

Sample Safety Risk Assessment Matrices for Rail Transit Agencies

Version 1
October 2019

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The Federal Transit Administration (FTA) prepared this guide to assist your rail transit agency in establishing a safety risk assessment matrix appropriate for the size and complexity of your operations. Choosing to adopt such a matrix may help your agency implement the Safety Risk Management process required in FTA's Public Transportation Agency Safety Plan (PTASP) regulation at 49 C.F.R. Part 673 (Part 673).

Each transit agency must “establish methods or processes to assess the safety risks associated with identified safety hazards.” A safety risk assessment includes “an assessment of the likelihood and severity of the consequences of the hazards, including existing mitigations, and prioritization of the hazards based on the safety risk.”
– 49 C.F.R. § 673.25(c)

A safety risk assessment matrix provides a structure for a systematic approach to:

- Assessing the likelihood and severity of the consequences of identified hazards;
- Determining if the safety risk is acceptable with existing mitigations or if additional action is needed; and
- Prioritizing hazards based on the safety risk of their potential consequences.

1 Foundations of the Safety Risk Assessment

1.1 Key Terms

Part 673 provides definitions for key terms related to safety risk assessment:

- **Hazard** means any real or potential condition that can cause:
 - Injury, illness, or death;
 - Damage to or loss of facilities, equipment, rolling stock, or infrastructure of a public transportation system; or
 - Damage to the environment.
- Based on the definition of a hazard, **potential consequence** can be defined as an effect of a hazard involving 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.
- **Risk** means the composite of predicted severity and likelihood of the potential effect of a hazard.
- **Risk mitigation** means a method to eliminate or reduce the effects of hazards.

A hazard holds the potential that, when triggered, may result in a consequence that could cause harm or damage. The identified potential consequence may be minor or catastrophic, depending on the nature of the hazard.

Within the Part 673 Safety Risk Management process, a rail transit agency analyzes an identified hazard to determine its potential consequences. Then, the agency assesses how often each potential consequence could occur (likelihood) and its harm or damage (severity). This assessment helps the agency understand the safety risk associated with the hazard and helps agency management decide if it needs to take action, e.g., a safety risk mitigation, to address the safety risk.

EXAMPLE

Chemicals commonly used in rail vehicle maintenance can be hazardous to personnel responsible for their use and storage. Chemicals can cause skin irritation, chemical burns, and organ failure – exposure to the chemicals leading to injury is a potential consequence.

The risk of the potential consequence to personnel from the hazard, using chemicals, is a composite of the likelihood and severity of the hazard's potential consequences. In other words, the risk of the potential consequence is defined by how often the agency thinks it could experience the potential consequence (likelihood) and how serious the agency thinks the potential consequence could be (severity), accounting for existing mitigations that may be in place to protect workers using chemicals, such as personal protective equipment (PPE).

Based on this assessment, the agency determines whether it accepts the safety risk “as is” or if the agency requires additional risk mitigation. If the agency decides the safety risk is unacceptable, it can implement mitigations, such as conducting chemical handling training or monitoring maintenance personnel to ensure that they use PPE properly during activities requiring chemical use. Implementing mitigations to ensure personnel use chemicals safely reduces the risk to a level the agency is willing to accept.

1.2 Identifying Potential Consequences

A single hazard may have multiple potential consequences and your agency may choose to assess the likelihood and severity of a range of consequences related to a single hazard. In the example above, the agency mitigated the potential consequence of exposure to chemicals leading to injury by implementing training and monitoring PPE use. Other potential consequences could be an environmental spill or equipment damage due to improper use.

In some cases, the potential consequences of a hazard are fairly easy to identify. In other cases, they are not so easy to identify. One technique that both narrows down a large number of potential consequences and helps the agency identify consequences is to consider what the *most common*, *worst possible*, and *worst credible consequences* could be for the hazard:

- The *most common consequence*, or what the agency expects could most reasonably happen given the circumstances of the hazard;
- The *worst possible consequence*, or what the agency expects to be the worst imaginable outcome given the circumstances of the hazard; and/or
- The *worst credible consequence*, or what the agency expects to be a realistic and imaginable consequence that is not as extreme as the *worst possible* consequence.

EXAMPLE

Water leaking from the roof of a vehicle maintenance building results in puddling on the floor.

