of checks, establishing methods of verification, metrics, and validating/analyzing program effectiveness.

Evaluations of the operating rules are an essential part of the investigative process. Investigators need to be familiar with the rules and determine what was required, what transpired and be able to factually document and describe any deviations or anomalies. If rules were not followed, how did that affect the event? Was the training in conformance with the current rules and the existing equipment configurations? If not, what bearing did that have on the event? It is important to determine what rules were clear, were understood by those involved, and whether employees had received sufficient initial and refresher training on the rules. It is also essential to evaluate the compliance program conducted by managers.

Effective Investigation Practice

When reviewing the rules compliance program data relevant to the accident under investigation, investigators should consider the following:

- Is the program guidance to managers clear on what rules to check and how to perform checks?
- Are managers performing checks themselves qualified on the rules?
- Are reports produced showing compliance data over time? Examine how managers use the data.
- Red flags:
 - Compliance check results that are “too good,” i.e., there are never any exceptions.
 - Compliance checks are not spread over days and times; From an employee perspective, compliance checks should be unexpected.
 - Compliance checks limited to PPE, tardiness, and “easy” checks.

If there have been revisions to the rules involved in the event, investigators should look at the change management process, stakeholder involvement, and how rules revisions were communicated to those affected. The APTA standard for rail transit rule books (APTA-RT-OP-S-001-02 Rev. 2) includes a suggested change management process. Part of the recommended operating rules change management process involves a committee structure:

- The general rulebook committee with chairperson may be composed of senior managers from operating, maintenance, safety, labor, risk, security, and law offices.
- The objective of such a committee structure is to make sure that all departments affected by changes understand and approve the changes.

Interviews

Conducting interviews is one of the most important responsibilities in the investigation process. The following section discusses who should be interviewed and why. (*Note:* Appendix C includes key points that should be considered when conducting interviews and recommended processes.)

Interviewees should be selected who meet the objectives of filling in the blanks or clarifying events. These may include:

- Eyewitnesses
- Employees
- Passengers

In addition to immediate on-scene interviews, it is often desirable to conduct follow up interviews during the post-on-scene phase of the investigation, particularly with key individuals who may have played a role in the event such as vehicle operators, controllers, and maintenance technicians.

At the scene, investigators are the least informed about the specifics of the accident. After a few days, investigators have more information that can help them ask better questions and better assess the information provided by interviewees. Additionally, information developed after the on-scene phase may identify new individuals who can shed light on the event.

One-on-one interviews may be necessary, particularly when obtaining witness statements after an event, as witnesses may be anxious to leave. An interview team of two is preferred—one person to conduct the interview, and one to take notes or operate recording devices. Having a second person as a witness may also be desirable in some cases, as larger groups of interviewers can be challenging and require a leader to set clear ground rules about questions and the interview process.

The interview approach used by the NTSB has been proven effective. It is not an interrogation. Interviews can be described as a structured conversation where the interviewee is an equal partner. The interviewee is made to feel at ease and encouraged to relate observations without interruption. Interviewees are allowed to have one representative with them (union rep, attorney, and co-worker). An interviewee's supervisor or manager cannot be a representative. Your agency policy may differ. NTSB investigators typically record interviews, have them transcribed, and share with the interviewee allowing an accuracy check.

Experience has shown that an adverse interrogation approach is not productive; full cooperation cannot be compelled. The interviewee should be made aware of the social benefit (to fellow employees, passengers, society) of prevention of

future events. The purpose of the investigation interview is to get a complete picture of the facts to prevent future occurrences rather than to attempt to identify blame or solicit a confession.

An interrogation implies that questioning is done on a formal or authoritative level, such as a lawyer/witness situation or a police officer/suspect session. Here the questioning may be devious, shrewd, or clever with the objective of tricking, trapping, or antagonizing the witness to get the information. It is the interview, rather than the interrogation philosophy, that is desirable in the questioning of witnesses by accident investigators. Witnesses are encouraged with the need for safety and prevention. Most people are in favor of these goals and willingly recount their observations.

Effective Investigation Practice — NTSB Approach to Interviews

- Interview, not an interrogation.
- Cooperative and informal, yet structured conversation.
- Interviewee is an equal partner.
- Interviewee is encouraged to cooperate.
- Interviewee allowed to relate observations without interruption or intimidation.
- Usually conducted informally and voluntarily.
- Interviewee can have one representative present.
- Interview is recorded and transcribed.
- No “off the record” interviews.
- An interrogation approach is counterproductive.
- Appeal to the interviewee with the need for transportation safety and prevention.
- Most people want to help and share their observations.

- **Identify the interviewee.** Who will be interviewed? When? Why? If possible, select a time and place for the interview that will put the interviewee most at ease. Set goals for the interview. Identify some of the critical areas you hope to understand better.
- **Acknowledge interviewee concerns.** Be aware of concerns the interviewee may have and be ready to discuss and address as much as possible. Eyewitnesses may fear seeing the name in media or be reluctant to get involved, or may fear “getting it wrong.” Those familiar with the incident may be aware of their effect on potential participants, damage to company/organization, or personal responsibility. Potential participants may fear loss of livelihood, damage to their reputation, a lawsuit, or responsibility for the injury/death of innocent people.
- **Preparation.** Do your homework; know the operating rules and method of operation involved as much as possible. Review the circumstances of the accident—the rules and procedures involved, witness statements, timeline, video, event recorder, and other recorded data.
- **Identify the information to be obtained.** Determine the order in which information is to be obtained and the general questions that will elicit the information to be obtained for each topic; establish ground rules

for conducting the interview, and ensure that the interviewee is as comfortable as possible.

- **Establish ground rules.** Have an understanding of the ground rules in advance with the interview team. Know how you will manage requests for representation.
- **Follow common sense rules.** Do not conduct an interview alone, particularly with someone who may have been involved in the event. Ensure that notes are taken during the interview, interview only one person at a time, and allow no interviewees to observe other interviews or talk to each other between interviews. In addition, separating multiple interviewees to reduce the likelihood of them influencing each other's recollection of events.
- **Do not permit interruptions** to either questions or answers, but allow follow-up questions. One person should be responsible for taking notes during the interview, and notes should be agreed to and signed by all interviewers present in the interview as soon as possible.
- **Allow an interviewee representative.** In some cases, interviewees may want a representative. NTSB protocol allows an interviewee to have no more than one representative of the interviewee's choosing. Unionized agencies typically provide for a union representative if requested. The representative may not answer questions for the interviewee. Just as it is important to establish rapport with the interviewee, the interviewer should try to develop a rapport with the representative.
- **Take notes or record the interview.** The interviewee should be informed if the interview will be recorded. Some agencies (including NTSB) record interviews; others do not. Recording has obvious advantages in terms of accuracy. Even with a recorder, someone should be taking good notes, as recorders can fail and there may be nuances such as body language that a recording will not capture. An interviewee may object to recording; the objective is to make the interviewee comfortable. Conducting an interview without a recorder is preferable to a confrontational interview or no interview at all.
- **Set the stage.** Develop a rapport with the interviewee, even if it takes an extended amount of time. Find some common ground. This should be done before beginning the interview. Developing rapport will set the stage for the rest of the interview.

Effective Investigation Practice

Transcribed recordings should:

- Be word for word, no interpretation.
- Note time stamps on transcript.
- Record actual language or lack of words.
- Indicate who initiated the conversation.
- Indicate whose words were "stepped on."
- Indicate who acknowledged the information provided.
- If readbacks were repeated word for word.
- Include a second set of ears verify accuracy.

Reenactments and Sight Distance Evaluations

Reenactments and sight distance observations often are done to verify the conditions at the time of the accident. The goal is to come as close as possible to duplicating the accident conditions and when participants could have seen a hazard before the accident.

Tests

Agencies typically have existing test criteria that are used on a routine basis in preventive maintenance or when subsystems or components are replaced. Post-incident testing can use the same tests to verify the operating condition of signal systems, ventilation fans, track switch operation, vehicle braking, and any other subsystem or component that may be relevant to the event under investigation. For example, if signal system performance needs to be validated, it may require a simple series of shunt tests or, in more complex events, the functional verification of an entire interlocking.

Most investigators usually will need to rely on technical staff to perform many of the tests, but they may need to witness the test performance. Any test not already covered by an internal maintenance procedure should have a written test plan developed and reviewed by agency technical and investigative staff.

Laboratory Testing

A contract laboratory may be needed for specialized tests beyond the capability of the agency—i.e., metallurgical analysis, materials testing, software testing. Investigators will need engineering support from within agency or specialized consultants to help organize and select appropriate labs and testing protocols. The agency engineering group may already have some contracts in place.

Drug/Alcohol Testing

FTA drug-alcohol testing requirements are found at 49 CFR Part 655; additional DOT requirements are found at 49 CFR Part 40. In addition to alcohol testing, FTA requires tests for marijuana, cocaine, opioids, amphetamines, and

Effective Investigation Practice

Reenactments should be done as soon after the accident as possible and at the same time of day with the same lighting and weather conditions. The same equipment or the same type of equipment should be used. Equipment operators/train operators should be qualified on the equipment, and their observations and insights should be noted. In measuring sight distance, investigators should note in documentation that everyone was focused on identifying the item (train, auto, worker), creating an artificiality from normal operations.

Effective Investigation Practice

For an impairment to be considered a cause or contributor to an accident following a positive test result, the investigator needs to determine that vigilance, reaction time, perception, or decisionmaking was a factor in the accident and was influenced by the substance involved. The agency medical officer may be of help in making this determination.

phencyclidine. Specific protocols will be spelled out in the agency's testing program. A post-accident test needs to be done within two hours. Some agencies may have testing programs that screen for additional substances. Investigators should know what the specific requirements are for their agency. (See the Human Factors section of this document for more detail). If the accident conditions triggered employee post-accident or probable cause drug-alcohol testing, results will come back negative or positive; a positive result will need some analysis to determine if it is relevant to the accident.

Before ruling out impairment as a factor following a negative test, remember that the federally required protocols test only for a limited number of substances. A negative test result for FTA test criteria does not necessarily mean impairing drugs were not tested for by the FTA panel and were not involved.

Emergency Response Documents and Debrief

Resources for evaluating the agency's emergency preparedness and response include the following:

- APTA Standard: Standard for Rail Transit System Emergency Management (RT- S-OP-007-03)
- FTA guidance documents—*Recommended Emergency Guidelines for Rail Transit Systems* (March 1985), *Public Transportation System Security and Emergency Preparedness Planning Guide* (January 2003)
- National Fire Protection Association (NFPA) 130: Standard for Fixed Guideway Transit and Passenger Rail Systems

On-scene investigators should attend a “hot wash” session with responders documenting what went right and what challenges were encountered. Documentation produced by response agencies is valuable and should be obtained. Emergency response documentation may include:

- 911 call center logs showing time and source of initial notification and who was notified/dispatched.
- Fire department/Emergency Medical Services dispatch logs that show when the notification was received, when units were dispatched, and when they arrived on-scene.
- EMS triage logs that indicate how many people were triaged, color-coded tag counts, lists of names, and disposition of injured.
- IC logs and made notes, if available.
- Photographs and videos from response agencies and other parties.

Challenges or problems identified in the hot wash and debrief should result in a review of the agency SOPs and emergency plan resulting in revisions where warranted.

On the transit agency side, control center records, recorded transmissions, SCADA data, and any other records of the event should be obtained and reviewed.

Debriefs with responders are required on FRA-regulated properties and are recommended for transit by NTSB and by APTA standards. FTA Safety Advisory SA-15-1 requires SSOAs to audit agencies with subway tunnel environments for compliance with NFPA Standard 130, which, in turn, requires critiques “after exercises, drills, and actual emergencies.”

Effective Investigation Practice

For major events, responders will often hold a more formal debrief one or two weeks after the event. Investigators should attend and participate. Valuable information for the survival factors investigation will be covered at the debriefing.

The goal of the emergency response element of the survival factors investigation is to determine if the response contributed positively or negatively to the event. A delayed or substandard response by emergency responders coupled with severe passenger/crew injuries could result in additional fatalities or more severe injuries to passengers and crew.

An evaluation of medical response also should be provided, including a list of agencies involved in the response (transport agency, hospitals), number of individuals transported, and where they were transported.

Law enforcement response should be assessed to include which jurisdictions responded, when and how they were notified, when they arrived on the scene, how they assisted with the evacuation, crowd control, and information on who collected witness statements. It is important to debrief with as many emergency response, police, and medical staff to determine what problems were encountered while responding to the event.

