SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

METRO RAIL SYSTEM

PRELIMINARY HAZARD ANALYSIS

WBS 06

September 1985

Prepared by

BOOZ·ALLEN & HAMILTON Inc.
Transportation Consulting Division
523 West Sixth Street, Suite 502
Los Angeles, California 90014

ABSTRACT

This document presents the SCRTD Metro Rail Preliminary Hazard Analysis (PHA) performed as part of the Metro Rail Safety and System Assurance Program. The PHA analyzes potentially hazardous conditions that could affect the safe operation of the Metro Rail System. The PHA is a dynamic document to be updated throughout the program and to be used as the basis for performing other safety-related activities and analyses. The initial PHA was performed by Abacus Enterprises Ltd. as part of its FY 1984 subcontract to Booz, Allen & Hamilton Inc. At the end of the final design phase, the PHA has been updated to reflect the SCRTD System Design Criteria and Standards

T A B L E O F C O N T E N T S

1.0 INTRODUCTION

1.0 INTRODUCTION

This document presents the SCRTD Metro Rail Preliminary Hazard Analysis (PHA). The PHA was performed as part of a comprehensive Metro Rail Safety and System Assurance Program. The program defines an integrated set of safety-related activities and analyses directed towards achieving established Metro Rail safety criteria.* The remainder of this chapter presents background information on the PHA.

1.1 Purpose

The overall purpose of the PHA is to help the SCRTD design a safe and effective rail rapid transit system. Specifically, the PHA addresses potentially hazardous conditions that could affect the safe operation of the Metro Rail System. Identification and analysis of hazards during the design phase has enabled the SCRTD to:

- Design a system that eliminates or mitigates potential hazards and their associated causes and effects
- Document the resolution of potential hazards
- Conduct more detailed hazard analyses and other safety evaluations
- Begin development of coordinated safety-related policies, programs, and procedures.

1.2 Objectives

There are five specific objectives of the PHA. They are to:

- Identify hazardous conditions, their causes, and triggering events that could affect the safe operation of the Metro Rail System

---

* Metro Rail System Design Criteria and Standards, Volume 1, Chapters 2, 3, 4 and 5.

- Identify the potential accidents and consequences (i.e., loss of life and/or injuries) associated with each hazardous condition

- Identify potential accident prevention measures

- Document the results in a clear, concise manner, facilitating resolution of identified hazardous conditions

- Provide a foundation for conducting other safety analyses, including more detailed subsystem, interface, and operating hazard analyses.

1.3 Scope

The PHA addresses broad, top-level hazards, covering all elements of the Metro Rail system. It includes hazards pertaining to the following Metro Rail elements:

- Ways and structures, including tunnels and track.

- Stations, including access and parking; entrances, mezzanines, and platforms; and vertical circulation (i.e., stairs, escalators, and elevators).

- Yards, shops, and facilities, including storage yard, transfer yard area, various maintenance shops, yard tower, and all other facilities.

- Passenger vehicle, including all vehicle subsystems such as body; interior; couplers, draft gear and draw bars; doors; heating, ventilation and air conditioning; lighting; auxiliary electrical; propulsion and braking control; trucks and suspension; and operator controls. (Note: Vehicle communications and ATC equipment are addressed in subsequent system elements.)

- Automatic train control, including wayside equipment, central control equipment, passenger vehicle ATC equipment, and yard equipment.

- Communications, including all voice communications equipment, closed circuit television (CCTV) system, and data transmission service.

- Power systems, including traction power substations, auxiliary power, and third rail.

- Fare collection, including all equipment (e.g., gates).

- Auxiliary vehicles, including diesel locomotive, hi-rail vehicle, mobile cranes, etc.

The PHA covers four types of hazards. They are:

- Fire/Life - Hazards resulting in accidents, injuries, and/or death due to fire, smoke, explosion, toxic gases, or panic due to these causes.

- Security - Hazards resulting in accidents, injuries, and/or death due to acts of crime, violence, and abuse against persons.

- System assurance - Hazards resulting in accidents, injuries, and/or death due to system unreliability, maintainability, and lack of quality assurance.

- General safety - Hazards resulting in accidents, injuries, and/or death due to system design, equipment, or operations.

The PHA primarily addresses those hazards unique to rapid rail transit equipment and operation. Occupational and industrial safety hazards common to all types of organizations and business environments are not the focus of the PHA. These hazards are addressed in Federal, state, and local occupational health and safety codes and regulations.

1.4 Approach

A "bottom-up" approach was employed in conducting the PHA. Bottom or lower-level events (i.e., hazards) were initially identified, followed by a determination of what effect the lower level events (i.e., hazards) would have on the total system. This approach is consistent with UMTA methodologies* for performing a PHA of fixed guideway transit systems.

---

* System Safety Analysis: A Description of the Formats and Methodologies for System Safety Analysis of Fixed Guideway Transit Systems; prepared by Booz, Allen & Hamilton for the Office of Safety and Product Qualification, Urban Mass Transportation Administration, 1981.

Four specific activities were performed. They were to:

- Identify hazards - For each system element, hazards likely to result in an accident and/or personal injury or death were identified.

- Assess hazards - Each hazard was then examined relative to potential causes and effects. Worst case consequences were identified and documented.

- Identify prevention measures - Measures for preventing the potential accident from occurring were identified, including design and/or procedural related solutions.