- The *most common consequence* may be a slip resulting in a minor injury or abrasion.
- The *worst possible consequence* may be an employee slipping, striking their head on the floor or a nearby object, resulting in a fatality. The agency has not experienced such an incident; however, they believe it is possible based on subject matter expertise and industry data.
- The *worst credible consequence* may be a slip resulting in a major injury, such as a broken leg or arm, requiring hospitalization.

1.3 Assessing Safety Risk

Once your agency identifies potential consequences related to a hazard, it can assess these potential consequences for likelihood and severity. Your agency can use a risk assessment matrix to guide its determination. A risk assessment matrix typically assigns a number to the potential severity and a letter to the potential likelihood.

Table 1 below ranks the severity from:

- (1) Catastrophic, or resulting in multiple deaths, permanent disability, significant environmental impact, or significant monetary loss;
- (2) Critical, or resulting in a death, partial disability, injuries that result in hospitalization, major environmental impact, or major monetary loss;
- (3) Marginal, or resulting in an injury resulting in a lost work day, moderate environmental impact, or moderate monetary loss; to
- (4) Negligible, or resulting in a minor injury, minor environmental impact, or minor monetary loss.

These are sample severity and likelihood ratings and definitions. Your agency may adopt these ratings and definitions or create new ones to suit the agency's needs.

Table 1 below ranks the likelihood from:

- (A) Frequent, or likely to occur multiple times within a year;
- (B) Probable, or likely to occur no more than twice per year;
- (C) Occasional, or likely to occur no more than once per year;
- (D) Remote, or likely to occur no more than once per five years; to
- (E) Improbable, or unlikely to occur over the lifecycle of the hazard.

SAFETY RISK ASSESSMENT MATRIX				
Severity Likelihood	(1) Catastrophic	(2) Critical	(3) Marginal	(4) Negligible
(A) Frequent	High	High	High	Medium
(B) Probable	High	High	Medium	Medium
(C) Occasional	High	Medium	Medium	Low
(D) Remote	Medium	Medium	Low	Low
(E) Improbable	Medium	Low	Low	Low

Table 1: Sample Safety Risk Assessment Matrix

An alternative version of the table presented in Table 1 measures the level of safety risk in

terms of severity and likelihood, but intentionally does not include titles for the categories of severity and the levels of likelihood, relying instead on numbers and letters that would correspond to criteria specified in severity and likelihood tables. This approach may help avoid bias or assumptions based on differing interpretations of the words used to describe levels of severity or likelihood. Table 2 below provides an example of what this version could look like.

ALTERNATIVE SAFETY RISK ASSESSMENT MATRIX				
Severity Likelihood	1	2	3	4
A	High	High	High	Medium
B	High	High	Medium	Medium
C	High	Medium	Medium	Low
D	Medium	Medium	Low	Low
E	Medium	Low	Low	Low

Table 2: Sample Alternative Safety Risk Assessment Matrix

Whichever approach your agency takes, the matrix format combines severity and likelihood assessments to establish the overall risk rating of a potential consequence of a hazard. This rating may be referred to by the combined number and letter of the column and row on the matrix (i.e., “1E”), by the combined names of the selected column and row (i.e., “Catastrophic-Improbable”), or by both (i.e., “1E Catastrophic-Improbable”). Tables 1 and 2 also include color-coded risk categories. Table 3 describes these categories, red for unacceptable, yellow for undesirable, and green for acceptable, in greater detail.

SAFETY RISK LEVEL CATEGORIES	
Safety Risk Index	Criteria by Index
High	<i>Unacceptable – Action Required:</i> Safety risk must be mitigated or eliminated.
Medium	<i>Undesirable – Management Decision:</i> Executive management must decide whether to accept safety risk with monitoring or require additional action.
Low	<i>Acceptable with Review:</i> Safety risk is acceptable pending management review.

Table 3: Sample Safety Risk Level Categories

EXAMPLE

Water leaking from the roof of a vehicle maintenance building results in puddling on the floor.