FRA regulations have been developed to improve emergency response to passenger rail events. Although these regulations do not apply to most rail transit systems, they provide useful guidance to emergency planners and investigators. For rail transportation systems governed by FRA rules and procedures, 49 CFR § 239.105 requires emergency preparedness training to be performed with all potential emergency responders in the event of an event. The rule states that railroad officials must conduct a debriefing with emergency responders to determine the effectiveness of emergency plans and to critically review the roles, responsibilities, and performance of the agencies involved in responding to the event to improve emergency planning and response to any other events.

Investigating Injury and Fatality Events

In a mass casualty event on a public transit system, cataloging injuries can be challenging, as uninjured passengers and “walking wounded” with minor injuries may walk away to continue their journey. Even determining the number of passengers involved is difficult, as most transit agencies do not maintain a passenger manifest like some other modes of transportation. Additionally, the Health Insurance Portability and Accountability Act (HIPAA) provides patient privacy protections and restricts medical providers from providing patient information. Sources that investigators can use to catalog injuries and fatalities include:

- Vehicle interior video recorders
- Claims
- Interviews
- Statements
- Triage logs
- Other emergency responder records

Based on these sources, investigators should prepare a grid cataloging the numbers and types of injuries in accordance with the classifications in NTD’s *Safety and Security Policy Manual*. An example is shown below:

Injuries and Fatalities at Scene

	Employees	Responders	Passengers	Total
Fatal				
Serious Injury				
Non-Serious Injury				
Other Injuries				
Total				

*Includes individuals who stated they sustained injuries but did not seek immediate assistance and who were not transported away from the scene.

Per the NTD, a serious injury is one that:

- Requires hospitalization for more than 48 hours within 7 days of the event
- Results in a fracture of any bone (except simple fractures of fingers, toes, or nose)
- Causes severe hemorrhages, or nerve, muscle, or tendon damage
- Involves an internal organ
- Involves second- or third-degree burns or any burns affecting more than five percent of the body surface.⁶

⁶ <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/ntd/146986/2020-ntd-safety-and-security-policy-manualv1-1.pdf>.

Non-serious injuries are those that require immediate transport away from the scene for medical attention (one or more persons). For non-rail events or rail-mode non-serious injuries, if an individual seeks medical care several hours after an event or in the days following an event, that individual is not reportable as an injury. Fatalities are confirmed deaths within 30 days, including suicides.

A detailed list and interviews related to any injuries received by any emergency responders are also of great value to the survival factors investigation. Answering questions on how and why these injuries were received may help other emergency responders avoid the same risks. A detailed list of all fatal injuries should also be provided. Detail such as where the individual was sitting during the event is significant to the investigation as is all pathological information relating to the individual's injuries.

Injured passengers and employees should be interviewed to document as much information concerning their actions just before, during, and after the event. Additional information should be collected, such as where the passenger was sitting at the time of the event and what they noticed

Effective Investigation Practice

When interviewing individuals who were in accident vehicles, equipment layouts, photos, and scene diagrams should be available to help interviewees identify their location and the location of others for whom they may have information.

about what other passengers around them were doing just before, during, and after the accident. Injuries can be classified according to *NTD Safety and Security Manual* requirements. Survival and witness statement and interview guidance is provided in Appendix D.

Persons who can provide information and who should be interviewed include:

- Passengers
- Vehicle operators
- Other agency employees
- Responders
- Witnesses

Injuries and fatalities can occur under certain conditions, as a result, key questions should be answered and conditions documented associated with the vehicle interior and vehicle exterior.

Documentation and key questions regarding the vehicle interior include the following:

- Location of seats and equipment outside the vehicle
- Description of thermal and smoke damage

- Description of vehicle(s) damage as it relates to interior structural deformation (location/dimensions), fire pattern, egress
- Evidence of firefighting/rescue activity pertaining to all vehicles
- Condition of windshields, wipers, lights
- Did seats or other interior equipment become unsecured? Did any sharp edges show evidence of impact with vehicle occupants?
- Did windows and doors stay secured?
- Evidence of difficulty removing emergency egress windows or using emergency door releases
- Condition of debris, signage, emergency lighting, exits, carry-on baggage and mobility devices
- Seatbelt and shoulder harness conditions before and after impact (if applicable)
- Difficulty releasing restraints (if applicable)
- Any injuries that were the result of passenger ejection or penetration by outside objects
- Did doors function as intended for emergency access or passenger evacuation?
- Did emergency lighting function?
- Was fire involved? How did interior furnishings perform?
- Was the required emergency equipment in place (ex: fire extinguishers)? Were any used?
- Were instructions provided over vehicle intercom?

Documentation and key questions regarding the vehicle exterior include the following:

- External factors involved relative to accident site; document and supplement with photographs, videos, sketches, drawings
- Site description including final rest position of all vehicles
- Distance, heading, and relative bearing of evidence (e.g., ground scars, skid marks) and vehicle components from main wreckage
- Description of vehicle(s) damage as it relates to exterior structural deformation (location/dimensions), fire pattern, egress
- Description of group scars (length, width, depth, distance, bearing, and heading path and to from main wreckage site)
- Description of obstacles/structures struck (height, construction)
- Description of terrain (elevation, slope/grade, soil)
- Were emergency egress windows/door releases used? Issues?
- Was it difficult for responders to access equipment? Did they have keys or know how to trigger door release mechanisms?

- If applicable, did fuel tanks leak? Was fire involved?
- Was survivable space maintained in passenger areas and control cab?
- Was vehicle equipped with crash protective features like corner posts, accident posts, or crumple zones? Did they function as designed?

Several voluntary standards, regulations, and guidelines have been developed to improve the crashworthiness features of rail cars that can reduce injuries and fatalities of rail collisions and other events. Investigators can use these standards as benchmarks in comparison to performance in the event under investigation:

- FRA passenger equipment safety standards (49 CFR Part 238)
- APTA passenger rail equipment safety standards (PRESS standards)
- Moving Ahead for Progress in the 21st Century Act (MAP-21) requirements for minimum safety performance standards for rolling stock
- American Society of Mechanical Engineers (ASME) RT 1 (light rail), ASME RT 2 (heavy rail)
- APTA RT-VIM-S-026-12, Rail Transit Vehicle Passenger Emergency Systems
- NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems

Investigatory considerations can be broken down into several areas included in the following sections. A detailed listing of crew injuries should be generated, and the same type of interview process should be conducted with the operating crew as was done with the injured passengers. Particular attention should be taken to extract information that can shed light on crew actions just before and just after the event.

Survivability Factors⁷

The survival factors element of an investigation seeks to understand why some people were killed and injured and others walked away unscathed. Not every accident will require a full-scale survival factor investigation; however, investigators should be aware of what is involved and assess whether such an evaluation is appropriate. Survival investigations should focus on the examination of the factors included in Figure 3. The output of the survival factors investigation will be a separate survival factors report, or a survival factors section in the final report.

⁷ *National Transportation Safety Board Investigator's Manual Volume III – Regional Investigations.*

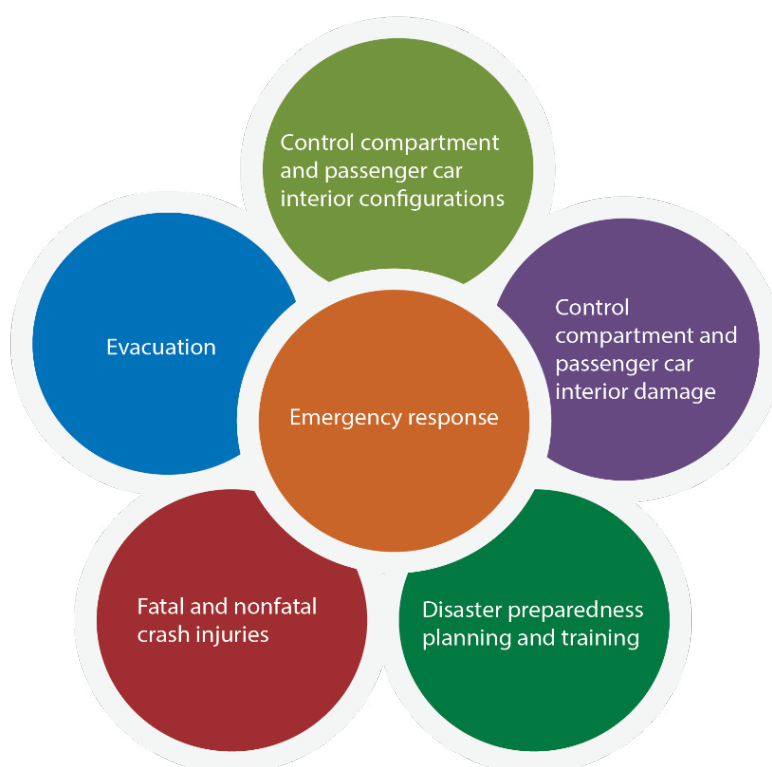


Figure 3-2 *Survivability Factor Examination*

Source: CUTR

A critical element of a survival factors investigation is documenting the response and actions of the emergency response and emergency responders. Several key facts need to be documented; information will come from emergency responder records and interviews with responders and persons attending post-event debriefings:

- Number of emergency responders on the scene
- Agencies represented
- Time of notification
- Delays in arriving at site
- Time ICS established
- Responder familiarity
- Command post
- Equipment utilized
- Adequacy of communication protocols and equipment

Survival factors investigations look closely at the preparedness training and exercises that have occurred in the past to understand how well agencies have

prepared. An assessment of disaster preparedness should be performed to include a review of any training provided to operating employees, fire, police, EMS, hospitals, and any city, county, or state Office of Emergency Management (OEM). It is also suggested that a review of the City, County, and transportation authority emergency management plans be reviewed and assessed for its efficacy.

Change Management/Configuration Management (CM)

When accidents are investigated, it is essential to understand what has changed or may have changed related to the various elements associated with the system being analyzed and the undesirable event being investigated. Failure to plan for and manage change may be part of the root cause of an accident. Configuration Management (CM) is a process for establishing and maintaining consistency of a product's performance, functional and physical attributes with its requirements, design, and operational information. CM is applied over the life cycle of a product and provides:

- Visibility and control of its performance, functional and physical attributes
- Verification that the product performs as intended
- Documentation to sufficiently detail its projected life cycle—fabrication or production, operation, maintenance, repair, replacement, and disposal

CM applies to both hardware and software⁸ components (including operating rules, procedures, and drawings). Changes to hardware and software needs to be evaluated and approved by affected agency departments, documented, and evaluated to make sure they do not adversely impact safety. Most agencies have a CM or change control board to monitor this process. Types of change include:

- Climatic
- Operational
- External influences
- Personnel
- Maintenance activities
- Technological
- System
- Budget

Climatic changes include variations in temperature, season precipitation, and acts of God. For example, heat can affect the system as a result of extremely high temperatures occurring during the summer months. The local electric utility company may not be capable of meeting the peak energy demand placed

⁸ “Software” is used in the generic sense to include written procedures, training plans, and other documents.

on it by customers using air conditioners and other appliances, which can result in sporadic “brownouts” or “blackouts” that can disrupt the signal system and other electronics. Operations using overhead catenary systems (OCS) may experience sags in hot weather, particularly if a weight tensioner binds. Track buckles (sun kinks) in continuously-welded rail are a serious heat-related concern. Inclement weather during winter months can also present challenges such as icing on the OCS and third rails, impacting traction power, and rail joints pulling apart or broken rails due to extreme temperature swings.

Investigators should be familiar with any special procedures triggered by temperature fluctuations. There may be “heat watch” inspection requirements or speed restrictions put in place when temperatures reach a certain point. In cold weather, there are risks of cracked rails, rail contraction and pull apart, and ice buildup on special trackwork and in flanges. Catenary, third-rail power, and switches may be interrupted by icing conditions. Vegetation such as crushed leaves on the tracks may affect braking performance.

Operational changes include service modifications to meet growing ridership demands and competition between maintenance crews and transportation personnel for track access due increased train set lengths, for example. Increased train traffic (tighter headways⁹) can result in less time to perform maintenance and inspections. Increased train length, coupled with closer headways, may put stress on the power system beyond design maximums resulting in fires or stranded trains.

