Federal Railroad Administration
Office of Safety

FRA Approach to Managing Gap Safety

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Revision 03

FRA Approach to Managing Gap Safety

1. Introduction:

The Federal Railroad Administration (FRA) is responsible for promoting the safety of the Nation's passenger and freight railroads. To address this responsibility, FRA develops programs that identify, monitor, and address railroad safety issues.

FRA is concerned about the risk of injury to passenger train users posed by the gap between railcars and high level station platforms. Although many gap accidents only result in minor injuries, they can initiate a chain of events that may lead to serious or fatal injuries. The FRA feels that an effective way to address the gap safety issue is for passenger train operators to develop a gap safety management program. The gap safety management program should:

- use engineering evaluation and analysis to establish gap standards for all high level stations, and
- apply mitigation strategies to further reduce the risk of gap accidents.

The passenger railroad gap safety management program should use hazard management techniques, such as hazard analysis, to identify appropriate hazard mitigation strategies. Hazard analysis is a process where hazards are identified and recorded and corresponding hazard mitigation strategies are identified, recorded and tracked to completion. The hazard mitigation strategies should be designed to eliminate, or control gap hazards and to lower the overall risk of injury to passengers. The hazard analysis and hazard mitigation process should recognize and include any existing strategies currently in place.

Hazard management is not a difficult process but it is designed to be both comprehensive and continuous. Passenger railroads must be prepared to develop and support a long term gap safety management program. A hazard management team made up of interdepartmental technical and safety experts from the railroad should be established to implement the gap safety management program. The hazard management team's primary role would be to identify the hazards and agree on the mitigation strategies. Hazard management is not a one time task but requires the passenger railroad go back and periodically reaffirm the gap safety management program. Review of the gap safety management program can be triggered by time, by a major event such as an accident, or by a change in the method of operations.

Some passenger railroads already have strong gap safety programs or appropriate hazard mitigation strategies in place. The gap hazard management program the FRA is suggesting is meant to enhance rather than replace the existing programs. The FRA gap hazard management program would compliment and formalize existing programs and document any existing mitigation strategies. The FRA gap safety management program can also confirm that all appropriate hazards have been identified and controlled or reveal hazards that were previously overlooked.

The gap, as discussed in this document, is defined as the horizontal space between the edge of the platform and the edge of the rail car door threshold plate, and the vertical difference from the top of the platform and the top of the rail car door threshold.

. **Figure 1** contains a diagram that illustrates the gap between the rail car and the platform.

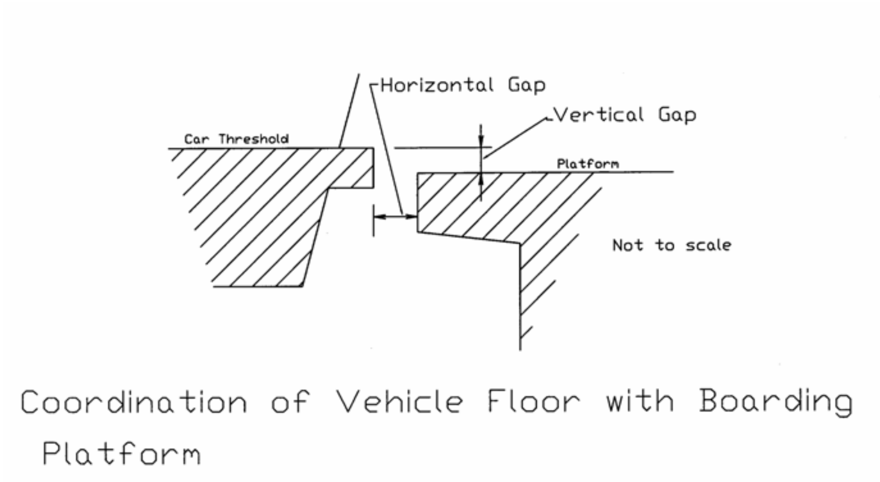


Figure 1. Horizontal and vertical gap between the railcar door threshold and the platform edge.

This document presents FRA's approach to managing gap safety. FRA considers the approach to be an effective method of managing safety hazards related to the gap at high level passenger platforms and a way to ensure minimum levels of safety for passengers.

The approach involves the following elements:

1. Station Gap Standards
2. Hazard Management
3. Maintenance Procedures
4. Inspection Procedures
5. Hazard Mitigation Strategies
6. Gap Safety Management Follow-up

Each step in the gap safety management process will be broken down and discussed in detail.

2. Station Gap Standards:

Passenger railroads should establish station gap standards for all high level platforms. The station gap standards should define the size of the gap between the door threshold and the platform by identifying critical dimensions that define the gap (such as the distance between the centerline of the track and the platform edge). These critical dimensions should include tolerances and be specified in the station gap standards. The standard gap that is determined at a particular station or stations is based on the geometries of the track, platform and the equipment that utilizes the station. Tolerances of the equipment, track and platforms will result in actual gap measurements which may vary from the standard gap.

Station gap standards may already exist in state regulations or the railroads own internal requirements. Some states, such as New York and Massachusetts, already have dimensional requirements for the location of high level platform edges with respect to the centerline of the track. Some of the state requirements were established to ensure proper clearance between railroad freight cars and the platform edges rather than maintain a safe gap for passenger boarding and alighting. In any case, passenger railroads should be aware of any state requirements and use those requirements as the starting point for establishing station gap standards.

Once the basic gap dimension requirements are established, passenger railroads should look for opportunities to reduce the gap. In some cases, rail traffic mix, method of operation, station configuration, or other factors will not support reducing the gap beyond the current requirements. If an engineering evaluation supports this conclusion, then maintaining the basic gap dimension is the appropriate action. However, larger gaps pose a greater risk for a passenger falling through the gap and may require specific mitigation strategies to control risk. Therefore, stations with larger gaps will likely need more hazard mitigations than stations with smaller gaps.

To determine if the gap dimension can be reduced, the railroad should review the current gap dimension requirements with respect to the operational environment. For example, the actual gap dimension may vary depending on the configuration of the station. Stations located on a curve will require more clearance between the rail car and the platform edge than stations on tangent track. Stations on curved track must compensate for car overhang on the ends.

As shown in **Figure 2**, the width of the gap depends on the sharpness of the curve, the length of the rail car, the truck spacing, the location of the doors relative to the trucks, and whether the platform is located on the inside or the outside of the curve.

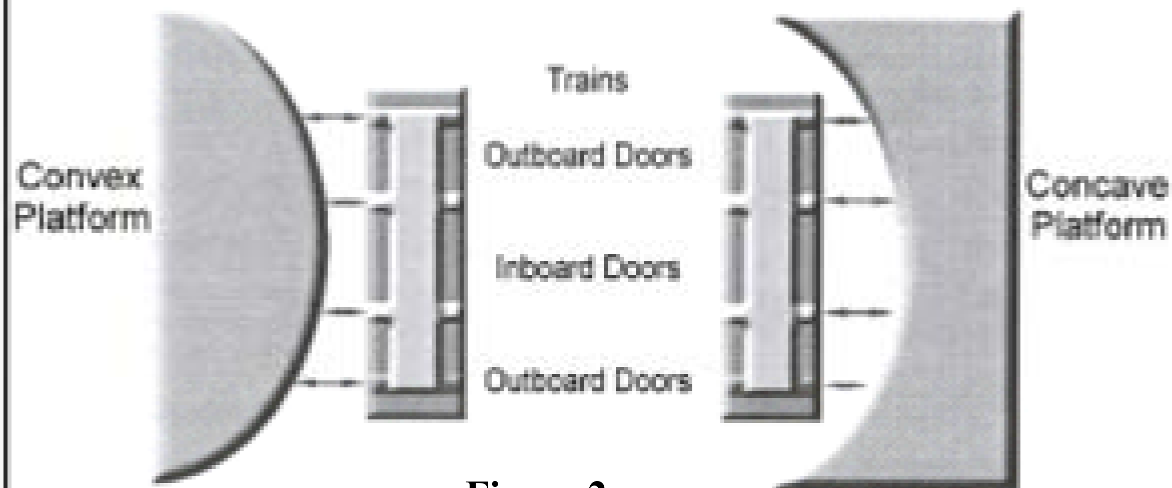


Figure 2

Figure 2. Illustration showing the relationship of the rail car doors and the platform edge on curved track.

Gap dimensions may also vary due to the type of rolling stock that uses the station. For example, some passenger railroads operate different widths of passenger equipment depending on the type and generation of the passenger car. Other railroads may operate identical passenger equipment but must accommodate commuter passenger equipment, long distance passenger equipment, freight equipment, or high and wide over dimension traffic at some or all of their stations. In other cases, stations or end terminals may be exclusively used by similar equipment and be able to tolerate a narrower gap. Still other stations may have to accommodate a subset of the types of trains described above.