- The *most common consequence* may be a slip resulting in a minor injury or abrasion.
 - The agency may determine that the severity would be negligible, and it is likely to occur occasionally, or, as dictated by Table 1, “4C Negligible-Occasional.”
 - A risk rating of 4C Negligible-Occasional is a low safety risk, meaning it is acceptable without further mitigation.
 - The agency may choose to monitor the situation to make sure the severity or likelihood of the hazard’s potential consequences do not change.
- The *worst possible consequence* may be an employee slipping, striking their head on the floor or a nearby object, resulting in a fatality.
 - The agency may determine that the severity would be catastrophic, and it is improbable, or “2E Critical-Improbable”.
 - A risk rating of 2E Critical-Improbable is a medium safety risk, meaning it is undesirable and requires an executive management decision on whether the potential consequence of the hazard is acceptable to the agency without additional mitigation.
- The *worst credible consequence* may be a slip resulting in a major injury, such as a broken leg or arm, requiring hospitalization.
 - The agency may determine that the severity would be critical, and it is likely to occur occasionally, or “3C Marginal-Occasional.”
 - A risk rating of 3C Marginal-Occasional is also a medium safety risk. The agency may decide to accept the risk from the water leak with monitoring to make sure the circumstances do not change. If the circumstances change, such as projected long-term flooding, the likelihood of a slip may increase and therefore increase the rating to a 3A Marginal-Frequent, requiring the agency to implement a mitigation.

2 Developing a Safety Risk Assessment Matrix

Your agency may choose to adopt one of the sample matrices provided in Tables 1 or 2, revise and adopt one of the sample matrices, or create its own safety risk assessment matrix. The most important factor in creating or adopting a safety risk matrix is ensuring that the categories and definitions are appropriate for the size and complexity of your operations.

Your agency may choose to develop a safety risk assessment matrix in consultation with the Accountable Executive and their executive leadership team. Since executive leadership may use these categories to determine when to take action to mitigate the potential consequences of a hazard, their active engagement in defining these categories and how the agency will assess and manage safety risk offers many benefits for your agency. The biggest benefit, other than executive leadership “buy in”, is that their involvement helps ensure that the matrix and the associated categories and definitions reflects their safety priorities.

When developing its safety risk assessment matrix, your agency may define for itself the categories of severity, levels of likelihood, and criteria for each respective severity category and likelihood level.

2.1 Severity Categories and Criteria

When defining consequence severity categories for your agency, it is important to consider the full range of potential impacts on your operations. Based on the definition of hazard and potential consequence, Part 673 identifies several potential criteria for consequence categories, including death, injury, illness, damage to the environment, and damage to or loss of facilities, equipment, rolling stock, or infrastructure.

Your agency may identify other criteria, such as loss of reputation (i.e., increase in negative perceptions among riders) or loss of organizational capability (i.e. loss of personnel or resources central to your agency's mission) that may not directly relate to safety performance.

Your agency may find it easiest to assess severity when distinct safety outcomes are in different categories. For example, an injury resulting in permanent disability would be in a different severity category from an injury requiring first aid. Similarly, a consequence with multiple fatalities would be in a different severity category from a consequence with a single fatality or no fatalities.

Using multiple criteria to define severity within each category offers multiple ways to justify each risk assessment's severity. For example, your most severe category may include criteria such as multiple fatalities, an injury or illness resulting in permanent disability, property damage of greater than \$1,000,000, system-wide shutdown for four or more hours, and irreversible environmental damage that violates law or regulation.

Your agency may place different levels of priority on individual consequences, such as assigning passenger and employee injuries a greater severity category than trespasser injuries.

Table 4 provides considerations for establishing severity category criteria

Potential Consequences	Considerations for Severity Categorization
Death	Number of fatalities, types of fatalities, priority for fatalities occurring under specific conditions (i.e., passengers and employees versus trespassers).
Injury	Number of injuries, types of injuries, priority for passenger and employee injuries or other injuries, full or partial disability, hospitalization, lost work days, first aid.
Illness	Full or partial disability, hospitalization, lost work days.
Environmental Damage	Extent of damage (reversible, reversible with mitigation, irreversible), legal determination regarding failure to comply with environmental regulations.
Property Damage or Loss of Property	Range of dollar values, total or partial destruction of vehicle or infrastructure element, system-wide shutdown, partial shutdown, significant limitations on service.

Table 4: Considerations for Categorizing Severity of Potential Consequences

EXAMPLE*

A transit agency establishes severity categories on a scale of one to four.