External changes include but may not be limited to:

- Increased ridership
- Shifts in populations
- Land-use change (zoning, development)
- Increased urbanization
- Population/demographic changes
- Land-use changes
- Regulatory changes

Examples of external changes that may impact system operation are station egress issues with increased patronage, increased trespassing, and local regulations on noise at crossings or from maintenance. For example, track drainage and fouled ballast may be exacerbated by raised paved areas adjacent to the track. Competition for track access can be the result of a mandated change by regulatory agencies, thereby increasing the amount of time needed

⁹ Headway is the time span between dispatching scheduled train intervals. Tighter headways shorten the duration between scheduled trains, resulting in increased train traffic per hour. A headway adjustment of 3 minutes reduced to 2 would result in 10 additional trains per hour.

to perform routine work activities. For example, a new RWP regulation may result in additional time consumed in establishing a work zone, which creates a demand for extra track time to complete the normal daily maintenance and inspection activities.

Personnel changes may include a high rate of attrition/retirement, resulting in a significant loss of institutional knowledge, i.e., “brain drain,” along with inadequate succession planning for the organization. Other personnel changes may include recent hires and changes in senior management or political leadership. As attrition occurs, employee development is a vital component of a productive workforce; therefore, training programs should always be evaluated as part of the investigation process. Absence or inadequate programs for development of talent management to address “brain drain” can be at the root or contributory cause of an incident.

Maintenance-related changes include but may not be limited to:

- Alignment and surfacing of the track, i.e., create changes in super-elevation, cross-level, or gauge
- Introduction of a new product that changes the track modulus
- Replacement of components that results in disarraying of wiring, leading to potential incorrect rewiring of circuitry
- Revised procedures not fully distributed to all departments
- Maintenance work on the OCS (re-tensioning, replacement of parts) that can change the interface with the train, pantograph, and wire to impact issues that may contribute to incidents.

Many agencies are implementing resiliency and recovery strategies following events such as Super-Storm Sandy; therefore, the use of outside contractors to support this work has dramatically increased at some rail agencies. The use of outside contractors for maintenance work can lead to changes in equipment loadings, equipment not compatible with tunnel clearances, and as a result of contractor unfamiliarity with system constraints. Additionally, the agency should ensure that these individuals are trained and qualified on RWP.

Technology changes by agencies adopting new technologies may be made based on the following goals:

- Improve performance
- Meet increased ridership demands
- Reduce accident claims
- Address retiring legacy systems that have exceeded their useful life
- Address current system inefficiency, i.e., difficulty with tracking and controlling train meets, overtakes, and alternative service needs

- Address equipment that exceeds its life expectancy and needs to be replaced, reconditioned, or retrofitted with a newer version
- Manufacturer no longer supports the equipment or it has become too expensive to repair and maintain
- Address equipment change out at end of life cycle
- Mandated by legislation, i.e., Positive Train Control (PTC) technology
- Make design modifications and retrofits
- Make upgrades as part of State of Good Repair (SGR) initiatives



Key Point—Investigators should evaluate the potential unintended consequences of technical change.

System changes include but may not be limited to:

- Rail line extensions
- New rail lines
- Added stations
- New signal systems to increase throughput
- Rail service improvements (adding new crossovers, new sidings, double tracking)
- Yard improvements
- New rail cars

Acquisition of additional rail cars from other manufacturers may create compatibility problems concerning crash energy management between different fleets as well as brake and acceleration rates, operator interface, customer interface, and maintenance capacity and training. The need for the system to consolidate, accept, and operate more effectively may lead the agency to operate more than one type of train service or rail equipment on any one line. Any change to the wheel profile on new cars will affect the track structure. The acquisition of new car equipment or the mixing of different fleets needs to be thoroughly evaluated.

Budget changes include but may not be limited to:

- Procurement Department may order a part at a significant cost savings to the agency, not realizing that it is inadequate and could cause a malfunction or an incident leading to a major rail incident.
- Budget constraints that may adversely impact maintenance and inspections and training.

- Low bid requirements that may result in parts and materials that do not meet agency needs.
- Specifications that may be rewritten to reduce costs at the risk of reducing safety.
- Labor costs that may impact the budget, driving the need for increased productivity and greater mechanization without corresponding training.

The system may have changed because the Purchasing Department accepted the lowest bid; persons deciding to accept the lowest bid may not fully understand the operating needs of the new equipment, systems, or service procured, perhaps because the specification used was too general and did not specify the system performance requirements. Even if the specification was sufficiently detailed and accurate, the number of bidders might have been too low due to the difficulty of the project. (*Note: This emphasizes the importance of including safety in the procurement process. If a specification is changed or a procurement is undertaken that does not meet the established specification, hazard analysis and safety risk evaluation would be required to ensure that the proposed change does not adversely affect the safety of the system.*)



Human Factors

The objective of the human factors (HF) portion of an investigation is to understand the nature and scope of human and organizational factors as they relate to transportation accidents. The methodology for conducting the investigation involves assessing information pertaining to the circumstances and conditions of an accident, operator background and performance, psychological and physiological sub-disciplines that can offer analytic explanations for operator performance (human and organizational), and the ergonomic and environmental issues affecting operator behavior.¹⁰

The investigator is responsible for documenting and analyzing various HF factors within the disciplines of engineering, physiology, and psychology. The analysis should determine how these factors interrelate and interact and how they influenced the perceptions, decisionmaking, and actions of individuals involved in an accident. The following human factor-related elements may contribute to an event and should be examined:

- Experience/familiarity/background
- Distraction
- Task–time relationships
- Environmental factors
- Noise/vibration/motion

¹⁰ The term “operator” may also include but not be limited to dispatchers, MOW personnel, and others whose actions or inactions are of interest to the investigator.

- Training
- Health factors



Experience/Familiarity/Background

The investigator should determine an operator's experience and familiarity with both the equipment and the territory. Areas of inquiry include the following:

- Was this your first time operating this type of vehicle? If not, how much experience do you have with this type of equipment?
- Was this your first time in this particular vehicle? If not, how much experience do you have with this vehicle?
- Do you ever drive a different vehicle? How often? What is the difference between the two vehicles?
- Have you operated over this territory before? How often? Have you operated it under similar conditions? When was the last time you operated over this territory before the accident?
- For a route or planned trip, have you operated over this route/trip before? How often? When was the last time before the accident?



Distraction

Distraction, in simple terms, is the operator's attention on or to something other than the operating task. As research has shown, distraction can be a factor in accidents. The investigator should work to determine if the operator was distracted at or near the time of the event. Areas of inquiry could include the following:

- What were you doing just before the accident?
- What were you thinking about just before the accident?
- Were you mentally preoccupied with something just prior to the accident?
- Was there anything interesting or unusual outside the vehicle before the accident?
- Was there anything interesting or unusual inside the vehicle just before the accident?
- Did you have any special concerns about operations just before the crash?
- Did you have any special concerns about the state of the equipment just prior to the crash? Was anything inoperable or not working correctly just prior to the crash?
- Did you have any particular concerns about your cargo (if applicable) just before the crash?

- Were you dealing with a customer, supervisor, or central/dispatch just before the incident?
- Were you listening to the radio? Did you change the channel/volume before the accident?
- Does your vehicle have a CB radio, television, or any other communication device? Were you using or manipulating any device before the accident? (Note: The investigator should determine and evaluate the agency's electronic device policy.)
- Were you eating or drinking anything at the time of the accident? If so, what/when?
- Were you smoking or chewing tobacco at the time of the accident? If so, when?
- Were you adjusting any of the vehicle controls – A/C, heat, seat, windows, doors, before the accident?
- Do you have a cellphone? What is the number? Were you using/on a mobile telephone before or at the time of the accident (phone call, e-mail, texting)? If yes, obtain complete details.



Fatigue-related Factors

Fatigue-related factors, such as cognitive overload, may also contribute to an event. Investigators should examine the operator workspace, devices in the workspace, and responses to the questions above to determine if cognitive overload may have been a factor. In addition, cognitive overload may occur due to an operator's high-demand performance over time, such as driving in dense traffic while adhering to a timed schedule, collecting fares, and communicating with dispatch simultaneously. Investigators should also review these elements during the investigation. Task–Time Relationships

Not only is it essential to determine what the operator was doing at the time of the crash but also what time pressure, if any, the operator may have been under and how their activities relate in time to other activities or events. Areas of inquiry could include the following:

- How long had you been operating at the time of the accident? How long had you operated that day? Did you take any breaks? When and how long? When was your last break before the accident?
- Were you operating on a deadline? Did you need to be anywhere at a particular time? If so, were you on time/on schedule? What would have been the consequences of being late? Of being early?
- If the accident had not happened, when would have been your next change—i.e., taking a siding or a stop? How far in distance and time were you from that change when the accident occurred?

In addition to a description of the task is the operator's perception of their workload. When assessing workload, be sure to look at typical and event-specific workload. Areas of inquiry could include the following:

- How would you describe your typical workload when operating the vehicle (1–10 scale, light/medium/heavy)?
- How would you describe your workload just before the accident (1–10 scale, light/medium/heavy)?
- Do you typically perform any non-operational activities? What activities, how often, for how long, and why?
- Were you performing any non-operating activities before the accident? If so, what were they, when, and why?
- Do you remember what you were thinking about just before the event (i.e., was it related to the task – possible heavy workload – or not – possible lighter workload)?



Environmental Factors

Environmental factors include both external and internal conditions. Questions to ask related to external conditions could include the following:

- What was the weather like at the time of the accident (cloudy, sunny, raining, windy, snowing, clear)? (The investigator should remember to obtain weather condition reports as an independent verification of the operator's statement.)
- Had the weather changed recently?
- What were the surface conditions at the time (icy, wet, dry)?
- Had the track surface/road conditions changed recently?
- Had there been any changes in the type or configuration of the track?

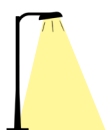


Source: istockphoto.com

Questions related to the conditions inside the vehicle at the time of the accident should begin with the following:

- Describe any noise in the vehicle just before the accident.
- What was the temperature in the vehicle? Was the heat on?
- Was the A/C on?
- Were any of the windows open? Which ones? How far?
- Were any of the doors open? Which ones? How far? Why?

- Were there any audible alarms or any illuminated warning indications on the train operator's control console?



Illumination

The purpose of the questioning in this section is to determine the level of illumination at the time of the accident. This will help the investigator determine how far the operator could see, what they could see, and if glare was a factor. Inquiries could include the following:

- Were you operating outdoors, elevated, open cut, or in a tunnel environment?
- If the accident occurred in a tunnel:
 - How was the lighting/illumination, i.e., what was the condition of the tunnel lighting?
 - Was the lighting sufficient for you to see everything?
- Did the accident occur in the daytime or the nighttime?
- Where was the sun/moon (if you know?)
- In which direction you were traveling?
- Did the sun/moon cause you any problems?
- Did the headlights of other trains, vehicles, reflections, or lights from the environment cause you any problems?
- Could you see and read your instrument panel?
- How well could you see other vehicles?
- Did the visibility or illumination level change before the accident?
- Was/were your headlight(s) on?
- Were you wearing sunglasses?
- How clean was your windshield? Any problems seeing through it?
- Were any of your vehicle's interior lights on? If so, why?



Noise/Vibration/Motion

Noise/vibration questions help to determine if noise may have played a part in the accident. Also, by asking about vibration and motion, the investigator may be able to determine if a mechanical failure occurred or if some feature contributed. Questions could include the following:

- What did you hear just before the accident?
- Any new or unusual noises, either from the track or from the train?
- Did you notice any unusual motion or vibration in the vehicle?
- Describe the vehicle's motion during the accident.



Training

Required and completed training of operators is of interest to the investigator. The following questions should initially be asked of an operator, tailored as needed and based upon their level of experience, education, as well as their familiarity with equipment, procedures, policies, and systems:

- What operator education classes or technical training have you had? List when and where you had the training, including the most recent training (before the accident) and describe it. Who offered/provided the training? What was your opinion of the quality of training?
- Have you had any on-the-job training? If so, provide details.
- Do you take any annual or recurrent training? If so, provide details.
- Have you ever been required to take re-training? If so, provide details.
- Have you ever taken any simulator training? If so, provide details.
- When did you receive your first license/certificate?
- What license/certificate do you currently hold?
- Based on your training, how confident are you that you can effectively and safely performing your duties?

The investigator should confirm the training completed by the operator and compare the training against agency training requirements. Sources of training information may include the following:

- Company records and company training personnel
- Personnel records
- Operational training procedures
- Simulator records
- Licenses/certificates
- Logbooks
- Fellow operators who may know the operator's skills and abilities

As a part of the agency's risk management process, the investigator should also examine any consistent training-related findings that may occur from event to event. Similar event investigation outcomes associated with operator behavior or compliance with an agency's safety protocols may be indicative of ineffective or insufficient training.