Train speed is also a consideration when developing gap standards. Some passenger operations have rail traffic that passes high level platforms without stopping. In this situation, the dynamic characteristics of the passing trains must be considered and enough clearance provided between the train and the platform edge to prevent railroad equipment from striking the platform edge.

It is clear from this discussion that different gap standards may be appropriate for different stations and that gap dimensions maintained by the railroad may vary with the circumstances. A railroad with some tangent and some curved station platforms and a variety of equipment passing through stations will probably need more than one gap standard for its stations. In the extreme, each individual station may need to have its own gap standard due to the characteristics of the station and the type of traffic. Passenger railroads should consider all of the variations in operations that exist on their property as they develop station gap standards or attempt to further reduce the gap.

3. Hazard Management:

Once a passenger railroad has established gap standards for all of its high level stations, the hazard identification and hazard management process can begin. FRA suggests that the passenger railroad use a comprehensive hazard analysis as the core of the hazard management process. Passenger railroads should already have hazard analysis techniques identified as part of their system safety program plans. The techniques identified in the system safety program plan should be appropriate for conducting a hazard analysis on the gap safety issue. If the current hazard analysis techniques are not appropriate for analyzing the gap issue then the passenger railroad should develop a new hazard analysis approach.

Appendix A of this document contains guidelines for conducting a gap safety hazard analysis that can minimize risk to passengers. The hazard analysis guidelines are based on the United States Department of Defense 1993 document "System Safety Program Requirements," Mil-Std-882C and the hazard identification and resolution process described in APTA publication "Manual for the Development of System Safety Program Plans for Commuter Railroads." The APTA document and Mil-Std-882 are excellent methods for conducting hazard analyses in a disciplined, structured manner. A disciplined and structured approach is valuable because it allows hazards to be systematically identified, inventoried, analyzed, and addressed. The methodology ensures that all hazards and mitigation strategies are adequately reviewed. The process provides a permanent record of the hazard analysis and serves as a reference document to review and analyze future accidents or changes in system operations.

4. Maintenance Procedures:

Once gap standards are established and the gap is set within tolerances, maintenance procedures will be needed to service station platforms, track, and rolling stock because elements of these items can directly affect the gap. Comprehensive maintenance procedures are vital for keeping the gap within acceptable tolerances. Many of the maintenance procedures that affect gap safety may already be in place in the passenger railroad's maintenance plan.

For example, station maintenance can affect the gap and the overall risk to passengers boarding the train. Platform resurfacing and modifications should only be performed when their influence on the gap is understood. Extended edges also need to be maintained to preserve the established gap and ensure that firm footing is available at the edge of the platform. Damaged or broken edges should be repaired promptly and with adequate consideration for maintaining the correct gap.

Track maintenance is another area that can influence the gap. The relative position of the track with respect to a stationary platform edge essentially defines the gap. Track maintenance including track alignment, leveling, cross level and ballast cleaning may move the track laterally and horizontally and will directly affect the gap. Track class designations may also affect maintaining the gap because lower classes of track allow greater tolerances on vertical and horizontal alignment. A more extensive list of some of the elements that should be considered for managing the gap from a track and platform perspective appears in **Appendix B**.

Rolling stock maintenance involving the wheels, car suspension, or car leveling system can also influence the gap at a station platform. Worn wheels lower the car floor and can continuously impact the vertical gap over the life of the wheel set. Settling and wear in truck suspension components can affect the horizontal and the vertical gap. Worn truck components can allow excessive side to side clearance that can either close or open the horizontal gap depending on the vehicle dynamics as the rail car rolls to a stop at a station. Rail car pneumatic leveling systems that use air springs can also affect the vertical gap if they are not maintained or properly adjusted. Other rolling stock components that may potentially affect the gap are listed in **Appendix C**.

In a perfect world with unlimited resources and a perfect maintenance program, the influence of maintenance procedures on the gap would probably not be a consideration. However, passenger railroads sometimes have to make decisions on deferring or delaying maintenance on track and equipment that is in need of repair. The effect of deferred maintenance on gap safety should be considered in the discussion.

Finally, passenger railroads should have specific maintenance procedures in place to respond to gaps that are out of tolerance. When the gap is out of tolerance, there should be standard procedures used to systematically review the platform, track, and rolling stock to determine the cause and correct the out of tolerance condition.

5. Inspection Procedures:

Inspection procedures can provide the railroad with comprehensive information necessary to manage gap safety. Once a railroad establishes a gap standard and uses the standard to adjust station platform gaps, periodic inspection of the gap is necessary to monitor and maintain the gap within tolerances. Periodic inspections should be conducted often enough to detect any significant movement of the track with respect to the platform and confirm that the rolling stock is working satisfactorily within the system. The passenger railroads should determine appropriate inspection periods and procedures based on their gap standards and tolerances.

The inspection program may yield valuable information on how the gap varies from day to day - train to train – or car to car. The railroad should establish limits for the gap that trigger appropriate actions to determine the cause and to correct the gap. Correcting the gap may require maintenance on the track, the rolling stock, the station platform or a combination thereof.

The passenger railroad's inspection procedures may require measuring the distance between the centerline of the track and the platform edge or measuring the actual gap between the door threshold and the platform edge. Measuring the actual gap, however, only indicates that the gap is within or outside tolerances. Measuring the actual gap does not indicate the contribution of the station platform, track, or rail car to the overall gap dimension. The contribution of other components can only be determined through additional inspections of the platform, track, and rail cars that make up the system. Procedures should be established to decide what action to take if the actual gap dimension is out of tolerance.

In support of hazard management, it is important that the gap be inspected periodically based on a specific time interval – not just after an accident or incident.

6. Hazard Mitigation Strategies:

After the passenger railroad has established gap standards and reviewed or modified the maintenance and inspection criteria to maintain the gap, the railroad is still left with a hazard. The gap dimension and tolerances may be well established and understood but the remaining gap still poses a risk to passengers.

System safety and hazard management techniques are used to identify additional steps necessary to further reduce the risk to passengers. FRA believes that using a hazard analysis approach to identify and mitigate hazards as described in Section 3 of this document is an appropriate way to proceed. Using a hazard analysis approach documents the hazard and – just as important – documents the hazard mitigation. Only when you have a complete hazard list with corresponding hazard mitigation strategies are you actually performing hazard management.

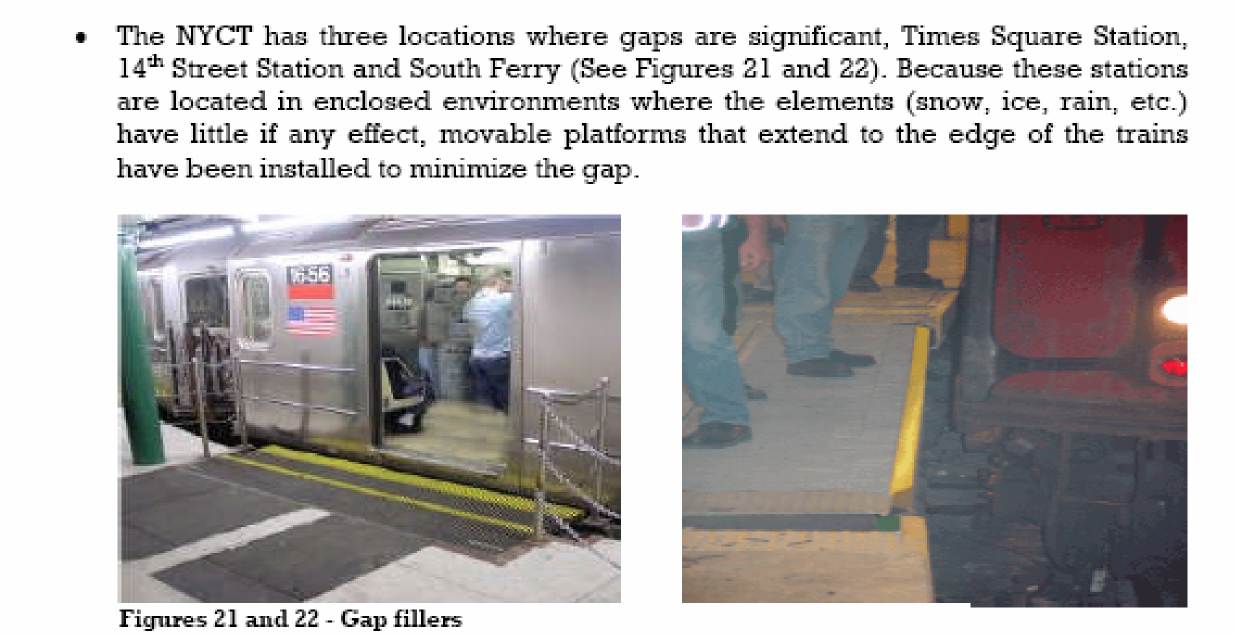
Larger gaps pose a greater risk for a passenger falling through the gap and may require specific mitigation strategies. If a railroad decides to follow the basic gap dimension requirements specified by the state or other regulatory entities, then the railroad should be prepared to identify and institute additional mitigation strategies to reduce the risks to all passengers – including those with disabilities, the aged, or the very young. Some suggestions of items to be considered when identifying mitigation strategies for high level platforms appear in **Appendix D**.
Several types of hazard mitigation strategies are available to manage gap hazards. These include:

- Hardware and Technology
- Policies and Procedures
- Employee Training
- Passenger Outreach
- Passenger Behavior

6.1 Hardware and Technology:

Hardware and technology solutions can offer effective hazard mitigation and should be carefully considered. Engineered systems are especially useful because many are not dependent on the human being to follow a procedure or take an action. There are many examples of hardware and technology used in the passenger railroad industry used to reduce the gap or to assist passengers to safely board or alight from trains. The passenger railroads should carefully evaluate any proposed technology or hardware solutions because they may create other safety hazards.