- 1, Catastrophic, which involves one or any combination of the following:
 - Multiple fatalities;
 - One fatality *and* one or more major injuries;
 - One pedestrian or worker in the right-of-way fatality;
 - Irreversible environmental damage;
 - Damage to property or infrastructure of greater than \$1M; and/or
 - Greater than one day total system outage.
- 2, Critical, which involves one or any combination of the following:
 - One fatality;
 - Multiple major injuries;
 - One or more injuries of any kind to pedestrians or workers in the right-of-way;
 - Reversible with mitigation environmental damage;
 - Damage of greater than \$250K, but less than \$1M; and/or
 - Greater than two days of 50-percent system outage.
- 3, Marginal, which involves one or any combination of the following:
 - One major injury;
 - More than one minor injury;
 - Reversible environmental damage with remediation of greater than \$500K;
 - Damage of greater than \$50K, but less than \$250K; and/or
 - Greater than two days of less than 50-percent system outage.
- 4, Negligible, which involves one or any combination of the following:
 - Minor injury; and/or
 - Damage of less than \$50K; and/or
 - Reversible environmental damage with remediation of less than \$500K.

*Numbers provided in this example for illustration only

Depending on the types of hazards you identify, your agency may choose to establish two or more sets of severity categories and criteria. For example, one set of categories and criteria may be used for rail operations, another for rail maintenance, and a third for all hazards related to trespassers, which may be a major safety focus for your agency. While the specific measures or data used for these categories will differ across the matrices, your agency may choose to keep a similar proportional relationship between its severity categories across its matrices.

2.2 Likelihood Levels and Criteria

When defining consequence likelihood levels, your agency will establish a standard frequency of occurrence for each category. These are often measured in calendar days, weeks, months, years, or decades. Your agency may choose to have a standard frequency of occurrence across all possible consequences or you may also decide to vary the definition of likelihood for specific assessments based on data, process cycles, or life cycles. (Numbers provided below for illustration purposes only.)

Rate-based likelihood criteria leverage available agency or industry data in their definition to

establish rates of likelihood. For example, your agency may choose to assess how often a particular consequence occurs per a certain measure of vehicle revenue miles, unlinked passenger trips, or specific infrastructure elements related to the hazard and its unique potential consequences, such as the number of passenger train door cycles per month. Another commonly used sample for assessing likelihood is operating hours or the number of hours during which your agency provides service over a specific time period, such as 500 operating hours per month or 60,000 operating hours per year.

Process cycle-based likelihood criteria define likelihood by the number of occurrences in relation to the number of times a specific process is completed, such as the series of steps associated with stopping at a station or performing a specific maintenance activity such as inspection of train wheels for critical measurements.

Life cycle-based likelihood criteria define likelihood based on the life cycle of a component, vehicle, sub-system, system, or infrastructure element. The various milestone phases for such assets include planning, design, operations, maintenance, and disposal. Such life cycles typically use a range of time periods, such as 15, 25, or 30 years, depending on the nature of the hazard and its potential consequences.

EXAMPLE

A transit agency establishes likelihood criteria on a scale of “A” to “E”.

- A, Frequent, which means they expect the potential consequence to occur continuously, or:
 - More than once per:
 - Month;
 - 500 operating hours;
 - 1,000 operating hours;
 - 50,000 unlinked passenger trips; or
 - 40,000 vehicle revenue miles.
 - More than 15-percent of instances within a process.
 - More than once per year throughout a vehicle's operations life cycle.
- B, Probable, which means they expect the potential consequence occur frequently, or:
 - Less than once per month, but more than once per year.
 - Once per:
 - 500 to 6,000 operating hours;
 - 1,000 to 100,000 operating hours;
 - 50,000 to 600,000 unlinked passenger trips; or
 - 40,000 to 480,000 vehicle revenue miles.
 - More than 10-percent but less than 15-percent of instances within a process.
 - Once per year throughout a vehicle's operations life cycle.