Health Factors

Health factors include the employee's general health, sensory acuity, and ingestion of drugs or alcohol including over-the-counter (OTC) and prescription (Rx) medication, and fatigue.

General Health

The NTSB has subpoena authority to obtain medical records; however, an RTA investigator is restricted by HIPAA regulations, which were enacted to safeguard an individual's medical information. As such, the investigator will have difficulty determining the operator's state of general health unless the individual voluntarily provides this information. The investigator should discuss this issue with agency legal and medical personnel to ensure alignment regarding the proper protocols to follow during an event to ensure HIPAA regulations are not violated. In many instances, the agency's medical staff will be relied upon to review the employee's medical work history to determine if preexisting medical conditions were known and adequately controlled.



Source: Pixabay.com

The investigator should evaluate the RTA's medical screening process for medically-based conditions such as sleep disorders. Some RTA's attempt to elicit this information from questionnaires, which are not always successful in identifying at-risk employees. Effective measures include such things as obtaining body mass index (BMI) or having an employee suspected of having a sleep disorder undergo a polysomnography (sleep study). An investigator should ask the employee questions about their overall health, including the date of the last physical examination, results indicated, or any problems or issues noted.

Sensory Acuity

An operator's sensory acuity may play a vital role in an accident. Information on both vision and hearing may also be protected by HIPAA regulations; however, this information may be available for the internal medical department to assess; however, this information may not be available to the RTA investigator unless the individual volunteers it. Questions to ask the operator (or family members) include the following:

- How is your vision generally?
- How was your vision at the time of the accident?
- Do you have, or have you ever had problems with your sight?
- Do you have difficulty distinguishing colors?
- Do you wear glasses/contacts?
- Do you see an optometrist/ophthalmologist?
- How is your hearing generally?
- How was your hearing at the time of the accident?

- Do you have or have you ever had problems with your hearing?
- Do you wear a hearing aid? Were you wearing it at the time of the accident? When was the last time it was serviced or changed the batteries? (Get make/model/date of manufacture)
- Are you under the care of an audiologist or another doctor for your hearing?

Drug/Alcohol Ingestion

A post-accident examination of drug and alcohol consumption should be compliant with FTA post-accident regulations found at 49 CFR 655.44. This regulation requires that an alcohol test must be documented within two hours, i.e., if an alcohol test required by this section is not administered within two hours



Source: CUTR

following the accident, the employer must prepare and maintain on file a record stating the reasons the alcohol test was not promptly administered. If an alcohol test required by this section is not administered within eight hours following the accident, the employer must cease attempts to administer one and maintain the record. Also, regulations require that a drug test must be administered within 32 hours of the accident.

Unfortunately, many OTC drugs are not currently part of FTA's testing panel. The investigator should determine and document the applicable RTA policy, or lack thereof, on self-reporting the use of all medications by covered employees. Also, it is important to determine what drugs the operator did NOT take, such as regular or Rx medications that the operator missed or chose not to take. The absence of a drug could be just as important as its presence. Areas of inquiry include the following:

- Do you drink alcohol? How much? How often?
- When was the last time you drank alcohol before the accident? How much?
- Do you use illicit drugs? Which, and how often? When was the last time you used illegal drugs before the accident?
- Do you take prescription medications? Which? How often? What doctor prescribed them (contact information needed?) What conditions do they treat?¹¹
- Did you take all of your prescribed drugs in the three days before the crash? At what times? Did you forget to take any, or miss any doses?
- Did you take any over-the-counter drugs (aspirin, Tylenol) in the three days before the accident? When? Why did you take them?

¹¹ This is HIPAA-protected information; however, the investigator may wish to discuss the employee's medical history with trained RTA Medical personnel while following defined protocols.

- Did you take any herbal supplements, homeopathic remedies, or vitamins in the three days before the accident? When and why?

Fatigue

Fatigue is a significant problem across all modes of transportation. Fatigue can be defined as a subjective feeling of tiredness that has a gradual onset and can have physical or mental causes. For the purposes of this document, the focus is on mental fatigue. Mental fatigue is a temporary inability to maintain optimal cognitive performance. The onset of mental fatigue during any cognitive activity is gradual, depends upon an individual's cognitive ability, and also upon other factors, such as sleep deprivation and overall health, which can reduce mental and physical functioning. Although the level of fatigue varies, causes of fatigue in a work context may include the following:

- Long work hours
- Long hours of physical or mental activity
- Insufficient break time between shifts
- Changes to jobs or shift rotations
- Inadequate rest
- Excessive stress
- Having multiple jobs
- Combination of these factors
- Changes to home environments can also impact sleep, such as a new baby, change in patterns and routines, new or changing caregiver roles
- Changes in home relationship status such as divorce or separation

Effects of Fatigue	
Reduced decision-making ability	Increased tendency for risk-taking
Reduced ability to do complex planning	Increased forgetfulness
Reduced communications skills	Increased errors in judgment
Reduced productivity or performance	Increased sick time, absenteeism, turnover
Reduced attention and vigilance	Increased medical costs
Reduced ability to manage stress on the job	Increased incident rates
Reduced reaction time – both in speed and thought	Increased risk-taking behavior
Reduced memory/ability to recall details	Impaired judgment
Failure to respond to changes in surroundings	Lowered motivation
Unable to stay awake	Slow reaction time

The investigator should always try to obtain information on both the quality and quantity of an operator's sleep. The time of the accident for comparison should be noted for comparison to known circadian low points. Sources of information other than the operator include work schedules, work cellphone records, and

logbooks. A baseline for on- and off-duty days should be established if possible, as well as specifics for the 72 hours the incident and the two compared. Specific information to obtain includes the following:

- Times the operator awoke/went to bed each day
- Commute time
- Times, content, and duration of meals, including snacks
- Step-by-step recounting of activities, including times and durations
- Relationship between that day's activities and their normal ones—anything missing, anything new, anything odd
- People they saw or talked to and times
- Time, duration, and location of any naps
- Any medications that are taken, including prescription, OTC, or herbal, including time and dose
- Time and amount of any intoxicant ingestion, including alcohol and illegal drugs

If granted an interview by a surviving operator, the most effective way to obtain this information may be to have them begin at awaking three days before the accident and move step-by-step through the days. The more detail that can be obtained, the better the investigator will be able to determine if fatigue did or did not play a role in the accident. If an operator declines to be interviewed or does not survive, the investigator should attempt to obtain this information from family members, roommates, neighbors, co-workers, or other sources. The goal of the 72-hour history is to obtain, in as much detail as possible, information on the operator's activities in the 72 hours before the accident. Information from this history will touch on every area of the HF investigation, making it one of the most important activities the investigator will undertake. It may be beneficial to go back slightly longer than 72 hours, to the time the operator awoke. (See 72-Hour Pre-Incident History Checklist in Appendix E).

Analysis Phase

There is no obvious line that separates the fact-gathering phase from the analysis phase of an investigation. In the on-scene and early stages of the investigation, investigators are cautioned about reaching conclusions. This is important because they need to keep an open mind and not close off lines of inquiry that may yield valuable information.

At some point, usually days or weeks into the investigation, it is appropriate to begin analyzing information gathered during the fact-finding phase. This serves to focus the investigation on relevant areas. For example, investigation of a rear-end collision between two trains will concentrate more on signals, braking, operational performance, and human performance than on track conditions.

Analysis can be described as separating the significant few (facts) from the trivial many. The facts and necessary analysis will vary from event to event, but the process is the same. Appendix F provides information on the Safety Risk Management hazard identification process and includes several analytical tools including in that may be used to assist the investigator in cause or contributing factor determinations.

Section 4

Report Development and Corrective Action Plans

Report Timing

Generally, agencies have internal requirements to produce a preliminary summary report on the incident along with any recommended immediate actions within 24–36 hours. SSO program standards may also contain timelines for interim and final reports. Whereas developing the report promptly is essential, the quality of the investigation and analysis should remain the top priority. Production of quality preliminary and interim reports can help assuage the impatience of those anxious for a final product in a complex investigation.

Report Format and Organization

The agency's report format will be driven by SSO program standard requirements. The report format in this manual uses an NTSB report format for convenience, and it is not intended to supplant what may be required by the individual SSOs or agency policy. When developing the report, it may be useful to review NTD's Safety and Security Reporting fields to help with monthly NTD reporting.

For stylistic formatting (punctuation, numbering, references), unless otherwise directed by the SSO program standard or an agency style manual, the *Chicago Manual of Style* is a useful standard. Reports should be written in plain English; jargon and obscure technical terms should be avoided unless they are critical to an understanding of the event, in which case they should be defined or explained.

Transit agencies may use NTSB major accident reports as a template for its review report. Report contents should include the following (see details in Appendix G):

- Acronyms and Abbreviations
- Executive Summary
- Factual Information
- Analysis
- Conclusions
- Recommendations

Report headings may vary slightly based on the circumstances of the individual accident. Less complicated and more minor accidents may use a more abbreviated format depending on the circumstances and SSO program standard requirements.

Absent other direction from the SSO program standard or FTA, the NTSB accident report organizational model is considered an industry best practice for accident reports. The format and report organization used by the agency may be spelled out in the SSO program standard. In some cases, the program standard will require the agency to submit an accident investigation procedure for review and approval. The development of such a procedure is a good opportunity to come to agreement with the SSOA on process details, including acceptable formats.

Accident Investigation Report Recommendations

Once the cause and contributing factors have been determined, the investigators, together with the associated agency departments, should develop a realistic and practical remedy to prevent a similar accident from happening again. This may take time and money or may involve immediate changes to rules and procedures, but it should be fully understood what needs to be done immediately, within the short term, and what long-term solution is required to prevent future events of this nature.

The recommendations section of a rail report should provide a set of actions that should be taken to prevent reoccurrences of this accident. These recommended improvements should be organized by time so that those requiring immediate action can be implemented, while others requiring more time and funding can be scheduled for a permanent fix for elimination of the problems leading to this accident. Long term recommendations may require capital budgets, re-design, or extensive system modifications, i.e. retiring legacy signal systems and upgrading them with PTC systems.

Recommendations are action items. Each should begin with an action verb (i.e., conduct, revise, or modify) that will result in measurable action. There should be a clear logic chain from the facts to the analysis to the conclusions to the recommendations.

Recommendations will drive corrective actions, so they need to be worded in a way that supports the corrective action format and have identifiable and measurable outcomes. For example, a recommendation reading “improve emergency response electrification safety training” would not meet this test. A more focused approach is needed, such as “revise the emergency response training program to cover the use of agency supplied third rail probes.” Recommendations should logically link to the corrective action plans.

Corrective Action Plan (CAP)

Corrective actions need to be linked to the investigation report and associated recommendations and developed in a way that is achievable and measurable.

As with any action plan, a CAP should explain the action being taken, the reason, the person responsible for making it happen, and a realistic schedule. Without these key elements, any action plan is likely to fail.

Key CAP Elements	
What	What are the specific actions and measurable results?
Why	Links back to the accident investigation and recommendations
Who	Who (job title) is responsible for shepherding the action to completion?
When	Identify a realistic time frame and set a date.

The CAP should be developed by the department responsible for implementation of the CAP item in conjunction with the investigators (usually the Safety Department). The State Safety Oversight Agency (SSOA) is the regulatory body that will approve the CAP and approve and verify the closure. The SSOA should also be involved in CAP development.

Most agencies use a CAP database or spreadsheet as a tracking tool and to provide periodic reports on CAP status. It should be easy to use and allow for generating reports on current status. Additionally, CAPs should be monitored through regular status meetings, at which problems can be identified and resolved. This also allows for the identification and resolution of unintended consequences. Often, SSOA personnel participate in CAP status meetings.

Effective Investigation Practice

Example of Washington Metrorail Safety Commission required CAP elements include:

- Date CAP generated
- Unique CAP identifier
- Source
- Description
- Hazard rating
- Estimated cost and funding strategy, if known
- Interim mitigations in place (if applicable)
- Anticipated completion date
- Responsible party/department

Some agencies have found that color-coding CAP items is helpful, with green meaning satisfactory progress, yellow meaning falling behind schedule, and red meaning a risk of not meeting schedule. This can also serve as motivation for responsible managers to stay on task.

The CAP puts the action into an actual implementation plan—how it will be done, who will be responsible for doing it, and when it will be completed. Complex CAPs may have interim milestones and multiple tasks under the control of different personnel.