Moveable platforms have been applied to some stations and are designed to close the gap after the train arrives. The moveable platform is especially appropriate for reducing the gap at stations located on curved track. **Figure 3** shows an application of an extendable platform on New York City Transit. Pictures of platform edge extenders used at a station on a curved track are shown in **Figure 4**. Other stations use platforms with fold up edges that provide comfortable boarding for commuter trains but can be folded out of the way to allow high and wide freight or military trains to pass.



- The NYCT has three locations where gaps are significant, Times Square Station, 14th Street Station and South Ferry (See Figures 21 and 22). Because these stations are located in enclosed environments where the elements (snow, ice, rain, etc.) have little if any effect, movable platforms that extend to the edge of the trains have been installed to minimize the gap.

Figures 21 and 22 - Gap fillers

Figure 3. Photograph of the extendable platform used on New York City Transit indoor platforms.

Figure 4. Moveable platform edge

Gauntlet tracks that provide increased clearance between the rolling stock and the platform edge are used at some stations to route freight trains and excess dimension equipment past station platforms. Passenger trains are routed on a second track located to maintain an appropriate gap for passenger boarding and alighting.

One manufacturer has developed a rubber platform edge with fingers that extend towards the door threshold to serve as a gap filler. The fingers provide fall through protection and also bend out of the way if struck by a passing trains. The configuration of the rubber platform edge is shown in **Figure 5**.

Figure 5. Extended rubber fingers on platform edge gap filler.

The resulting gap can also be mitigated by adding extended threshold plates to the passenger car. The threshold extender can close the gap to make boarding or alighting safer. A gap filler used on the Washington METRO is shown in **Figure 6**.

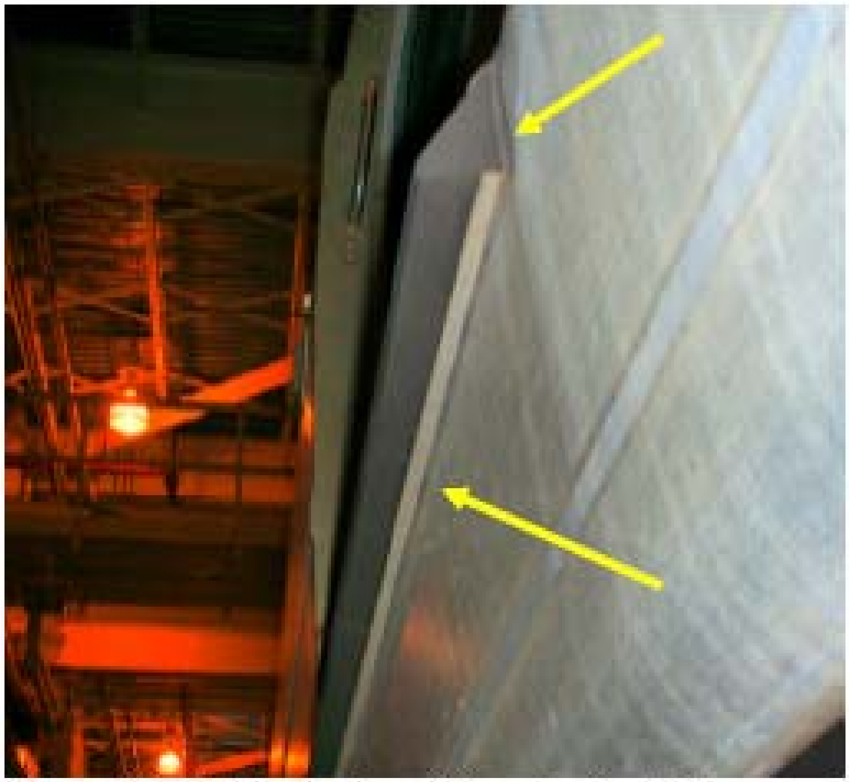


Figure 23 – Rubberized gap filler attached below threshold on WMATA car (as seen from below)

Figure 6. Rubberized gap filler attached below threshold on WMATA car (shown from below).

Some commuter railroads use lighting at edge of the platform and door threshold interface to accentuate the gap and warn passengers of the danger. Gap safety lighting can either be mounted under the platform or under the door threshold.

Another method to reduce the gap is to use power bridge plates that extend the door threshold towards the platform edge or bridge the gap completely. A power bridge plate or door threshold can be helpful to disabled passengers when boarding and alighting from the train.

Other hardware and technology solutions exist that can be effectively used to mitigate gap hazards.

6.2 Policies and Procedures:

A passenger railroad may need to develop new policies or procedures that serve as hazard mitigation strategies. Policies and procedures can be an important component of safe operation. The passenger railroad should use the hazard analysis to identify the specific types of policies and procedures that are needed. The hazard analysis may show that the railroad already has all the necessary policies and procedures in place. However, sometimes the analysis will indicate the need for new or modified policies and procedures to support the gap safety program.

For example, some railroads restrict the number of doors that can be opened on certain curved platforms. Restricting door openings to those with the smallest gap on a curved platform can mitigate some of the safety risk for passengers boarding or alighting from the train. This procedure serves as an important hazard mitigation strategy.

Other passenger railroads have special procedures to observe doors as they close or as the train leaves the platform. Door operations are not directly related to gap safety, door operations are certainly part of the station system, and observing the train during loading, unloading, and door closure can assist in detecting a gap accident and preventing a train from leaving a station with someone trapped in the gap or on the tracks.

At some stations or under some operating conditions, it may be necessary to post a station attendant on the station platform to monitor and assist passengers during boarding and alighting. Special policies and procedures that specify when and where a station attendant should be used may need to be developed as a hazard mitigation strategy. For example, platform crowding during special events may become an issue. Crowding on platforms may result in additional gap incidents – even on platforms with minimal, well controlled gaps. When excessive platform crowding is expected, platform monitors or other special processes or procedures may be appropriate.

6.3 Passenger Outreach:

A comprehensive passenger outreach program can serve as an effective method to enlist the help and cooperation of the passengers in gap safety. The program should utilize a variety of media to effectively present the information. The media may include:

- On Board Announcements
- Signage
- Posters
- Brochures
- Seat Drops
- Videos

Onboard announcements can be used to address gap safety. Amtrak and some other railroads operating in the northeast include "watch the gap" in the conductor's station announcements.

Signage instructing passengers to "watch the gap" in the area of the vestibule or on the station platform may also be appropriate. However, it is important not to provide so much signage in the vestibule area as to become ineffective or to detract from other important signage in the area.

Posters with gap safety themes can be mounted on advertising racks throughout the train. Gap safety (or general safety) brochures can be located in racks next to train timetables or incorporated in public timetables distributed to passengers. Additional information can be included on tickets or monthly passes.

On some railroads, seat drops may be appropriate. Seat drops are brochures, letters, or pamphlets left on every passenger seat at the beginning of service. Each passenger would have to pick up the material before sitting.

Videos are another important tool – especially on commuter railroads that have advertising or information monitors on their trains or platforms.

If a commuter railroad has access to celebrities, then a taped celebrity announcement may be helpful. The Las Vegas airport uses celebrity announcements to provide safety and security information to patrons. For example, Don Rickles instructs airport patrons to hold children's hands when using the escalator. A similar automatic celebrity announcement may be appropriate for some trains or station platforms.

Passenger outreach announcements and materials should be clear and concise but detailed enough to define the gap and the related safety issues. The message should be targeted at all passengers – both regular customers and one time users – so that everyone will fully understand the gap issue and act accordingly.

6.4 Employee Training:

New policies or procedures developed as gap safety hazard mitigation strategies should be addressed in training programs as necessary. The training should be focused on the particular groups that are responsible for carrying out the new policies and procedures such as:

- Train crews,
- Maintenance staff,
- Station personnel,
- Station supervision,
- Station security, and
- Railroad police

Training should also be developed for others who deal directly with gap issues.