- Document findings - All hazards were organized and compiled according to system elements. They were documented in a consistent format and depth of analysis.

The above activities were performed using information on accidents that have occurred on other systems, PHAs of other transit properties, pertinent SCRTD documents, and sound engineering judgment.

1.5 Definitions

The following are definitions of key terms used throughout the PHA, as defined in the UMTA guidelines.

- Hazard - An immediate condition which could cause an accident involving personal injuries or death.

- Hazard Causes - Those events or conditions that contribute to the existence of the hazard.

- Triggering Events - Conditions that taken in combination with a hazard will almost certainly lead to an accident unless some corrective action is taken to prevent it.

- Potential Accident/Injuries - The anticipated "worst case" accident and injuries that are expected to occur if both the hazard and the triggering events are left uncorrected.

- Hazard Class - An index of the "worst case" potential consequences resulting from the hazard. Indices are as follows:

  - Category I (Catastrophic) - A hazard that may result in loss of life

- Category II (Critical) - A hazard that may result in severe injury, severe occupational illness, or major system damage

- Category III (Marginal) - A hazard that may result in minor injury, minor occupational illness, or minor system damage

- Category IV (Negligible) - A hazard that will not result in injury, occupational illness, or system damage.

- Prevention Measures - Actions that can be taken to prevent the potential accident from occurring.

- Resolution - Changes that are made relative to system design and/or operation to eliminate or control the hazard.

1.6 Update Process

This PHA is the initial safety analysis performed as part of the Metro Rail safety and system assurance program. It is a dynamic document designed to be updated throughout the program and to be used as the basis for performing other safety-related activities and analyses.

The document is to be updated by the:

- Addition of other hazards. Other top-level hazards identified throughout the Metro Rail development process should be documented as part of the PHA.

- Documentation of hazard resolution. Action taken to resolve each hazard should be recorded in Section D of the appropriate hazard form.

All updates to the PHA must be processed through the Office of Safety and System Assurance, Systems Design and Analysis Department.

This September 1985 version of the PHA has been updated to reflect hazard resolutions as contained in the SCRTD Metro Rail Project System Design Criteria & Standards (SDCS), Volumes 1 through 5.

1.7 Report Organization

The remainder of this report contains PHA forms organized in the following chapters:

- Chapter 2.0 Ways and Structures
- Chapter 3.0 Station
- Chapter 4.0 Yards, Shops and Facilities
- Chapter 5.0 Passenger Vehicle
- Chapter 6.0 Automatic Train Control System
- Chapter 7.0 Communication System
- Chapter 8.0 Power System
- Chapter 9.0 Fare Collection System
- Chapter 10.0 Auxiliary Vehicles.

Each chapter is organized by sequentially numbered subsystems pertaining to each chapter heading. In the beginning of each chapter is a summary of hazards analyzed in the chapter.

1.8 Hazard Numbering Scheme

All hazards are numbered according to the following three digit format:

- Chapter number (i.e., 1 through 10)
- Subsystem number (i.e., 1, 2, 3, etc.)
- Subsystem hazard number (i.e., 1, 2, 3, etc.).

2.0 WAYS AND STRUCTURES

SUMMARY OF WAYS AND STRUCTURES HAZARDS

Subsystem	Hazard	Type: Fire/ Life	Security	System Assurance	General Safety
1. Tunnels	1. Fire/Smoke in tunnels	X			
	2. Intrusion of toxic/flammable gases	X			
	3. Intrusion of flammable/ combustible liquids	X			
	4. Unauthorized intruder		X		X
	5. Structural deficiencies	X		X	
	6. Poor tunnel lighting	X			X
	7. Serious flooding	X			X
2. Track	1. Structural deficiency/ excessive deterioration			X	
	2. Workmen on tracks During Operating Hours				X

HAZARD NUMBER: 2.1.1

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Fire/Smoke in Tunnel

3. Causes(s):

- Ignition of flammable/combustible liquids or gases
- Train collision/fire
- Electrical fire
- Debris fire.

4. Triggering Events:

- Passenger-loaded train enters area filled with fire/smoke. Passenger evacuation required.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to patrons as they are exposed to fire and smoke.

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Establish procedures for prompt and safe evacuation and safe train operations during hazard
- Provide procedure training to all participating parties (i.e., fire, police, etc.).

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for fire protection systems including protective signaling systems (Vol. 1, 2.3.6.1), a standpipe and hose system (SDCS Vol. 1, 2.3.6.2) and fire extinguishers (SDCS Vol. 1, 2.3.6.3)

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for fire/security subsystems including automatic fire detection, alarm and supervision (SDCS Vol. 1, 2.7.9.1.1), fixed extinguishment equipment actuation, alarm, and supervision (SDCS Vol. 1, 2.7.9.1.2), emergency management panels (SDCS Vol. 1, 2.7.9.1.3), and public address system supervision (SDCS Vol. 2, 2.7.9.1.4)

- Development of an Emergency Preparedness Plan (EPP) (SDCS Vol. 1, 2.6.1.1)

- Provision for emergency tunnel egress (SDCS Vol. 1, 2.3.4.1) and emergency access (SDCS Vol. 1, 2.3.4.8)

- Provision for emergency communications including emergency telephones (SDCS Vol. 1, 2.3.7.1), Fire Department tactical communications (SDCS Vol. 1, 2.3.7.3) and command post locations (SDCS Vol. 1, 2.3.7.4)

- Development of a Public Emergency Personnel Training Program (SDCS Vol. 1, 2.9.2.2) and an Employee Training Program (SDCS Vol. 1, 2.9.2.3).