The responsible manager will report that a CAP item has been completed. Before closure, the CAP item's satisfactory completion should be verified, and appropriate signoffs documented, including that of the SSOA.

Appendix A

What to Expect: NTSB Investigations

NTSB was originally part of the U.S. Department of Transportation; Congress later established it as an independent accident investigation agency. NTSB has broad investigative authority but no regulatory authority; its single focus is on gathering facts, determining causes, assisting victims, and making recommendations to improve transportation safety. Title 49 CFR 800-850 establishes how NTSB performs its responsibilities.



Source: NTSB

The NTSB Rail Division has 12–18 investigators and will not launch to most rail transit accidents. When an accident notification is received, it is passed to an investigator/duty officer who assesses the likelihood that NTSB will investigate. The NTSB duty officer may reach out to the agency's point of contact and obtain additional information, which is then passed up the management chain where the decision to/not to send investigators is made.

If the NTSB decides to send investigators, the agency point of contact will be informed by the duty officer or the NTSB Investigator-in-Charge (IIC). Some expectations of the agency are as follows:

- Provide telephone number of on-scene contact to NTSB IIC.
- Ensure preservation of evidence and scene in accordance with instructions and requirements of NTSB, which may supersede or supplement the RTA's actions to secure the scene.
- Identify and make available personnel to represent the agency and SSOA on the technical (discipline) investigative teams.
- Establish points of contact to discuss appropriate responsibilities and roles for scene management and evidence preservation.
- Provide the name and telephone number of the agency's and SSOA's public information officer
- Refer all press inquiries on the investigation to the public information officer for the NTSB.

The seriousness and complexity of an accident will determine the size of the NTSB team. A Board Member may or may not arrive with the team. When NTSB arrives on the scene, technical workgroups will be formed to develop factual information relevant to the accident.

The NTSB on-scene investigative team for a more substantial accident typically consists of an IIC and technical specialists to lead the investigative groups. Technical groups may include:

- Mechanical (vehicles)
- Operations
- Signals
- Track
- Human Performance
- Survival Factors
- Other specialized groups may be formed as needed

NTSB leverages its limited resources using technical staff from party organizations. Typically, the RTA and SSOA will be asked to provide senior managers as the primary contacts and technical specialists for the various investigative groups. Party participation is at the discretion of the NTSB IIC. Party organizations are those who have people, procedures, or equipment involved in the accident and can provide technical expertise to assist NTSB. Party participants may not make public comments on the investigation and may not distribute information outside the investigation. Parties may include:

- Railroad/transit agency
- FRA/FTA/SSOA
- Labor organizations
- Emergency responders
- Equipment manufacturers
- Persons that have a connection to the event and bring technical expertise to the investigation

Attorneys, claims agents, Public Information Officers (PIOs), and media are not permitted to participate in investigative activities.

The on-scene phase of an NTSB investigation is focused on developing facts and begins with an organization meeting at which party organizations and individual roles are established. Each following day, there will be a progress meeting at which information is shared among the technical groups and work for the next day is planned. All factual information is shared; information may not be withheld.

At the end of the on-scene phase, a closeout meeting is held that involves the final exchange of factual data and field notes from each technical group. Follow-on activities may include additional interviews, laboratory exams, testing, or equipment teardowns. Each technical group will produce a factual report that will be reviewed by the group members to ensure factual accuracy.

Sometimes, the Board will hold investigative hearings to further develop the facts.

NTSB staff performs the analysis and completes the full report independently. Parties have the opportunity to provide their analysis and to suggest the probable cause and recommendations for NTSB's consideration. The final report is presented at a public meeting at which Board Members discuss it and adopt it or make edits.

Appendix B

Investigator Go-Bag Contents

Investigators typically “customize” their go-bags (resource kit) to include items they anticipate using or have found useful in the past. The following are items that investigators should consider as they develop a resource kit to have available when duty calls.

Safety Equipment

- Reflective vest
- Eye protection – safety glasses, chemical splash goggles, chemical face shield
- Hard hat
- Gloves – vinyl/latex/nitrile examination gloves, chemical resistant gloves
- Bloodborne pathogens protection kit
- Cones/reflective triangles for traffic warnings

Investigative Tools

- Video recorder
- Tape recorder
- Camera, charged batteries
- Flashlights/extra batteries
- Note pads/pens/graph paper pad/memory sticks
- Templates for sketches
- Chalk/paint pens/spray paint
- Measuring wheel, non-metallic tape measure
- Spare film/memory cards
- Evidence control kit (containers/forms/tags/markers)
- Calibrated gauges¹²
- Track gauges, top & side wear gauges
- Track shunts, switch fouling gauge
- Wheel flange, “back to back” gauges
- Other gauges and meters specific to agency equipment
- Pre-identified and up-to-date agency manuals/documents
- Signal system drawings
- Schematics
- Track charts
- Rule books
- Other specialized documents and plans specific to agency operations

¹² Specialized tools must be kept calibrated, and users should be trained and familiar with their use. Some agencies choose to rely on technical staff to bring tools, make measurements, and record data while the investigator observes.

Appendix C

Key Points for Conducting Interviews

One-on-one interviews may be necessary for the investigation, particularly when obtaining witness statements after an event, as witnesses may be anxious to leave the scene. An interview team of two is preferred—one person to conduct the interview and the other to take notes or operate a recorder. Having a second person as a witness may also be desirable in some cases. Larger groups of interviewers can be challenging and require a leader to set clear ground rules about questions and the interview process.

Key points for team interviews:

- Designate one person as the lead interviewer.
- Keep a professional and non-judgmental atmosphere; an interview is not an interrogation.
- Do not allow other interviewers to interrupt each other or the interviewee.
- Agree not to interrupt the questioning; each interviewer should wait their turn.
- Establish when follow-up questions to an interviewer's initial question will be addressed.

Interviews are conducted to obtain factual information to verify other data already obtained and to understand different perspectives of the same event. People involved may have information not obtained; information is needed to develop a factual record, and interviewee cooperation is needed. Some people may be compelled to be interviewed but cannot be compelled to be helpful; establishing rapport is key to success. Also, interview objectives may change.

Potential interviewees include:

- Operating & maintenance personnel
- Supervisors/managers
- Victims
- Bystanders
- Residents
- Persons familiar with potential participants
- Friends
- Coworkers
- Managers
- Emergency crews such as fire and EMS
- Hospital staff
- Law enforcement

- News media
- Walk-ins

Key interview points before the interview starts:

- Introduce yourself, present identification, and chat with the interviewee.
- Explain the process, your role, and the identity of others who are present.
- Put the interviewee at ease as much as possible.
- Explain that they can call for a break anytime.
- Identify their concerns and try to address them.
- Answer any questions they may have.
- Explicitly instruct them to generate information—explain the ground rules.

Key points on question sequence:

- With two or more interviewers, follow a predetermined order of questioning; do not interrupt each other.
- Begin with open-ended questions—What happened? Walk me through it in detail.
- Determine beforehand the order of issues to be addressed in questioning each interviewee.
- Guide the interviewee back to areas of interest where more detail is needed.
- Introduce new issues after each issue has been addressed in turn.
- Use one of two types of sequences of issues with interviewees—chronological order or order of importance.
- Address issues that the interviewee may have raised while discussing another issue, even if it means going out of sequence.

Key points on attending to the interviewee:

- Show attention to the interviewee at all times.
- Be aware of and avoid non-verbal interviewer cues that may unwittingly be sent to the interviewee.
- Ensure that the interviewee is comfortable and that the interview location is free of distractions. Stop the interview if the interviewee appears uncomfortable or begins to lose their composure. This is especially important if interviewing a victim of the event.
- Do not offer the interviewee career or personal assistance but demonstrate concern for the interviewee. Suggest a break if the interviewee becomes emotional or seems stressed.

- Have paper or whiteboard available in case the witness wants to draw a diagram. Also have a scene sketch available so the witness can point to what they have seen.
- Have a passenger car interior layout available to aid an interviewee in recalling locations of people or events.

Key points on follow-up questions:

- Use follow up questions when one of several interviewers has not pursued an issue that an interviewee has raised or when an interviewee has raised multiple issues in response.
- Ensure that other interviewers wait until their turn to follow-up on an issue rather than disrupt other interviewers.
- Allow each interviewer at least two opportunities to ask questions—one to ask the initial questions and a second for follow-up questions.

Key points on false responses:

- Rephrase or refocus questions if there is a reason to believe the interviewee has answered questions falsely.
- If there is contradictory factual information available, ask the interviewee to explain the discrepancy in a non-confrontational way.
- Do not express disapproval or attempt to coerce a truthful response from the interviewee.
- Do not use a prosecutorial tone in asking questions.
- Do not ask yes or no questions; ask open ended questions.

Key points on concluding the interview:

- Ask the interviewee if they have anything else to add or change.
- Ask if there are any questions they have that should have been asked.
- Ask if they have any suggestions for preventing a recurrence.
- Ask if they can think of anyone else that should be interviewed to understand what happened.
- Give interviewees business cards and ask them to contact you later if they have additional recollections or further information to provide.
- Let the interviewee know that they can contact you with any questions that they may have; this will also allow you to collect any follow-up information.
- Thank interviewees for their cooperation.

Appendix D

Survivor and Witness Statements and Questions

Injured passengers and employees should be interviewed to document as much information concerning their actions just before, during, and after the event. Additional information should be collected, such as where the passenger was sitting at the time of the event and what they noticed about what other passengers around them were doing just before, during, and after the accident.

Persons who can provide information and who should be interviewed include:

- Passengers
- Vehicle operators
- Other agency employees
- Responders
- Witnesses

Be sensitive to interviewee injuries. Request permission to record the interviews. If a recorder is used, the interviewer and interviewee should identify themselves as well as the date, time, and location of the interview and others present.

A technique that has been successful in interviewing survivors is to permit the interviewee to discuss their observations without interruption. The person designated as note-taker writes down only pertinent information. At the conclusion of the interviewee's statement, some specific questions noted below may be asked if they were not covered and to clarify certain areas of interest. It is useful to have copies of seating diagrams of the vehicle type the interviewee was occupying available. Allow the interviewee to mark their location and other relevant information on the copy:

- What position/seat/location did you occupy?
- Describe the vehicle occupancy level.
- Were you seated or standing?
- Can you recall anything prior to the accident once you boarded the vehicle?
- Can you describe any impact forces (direction, magnitude)?
- (If injured): Can you describe your injuries and how they were sustained?
- Did you observe other passengers who were injured?
- Where were they located?
- Describe the injury mechanism if you observed.
- Can you describe your escape (method, time, difficulties, smoke, fire, egress routes)?

- Were there any difficulties during escape/rescue?
- Was there any difficulty opening doors/windows/emergency exits?
- Can you recall any observations of trapped passengers after the accident and during egress?
- Can you describe rescue/firefighting activities (location of fire, smoke)?
- Did you take any photographs/video after the accident? (if yes, ask for copies)
- Do you know how the vehicle was evacuated?
- Was any emergency equipment used, i.e., flashlights, megaphones, loudspeakers, PA?
- Did you observe any floor path emergency lights?
- Did you recall seeing/reading any safety card or other safety information?
- For passengers with disabilities: if possible, obtain name, address (age, weight, height), disability, mobility impairment.
- Were you using a mobility aid (walker, wheelchair)?
- What was the status of the mobility device during the evacuation and after?

Appendix E

72-Hour Pre-Incident History Checklist

The goal of the 72-hour pre-incident history is to obtain, in as much detail as possible, information on the operator's activities in the 72 hours prior to the accident. Information from this history will touch on every area of the investigation, making it one of the most important activities the investigator will undertake. It may be beneficial to go back slightly longer than 72 hours. Initial questions to ask include, but are not be limited to the following:

- When do you normally go to sleep and get up on your days off?
- How much sleep do you normally get?
- When do you normally go to sleep and get up on days you have to work?
- How much sleep do you normally get on those days?
- Do you normally take naps? When, for how long, and why?
- How would you describe the general quality of your sleep?
- Can you estimate how long it normally takes you to fall asleep after you go to bed?
- Do you wake during the night? If so, how often, for how long, and how long does it take you to get back to sleep?
- Specifically, when did you go to sleep and get up the three days before the accident?
- Did you nap any of the three days before the accident? If so, when and for how long?
- Did you wake during the night any of the three days before the accident? If so, why?
- How long were you awake?
- How long did it take you to get back to sleep?
- How long did it take you to fall asleep initially the three days before the accident?
- Do you take any medications to help you fall asleep or stay asleep?
- What medications? (contact prescribing doctor) Did you take them three days before the accident?
- Do you take any medications that make it difficult to fall asleep? Did you take them in the three days before the accident?