The type of training that is provided will vary depending on the requirements for hazard mitigation. Trainmen and conductors may need training in such areas as:

- Look back procedures

- Monitoring door openings and closings
- Assisting special needs passengers on and off the train
- Platform monitoring

Track, car, and platform maintenance workers may require training in:

- Critical maintenance procedures that affect the gap
- Approved inspection procedures for monitoring the gap
- Quality control during and after maintenance procedures that affect the gap

Training is essential for establishing and maintaining employee involvement in mitigation strategies designed to minimize the risk posed by the gap.

6.5 Passenger Behavior:

Passenger behavior is often random and hard to control. Train crews are hard pressed to reliably predict what a passenger may do next. However, there are steps that can be taken to influence or respond to undesired passenger behavior – especially behavior that may lead to unsafe acts during boarding and alighting from trains.

To analyze gap hazards related to passenger behavior, the passenger railroad should first identify the situations or types of behavior present on the railroad that can lead to gap safety hazards. For example, the passenger railroad may be concerned with the following types of behavior:

- Disorderly Conduct or Disruptive/Unsafe Behavior
- Unmonitored children

Disorderly Conduct or Disruptive/Unsafe Behavior can lead to gap safety hazards – especially if taking place when the individuals are boarding or alighting from the train. Unmonitored children pose a risk to themselves and others when they run down the platform to board a train. Even a small gap can pose a hazard to an unsuspecting child that is not properly supervised.

The key to responding to these types of behavior is to have policies and procedures in place to address the issues as they occur. The responsibility for developing the policies and procedures belongs to the passenger railroads but the responsibility for addressing the behavior rests primarily with the on board crew. Passenger railroads should establish passenger behavior policies and insist that their crews enforce those policies. The railroads should determine if there are adequate existing policies in place to address the types of behavior that lead to gap safety issues. For example:

Does the railroad have policies that:

- Address issues of disorderly passengers or those displaying disruptive and/or unsafe behavior on the station platforms or trains including denying boarding or putting individuals off the train?
- Require train crews to address issues with unmonitored children on trains or on station platforms?

Passengers may need to be reminded of the responsibilities of the conductor and his right to address passenger behavior issues. For example, a commuter railroad could provide a flyer that states the conductor's authority and responsibility to remove disorderly passengers or those displaying disruptive and/or unsafe behavior from the train.

Passenger behavior issues are delicate issues but they must be addressed in a consistent and responsible manner. The railroad must provide their onboard crews with the tools that they need to control the situation. This includes the policy, appropriate training, and support when the policy is applied. If a passenger railroad uses new or existing policies as a hazard mitigation strategy, then the policies must be enforced. The passenger railroad should use efficiency testing or observations to ensure that crews consistently follow the policies.

Other types of passenger behavior can be broken down in a similar way. Using a hazard management team to explore passenger behavior issues by asking questions and reviewing policies can lead to identifying appropriate mitigation strategies to address the behavior.

7. Gap Safety Management Follow Up

The passenger railroad gap safety management plan is an ongoing activity that will require regular follow up. Periodic review of the hazard management plan and the hazard analysis should be conducted to ensure that mitigation strategies remain fully implemented and that all hazards are satisfactorily closed out.

The hazard management program described in this document and captured in the hazard analysis should also be reviewed as changes occur in the configuration or the operation of the passenger rail system or as the external environment changes. The hazard analysis worksheets should be revisited and updated whenever changes occur. Changes that can affect the hazard analysis include:

- new or expanded passenger service,
- revised operations procedures,
- use of new or modified equipment
- changes to existing stations or building new stations

It is important to make the hazard analysis a living document that can be modified and updated as new information is collected about the gap safety issue. The hazard analysis work sheet should also be reviewed after each serious gap accident or incident to determine if the hazard analysis and the mitigation strategies are valid or need to be updated. The review of the hazard analysis is conducted to confirm that all hazards are identified and that the frequency and severity classifications for specific hazards remain accurate.

8. Summary:

FRA encourages passenger rail operators to examine the risk posed by the gap between the rail car door threshold and high level station platforms and recommends that all passenger rail operators establish gap safety management programs to establish and consistently maintain a uniform gap and uniform boarding and alighting conditions at each station. The gap safety management program should:

- use engineering evaluation and analysis to establish gap standards for all high level stations, and
- apply mitigation strategies to further reduce the risk of gap accidents.

Recognizing that passenger railroads typically operate over the rights-of-way of freight railroads, FRA recommends that, in developing and implementing gap safety management programs, passenger rail operators coordinate with the freight railroads which host their operations or which operate over passenger railroad owned lines, and that the freight railroads assist in their efforts to promote platform gap safety. Using this approach, FRA hopes to achieve improvements in passenger rail platform safety.

The hazard analysis approach outlined in Appendix A of this document represents one method to conduct hazard analysis. However, there are many other methods and techniques for managing hazards. Additional information on how to apply hazard management techniques to railroad operations exists in a variety of documents. The documents listed in the bibliography section represent a small sample of the type of information available.

9. Bibliography

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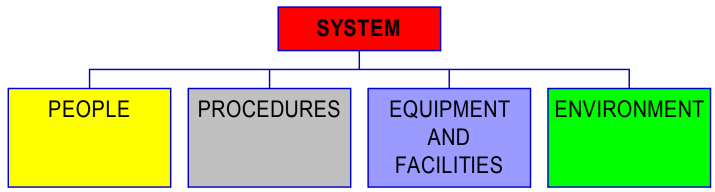
APPENDIX A

HAZARD ANALYSIS PROCESS

1. Hazard Management System Safety Approach

The system safety approach is a holistic process for hazard analysis because it considers the overall passenger railroad system. A passenger railroad system is made up of the following elements:

- People
- Procedures
- Equipment & Facilities
- Operating environment



These elements need to interact and integrate with each other in order for the system to function. Changes to one element or part of an element may have a profound effect on the other element of the system, and thus, affect the safety of the system.

2. Hazard Analysis as a Tool

Hazard analysis is a tool used in the system safety process to allow a passenger railroad to evaluate hazards in the various modes of operation. This process should start in the design phase (include any system extensions, modifications, or vehicle purchases) and continue until the system is retired; the hazard analysis is a continuous process.

Hazard analysis is defined as an analysis performed to identify hazardous conditions for the purpose of their elimination or control. The purpose of hazard analysis is to:

- Identify safety hazards and their causes
- Determine hazard severities/probabilities
- Recommend corrective action to correct procedures and resolve design problems
- Provide documented evidence of compliance with design, code, or specification requirements to management

2.1 Identifying Hazards

The passenger railroad hazard management team must have a working knowledge and understanding of how the individual system elements (people procedures, facilities & equipment and the environment) interface with each other. When identifying safety hazards present in a system, every effort should be made to identify and catalog all potential hazards. For the purpose of this project we will limit ourselves to platform gap safety. However, if in the process of identifying hazards, other non related hazards are identified, then they should also be captured and analyzed.

There are many techniques for identifying hazards. Basic methods to help identify hazards may include:

- Data from previous accidents or operating experience or case studies.
- Scenario development (what if) and judgment of knowledgeable individuals (hazard management team members)
- Development of Generic hazard checklists.
- Development of specific hazard checklists pertinent to the operating railroad
- Pictures
- System tours
- Formal hazard analysis techniques
- Design data and drawings
- Analysis and compare similar systems
- Identify codes standards and regulations that may affect the system (highway codes regarding grade crossing)

3. Hazard Analysis and Resolution Process

There are five main steps in performing the hazard analysis process. They are:

1. System Definition
2. Hazard Identification
3. Hazard Assessment
4. Hazard Resolution
5. Follow Up

The five steps are shown schematically in **Figure A1**. Each step of the process will be explained in detail in the following sections.

3.1 Step 1 – System Definition

The first step of the hazard analysis identification and resolution process is to define the system under consideration. A good system definition is important to understand the environment and interfaces that occur during operation of passenger trains – especially those elements that may positively or negatively affect safety. The system definition is best accomplished by individuals who are intimately familiar with the passenger rail operation.

The system definition should be a narrative statement that fully describes, at a minimum, train operations, the rolling stock, track configuration, infrastructure, and environment.

This guideline will limit the system to the station platform of the passenger railroad. Here are a few examples that may help to define the system. (These examples will vary with each railroad).