HAZARD NUMBER: 2.1.2

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Intrusion of Toxic or Flammable Gases

3. Causes(s):

- HAZMAT gas accident near station entrance or air ducts
- Hydrogen gas or other hazardous gases released from battery storage or similar ancillary rooms
- Natural gas intrusion

4. Triggering Events:

- Malfunction/failure of emergency ventilation fans
- Short circuit/spark in tunnel

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to contaminated air, fire or smoke

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Conduct periodic inspection and maintenance of ventilation system
- Provide procedures for safe and prompt evacuation and safe train operations during hazard

D. RESOLUTION: ACCOMPLISHED BY:

- Installation of emergency ventilation system to control smoke and fire gas hazards (SDCS, Vol. 1, 2.3.5.2.1)
- Tunnel liner requirements in gas areas (SDCS Vol. 1, 2.3.2.1.3)

HAZARD NUMBER: 2.1.2 (continued)

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

D. RESOLUTION: ACCOMPLISHED BY:

- Underground trainways designed to preclude flamable and combustible liquid intrusion (SDCS Vol. 1, 2.3.2.3)
- Installation of automatic gas sensors in tunnels, capable of detecting concentration of any gas which may become dangerous due to toxicity or explosion hazard (SDCS, Vol. 4, 8.5.1)
- Development of an Emergency Preparedness Plan (EPP) containing emergency procedures (SDCS, Vol. 1, 2.6.1.1).

HAZARD NUMBER: 2.1.3

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Intrusion of Flammable//Combustible Liquids

3. Causes(s):

- HAZMAT liquid spill or leakage from service stations, storage tanks or pipes near system.

4. Triggering Events:

- Spark from passing train
- Electrical short circuit in tunnel
- Inadequate drainage.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to explosion, fire and smoke.

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Provide adequate drainage capacity
- Conduct periodic inspection and maintenance of drainage system
- Establish procedure for prompt and safe evacuation and safe train operation during hazard.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for fire protection systems including protective signaling systems (SDCS, Vol. 1, 2.3.6.1), a standpipe and hose system (SDCS Vol. 1, 2.3.6.2) and fire extinguishers (SDCS Vol. 1, 2.3.6.3)

HAZARD NUMBER: 2.1.3 (continued)

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for underground trainway protection against flammable and combustible liquid intrusion including service station drainage requirements (SDCS, Vol. 1, 2.3.2.3.6) and adequate storage of underground tanks containing flammable or combustible liquids (SDCS, Vol. 1, 2.3.2.3.3; 2.3.2.3.4)

- Development of an Emergency Preparedeness Plan (EPP) (SDCS, Vol. 1, 2.6.1.1)

HAZARD NUMBER: 2.1.4

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

A. HAZARD IDENTIFICATION

1. Type: Security/General Safety

2. Description: Unauthorized Intruder

3. Causes(s):

- Absence of proper barriers, signage, and alarms prohibiting unauthorized tunnel intrusion.

4. Triggering Events:

- Approaching train.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to intruder hit by train
- Electrocution by third rail.

C. PREVENTION MEASURES

- Install automatic closing gates at ends of platforms
- Provide proper signage on gates prohibiting unauthorized access
- Provide gate alarm, warning Operations Control Center of intrusion
- Provide CCTV coverage of platform ends.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for audible alarms to alert control personnel of emergency situations (SDCS, Vol. 1, 3.8.4)
- Provision for CCTV coverage of platform edges (SDCS, Vol. 1, 3.4.1)
- Provision for signing and graphics in the station located in a manner which enhances the safety and convenience of patrons (SDCS, Vol. 1, 3.3.2)

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for gates at the end of each platform that shall swing in the direction of access to the platform (SDCS, Vol. 1, 2.2.5.3.12)
- Non-public areas are secured from unauthorized entry (SDCS, Vol. 1, 4.3.4.2)
- Station entrances secured and alarmed during non-revenue hours (SDCS, Vol. 1, 4.3.4.1.

HAZARD NUMBER: 2.1.5

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Structural Deficiencies

3. Causes(s):

- Design/engineering deficiency
- Poor construction quality control/low quality materials
- Improper Maintenance and Inspection Procedures.

4. Triggering Events:

- Sizeable earthquake affecting tunnel area in question
- Vibration from trains

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Tunnel walls collapse on train and crush passengers to death
- Passengers panic during evacuation from train obstructed by collapsed tunnel and incur injuries when falling, tripping, and trampling one another.

C. PREVENTION MEASURES

- Conform to applicable structural codes
- Conduct periodic safety/quality assurance inspections during construction
- Conduct periodic inspection of tunnel wall integrity after revenue start-up.

D. RESOLUTION: ACCOMPLISHED BY:

- Structures designed to resist earthquake forces (SDCS, Vol. 2, 2.3.3) and other requirements (SDCS, Vol. 2, 2.4 (Underground Structures), 2.5 (Portals), 2.8 (Reinforced and Pre-stressed concrete), 2.9 (Structual Steel), 2.10 (Support and Underpinning).