The HF investigator should also try to obtain information on both the quality and quantity of an operator's sleep. Note the time of the accident for comparison to know circadian low points. Sources of information other than the operator include work schedules, cellphone records, logbooks, alarm clock settings, and hotel wake-up calls. A baseline should be established for on- and

off-duty days and for specifics for the 72 hours before the accident and the two compared. Specific information to obtain includes the following:

- Times the operator awoke/went to bed each day
- Times, content, and duration of meals, including snacks
- Step-by-step recounting of activities, including times and durations
- Relationship between that day's activities and their normal ones—anything missing, anything new, anything odd
- People they saw or talked to, and times
- Time, duration, and location of any naps
- Any medications that are taken, including prescription, OTC, or herbal, including time, and dose
- Time and amount of any intoxicant ingestion, including alcohol and illegal drugs

Appendix F

Safety Risk Management Process

Hazard identification is a prerequisite to the Safety Risk Management (SRM) process and is further described in the companion resource *Rail Transit Agency Accident Investigations – Background Research*. A formal safety risk management process 1) describes a system, 2) identifies hazards, 3) assesses hazards, 4) identifies consequence(s) that the hazard could trigger, 5) analyzes those consequences to evaluate the safety risk, and 6) establishes controls to manage those safety risks. The objective of SRM is to assess the risks associated with the consequences of identified hazards and develop and implement effective and appropriate mitigations. Therefore, SRM is an essential component of the SMS process. SRM includes three elements:

- Safety Risk Management process
- Safety Hazard Identification
- Safety Risk Evaluation and Mitigation

During an investigation, it might be suspected that the existing safety risk controls or mitigations are ineffective due to a change in conditions, inappropriateness, or were not implemented as intended. The investigation might also identify previously unidentified or new hazards, such as the unintended consequences that occur due to operational or other system changes, mitigations, or the institution of a new technology. The circumstances noted above require that the transit agency evaluate the existing safety risks and mitigations, newly-identified hazards, and any resultant risk through its SRM process.

The SRM process defines an RTA's approach and the implementation of an integrated systemwide safety risk resolution process. It specifies the sources of and mechanisms to support the ongoing identification of hazards. It defines the process by which identified hazards and resulting consequences and level of safety risk will be evaluated and prioritized. It identifies the mechanism(s) that will be used to notify and report hazards to oversight agencies and the process by which an RTA will provide ongoing reporting of hazard identification, consequence, and risk mitigation activities. This process is illustrated in Figure F-1.

The elements of this process should be applied, either quantitatively or qualitatively, to:

- Initial system, vehicle, equipment, and material designs
- Development of safety operational procedures
- Planned changes to the operational system, including the introduction of new equipment, material, systems, and procedures to identify hazards associated with those changes.

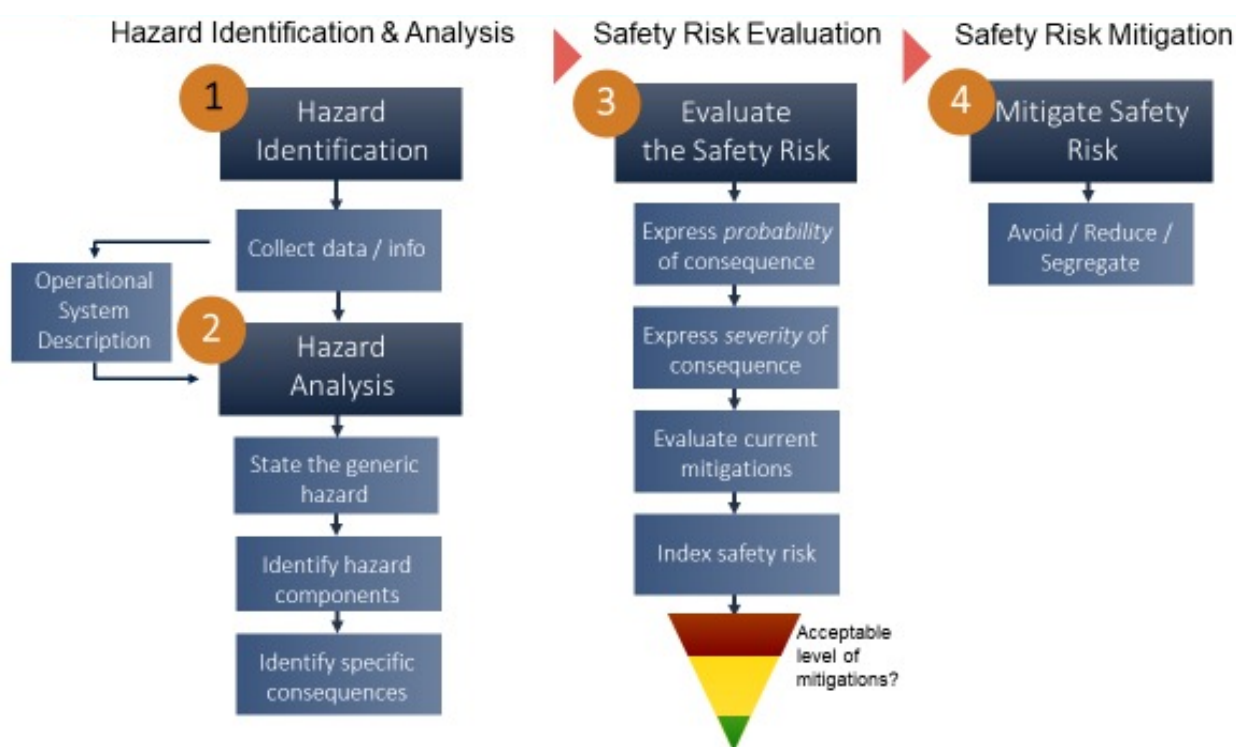


Figure F-1 *Safety Risk Management Process*

Source: TSI

A hazard is any real or potential condition that can cause injury, illness, or death; damage to or loss of the facilities, equipment rolling stock, or infrastructure of a public transportation system; damage to the environment; or reduction of the ability to perform a prescribed function (e.g., unclear/non-existent roadway signage or unnoticed traffic pattern notifications; vehicle system deficiencies, such as worn vehicle brake assemblies; other forms of infrastructure design or deficiencies, such as narrow traffic lanes and grade crossings). The hazard identification process is described in the following section.

Hazard Identification

Each RTA should establish a process for safety hazard identification, including the identification of the methodologies—predictive, proactive, and reactive, for identifying hazards and their associated consequences. This process is presented in Figure F-2 and includes the steps to both hazard identification and analysis.



Figure F-2 Hazard Identification and Analysis

Source: TSI

The steps to hazard identification and data collection are included in Figure F-3. Hazard identification is data-driven; data facilitates hazard identification. Although data itself will identify hazards, collection and analysis of data may disclose further/deeper safety concerns worth further examination. Data and information should be collected from various sources. However, it is of the utmost importance that the quality and integrity of the data be maintained. Inaccurate data, whether false or otherwise compromised, will not provide an accurate representation of what is happening in the agency.



Figure F-3 Hazard Identification and Data Collection

Source: TSI

Identification of hazards is the responsibility of all departments, offices, branches, and individual employees, and continual management of hazards is the key to an effective safety risk management program. The three methodologies for identifying hazards are the following:

- **Reactive** involves analysis of past outcomes or events. Hazards are identified through an investigation of safety occurrences. Incidents and accidents are clear indicators of system deficiencies and, therefore, can be used to determine the hazards that either contributed to the event or are latent.
- **Proactive** involves analysis of existing or real-time situations, which is the primary job of the safety assurance function with its audits, evaluations, employee reporting, and associated analysis and assessment processes. This involves actively seeking to identify hazards in the existing processes.
- **Predictive** involves data gathering to identify possible adverse future outcomes or events, analyzing system processes and the environment to identify potential future hazards, and initiating mitigating actions.

Hazards are identified through several sources:

- System inspections, audits, evaluations, assessments, regulatory inspections, and observations
- Accidents, incidents investigations
- Employee reporting to local safety committees
- Confidential Employee Reporting Systems
- Safety hotline
- Ride checks and proficiency checks
- Customer reporting
- Transit industry experience
- Change Management and Safety Certification
- Reactive, proactive, and predictive analyses
- Formal system safety analysis
- System reliability and failure reports
- Data acquisition and data mining
- System monitoring

The three methods used to approach hazard responses are described below and presented in the order of an agency's SMS maturity (Figure F-4).

Analytical Tools to Aid the Investigation Process

Fishbone Charts

Ishikawa or fishbone charts (Figure F-4) aim to help list all possible causal factors. The categories in the boxes can change as needed for the investigation. The items listed under each category can help the investigator make sure that all potential causal factors have been examined.

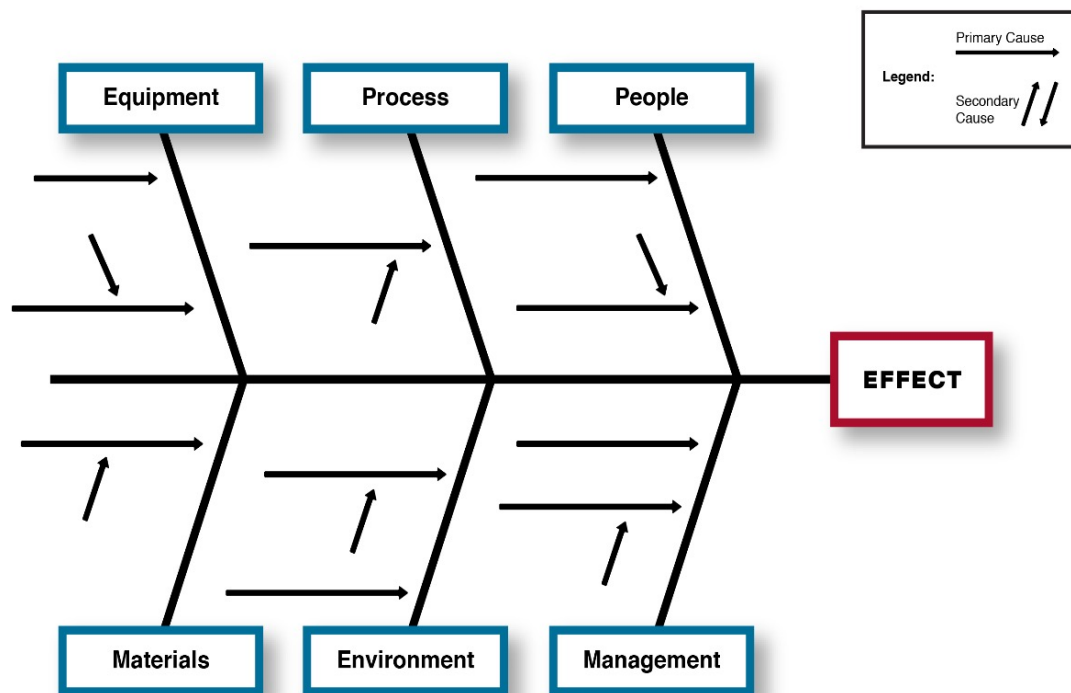


Figure F-4 Fishbone Chart

Source: TSI

Fault Tree Analysis

Fault tree tools are designed to help the investigator dig deeper beyond proximate cause and identify more fundamental or “root” causes. Fault tree analysis allows an investigator to map out possible causal scenarios in a graphic manner and imposes a logic flow that can help to support the probable cause of an event. A simplified example is shown in Figure F-6. At the top of the chart is the “event”—in this case, no light in a room. Two logical explanations are provided—no natural light and no artificial light. These are proximate causes, and these conditions are linked to the event box by an “and” gate meaning both conditions should exist together. Possible causes are in circles at the bottom of the graphic, which are connected to the logical explanations by “or” gates, meaning that any one of these causes would be sufficient to result in the event.

Further analysis of factual information developed in an investigation will help to rule in or rule out the bottom level causes. For example, if the light bulb tests OK, light bulb failure can be ruled out from the equation. The bottom

level of a fault tree is the root cause. The above example can include going deeper (e.g., “5 Whys”); for instance, if a fault in the electric circuit is verified, the question is why?—was there a maintenance issue, an overload issue, a training issue, a parts issue? Several commercial vendors produce proprietary root cause analysis tools and also provide training classes.