- Location of station tangent track and curved track
- How many passengers utilize station the every day
- How many and what type of stations make up the system

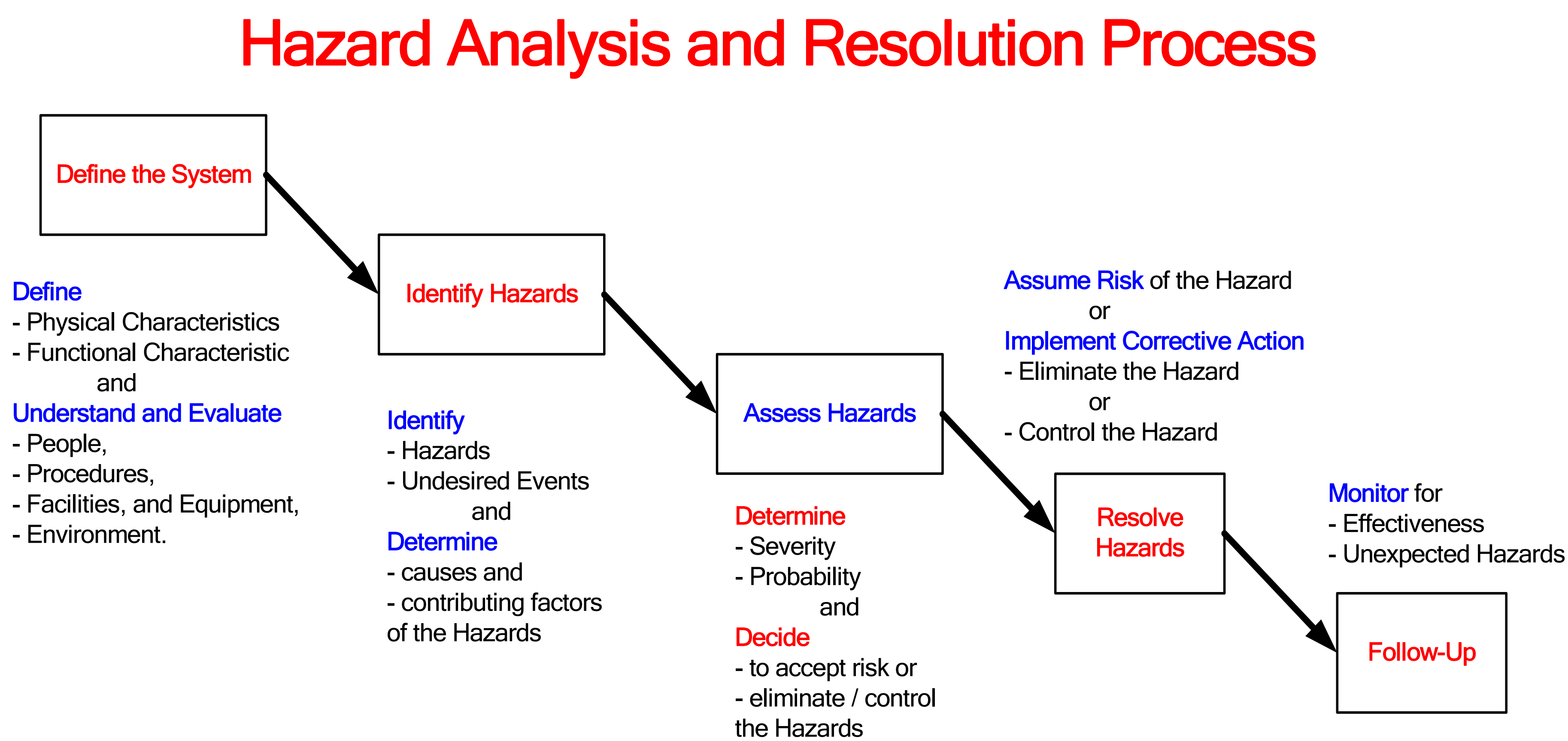


Figure A1. Schematic diagram of the Hazard Analysis and Resolution Process.

- Location of stairways escalators and elevators
- Pedestrian crossings at station locations
- Type of Platform edge
- Boarding level or low level boarding
- Number and type of trains that pass through the station
- Operating environment (Weather)

The system definition list presented above is not intended to be a complete list but a sample of the types of information that should be collected on the passenger rail property. The system definition list will vary depending on the specific conditions and circumstances that exist on a particular passenger railroad. It is important that the individuals who develop the definition list include all elements that could potentially affect safety. Therefore, the system definition should be prepared by a team that is very familiar with the passenger rail operation.

3.2   Step 2 – Hazard Identification:

Hazard identification is looking for potential hazards that may exist on the passenger railroad property. In this case, the area of interest is platform gap safety so hazard identification should be restricted to those hazards related to primary or secondary platform gap incidents. Many organizations form an expert panel or hazard management team to identify the hazards related to the operation. The team consists of individuals who have detailed knowledge of the system. As a minimum, a passenger rail hazard management team should include representatives from the system safety, operations, mechanical, and track & signals departments.

Hazard identification is a “What if?” activity that looks for the potential causes and results of accidents. The hazard management team “brainstorms” to come up with as many viable hazards as possible for use in the hazard analysis. In this case, the focus of the Hazard Management Team should be to identify hazards that could result in passenger injury as a result of platform gaps, second train coming or other platform hazards that affect the safety of passengers.

Some hazards, such as excessive platform to train gaps, may seem obvious. Other types of hazards such as passenger behavior may not be as obvious but should be considered. Use prior accidents as examples of what might happen and determine if the same scenario is possible.

Some of the hazards that are associated with passenger gap platform incidents that should be considered in the hazard analysis are listed below.

- Passenger Accidents
  - Passenger falls between the Train and the platform
  - Passenger slips on platform
  - Passenger caught in door

  - Passenger slips while boarding or alighting the train
  - Child falls into gap when boarding the train

- Vehicle incidents
  - Wide load freight train hits side of platform
  - Vehicle suspension system failure
  - Vehicle wheel wear
  - Door Failure

- Track Structure
  - Track movement
  - Super elevation
  - Track Maintenance
  - Track configuration
  - Rail wear

As with the system definition list, the above list is not intended to be a complete list of all the hazards that should be considered. The hazard management team is in the best position to identify potential accidents on the specific passenger railroad. The hazard management team should consider the physical characteristics of the passenger railroad when identifying the hazards.

3.3 Step 3 – Hazard Assessment

There are many ways to document and assess the hazards identified. Generic hazard analysis worksheet can be found in this Guide. Each railroad should tailor the work sheet to suit their environment and develop a worksheet that the hazard management team is comfortable using.

3.3.1 Classification/Assessment of Hazards

Classification and assessment of hazards is challenging and probably the most intense part of the hazard analysis process. This process takes place once the hazards are documented and the railroad hazard management team) sits down to classify and assess the hazards.

3.3.2 Assessment Tools

One of the tools used in all industries is Mil Standard 882. This standard was designed by the military for analyzing weapons systems where there were no outside influences on the system. The weapons systems were under the complete control of the military. Railroads have outside influences that are beyond their control. Thus the Mil Standard needs to be adjusted for the railroad environment. The railroad may want to examine methods to classify hazards that are meaningful and practical to its operation.

The hazard assessment approach involves assessing each hazard for severity and frequency to determine the relative risk of different types of occurrences. The assessment can be based on statistics (quantitative) or the collective opinions of the hazard management team (qualitative). Since quantitative data are often not available for accident severity or frequency or are not directly applicable to a specific passenger rail operation, a qualitative analysis, properly executed, is an acceptable method to perform hazard assessment.

The hazard assessment should follow ground rules for hazard resolution defined in the passenger railroad's system safety program plan or established by the hazard management team. The hazard resolution procedure should be established early to prevent disagreements on accepting or rejecting mitigation strategies. The hazard assessment should include several steps:

3.3.2.1 Hazard Criticality

A risk matrix should be developed to provide a framework to categorize hazard severity and frequency and allow the hazards to be prioritized so that the most important hazards are addressed first. There are other approaches to the risk matrix and, as mentioned above, a passenger railroad may already have developed a standard risk matrix approach defined in their system safety program plan. If an existing risk matrix approach is not available, then an approach similar to the Mil-Std-882C approach described below should be followed.

First, classify the hazards identified in the hazard identification step into criticality categories. How serious is the hazard under evaluation? Use the criticality definitions shown in **Table A1** or develop appropriate alternatives that are meaningful for gap safety.

Category	Description	Definition
I	Catastrophic	Death, system loss, or severe environmental damage.
II	Critical	Severe injury, severe occupational illness, major system or environmental damage.
III	Marginal	Minor injury, minor occupational illness, or minor system or environmental damage.
IV	Negligible	Less than minor injury, occupational illness, or less than minor system or environmental damage.

Table 1. Hazard Criticality Categories from Mil-Std-882C.

In the railroad industry, where any incident can lead to a serious or fatal injury, it is sometimes necessary to consider the level of system loss when assessing the criticality of a hazard. Considering system loss is not meant to downplay the occurrence of a serious or fatal injury but is provided as an additional tool to determine the relative seriousness of a hazard. For example, an incident at a station platform involving a passenger who fell into the gap could shut down passenger rail service for an extended period of time. Therefore, a hazard that causes this level of disruption should probably be considered critical or catastrophic – even if the hazard does not generate serious personal injury.