HAZARD NUMBER: 2.1.5 (continued)

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

D. RESOLUTION: ACCOMPLISHED BY:

- Tunnel conformance to applicable structural codes (SDCS, Vol. 2, 2.2.1; 2.2.2)

- Establishment of SCRTD reliability requirements including a reliability program (SDCS, Vol. 1, 5.2.1), quantitative design requirements (SDCS, Vol. 1, 5.2.2), warranties (SDCS, Vol. 1, 5.2.3), reliability data (SDCS, Vol. 1, 5.2.4) and requirements for system design life and environment (SDCS, Vol. 1, 5.2.5)

- Establishment of SCRTD maintainability requirements for the transit system including a maintenance program (SDCS, Vol. 1, 5.3.1), quantitative and qualitative design requirements (SDCS, Vol. 2, 5.3.2), maintainability data (SDCS, Vol. 1, 5.3.3), manuals (SDCS, Vol.1, 5.3.4), training (SDCS, Vol. 1, 5.3.5), and human factors considerations (SDCS, Vol. 1, 5.3.6)

- Establishment of SCRTD quality assurance criteria including a quality assurance program (SDCS, Vol. 1, 5.4.1) warranties (SDCS, Vol. 1, 5.4.2) and quality program content (SDCS, Vol. 1, 5.4.3).

HAZARD NUMBER: 2.1.6

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Poor Tunnel Lighting

3. Causes(s):

- Inadequate design of tunnel lighting arrangement
- Bulbs burn out and not replaced fast enough
- Power failure.

4. Triggering Events:

- Workman, patron, or large object on track undetected by ATP and train operator
- Emergency evacuation from train in tunnel

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life resulting from train hitting the individual on the track
- Loss of life or severe injuries as train derails after it hits object on track
- Injuries to individuals slipping, falling or tripping while working in tunnel or during evacuation from train through the tunnel.

C. PREVENTION MEASURES

- Provide adequate tunnel lighting
- Conduct periodic light and tunnel inspections
- Provide redundant circuits and feeders in the event of power failure
- Provide back-up emergency power.

HAZARD NUMBER: 2.1.6 (Continued)

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for adequate lighting for the general tunnel area, tunnel walkways and trackway crossover locations (SDCS, Vol. 4, 4.19.2)
- Provision for available emergency power at certain station locations for critical functions during power failures (SDCS, Vol. 1, 3.7.2)
- Provision for tunnel lighting to be fed from two substations so that the loss of a single substation or tunnel feeder should not interrupt the functioning of the lighting system (SDCS, Vol. 2, 3.7.3).

HAZARD NUMBER: 2.1.7

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

A. HAZARD IDENTIFICATION

1. Type: Fire/Life and General Safety

2. Description: Serious Flooding

3. Causes(s):

- Poorly designed drainage system
- Improper maintenance - clogged drains, etc.

4. Triggering Events:

- Excessive rain
- Fire main failure or breakage.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Minor to severe injuries to patrons who panic, trip and fall while evacuating from stalled trains in tunnels
- Loss of life or injuries due to electrical shock while evacuating tunnel.

C. PREVENTION MEASURES

- Conduct proper maintenance of drainage system
- Provide mechanism to detect pumping station malfunction
- Establish procedure to cut off main line power in times of tunnel evacuation due to flooding
- Provide adequate drainage capacity and waterproofing
- Design locomotive to operate in several feet of water
- Conduct periodic inspection of fire mains and standpipes.

HAZARD NUMBER: 2.1.7 (Continued)

SYSTEM: Ways/Structures SUBSYSTEM: Tunnels

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for adequate drainage capacity and waterproofing (SDCS, Vol. 2, 1.10.1, 1.10.2, 1.10.3, 1.10.4, 1.10.11, 2.8.6/Vol. 4, 8.9.1)
- Provision for alarm activation at Central Control if tunnel water level continues to rise after standby pump is activated (SDCS, Vol. 4, 8.9.1, 8.9.2)
- Provision for conducting proper maintenance of the drainage system (SDCS, Vol. 4, 8.9.1)
- Provision to permit interruption in third-rail power by means of emergency trip stations located at designated intervals throughout the system (SDCS, Vol. 5, 4.5.4).

HAZARD NUMBER: 2.2.1

SYSTEM: Ways/Structures SUBSYSTEM: Track

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Structural Track Deficiency or Excessive Deterioration

3. Causes(s):

- Track design or installation deficiency
- Inadequate inspection and maintenance
- Fatigue.

4. Triggering Events:

- Trains passing over deficient area.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Severe injuries or deaths due to train derailment.

C. PREVENTION MEASURES

- Ensure proper design, installation and inspection of tracks prior to revenue service

- Conduct periodic inspection and repair of track..

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD reliability requirements including a reliability program (SDCS, Vol. 1, 5.2.1), quantitative design requirements (SDCS, Vol. 1, 5.2.2), warranties (SDCS, Vol. 1, 5.2.3), reliability data (SDCS Vol. 1, 5.2.4), and requirements for system design life and environment (SDCS, Vol. 1, 5.2.5)

- Establishment of SCRTD maintainability requirements for the transit system including a maintenance program (SCRTD Vol. 1, 5.3.1), quantitative and qualitative design requirements (SDCS, Vol. 1, 5.3.2), maintainability data (SDCS, Vol. 1, 5.3.3), manuals (SDCS, Vol. 1, 5.3.4) and human factors considerations (SDCS, Vol. 1, 5.3.6)

HAZARD NUMBER: 2.2.1 (continued)

SYSTEM: Ways/Structures SUBSYSTEM: Track

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD quality assurance criteria including a quality assurance program (SDCS, Vol. 1, 5.4.1), warranties (SDCS, Vol. 1 5.4.2) and quality program content (SDCS, Vol. 1, 5.4.3).