Effective Investigation Practice

A free root cause analysis tool can be obtained from the National Aeronautics and Space Administration (NASA) at <http://nsc.nasa.gov/RCAT/>.

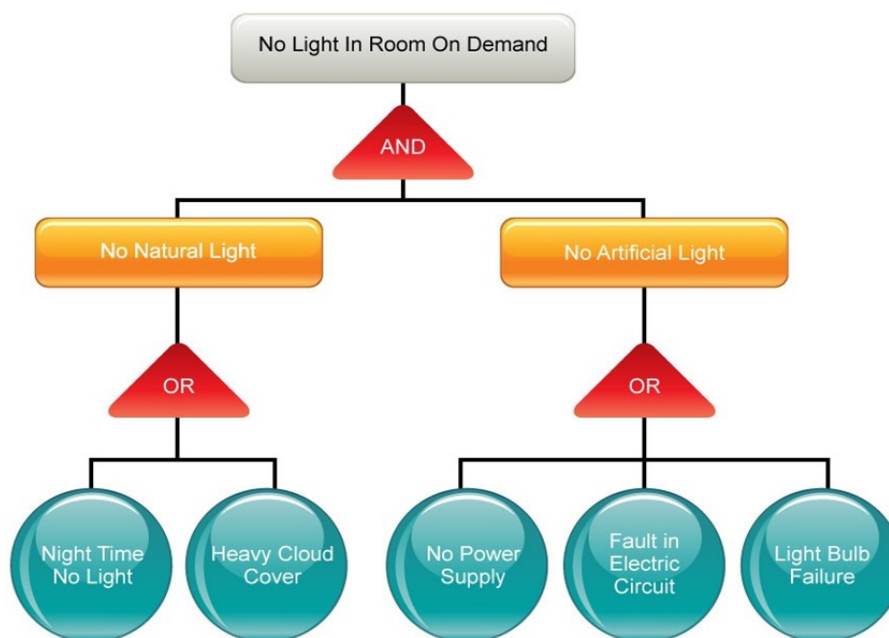


Figure F-5 Fault Tree Analysis

Source: TSI

SHEL Model

The International Civil Aviation Organization (ICAO) SHEL Model (Figure F-6) is a conceptual tool used to analyze the interaction of multiple systems. It was first introduced by Edwards in 1972 and modified by Hawkins in 1975. According to the SHEL Model a mismatch between the Liveware and the four other components contributes to human error. It groups factual information into the five groups shown in Figure F-7.

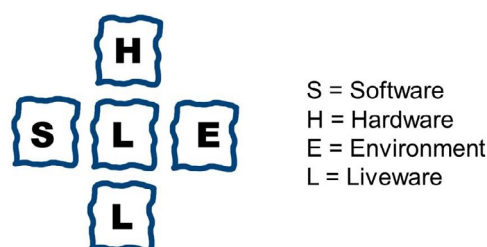


Figure F-6 SHEL Model

Source: ICAO 9859, *Safety Management Manual*

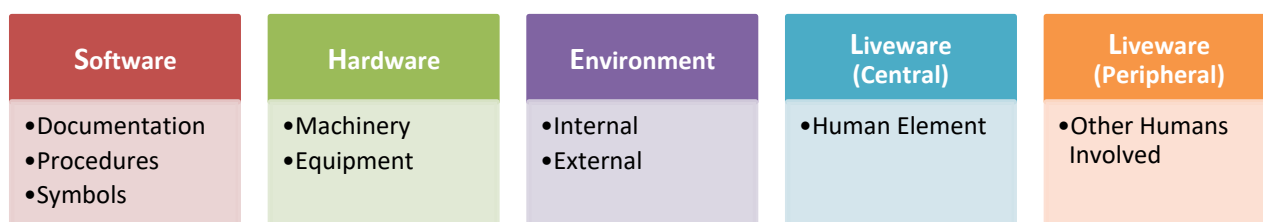


Figure F-7 Components of SHEL Model

Source: CUTR

The “5 Whys”

A similar method of getting to the root cause is often referred to as the “5 Whys.” This system involves asking “why” until the root cause of an event is determined, as in the following simplified example:

- Why did the vehicle veer off the road? Because the left front rim and tire separated from the hub.
- Why did the left front rim and tire separate from the hub? Because the lug nuts came loose.
- Why did the lug nuts come loose? Because they were improperly torqued.
- Why were they improperly torqued? Because the torque wrenches were out of calibration.
- Why were the torque wrenches out of calibration? Because the organization lacked an effective calibration policy and procedure.

Stopping at number 1 or 2 fixes only the immediate problem on the accident vehicle—the out of calibration torque wrench remains in service awaiting the next accident. Stopping at #5 fixes only the individual torque wrench and do not entirely solve the problem.

Proceeding with more “why” levels can help get at a root cause related to organizational policy, procedures, management oversight, quality control, and

training and not stopping short so the underlying problem can be identified and addressed. The analysis logically links to the cause and lays the foundation for the recommendations to address the deficiencies and which lead to corrective action plans. These tools help the investigator organize their thinking and assist in determining the critical factors in the accident scenario

Rail Investigation Report Organization

Transit agencies can use NTSB major accident reports as a template for its accident investigation report. Sections of the report should include the following, further described below:

- Section 1: Acronyms and Abbreviations
- Section 2: Executive Summary
- Section 3: Factual Information
- Section 4: Analysis
- Section 5: Conclusions
- Section 6: Recommendations

Section 1: Acronyms and Abbreviations

A general report-writing convention is to spell out a complete acronym or abbreviation for the first use in the text and include the acronym or abbreviation in parenthesis. After that, the acronym or abbreviation should be used. Only the acronyms and abbreviations used in the report should be included in this section.

Section 2: Executive Summary

The Executive Summary is a condensed version of the full report that is intended to allow readers to get acquainted with a large body of material without having to read the entire document. It is one of the essential sections of a major report, as many readers will rely on it for a “big picture” view of the accident and may not read many other parts of the report. The Executive Summary typically will contain a brief description of the accident, pertinent background information, a concise analysis, main conclusions concerning causal and contributing factors in the accident, and any corrective actions already undertaken.

Section 3: Factual Information

This section starts the full report and provides a detailed factual account of the accident without providing an analysis. It provides an overview of the accident and focuses on areas that are relevant to the cause of the accident and lead to the recommendations. The facts support the analysis, which supports the cause and recommendations; the factual portion of the report is the foundation. The factual section does not need to address every fact that has been developed over the course of the investigation; however, there should be a clear logic chain between facts, analysis, conclusions, and cause.

Accident Description

The accident description provides the basic facts of the accident, telling the reader the “who,” “what,” “where,” and “when”; the “why” is reserved for the analysis section. Maps or aerial images of the scene are helpful here.

Accident Narrative

This section tells the factual story of the accident. The timeline is a significant help here—usually, the “story” begins at the start of the trip or shift and leads up to and includes the accident sequence.

Agency Background

This section explains the organizational relationships and how the agency's (or agencies') safety plan ties it all together. With a single owner/operator, it is relatively straightforward, but some agencies have more complicated arrangements, with multiple contractors operating trains and maintaining rolling stock and infrastructure.

Effective Investigation Practice

Typical information in the accident description section of a report includes:

- Type of accident, i.e., derailment, collision
- Accident date and time
- Accident location, including name of rail line, track number and milepost (stationing marker, column number) or cross street(s)
- Train/equipment/staff involved
- Train type, direction of travel, consist (train makeup)
- Operator's view on approach
- Other vehicles/equipment/persons involved
- Other vehicle types, direction, makeup (if applicable)
- Injury summary
- Total damage
- Weather conditions

Operations

This section lays out the operating scheme—single track, double track, signaled, non-signaled, train control system, governing operating documents, operating rule book, and any other operations manuals or guidance. Any discrepancies between requirements and what happened during the accident sequence should be explained. For example, the train order showed a 10 mph speed restriction between MP 14.5 and MP 15.0; event recorder data indicated that the accident train was traveling at 25 mph between these two points. Discussion of the significance of these facts should be included in the analysis section.

Oversight

This section explains the SSOA relationship, when and how the event was reported, and the involvement of the oversight agency in the investigation. Depending on the circumstances of the accident, the agency may discuss its safety plan, rules compliance programs, and other relevant management programs. Any other agency that may be involved should be noted here—for example, if FRA has a role in shared-use or OSHA is engaged in an employee injury.

Personnel Information

This section includes the relevant key players in the accident, such as train operators, maintenance technicians, controllers, or supervisors. Personnel information might consist of fitness-for-duty checks, training and experience, disciplinary record, and promotion history. No personally identifiable information such as social security numbers, phone numbers, or addresses should be included.

Damages

Dollar damages should be presented by category (e.g., track, signals, electrification, vehicles) in a simple table format.

Equipment Information

This section lays out the necessary information on the train consist and other equipment involved, including pre-departure inspection of the equipment and any anomalies discovered. Factual information that is relevant to the accident should be included—for example, weight, crashworthiness design features, rehabilitation history, or age—and the post-accident positions of equipment and a factual description of damage should be described, including photos and diagrams.

Survival Factors

This section of the report focuses on the issues related to the survivability of the passengers and train crew and the ability of the passengers and crew to safely evacuate. Factual information on survivable space, emergency exits, and lighting, emergency information (signs and announcements), seat securement, emergency equipment, and injury locations within equipment should be included. The size, scope, and content of this section will vary considerably based on the circumstances of each accident; some accidents may not need a survival factors discussion, but investigators should be alert to improvement opportunities that survival factors investigation can reveal.

Injuries

This section should include a simple injury table. More detailed injury information, if available, should be used to show injury locations within equipment and other details that may support recommendations for equipment improvements. The agency's legal department should be consulted on any health-related data to avoid sharing medical information in violation of HIPAA.¹³

¹³ For specific details on HIPAA requirements, assistance can be found at the U.S. Department of Health & Human Services' website at www.hhs.gov.

Emergency Response

This section identifies the response agencies that were involved. Factual information regarding time notified, time of arrival, and any delays or problems with evacuation, triage, or transport of injured is helpful, as is a response timeline table. Any factual information from the debriefing should be included.

Track and Structures

In an accident with no track connection, this section can be omitted or can include a concise description of the track structure. If track and structures were factors in the accident, a detailed factual description of the condition, history, inspections, maintenance, and any discrepancies should be provided in sufficient detail to support any conclusions and causal statements in the analysis with facts.

Signal and Train Control

In an accident with no signal connection to the cause, this section can be omitted or include a concise description of the signal system. If the signal system was a factor in the accident, a detailed factual description of the condition, history, inspections, maintenance, and any discrepancies should be provided in sufficient detail to support any conclusions and causal statements in the analysis with facts.

Other Infrastructure

This section discusses any other infrastructure or system that may have been a factor in the accident—for example, power, communications, ventilation, or SCADA. Any discrepancies between requirements and performance should be laid out factually to logically support the conclusions in the analysis.

Section 4: Analysis - General

This section of the report is where the meaning of the facts is explained. When a discrepancy is found between what policy, procedures, specifications, or regulation requires in the accident, it is important to determine if the discrepancy is relevant. The analysis section is where the significance of the facts developed are explained. Some discrepancies may not be important—for example, a train traveling 3 mph over the speed limit is not likely a factor in a derailment event, but a train 30 mph over the speed limit likely is. The logic chain that should be present.

Effective Investigation Practice

The logic chain to strive for:

- Facts based on observable, verified and accurate information
- Analysis based on those facts
- Conclusions based on the analysis
- Causes and contributing factors, the output of the logic chain
- Recommendations that address cause and contributing factors

Introduction

The introduction provides the opportunity to discuss the exclusions. Exclusions are the potential causal areas examined and found not to be factors in the accident. For example, in a hypothetical grade-crossing collision, the report might note that investigators inspected the track and examined maintenance records and found no anomalies.

At the end of the introduction, for example, provide a summary noting that the agency concludes that none of the following was determined to be a factor in this accident: the condition of the track. That statement is then repeated in the conclusions section.

Specific Issues Identified in Accident

This section discusses and analyzes the factors that were judged to be factors in the accident. For example, in a hypothetical grade-crossing collision, if it was found that the crossing gates did not lower because a circuit had been bypassed with a “jumper wire” during maintenance, the report would provide a detailed analysis of the factors involved. This is where the “5 Whys” might come into play in examining procedures, equipment, and communication between maintenance and the control center and between the control center and the train.