3.3.2.2 Hazard Frequency

Once the hazard criticality is determined, the frequency of the hazard should be established. The frequency of the hazard can be determined quantitatively using failure rates or accident/incident statistical data. The frequency can also be established qualitatively based on the relative frequency of expected occurrence. An estimate of how often a hazard may occur during the life of the system may be helpful in establishing frequency. Mil-Std-882C guidance on hazard frequency is shown in the first columns of **Table A2**. The last column illustrates a time based method to look at frequency that may be more meaningful for gap hazard analysis. The railroad should develop frequency categories that are appropriate for their gap safety hazard analysis and that are useful for determining the relative frequency of occurrence of various gap incidents.

Level	Description	Quantitative Definition (Frequency x)	Qualitative Definition	Time
A	Frequent	$x > 1x10^{-1}$	Likely to occur frequently, continuously experienced in the system.	Once a week
B	Probable	$1x10^{-1} > x > 1x10^{-2}$	Will occur several times in the life of an item, will occur frequently in the system.	Once a month
C	Occasional	$1x10^{-2} > x > 1x10^{-3}$	Likely to occur some time in the life of an item, will occur several times in the system	Once a year
D	Remote	$1x10^{-3} > x > 1x10^{-6}$	Unlikely but possible to occur in the life of an item, unlikely but can reasonable be expected to occur in the system.	Once every 10 years
E	Improbable	$1x10^{-6} > x$	So unlikely that it can be assumed occurrence may not be experienced, unlikely to occur but possible.	Less than once in 10 years

Table A2. Hazard Frequency Categories from Mil-Std-882C.

3.3.2.3 Risk Matrix

The next step in the process is to establish a risk matrix to assess each hazard and provide guidance on how to eliminate or control the hazard. The risk matrix also serves to establish, the overall relative risk for each hazard. Risk is defined as a combination of the probability and the severity of a hazard (the frequency and criticality). **Table A3** contains a risk matrix that combines the frequency and criticality for each hazard. The frequency and criticality can be used to find the level of risk for each hazard.

Associated with each level of risk are recommended actions that provide guidance on how to respond to each identified hazard. A list of recommended responses appears in **Table A4**.

	Hazard Categories			
Frequency of Occurrence	**I Catastrophic**	**II Critical**	**III Marginal**	**IV Negligible**
A – Frequent	1A	2A	3A	4A
B – Probable	1B	2B	3B	4B
C – Occasional	1C	2C	3C	4C
D – Remote	1D	2D	3D	4D
E – Improbable	1E	2E	3E	4E

Table A3. Risk Matrix Hazard Categories from Mil-Std-882C.

Risk Matrix Hazard Category	Suggested Action
1A, 1B, 1C, 2A, 2B, 3A	Unacceptable, eliminate hazard.
1D, 2C, 2D, 3B, 3C, 4A, 4B	Undesirable, upper management decision to accept or reject risk.
1E, 2E, 3D, 3E	Acceptable with management review.
4C, 4D, 4E	Acceptable without review.

Table A4. Suggested Responses to Risk Matrix Hazard Categories.

3.3.3 Applying the Tools to Classify Hazards (What do we do with the information?)

So now that we are in the process of assessing the probability and severity of the hazardous events, what are we going to due with the information? The Hazard Risk Index (HRI), coupled with the Risk Decision Criteria, indicate how the hazard should be treated. It is very important to track hazards and verify that they have either been controlled or the risk accepted. A closed loop tracking system prevents a hazard from slipping through the cracks.

Lets first look at the Severity Categories. What does your railroad want to define as catastrophic, critical, marginal and negligible? Next we take a look at the Probability Categories and again what does your railroad want to define as frequent, probable, occasional, remote and improbable

The results of the hazard identification and hazard assessment steps should be captured on a hazard analysis worksheet. The hazard analysis work sheet contains all of the information collected on each hazard and serves as the record of how hazards are to be controlled or mitigated. Use of the work sheet ensures that all identified hazards are systematically addressed. A sample work sheet including sample hazards appears in **Table A5**.

3.3.4 Hazard Analysis Worksheet

The left side of the hazard analysis worksheet contains information on each hazard under consideration. The hazard description and the cause and effects are included in this section along with an estimate of the severity and the frequency or probability of the hazard. It is important for the hazard to be adequately defined within the environment and operating parameters of the passenger railroad. It is important that these various combinations be considered when analyzing platform interfaces and passenger dynamics and associated safety issues because the results of each type of incident or issue may be quite different.

The hazard analysis process should also consider different locations and configurations of platforms on the system that may be critical in escalating an incident. When performing hazard analyses, consider locations at stations that could potentially cause, contribute to, or escalate an incident.

3.4 Step 4 – Hazard Resolution

3.4.1 Developing a Mitigation Approach

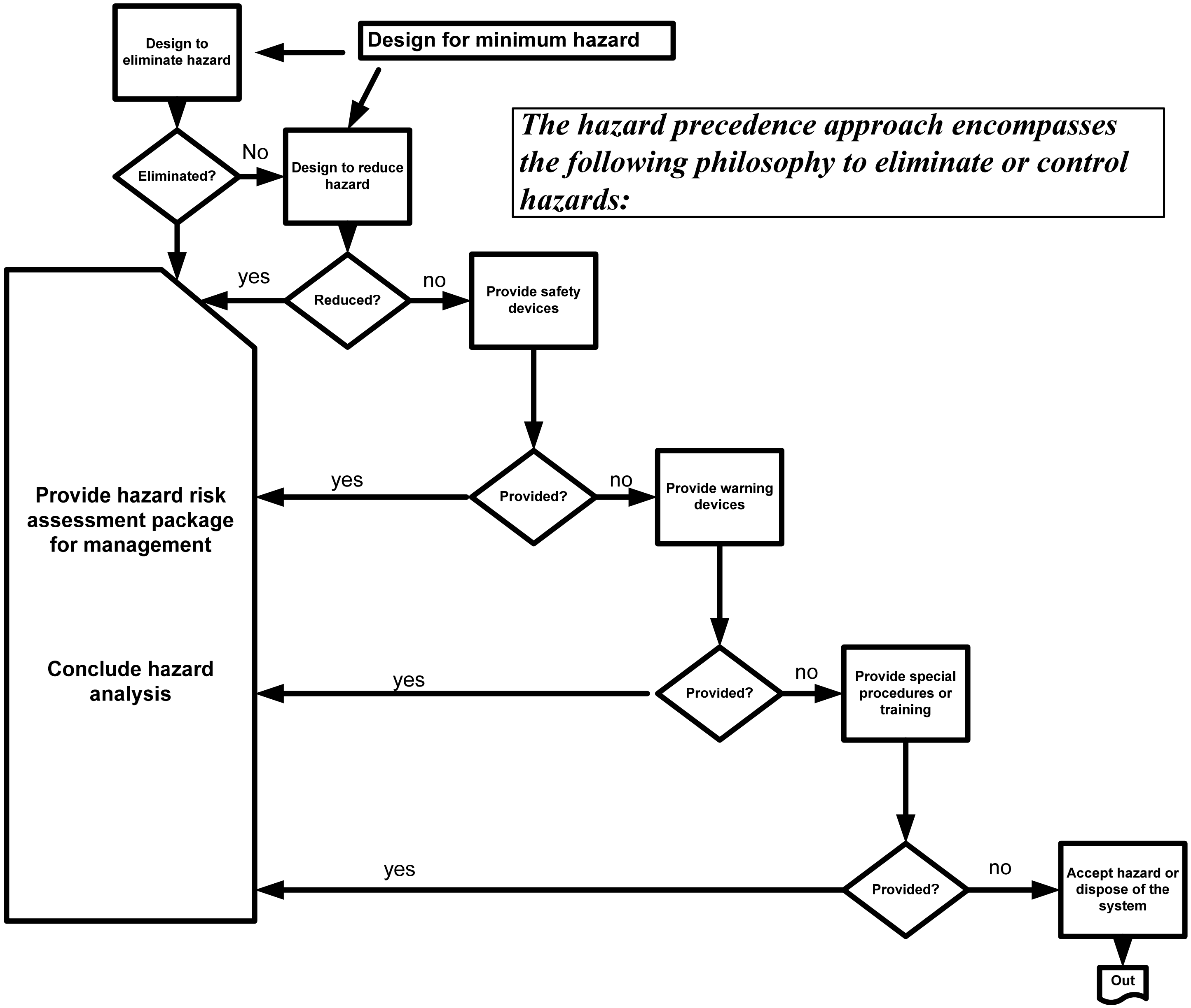
The right side of the worksheet includes information on the mitigation approach – the strategy adopted to reduce the severity or the frequency of the hazard. Once a mitigation approach is determined, the effect of the mitigation strategy on the severity and the probability or frequency of the hazard is estimated and the revised risk matrix figure is recorded on the worksheet. In this manner, hazards that require mitigation can be moved to a lower criticality and/or frequency category where the risk may be more acceptable to the passenger railroad operator. As mitigation actions are implemented, the status of the hazard will change from open to closed. The last column should include references to the dates and documents that establish the closure action.