HAZARD NUMBER: 2.2.2

SYSTEM: Ways/Structures SUBSYSTEM: Track

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Workmen on Tracks During Operating Hours

3. Causes(s):

- Repair/maintenance tasks.

4. Triggering Events:

- On-coming trains.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to train hitting individual
- Loss of life or severe injuries due to third rail shock.

C. PREVENTION MEASURES

- Establish restrictive train operating rules when workmen are on tracks and work rules for workmen
- Provide protective coverings for third rail - conform to applicable fire/life safety criteria
- Provide adequate walkway for workmen
- Establish procedures for de-energizing third rail when workmen are in tunnel.

D. RESOLUTION: ACCOMPLISHED BY:

- Installation of rigid third rail coverboards to reduce the possibility of employees inadvertently contacting the third rail (SDCS, Vol. 1, 3.7.4)
- Provision for a walkway adjacent to one side of every track to provide access to the track area for maintenance personnel (SDCS, Vol. 2, 1.7.10)

HAZARD NUMBER: 2.2.2 (continued)

SYSTEM: Ways/Structures SUBSYSTEM: Track

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for traction power to be removed prior to participating agency personnel operating on the trainway (SDCS, Vol. 1, 2.6.11.1.2).

3.0 STATION

SUMMARY OF STATION HAZARDS

Subsystem	Hazard	Type: Fire/Life	Security	System Assurance	General Safety
1. Station-Wide	1. Fire/smoke in station	X			
	2. Intrusion of toxic/flammable gases	X			
	3. Intrusion of flammable/combustible liquids	X			
	4. Structural deficiencies			X	
	5. Unauthorized intrusion/vandalism during non-operating hours		X		X
	6. Criminal acts against system patrons/employees		X		X
	7. Improperly insulated, grounded, or covered electrical wiring	X			X
	8. Obstacles with sharp protruding edges				X
	9. Slippery surface				X

SUMMARY OF STATION HAZARDS
(continued)

Subsystem		Hazard	Type: Fire/ Life	Security	System Assurance	General Safety
2. Access/ Parking	1.	Persons walking in front of moving automobiles				X
	2.	Inadequate parking for handicapped				X
3. Entrances, Mezzanines and Platforms	1.	Persons standing too close to edge of platform				X
	2.	Persons intrude upon tracks from platform				X
	3.	Excessive gap between platform and train				X
	4.	Persons sitting or placing objects on top of parapet				X
4. Vertical Circulation	1.	Failure of escalator to stop or reverse in times of emergencies	X			
	2.	Escalator/ elevator malfunction or failure			X	

SUMMARY OF STATION HAZARDS
(continued)

Subsystem	Hazard	Type: Fire/ Life	Security	System Assurance	General Safety
	3. Person gets clothing caught on moving escalator				X
	4. Improper physical dimensions of stairs, elevators, escalators, or wheelchair ramps	X			
	5. Inadequate Lighting		X		X
	6. Excessive gap between floor and pedestrian handrails				X

HAZARD NUMBER: 3.1.1

SYSTEM: Stations SUBSYSTEM: Station-Wide

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Fire/Smoke in Station

3. Causes(s):

- Train fire
- Electrical fire
- Debris fire
- Ignition of flammable/combustible gases or liquids.

4. Triggering Events:

- Patrons in station.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or injuries due to patron exposure to fire and smoke.

C. PREVENTION MEASURES

- Conform to applicable Fire/Life Safety Criteria
- Establish station evacuation procedures
- Provide evacuation training to all participating parties (i.e., fire, police, etc.)
- Establish procedure for safe train operations during hazard.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for emergency ventilation (SDCS Vol. 1, 2.2.3.1)
- Installation of station fire protection systems including protective signaling systems (SDCS Vol. 1, 2.2.6.1), automatic fire protection systems (SDCS Vol. 1, 2.2.6.2), standpipe and hose systems (SDCS Vol. 1, 2.2.6.3) and fire extinguishers (SDCS Vol. 1, 2.2.6.4)

SYSTEM: Stations SUBSYSTEM: Station-Wide

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for station emergency communications including an emergency telephone system (SDCS Vol. 3, 6.3.1), fire phones (SDCS Vol. 3, 6.3.2),patron assistance intercom (SDCS Vol. 3, 6.3.3) and public address system (SDCS Vol. 3, 6.3.7)
- Development of an Emergency Preparedness Plan (EPP) (SDCS Vol. 1, 2.6.1.1)
- Development of a Public Emergency Personnel Training Program (SDCS Vol. 1, 2.9.2.2) and an Employee Training Program (SDCS Vol. 1, 2.9.2.3)
- Installation of automatic spot-type heat sensing and smoke detectors in station areas (SDCS Vol. 4, 8.6.2).

HAZARD NUMBER: 3.1.2

SYSTEM: Stations SUBSYSTEM: Station-Wide

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Intrusion of Toxic/Flammable Gases

3. Causes(s):

- HAZMAT gas accident near station entrance or air ducts
- Hydrogen gas or other hazardous gases released from battery storage or similar ancillary rooms.