At the end of each analysis discussion, conclusions reached should be specified and explained. There should be a clear logic chain between the facts, analysis, and conclusion.

Human Performance

Any human performance issues such as work environment, fatigue, experience, training, impairment, distraction, or medical conditions¹⁴ are discussed here. (See the Human Factors section of this guidebook for more details.)

Survival Factors – Equipment Crashworthiness

If no crashworthiness issues were developed, this section may not be needed. Crashworthiness issues, such as loss of survivable space, windows that detached resulting in ejections, or interior amenities that broke loose resulting in injuries, should be discussed here.

Survival Factors – Emergency Response

This section evaluates the response and highlights any problems with the response. Areas that might be covered include:

- Delayed arrival/locating accident scene
- Access to scene and equipment

¹⁴ Ensure compliance with HIPAA requirements

- Evacuations
- Agency employee performance and training
- Rescue and recovery
- Triage and transport of injured
- Communication and coordination between transit agency and first responders
- Responder training and familiarization provided by transit agency
- Past exercises, or lack thereof

If any responders were injured during the response, a discussion should be included in this section on the nature of the injuries and the circumstances, which may lead to recommendations on training, equipment, or procedures under agency control. Any problems discussed in this section should be supported by factual information.

Section 5: Conclusions and Findings

Findings are the logical outgrowth of the analysis, which is the logical outgrowth of the facts. This section repeats the conclusions developed and presents them in a list format.

Probable Cause and Contributing Factors

This section is in two parts—1) the primary cause, as determined by the facts and the analysis conducted by the rail investigative team, and 2) contributing factors discovered during the analysis of the facts without which the accident may not have occurred.

Differences between probable cause and contributing factors may be gray rather than black & white. In NTSB reports, probable cause sometimes is the proximate (as opposed to root) cause with elements of the root cause listed as contributing factors. In other reports, the probable cause is a root cause with proximate causes listed as contributing.

Effective Investigation Practice: Example of Logic Flow

- Fact: Eight ineffective ties were observed at point of derailment (POD).
- Fact: Track gauge and tie conditions exceeded tolerance allowed by standards.
- Fact: POD was at point of wide gauge.
- Analysis: Wide gauge resulted from ineffective ties.
- Analysis: Conclusion—Derailment resulted from wide gauge in track.
- Probable Cause—Wide track gauge condition resulting from use of deteriorating wooden crossties.

Note: Contributing factors in this hypothetical example would lay out relevant issues such as training, inspection schedules, and capital replacement programs explained in the analysis.

As the more in-depth objective of the investigation is to identify preventive measures, report writers should consider the elements of the causal picture that best logically support the preventive recommendations. The primary causal and contributing factors of the accident should be clearly stated in the conclusion section.

Once probable cause has been determined and the contributing factors identified, the investigators, together with the associated departments, then develop a realistic and practical remedy to prevent a similar accident from occurring again.

Section 6: Recommendations

The Recommendations section should provide the corrective actions that were implemented as the report was being prepared, i.e., a chafing wire was identified during the post-accident investigation of a train fire, which triggers a fleet-wide inspection.

Recommendations are action items. Each should begin with an action verb (i.e., conduct, revise, or modify) that will result in measurable action. There should be a clear logic chain from the facts to the analysis to the conclusions to the recommendation. Recommendations should lead to corrective actions.

Acronyms and Abbreviations

A/C	Air conditioning
APTA	American Public Transportation Association
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASME	American Society of Mechanical Engineers
ASSP	American Society of Safety Professionals
AVL	Automatic Vehicle Locator
CAP	Corrective Action Plan
CSB	Chemical Safety and Hazard Investigation Board
CFR	Code of Federal Regulations
CM	Configuration Management
EMS	Emergency Medical Services
FEMA	Federal Emergency Management Agency
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HAZWOPER	Hazardous Waste Operations and Emergency Response
HBV/HIV	Hepatitis B Virus/Human Immunodeficiency Virus
HIPAA	Health Insurance Portability and Accountability Act
IC	Incident Commander
ICAO	International Civil Aviation Organization
ICS/NIMS	Incident Command System / National Incident Management System
IIC	Investigator-in-Charge
MAP-21	Moving Ahead for Progress in the 21st Century Act
MTA	New York Metropolitan Transportation Authority
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NATSA	North American Transit Services Association
NFPA	National Fire Protection Association
NTSB	National Transportation Safety Board
OCS	Overhead Contact Systems
OEM	Office of Emergency Management
OSHA	Occupational Safety and Health Administration
OTC	Over the Counter
PD	Police Department
PIO	Public Information Officer
PPE	Personal Protective Equipment
PTASP	Public Transportation Agency Safety Plan
PTC	Positive Train Control
RTA	Rail Transit Agency
RWP	Roadway Worker Protection

SA	Safety Assurance
SCADA	Supervisory Control and Data Acquisition
SGR	State of Good Repair
SHEL	Software Hardware Environment Liveware
SME	Subject Matter Expert
SMS	Safety Management System
SOP	Standard Operating Procedure
SRM	Safety Risk Management
SSO	State Safety Oversight Program
SSOA	State Safety Oversight Agency
TRACS	Transit Advisory Committee for Safety
TSI	Transportation Safety Institute
TSS	Transit System Security
TSSP	Transit Safety and Security Program
TWU	Transport Workers Union
USDOT	U.S. Department of Transportation
WMATA	Washington Area Metropolitan Transit Authority

Glossary

Title 49 CFR § 673.5 and § 674.7 are the sources of the definitions included within this glossary, unless otherwise indicated.

Accident: Event that involves any of the following: a loss of life; a report of a serious injury to a person; a collision involving a rail transit vehicle; a runaway train; an evacuation for life safety reasons; or any derailment of a rail transit vehicle, at any location, at any time, whatever the cause.

Accountable Executive: Single, identifiable person who has ultimate responsibility for carrying out the Public Transportation Agency Safety Plan of a public transportation agency; responsibility for carrying out the agency's Transit Asset Management Plan; and control or direction over the human and capital resources needed to develop and maintain both the agency's Public Transportation Agency Safety Plan, in accordance with 49 U.S.C. 5329(d), and the agency's Transit Asset Management Plan in accordance with 49 U.S.C. 5326.

Administrator: Federal Transit Administrator or Administrator's designee.

Chief Safety Officer: Adequately trained individual who has responsibility for safety and reports directly to a transit agency's chief executive officer, general manager, president, or equivalent officer. A Chief Safety Officer may not serve in other operational or maintenance capacities, unless the Chief Safety Officer is employed by a transit agency that is a small public transportation provider as defined in this part, or a public transportation provider that does not operate a rail fixed guideway public transportation system.

Contractor: Entity that performs tasks on behalf of FTA, a State Safety Oversight Agency, or a Rail Transit Agency, through contract or other agreement.

Corrective Action Plan: (CAP): Plan developed by a Rail Transit Agency that describes the actions the agency will take to minimize, control, correct, or eliminate risks and hazards, and the schedule for taking those actions. Either a State Safety Oversight Agency (SSOA) or FTA may require a Rail Transit Agency to develop and carry out a corrective action plan.

Equivalent Authority: Entity that carries out duties similar to that of a Board of Directors, for a recipient or subrecipient of FTA funds under 49 U.S.C. Chapter 53, including sufficient authority to review and approve a recipient or subrecipient's Public Transportation Agency Safety Plan.

Event: Accident, incident, or occurrence.

Fatalities: Confirmed deaths within 30 days, including suicides.

FRA: Federal Railroad Administration, an agency within the USDOT.

FTA: Federal Transit Administration, operating administration within the USDOT.

Hazard: Any real or potential condition that can cause injury, illness, or death; damage to or loss of the facilities, equipment, rolling stock, or infrastructure of a public transportation system; or damage to the environment.

Incident: Event that involves any of the following: a personal injury that is not a serious injury; one or more injuries requiring medical transport; or damage to facilities, equipment, rolling stock, or infrastructure that disrupts the operations of a transit agency.

Investigation: Process of determining the causal and contributing factors of an accident, incident, or hazard, for the purpose of preventing recurrence and mitigating risk.

National Public Transportation Safety Plan: Plan to improve the safety of all public transportation systems that receive Federal financial assistance under 49 USC Chapter 53.

Non-serious injuries: Injuries that require immediate transport away from the scene for medical attention (1 or more persons). For Non-Rail Events or Rail-Mode Non-Serious Injuries (defined below), if an individual seeks medical care several hours after an event or in the days following an event, that individual is not reportable as an injury. Source: NTD.

NTSB: National Transportation Safety Board, an independent Federal agency.

Occurrence: Event without any personal injury in which any damage to facilities, equipment, rolling stock, or infrastructure does not disrupt the operations of a transit agency.

Performance measure: Expression based on a quantifiable indicator of performance or condition that is used to establish targets and to assess progress toward meeting the established targets.

Performance target: Quantifiable level of performance or condition, expressed as a value for the measure, to be achieved within a time period required by FTA.

Person: Passenger, employee, contractor, pedestrian, trespasser, or any individual on the property of a rail fixed guideway public transportation system.

Public Transportation Agency Safety Plan (PTASP): Documented comprehensive agency safety plan for a transit agency that is required by 49 USC 5329 and this part.

Public Transportation Safety Certification Training Program: Certification training program for Federal and State employees or other designated personnel who conduct safety audits and examinations of public transportation systems, and employees of public transportation agencies directly responsible for safety oversight, established through interim provisions in accordance with 49 U.S.C. 5329(c)(2), or the program authorized by 49 U.S.C. 5329(c)(1).

Rail fixed guideway public transportation system: Any fixed guideway system that uses rail, is operated for public transportation, is within the jurisdiction of a State, and is not subject to the jurisdiction of the Federal Railroad Administration, or any such system in engineering or construction. Rail fixed guideway public transportation systems include but are not limited to rapid rail, heavy rail, light rail, monorail, trolley, inclined plane, funicular, and automated guideway.

Rail Transit Agency (RTA): Any entity that provides services on a rail fixed guideway public transportation system.

Risk: Composite of predicted severity and likelihood of the potential effect of a hazard.

Risk mitigation: Method or methods to eliminate or reduce the effects of hazards.

Safety Assurance: Processes within a transit agency's Safety Management System that functions to ensure the implementation and effectiveness of safety risk mitigation, and to ensure that the transit agency meets or exceeds its safety objectives through the collection, analysis, and assessment of information.

Safety Management Policy: Transit agency's documented commitment to safety, which defines the transit agency's safety objectives and the accountabilities and responsibilities of its employees in regard to safety.

Safety Management System (SMS): Formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of a transit agency's safety risk mitigation. SMS includes systematic procedures, practices, and policies for managing risks and hazards.

Safety Management System Executive: Chief Safety Officer or an equivalent.

Safety performance target: Performance target related to safety management activities.

Safety promotion: Combination of training and communication of safety information to support SMS as applied to the transit agency's public transportation system.

Safety risk assessment: Formal activity whereby a transit agency determines Safety Risk Management priorities by establishing the significance or value of its safety risks.

Safety Risk Management: Process within a transit agency's Public Transportation Agency Safety Plan for identifying hazards and analyzing, assessing, and mitigating safety risk.

Serious injury: Any injury that 1) requires hospitalization for more than 48 hours, commencing within 7 days from the date of the injury was received; 2) results in a fracture of any bone (except simple fractures of fingers, toes, or noses); 3) causes severe hemorrhages, nerve, muscle, or tendon damage; 4) involves any internal organ; or 5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.

State: US State, District of Columbia, Puerto Rico, Northern Mariana Islands, Guam, American Samoa, and Virgin Islands.

State of Good Repair (SGR): Condition in which a capital asset is able to operate at a full level of performance.

State Safety Oversight Agency (SSOA): Agency established by a State that meets the requirements and performs the functions specified by 49 U.S.C. 5329(e) and the regulations set forth in 49 CFR part 674.

Transit agency: Operator of a public transportation system.

Transit Asset Management (TAM) Plan: Strategic and systematic practice of procuring, operating, inspecting, maintaining, rehabilitating, and replacing transit capital assets to manage their performance, risks, and costs over their life cycles, for the purpose of providing safe, cost-effective, and reliable public transportation, as required by 49 U.S.C. 5326 and 49 CFR part 625.

Vehicle: Any rolling stock used on a rail fixed guideway public transportation system, including but not limited to passenger and maintenance vehicles.



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Federal Transit Administration
East Building
1200 New Jersey Avenue, SE
Washington, DC 20590
<https://www.transit.dot.gov/about/research-innovation>