Some hazards will require more than one mitigation strategy. For example, a passenger railroad may decide to place personnel on station platforms with excessive gaps as a way of reducing the risk of passenger injury. This would be a valid short term strategy but may not be appropriate in the long term. A longer term strategy, however, may be to realign and re-tamp the track to the established track centerline to platform edge Improvements in rolling stock suspension along with track improvements may represent a valid method to reduce platform gap dimensions. Therefore, the mitigation strategies or actions should be categorized as short term, medium term, or long term actions.

3.4.2 Hazard Precedence

The hazard precedence approach is a technique for controlling hazards during different phases of the system life cycle. Keep the hazard precedence approach to hazard mitigation in mind when developing mitigation strategies. The approach is most often used on new systems because many hazards can be eliminated during the design stage - before the system is initiated and put in service. The hazard precedence approach, however, is also useful when assessing existing systems although changes to the design become retrofits and are generally far more expensive.

The hazard precedence approach encompasses the following philosophy to eliminate or control hazards:



SAMPLE PLATFORM GAP HAZARD ANALYSIS WORKSHEET												
HAZARD IDENTIFICATION						MITIGATION APPROACH						
Hazard Number	**Hazard Description**	**Cause**	**Effects**	**S**	**P**	**Mitigation Strategy**	**Rev. S**	**Rev. P**	**Status**	**Responsibility**	**Comments**	
1	Platform Slippery weather condition	Weather Condition Rain, platform surface too smooth, standing water.	Boarding or alighting train passenger could slip and fall into the gap.	**2**	**A**	Establish new maintenance policy to include platform drainage inspection Passenger announcement policy includes warning about slippery conditions during rain or snow events Passenger announcement policy includes watch the gap announcement at all stations Follow existing maintenance and inspection plan to verify proper track alignment to platform Change specification for platform painting to include abrasives to improve footing	**3**	**B**	Open	Operations, maintenance and track maintenance	This is a system wide hazard during inclement weather. Review platform maintenance contract to assure platform drain cleaning is part of the contract and timely response to platform maintenance issues is addressed. Station personnel and crews are required to make announcements to watch the gap per SOP P-1 and identify and report hazardous conditions to maintenance control. Maintenance control will immediately dispatch personnel to the affected platform The safety department will add this item as an attribute to audit for compliance every quarter. The safety department will also verify quarterly that track alignment to platform maintenance is being performed in accordance with Track Procedure TA-5.	

SAMPLE PLATFORM GAP HAZARD ANALYSIS WORKSHEET												
HAZARD IDENTIFICATION						MITIGATION APPROACH						
Hazard Number	**Hazard Description**	**Cause**	**Effects**	**S**	**P**	**Mitigation Strategy**	**Rev. S**	**Rev. P**	**Status**	**Responsibility**	**Comments**
2	Uneven transition between the train and platform.	Track alignment or vehicle suspension out of tolerance.	Passenger tripping and falling onto the platform, into the train or into the gap.	**2**	**A**	Follow existing maintenance and inspection plan to verify proper track alignment to platform Follow existing maintenance and inspection plan to verify proper vehicle suspension adjustment Passenger announcement policy includes watch the gap announcement at all stations	**3**	**C**	Open	Operations, vehicle and track maintenance	The safety department will verify quarterly that track alignment to platform maintenance is being performed in accordance with Track Procedure TA-5. Vehicle maintenance suspension inspections will be conducted monthly in accordance with Procedure VS -03. Station personnel and crews are required to make announcements to watch the gap per SOP P-1 The safety department will audit for compliance quarterly

SAMPLE PLATFORM GAP HAZARD ANALYSIS WORKSHEET

HAZARD IDENTIFICATION						MITIGATION APPROACH					
Hazard Number	**Hazard Description**	**Cause**	**Effects**	**S**	**P**	**Mitigation Strategy**	**Rev. S**	**Rev. P**	**Status**	**Responsibility**	**Comments**
3	Passenger caught in closing door.	Train crew not attentive while closing the door.	Passenger caught in door or falls in gap as train moves.	**1**	**A**	Operating instructions include door closure and look back procedures Efficiency testing and observations policy includes requirements from observing crews during look back procedures Daily car inspection requires that all mechanical and electrical door interlock devices be in working order New policy established to take trains with malfunctioning interlocks out of service	**3**	**C**	Open	Operations and vehicle maintenance	Door interlock switch needs to be tamper proof. Supervisors will monitor and document that the door bypass switch has not been tampered with. Develop procedures to address conditions when the door bypass switch is disabled. Door look back procedures and door by pass switch will be observed for compliance and documented by supervision during efficiency and proficiency testing in accordance with SOP-8. The safety department will audit this process on a quarterly schedule

SAMPLE PLATFORM GAP HAZARD ANALYSIS WORKSHEET												
HAZARD IDENTIFICATION							**MITIGATION APPROACH**					
Hazard Number	**Hazard Description**	**Cause**	**Effects**	**S**	**P**	**Mitigation Strategy**	**Rev. S**	**Rev. P**	**Status**	**Responsibility**	**Comments**
4	Passenger caught in closing door.	Train crew not attentive while closing the door.	Passenger falls into the gap.	**1**	**A**	Operating instructions include door closure and look back procedures Efficiency testing and observations policy includes requirements from observing crews during look back procedures	**3**	**C**	Open	Operations and vehicle maintenance	Door look back procedures and will be observed for compliance and documented by supervision during efficiency and proficiency testing in accordance with SOP-8. The safety department will audit this process on a quarterly schedule. During regular maintenance schedules all mechanical and electrical devices associated with door operation will be inspected and tested and results document in accordance with SOP-VM-8-1. The safety department will audit compliance with this procedure during schedule maintenance audits.

SAMPLE
PLATFORM GAP HAZARD ANALYSIS WORKSHEET

HAZARD IDENTIFICATION						MITIGATION APPROACH					
Hazard Number	Hazard Description	Cause	Effects	S	P	Mitigation Strategy	Rev. S	Rev. P	Status	Responsibility	Comments
5	Excessive gap between the train and platform.	Track alignment or vehicle suspension out of tolerance.	Passenger falls into the gap.	1	A	Passenger announcement policy includes watch the gap announcement at all stations Follow existing maintenance and inspection plan to verify proper track alignment to platform Follow existing maintenance and inspection plan to verify proper vehicle suspension adjustment	2	C	open	Operations, vehicle and track maintenance	The safety department will verify quarterly that track alignment to platform maintenance is being performed in accordance with Track Procedure TA-5. Vehicle maintenance suspension inspections will be conducted monthly in accordance with Procedure VS -03. Station personnel and crews are required to make announcements to watch the gap per SOP P-1 The safety department will audit for compliance quarterly

SAMPLE PLATFORM GAP HAZARD ANALYSIS WORKSHEET												
HAZARD IDENTIFICATION						MITIGATION APPROACH						
Hazard Number	Hazard Description	Cause	Effects	S	P	Mitigation Strategy	Rev. S	Rev. P	Status	Responsibility	Comments
6	Platform Slippery weather condition	Platform covered with ice and snow	Passenger falls boarding or alighting or into the gap	2	A	Snow removal contract requires complete removal of all snow from platform and treatment of standing water to prevent ice from forming Passenger announcement policy includes watch the gap announcement at all stations Passenger announcement policy includes warning about slippery conditions during rain or snow events	3	C	closed	Platform maintenance and operations.	The platform maintenance contract has been revised and requires the contractor to commence sanding, salting and snow removal at the first sing of snow or ice conditions. Platform supervisors and train crews will monitor and report platform conditions to OCC in accordance with SOP 3. Operations and maintenance supervision are responsible to assure compliance in accordance with SOP 3 and SOP P-1. This process is subject to safety department audit for compliance.
7	Crowded Platform	Sports event exiting	Passenger fell into gap boarding train due to heavy passenger load exiting from sports event	1	A	Initiate crowd control procedures during special events. Policy requires a station platform monitor during special events	4	C	Closed	Operations, vehicle and track maintenance	Crowd control procedures CC -01 have been initiated and all crews have been trained. Supervision will monitor that the procedure is in place during special events where large crowds are expected.