4. Triggering Events:

- Malfunction/failure of emergency ventilation fans.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to contaminated air, fire or smoke.

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Conduct periodic inspection and maintenance of ventilation system
- Provide procedure to safely evacuate station.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for normal and emergency ventilation (SDCS Vol. 1, 2.2.3.1.1/Vol. 1, 2.2.3.1.2)
- Installation of station fire protection systems including signaling systems (SDCS Vol. 1, 2.2.6.1), automatic fire protection systems (SDCS Vol. 2.2.6.2), standpipe and hose systems (SDCS Vol. 1, 2.2.6.3) and fire extinguishers (Vol. 1, 2.2.6.4)

HAZARD NUMBER: 3.1.2 (continued)

SYSTEM: Stations SUBSYSTEM: Station-Wide

D. RESOLUTION: ACCOMPLISHED BY:

- Development of an Emergency Preparedness Plan (EPP) (SDCS Vol. 1, 2.6.1.1)
- Development of a program of testing and inspection of fire/life safety related equipment (SDCS Vol. 1, 2.9.1.3)
- Provision for station emergency communications including an emergency telephone system (SDCS Vol. 3, 6.3.1), fire phones (Vol. 3, 6.3.2), patron assistance intercom (SDCS Vol. 3, 6.3.3) and public address system (SDCS Vol. 3, 6.3.7).

HAZARD NUMBER: 3.1.3

SYSTEM: Stations SUBSYSTEM: Station-Wide

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Intrusion of Flammable/Combustible Liquids

3. Causes(s):

- HAZMAT liquid spill or leakage from nearby service stations, storage tanks or pipes.

4. Triggering Events:

- Inadequate drainage
- Spark from passing train.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to explosion, fire and smoke.

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Provide adequate drainage capacity
- Conduct periodic inspection and maintenance of drainage system
- Establish procedure to safely evacuate station.

D. RESOLUTION: ACCOMPLISHED BY:

- Installation of station fire protection systems including protective signaling systems (SDCS Vol. 1, 2.2.6.1), automatic fire protection systems (SDCS Vol. 1, 2.2.6.2), standpipe and hose systems (SDCS Vol. 1, 2.2.6.3) and fire extinguishers (SDCS Vol. 1, 2.2.6.4)
- Provisions for drainage in station entrances (SDCS Vol. 3, 15.7.1), mezzanine (SDCS Vol. 3, 15.7.2), platform (SDCS Vol. 3, 15.7.3) and roof areas (SDCS Vol. 3, 15.7.4)

HAZARD NUMBER: 3.1.2 (continued)

SYSTEM: Stations SUBSYSTEM: Station-Wide

D. RESOLUTION: ACCOMPLISHED BY:

- Development of an Emergency Preparedness Plan (EPP) (SDCS Vol. 1, 2.6.1.1).

HAZARD NUMBER: 3.1.4

SYSTEM: Stations SUBSYSTEM: Station-Wide

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Structural Deficiencies in Entrances, Mezzanines, Platforms and Stairs

3. Causes(s):

- Design/engineering deficiency
- Poor construction quality control
- Use of low quality construction materials.

4. Triggering Events:

- Sizeable earthquake affecting deficient area during system operation hours
- Vibration caused by trains, surface traffic and other related causes.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to patrons crushed by collapsed mezzanines, platforms or stairs.

C. PREVENTION MEASURES

- Conform to applicable structural codes
- Conduct quality assurance inspections of station structural integrity prior to revenue service.

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD reliability requirements including a reliability program (SDCS Vol. 1, 5.2.1), quantitative design requirements (SDCS Vol. 1, 5.2.2) warranties (SDCS Vol. 1, 5.2.3), reliability data (SDCS Vol. 1, 5.2.4), and requirements for system design life and environment (SDCS Vol. 1, 5.2.5)

SYSTEM: Stations SUBSYSTEM: Station-Wide

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD maintainability requirements for the transit system including an maintenance program (SDCS Vol. 1, 5.3.1) quantitative and qualitative design requirements (SDCS Vol. 1, 5.3.2), maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5) and human factors consideration (SDCS Vol. 1, 5.3.6)

- Establishment of SCRTD quality assurance requirements including a quality assurance program (SDCS Vol. 1, 5.4.1), warranties (SDCS Vol. 1, 5.4.2) and quality program content (SDCS Vol. 1, 5.4.3).

HAZARD NUMBER: 3.1.5

SYSTEM: Stations SUBSYSTEM: Station-Wide

A. HAZARD IDENTIFICATION

1. Type: Security/General Safety

2. Description: Unauthorized Intrusion/Vandalism During Non-Operating Hours

3. Causes(s):

- Absence of effective gates/fences
- Absence of proper security surveillance.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Intruders (children, vandals, etc.) injure themselves while playing in empty station
- Injuries related to damaged/vandalized safety related equipment.

C. PREVENTION MEASURES

- Provide effective barriers or gates preventing unauthorized station entry during non-operating hours
- Maintain security surveillance during non-operating hours (e.g., guards or CCTV).

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for all station entrances to be locked during non-revenue hours and to be equipped with an alarm signal audible at the entrance itself and directly connected to the Central Control Facility (SDCS Vol. 3, 18.9)
- Provision for closed circuit television as a means of maintaining surveillance over station areas from the Central Control facilities (SDCS Vol. 3, 6.3.9).