EXAMPLE

- C, Occasional, which means they expect the potential consequence to occur several times, or:
 - Less than once per year, but more than once per decade.
 - Once per:
 - Month;
 - 6,000 to 60,000 operating hours;
 - 100,000 to 1,000,000 operating hours;
 - 600,000 to 6,000,000 unlinked passenger trips; or
 - 480,000 to 4,800,000 vehicle revenue miles.
 - More than 5-percent but less than 10-percent of instances within a process.
 - At least once every two years throughout a vehicle's operations life cycle.
- D, Remote, which means the potential consequence is unlikely, but they can reasonably expect it to occur, or:
 - Less than once per decade but more than once in the life of the system.
 - Once per:
 - 60,000 operating hours to 180,000 operating hours;
 - 1,000,000 to 100,000,000 operating hours;
 - 6,000,000 to 18,000,000 unlinked passenger trips; or
 - 4,800,000 to 14,400,000 vehicle revenue miles.
 - More than 1-percent but less than 5-percent of instances within a process.
 - Once throughout a vehicle's operations life cycle.
 -
- E, Improbable, which means the potential consequence is unlikely to occur but is possible, or:
 - Will not likely occur during the life of the system.
 - Less than once per:
 - 180,000 operating hours;
 - 100,000,000 operating hours;
 - 18,000,000 unlinked passenger trips; or
 - 14,400,000 vehicle revenue miles.
 - Less than 1-percent of instances within a process.
 - Will not likely occur throughout a vehicle's operations life cycle.

Having multiple criteria available for assessing likelihood may expand your agency's capability to conduct safety risk assessment. For example, your most frequent category of likelihood may include criteria such as one or more occurrences per calendar month, per 500 operating hours, per 50,000 unlinked trips, etc. Previous guidance prepared by FTA on hazard analysis includes an approach to assessing likelihood based on the Mean Time Between Events (MTBE) as a multiple of 1,000 operating hours.¹ While some agencies use this approach, others prefer ranges of operating hours more in keeping with actual monthly (500) and annual (6,000) totals.

¹ Hazard Analysis Guidelines for Federal Transit Projects (2000).

2.3 Sample Matrices

To support your agency in designing its own safety risk assessment matrix, this guide contains three illustrative, sample matrices for your agency's consideration:

- The **Simple Matrix in Appendix A** has three categories for severity: Catastrophic, Serious and Marginal and three levels for likelihood: Frequent, Occasional and Remote.
- The **Standard Matrix in Appendix B** contains four categories for severity: Catastrophic, Critical, Marginal and Negligible and five levels for likelihood: Frequent, Probable, Occasional, Remote and Improbable.
- The **Subject-Specific Matrix in Appendix C** presents categories of severity and likelihood levels focused on assessing potential consequences of hazards related to a single subject, trespassing.

Appendices A and B present proposed criteria for consideration based on the potential consequences listed in the definition of hazard in Part 673 and the levels of likelihood discussed in this guide. Appendix C illustrates how additional data and information collected for a specific issue can be incorporated into the safety risk assessment process. FTA's sample matrices can be tailored and modified by your agency based on your unique operations and considerations.

All three matrices also include a proposed safety risk index to assess the composite severity and likelihood rankings. Each agency may choose to establish its own index appropriate to the size and complexity of its operations.

Table 5 describes the criteria for each safety risk index as used in the Appendices.

SAFETY RISK LEVEL CATEGORIES	
Safety Risk Index	Criteria by Index
High	<i>Unacceptable – Action Required:</i> Safety risk must be mitigated or eliminated.
Medium	<i>Undesirable – Management Decision:</i> Executive management must decide whether to accept safety risk with monitoring or require additional action.
Low	<i>Acceptable with Review:</i> Safety risk is acceptable pending management review.

Table 5: Sample Safety Risk Level Categories

Based on engagement with transit agency leadership and executive management, the safety risk index in Table 5 may be revised to reflect their guidance and preferences. For example, an additional safety risk index row may be added between High and Medium or additional levels of management review and approval may be specified.

Appendix A: Simple Matrix

SEVERITY CATEGORIES	
Severity Category	General Criteria for Category
(1) Catastrophic	<p>Could result in:</p> <ul style="list-style-type: none"> • Death; • Permanent total or partial disability; • Loss exceeding \$250,000; • System shutdown lasting four or more hours; or • Irreversible severe environmental damage that violates law or regulation.
(2) Serious	<p>Could result in:</p> <ul style="list-style-type: none"> • Injury or occupational illness resulting in hospitalization of at least one person; • Loss exceeding \$25,000 but less than \$250,000; • System shutdown lasting between ten minutes and four hours; or • Reversible environmental damage causing a violation of law or regulation.
(3) Marginal	<p>Could result in:</p> <ul style="list-style-type: none"> • Injury or occupational illness resulting in one or more lost workday(s); • Loss up to \$25,000; • System shutdown of less than ten minutes; or • Mitigatable environmental damage without violation of law or regulation.