SAMPLE
PLATFORM GAP HAZARD ANALYSIS WORKSHEET

HAZARD IDENTIFICATION						MITIGATION APPROACH					
Hazard Number	**Hazard Description**	**Cause**	**Effects**	**S**	**P**	**Mitigation Strategy**	**Rev. S**	**Rev. P**	**Status**	**Responsibility**	**Comments**
8	Excessive gap between the train and platform.	Track alignment or vehicle suspension out of tolerance.	Passenger wheel chair fell into gap causing person to fall onto platform	2	A	Follow existing maintenance and inspection plan to verify proper track alignment to platform Follow existing maintenance and inspection plan to verify proper vehicle suspension adjustment Operations policy requires conductors to assist all wheel chair bound passengers when boarding or alighting.	3	D	Closed	Operations, vehicle and track maintenance	The safety department will verify quarterly that track alignment to platform maintenance is being performed in accordance with Track Procedure TA-5. Vehicle maintenance suspension inspections will be conducted monthly in accordance with Procedure VS -03. Station personnel and crews have been instructed in the use of bridge plates for persons physically challenged SOP P-1 The safety department will audit for compliance quarterly

3.5 Step 5 – Follow Up

Regular review of the hazard analysis worksheet should be conducted to ensure that mitigation strategies are fully implemented and all hazards are satisfactorily closed out. Medium term and long term actions should be tracked to completion. The hazard analysis can also be used to justify capital dependent mitigation strategies and help maintain visibility during budget requests.

Hazard analysis should not be a one time activity. The techniques described in this document should regularly be applied to the passenger rail system as changes occur in the configuration or the operation of the system and as the external environment changes.

APPENDIX B

Managing the GAP, from a Track and Platform Perspective.

Effective practices for "Managing the GAP" at high station platforms.

1. Create an inventory for all high station platforms which includes the information below.

    a. Milepost
    b. Station name
    c. Number of tracks (one or two)
    d. Platform construction type
    e. Year platform was originally built
    f. Platform edge warning, type and width
    g. Curve or tangent track, or both-explain
    h. If curve, degree of curvature, in degrees and minutes
    i. Maximum speed for freight and commuter trains which operate on station track(s)
    j. Do passenger, commuter, or freight trains operate past this platform at maximum speed? Include details concerning type and speed.
    k. Standard railroad measurement, center of station track(s) to platform edge
    l. Standard railroad measurement, top of rail to top of platform
    m. Standard maximum and minimum GAP measurement, horizontal and vertical, designated by operating railroad.
    n. Do the passenger or commuter vehicles on this line automatically vertically adjust to compensate for passenger loading and unloading, which may keep the top of rail to top of platform standard measurement constant, see l. If so, what is the maximum vertical compensation that can be made, can it compensate for an overload of passengers standing in the aisles?
    o. Other freight, passenger, or commuter railroads operating on track
    p. Are there any other passenger or commuter vehicles that operate on the track that have different standard measurements regarding items (k) and (l) above?

Any permanent operational restrictions to loading and unloading passengers at certain areas of platforms?

Inspection and maintenance procedures at high station platforms

2. Develop standards for inspection and maintenance to ensure proper GAPS

    a. Inspection and reporting protocols
    b. Identify types of corrective actions that could be initiated by high station platform/track inspectors, which could include operating procedures, barriers at certain locations which would prevent passenger loading or unloading, etc.
    c. Develop standards and protocols which must be met before track surfacing at high station platform locations
    d. Additional inspections after any other disturbing of the station platform track
    e. Qualified high station platform inspectors-training. FRA track standards (deviations of FRA track standards should be found by railroad track inspectors during their required regular inspections, the railroad may not want to duplicate this inspection) and the relationship between the track and the high platform and all aspects of the information in the inventory which may effect the inspections and the corrective action(s) taken.

New station construction and rehabilitation of existing high platforms

1. Develop standards for construction of new high platforms

2. Develop standards for renovations at existing high platforms

3. Consider all aspects of the inventory above and especially high platforms in curved track locations.

4. Refer to ADA standards during the planning stage for new high platforms.

APPENDIX C

Rail Car Components

Recommendations for Equipment Design, Inspection, Testing and Maintenance for Passenger Equipment Operated in High Level Platform Territory

A. New Equipment

1. The following parameters should be specified in the procurement documents:
   a. Allowable car width with tolerances over the side door threshold plates.
   b. The finished car floor height with tolerance.
   c. The allowable wheel wear.
   d. The car body dynamic outline; including the limits of motion for the side door thresholds.
   e. The passenger side door locations.

2. The passenger side door location specification should consider minimizing gaps between floor and the platforms on curved track locations that are present on the carrier's right of way.

3. The procurement document should include the requirement for a dimensional analysis to be performed and documented by the builder to identify the expected car motions which will affect the vertical and horizontal gap between the car and the platform. This analysis shall include as a minimum: identification of critical components that affect the horizontal and vertical gap and, the dimensions and tolerances of such critical components. The dimensions and tolerances of these key components shall be agreed upon by the car builder and carrier, considering the goal of reducing the gap when possible.

4. The maintenance instructions should identify all items that affect the gap and their associated pass/fail criteria to ensure that the resultant car body to track motion is within the level agreed to between the car builder and the carrier.

B. Existing Equipment

1. Review the existing maintenance instructions to identify all components that affect the gap. Evaluate the parameters for possible gap reduction. Make revisions as necessary.

2. Inspection, Testing, Maintenance (Below are general recommendations. Other property or equipment specific procedures can be developed using the same principle).

   a. Daily inspection: (Add the following if not already included.)

1). Inspect suspension system as follows:
- (a) Ensure that outer coils springs are not broken.
- (b) Ensure that air springs are operating as intended.

2). Ensure gap signage is in place and legible. Ensure passenger announcement system (if equipped) is in proper working condition.

3). Inspect lighting near door way.

4). Ensure that passageways and side door threshold plates are free of oil, grease or any obstruction which would create a slipping or tripping hazard

b. Periodic Inspection: (Add the following if not already included.

For the identified components, (ref. Item B.1.)

1). Ensure air pressure gages and instruments used for adjusting the car body height are properly calibrated.

2). Check car body height. Adjust car body height as necessary according to established procedures.

3). Truck periodic inspection:

(a). Primary Suspension Inspection:
- o Inspect journal box suspension system (i.e. springs, dampers) for excessive wear, cracks or deterioration to ensure system integrity and proper adjustment.

(b). Secondary Suspension Inspection:
- o Inspect secondary suspension assembly for excessive wear, cracks or deterioration to ensure secure installation and proper adjustment.
- o Items to be inspected include: springs, rubber spring seats and shims, bushings, rubbers, etc., if so equipped.
- o Inspect all dampers for excessive leaks, excessive wear, and mounting deterioration.
- o Inspect air springs for deterioration, damage, or air leaks.
- o Inspect lateral damper system for excessive leaks, damage, excessive wear, and secure installation.
- o Inspect lateral bumper assemblies/parts for excessive wear, damage, and missing components.
- o Inspect leveling valves for fluid leaks, proper installation, and proper function.
- o Inspect steering rods for excessive wear, damage, secure installation, and proper function.
- o Ensure air bag height or pressure is within the specified range.

- o Inspect air spring system, including reservoirs, piping, valves, hoses, fittings, and clamps, for dents, cracks, wear, leakage, or undue stress. Ensure system integrity and proper function.

(c). Truck Frame Periodic Inspection:

- o Inspect truck frame for wear, cracks, and proper clearances.

(d). Wheel Periodic Inspection:

- o Inspect wheels for excessive wear (i.e. flange and tread thickness).

c. Unscheduled Maintenance

After any car maintenance that may affect the body height (e.g. truck replacement, air bag replacement, wheel set replacement), check the car body height.

Adjust car body height as necessary according to established procedures

APPENDIX D

Station Considerations

Gap Safety recommendations, in High Level Platform Territory:

A) Train Door Operating Procedures:
Train Door Operating Procedures are, important to ensure safety, at high level platforms. Some of the safety considerations, for door operations, in high platform territory are:

- Ensure that the engineer and the train door operator coordinate to hold the doors closed until the train is completely on the full platform;
- Ensure that train crew holds doors not fully aligned with the platform in the closed position;
- Ensure there are appropriate on-board announcements for passengers. i.e. ("mind-the-Gap" and "to hold the hand of small children");
- Ensure that all crew members are positioned at their assigned locations;
- Ensure safety notices are distributed to train crews alerting them to hazards at stations with "wide-gaps";
- Ensure procedures, for train crew members to view the entire platform, to observe conditions before closing train doors are in place and enforced;
- Establish procedures, where practical, to close train doors from the last open car and observe platform as the train begins to move;
- When it is not practical to close the train doors from the rear car, there should be look back procedures for the train door operator and the engineer to observe the platform, immediately after the doors are closed, to ensure the doors are clear of all persons attempting to board or de-board.

B) Platform Guidelines:

To enhance the safety of passengers, at high level platforms, where practical, there should be audible & visual safety mitigation strategies, in place to:

- Alert passengers on the platform to "mind-the-Gap between the platform and the train door threshold;
- Alert passengers with children, to hold the child's, hand, while on the platform and while boarding and alighting;
- Alert passengers to stand clear of approaching trains;