HAZARD NUMBER: 3.1.6

SYSTEM: Stations SUBSYSTEM: Station-Wide

A. HAZARD IDENTIFICATION

1. Type: Security/General Safety

2. Description: Criminal Acts Against Employees and Patrons (i.e., Robbery, Assault, etc.)

3. Causes(s):

- Failure to provide station security personnel
- Inadequate coverage of CCTV system
- Unlocked rooms (e.g., restrooms) or other hidden areas
- Inadequate lighting.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Severe physical injuries and psychological effects due to being assaulted
- Loss of personal property.

C. PREVENTION MEASURES

- Provide station security personnel
- Provide adequate CCTV coverage
- Restrict access to station rooms such as restroom
- Provide emergency telephones for patron use
- Provide proper lighting throughout station and in parking lots.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for closed circuit television as a means of maintaining surveillance over station areas from the Central Control Facility (SDCS Vol. 3, 6.3.9)

HAZARD NUMBER: 3.1.6 (continued)

SYSTEM: Stations SUBSYSTEM: Station-Wide

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for all ancillary spaces within the station to be protected by locks and intrusion alarms (SDCS Vol. 3, 18.9 and Vol. 1, 4.9)
- Installation of patron assistance and emergency phones (SDCS Vol. 1, 4.4.3)
- Provision for the illumination of station sites and parking lots during hours of darkness and reduced visibility (SDCS Vol. 1, 4.3.1)
- Provision for the Metro Rail station lighting systems to provide the intended quality and quantity of light required for each individual area and to sufficiently define the areas of potential hazard (SDCS Vol. 3, 12.5)
- Provision for roving security personnel and Metro Rail Transit Police in stations (SDCS Vol. 3, 18.4.1 and Vol. 1, 4.10.1).

HAZARD NUMBER: 3.1.7

SYSTEM: Stations SUBSYSTEM: Station-Wide

A. HAZARD IDENTIFICATION

1. Type: Fire/Life and General Safety

2. Description: Improperly Insulated, Grounded, or Covered Electrical Wiring

3. Causes(s):

- Design or installation oversight
- Vandalism
- Negligence of workmen/failure to replace protective coverings.

4. Triggering Events:

- Unauthorized intrusion into rooms containing electrical wiring.

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Minor to severe shock to individuals who accidentally touch exposed wiring.

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Restrict access of unauthorized individuals into rooms (e.g., auxiliary electrical) and areas containing station wiring and control panels
- Provide proper maintenance training relative to electrical systems
- Comply with applicable wiring codes and standards.

D. RESOLUTION: ACCOMPLISHED BY:

- Conformance of electrical equipment and wiring materials and installations within stations to National Electric Code (NEC) requirements (SDCS Vol. 1, 2.2.4.1)

HAZARD NUMBER: 3.1.7 (continued)

SYSTEM: Stations SUBSYSTEM: Station-Wide

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for non-public areas to be restricted (SDCS Vol. 1, 4.3.4.2) (Station Closure)

- Development of training programs including a Public Emergency Personnel Training Program (SDCS Vol. 1, 2.9.2.2) and an Employee Training Program to educate and familiarize employees and emergency personnel with the transit systems fire/life safety equipment and operations (SDCS Vol 1, 2.9.2.3).

HAZARD NUMBER: 3.1.8

SYSTEM: Stations SUBSYSTEM: Station-Wide

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Obstacles With Sharp Protruding Edges in or Adjacent to Station Walkways

3. Causes(s):

- Design oversight
- Vandalism.

4. Triggering Events:

- Patron walks on or near sharp edge.

B. POTENTIAL ACCIDENT/INJURY (Classification III)

- Minor injuries to patrons who accidentally hit a sharp edge.

C. PREVENTION MEASURES

- Eliminate all sharp protruding edges in or adjacent to pedestrian walkways in station
- Repair all sharp edges due to vandalism.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for finishing all surfaces exposed to the public in such a manner that the results of casual vandalism can be readily removed with normal maintenance techniques (SDCS Vol. 3, 13.2.4)
- Provision for the use of materials and details that do not encourage vandalism, that are difficult to deface, damage, or remove (SDCS Vol. 3, 13.2.4)
- Provision to eliminate hazard from dislodgement in station public areas due to temperature change, vibration, wind, seismic forces, aging, or other causes, by using proper attachments and adequate bond strength (SDCS Vol. 3, 13.2.1).

HAZARD NUMBER: 3.1.9

SYSTEM: Stations SUBSYSTEM: Station-Wide

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Slippery Surface

3. Causes(s):

- Use of surface material with low friction coefficient
- Oil, food, or other slippery substances on surface.

4. Triggering Events:

- Cars speeding in parking lot/access roads
- Patrons rushing in station.

B. POTENTIAL ACCIDENT/INJURY (Classification III)

- Injuries due to auto accidents
- Injuries due to slipping and falling.