LIKELIHOOD LEVELS		
Likelihood Level	Specific Item	Fleet or Inventory
(A) Frequent	Likely to occur often in the life of an item.	Continuously experienced. Potential consequence may occur more than once in 500 operating hours.
(B) Occasional	Will occur several times in the life of an item.	Will occur several times. Potential consequence may be experienced once in 500 to 60,000 operating hours.
(C) Remote	Unlikely to occur in the life of an item.	Unlikely but possible. Potential consequence may be experienced once in 60,000 to 1,800,000 operating hours.

RISK ASSESSMENT MATRIX			
Severity Likelihood	(1) Catastrophic	(2) Serious	(3) Marginal
(A) Frequent	High (1A)	High (2A)	Medium (3A)
(B) Occasional	High (1B)	Medium (2B)	Low (3B)
(C) Remote	High (1C)	Medium (2C)	Low (3C)

SAFETY RISK LEVEL CATEGORIES	
Safety Risk Index	Criteria by Index
High	<i>Unacceptable – Action Required:</i> Safety risk must be mitigated or eliminated.
Medium	<i>Undesirable – Management Decision:</i> Executive management must decide whether to accept safety risk with monitoring or require additional action.
Low	<i>Acceptable with Review:</i> Safety risk is acceptable pending management review.

Appendix B: Standard Matrix

SEVERITY CATEGORIES	
Severity Category	General Criteria for Category
(1) Catastrophic	<p>Could result in:</p> <ul style="list-style-type: none"> • Multiple deaths; • Permanent total disability; • Irreversible significant environmental impact; or • Monetary loss greater than or equal to \$1M.
(2) Serious	<p>Could result in:</p> <ul style="list-style-type: none"> • Death; • Permanent partial disability; • Injury or illness resulting in hospitalization; • Reversible significant environmental impact; or • Monetary loss greater than or equal to \$250,000, but less than \$1M.
(3) Marginal	<p>Could result in:</p> <ul style="list-style-type: none"> • Injury or occupational illness resulting in one or more lost workday(s); • Reversible moderate environmental impact; or • Monetary loss greater than or equal to \$25,000, but less than \$250,000.
(4) Negligible	<p>Could result in:</p> <ul style="list-style-type: none"> • Injury or occupational illness not resulting in a lost workday; • Minimal environmental impact; or • Monetary loss less than \$25,000.

LIKELIHOOD LEVELS		
Likelihood Levels	Specific Item	Fleet or Inventory
(A) Frequent	Likely to occur often in the life of an item.	Continuously experienced. Potential consequence may be experienced more than once in 500 operating hours.
(B) Probable	Will occur several times in the life of an item.	Will occur often. Potential consequence may be experienced once between 500 and 6,000 operating hours
(C) Occasional	Likely to occur sometime in the life of an item.	Will occur several times. Potential consequence may be experienced once between 6,000 and 60,000 operating hours.
(D) Remote	Unlikely, but possible to occur in the life of an item.	Unlikely but can reasonably be expected to occur. Potential consequence may be experienced once between 60,000 and 180,000 operating hours.
(E) Improbable	So unlikely, it can be assumed it will not be experienced in the life of an item.	Unlikely to occur, but possible. Potential consequence may be experienced less than once in 180,000 operating hours.

RISK ASSESSMENT MATRIX				
Severity Likelihood	(1) Catastrophic	(2) Serious	(3) Marginal	(4) Negligible
(A) Frequent	High	High	High	Medium
(B) Probable	High	High	Medium	Medium
(C) Occasional	High	Medium	Medium	Low
(D) Remote	Medium	Medium	Low	Low
(E) Improbable	Low	Low	Low	Low

SAFETY RISK LEVEL CATEGORIES	
Safety Risk Index	Criteria by Index
High	<i>Unacceptable – Action Required:</i> Safety risk must be mitigated or eliminated.
Medium	<i>Undesirable – Management Decision:</i> Executive management must decide whether to accept safety risk with monitoring or require additional action.
Low	<i>Acceptable with Review:</i> Safety risk is acceptable pending management review.

Appendix C: Subject-Specific Matrix

Appendix C provides an example of how to develop a matrix focused on a single subject: trespassers. It helps target activities to assess safety risk related to unauthorized intrusion onto a rail transit right-of-way. This matrix goes beyond the basic severity and likelihood information in Appendices A and B to demonstrate how specific assessment criteria can be used to help an agency assess risk from a unique hazard.

In this example, which is illustrative only, appropriate data and information could be obtained from site visits, engineering assessments and from actively monitoring specific locations to identify features that may indicate a greater likelihood or severity of the potential consequences resulting from trespassing. This may include:

- Identification of locations where engineering, education, and enforcement practices used on other parts of the rail transit system are not in use;
- Areas where trains travel through densely populated neighborhoods;
- Observations and reports from train operators;
- Changing land use along right-of-way;
- Areas with direct pedestrian access to the rail transit right-of-way; and
- Results of monitoring of operations to identify instances of trespassing on the rail transit right-of-way.

Designing a matrix like this one provides the opportunity to bring additional data and information into the safety risk assessment process. While your agency may experience one or two fatalities or serious injuries resulting from trespassing, using this additional data may help you identify and prioritize system design specifications, safety education, community outreach programs, and locations at high risk for trespassing as well promulgating safe operating practices from an organizational perspective where additional mitigations would further reduce safety risk. In addition, using information can shed more light on the potential safety risk associated with a particular shortcoming within the agency.

While this matrix has been modified to focus on a specific topic, it follows the same general ranges of magnitude for severity and likelihood used in the sample matrix in Appendix B. Therefore, discussions with executive leadership will involve similar potential events and frequencies as when discussing other topics. This will further align the risk assessment matrix and support consistency in evaluation and decision-making.



SEVERITY CATEGORIES		
Severity Category	General Criteria for Category	Specific Criteria for Assessment
(1) Catastrophic	Could result in: <ul style="list-style-type: none"> • Multiple deaths; • Permanent total disability; • Irreversible significant environmental impact; or • Monetary loss greater than or equal to \$1M. 	More than one fatality and/or more than one injury resulting in permanent total disability to an unauthorized individual in the past year.
(2) Serious	Could result in: <ul style="list-style-type: none"> • Death; • Permanent partial disability; • Injury or illness resulting in hospitalization; • Reversible significant environmental impact; or • Monetary loss greater than or equal to \$250,000, but less than \$1M. 	One fatality and/or injury resulting in permanent partial disability to an unauthorized individual in the past five years.
(3) Marginal	Could result in: <ul style="list-style-type: none"> • Injury or occupational illness resulting in one or more lost workday(s); • Reversible moderate environmental impact; or • Monetary loss greater than or equal to \$25,000, but less than \$250,000. 	At least one reported near miss involving an unauthorized individual on the right of way in the previous five years.
(4) Negligible	Could result in: <ul style="list-style-type: none"> • Injury or occupational illness not resulting in a lost workday; • Minimal environmental impact; or • Monetary loss less than \$25,000. 	No reported injuries, fatalities or near misses involving unauthorized individuals on the right of way in past five years.

LIKELIHOOD LEVELS		
Likelihood Levels	System	Specific Site or Location
(A) Frequent	Continuously experienced.	Three or more safety events within a year from unauthorized individuals at specific location.
(B) Probable	Will occur frequently.	One or more safety events within a year from unauthorized individuals at specific location.
(C) Occasional	Will occur several times.	At least one safety event within previous two years from unauthorized individuals at specific location.
(D) Remote	Unlikely but can reasonably be expected to occur.	One or more near miss safety events of unauthorized individuals at specific location in past five years.
(E) Improbable	Unlikely to occur, but possible.	No safety events involving unauthorized individuals at specific location in the past five years.

RISK ASSESSMENT MATRIX				
Severity Likelihood	(1) Catastrophic	(2) Serious	(3) Marginal	(4) Negligible
(A) Frequent	High	High	High	Medium
(B) Probable	High	High	Medium	Medium
(C) Occasional	High	Medium	Medium	Low
(D) Remote	Medium	Medium	Low	Low
(E) Improbable	Low	Low	Low	Low

SAFETY RISK LEVEL CATEGORIES	
Safety Risk Index	Criteria by Index
High	<i>Unacceptable – Action Required:</i> Safety risk must be mitigated or eliminated.
Medium	<i>Undesirable – Management Decision:</i> Executive management must decide whether to accept safety risk with monitoring or require additional action.
Low	<i>Acceptable with Review:</i> Safety risk is acceptable pending management review.