C. PREVENTION MEASURES

- Use surface materials with high friction coefficients
- Conduct preventive maintenance in parking lot and in stations
- Establish and enforce proper safe speed limits for autos in parking lots and access roads.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for all station walking surfaces including public areas and auxiliary spaces to be constructed of slip-resistant materials to reduce slipping, tripping, and falling potential (SDCS Vol. 1, 3.3.2)
- Provision for clearly defined, well-marked crosswalks and sidewalks with slip-resistant surfaces (SDCS Vol. 1, 3.3.1)
- Provision for safe speed limits on SCRTD streets (SDCS Vol. 2, 1.14.7)

HAZARD NUMBER: 3.2.1

SYSTEM: Stations SUBSYSTEM: Access/Parking

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Persons Walking in Front of Moving Automobiles

3. Causes(s): Absence of Dedicated Pedestrian Walkways

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Loss of life or injuries to the pedestrians who are hit by vehicles traveling in the parking lot or station access roads.

C. PREVENTION MEASURES

- Provide and enforce the use of dedicated pedestrian walkways in station parking lots and across access roads.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for emphasized pedestrian crosswalks with a strongly contrasting change in paving material, surface texture, or color and with good visibility for both pedestrians and drivers (SDCS Vol. 3, 19.4.2)

- Provision for arrangement of parking areas to minimize the number of pedestrian crossings of streets and access roads which carry vehicular traffic (SDCS Vol. 3, 19.4.2).

HAZARD NUMBER: 3.2.2

SYSTEM: Stations SUBSYSTEM: Access/Parking

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Inadequate Parking for Handicapped (i.e., Spaces Too Far From Entrance)

3. Causes(s): Design oversight

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Minor to serious injuries to handicapped who are hit by a car as they attempt to get to the station entrance.

C. PREVENTION MEASURES

- Provide convenient parking for handicapped adjacent to station entrances
- Enforce the policy that these spaces are to be used only by handicapped.

D. RESOLUTION: ACCOMPLISHED BY:

- Provisions for special space in the public parking area for the handicapped at the closest point to the station entrance to minimize their exposure to traffic (SDCS Vol. 1, 3.3.1.D).

HAZARD NUMBER: 3.3.1

SYSTEM: Stations SUBSYSTEM: Entrances, Mezzanines & Platforms

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Persons Standing Too Close to Edge of Platform

3. Causes(s):

- Blind or visually impaired cannot distinguish edge from rest of platform
- Excessive platform crowding
- Lack of device to warn patrons of approaching train.

4. Triggering Events:

- Train entering station.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to individuals who get hit by passing train.

C. PREVENTION MEASURES

- Provide non-slip platform edge material, different in color and texture from the main platform area
- Establish procedure to control access to platforms after special events
- Monitor (via CCTV) platform crowd levels
- Provide device/mechanism that warns all patrons of trains approaching station (i.e., flashing lights, signs, announcements, chimes, etc.).

HAZARD NUMBER: 3.3.1 (continued)

SYSTEM: Stations SUBSYSTEM: Entrances, Mezzanines & Platforms

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the platform edge material to be slip-resistant and different in color and texture from the main platform area (SDCS Vol. 1, 3.3.2)
- Provision for, as a minimum, CCTV coverage of platform edges to monitor the station and platform to prevent overcrowding (SDCS Vol. 1, 3.4.1)
- Provision for a visual and audible vehicle approach system to alert patrons of the impending arrival of a train (SDCS Vol. 1, 3.3.6)
- Provision for Central Control use of a public address system to make general announcements (SDCS Vol. 3, 6.3.7)
- Provision for remote operation from Central Control to permit control of inbound patrons passing through the fare collection gates (SDCS Vol. 1, 3.3.5).

HAZARD NUMBER: 3.3.2

SYSTEM: Stations SUBSYSTEM: Entrances, Mezzanines & Platforms

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Persons Intrude Upon Tracks From Platform

3. Causes(s):

- Blind or visually impaired person walks off platform
- Patron pushed or shoved onto tracks due to excessive crowding
- Irrational patron jumps onto tracks
- Platform slopes toward tracks, causing carriage/wheelchair to roll onto tracks.

4. Triggering Events:

- Train enters station at the same time individual is on tracks.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to train impact.

C. PREVENTION MEASURES

- Provide discernible platform edge for blind or visually impaired
- Establish procedure to stop on-coming trains in the event of hazard, when possible
- Monitor platform and tracks via CCTV
- Provide under platform refuge area
- Provide emergency call phones on platform which are conveniently available

SYSTEM: Stations SUBSYSTEM: Entrances, Mezzanines & Platforms

C. PREVENTION MEASURES

- Design and construct platforms that slope slightly away from tracks
- Provide proper gates at end of platform.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for a narrow tactile strip which contrasts with the platform edge and the main platform area (SDCS Vol. 1, 3.3.2)
- Provision for the train operators to initiate train stopping at any time (SDCS Vol. 5, 2.3.5.I)
- Provision for the use of CCTV as a means of maintaining surveillance over station areas from the Central Control Facility (SDCS Vol. 3, 6.3.9)
- Provision for an underplatform refuge area (SDCS Vol. 1, 3.3.2.C.2)
- Provision for emergency and assistance phones located at each level in the station (SDCS Vol. 1, 3.4.3)
- Provision for a visual and audible vehicle approach system (SDCS Vol. 1, 3.3.6)
- Provision for gates at the end of each platform that shall swing in the direction of access to the platform (SDCS Vol. 1, 2.2.5.3.12).

HAZARD NUMBER: 3.3.3

SYSTEM: Stations SUBSYSTEM: Entrances, Mezzanines & Platforms

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Excessive Gap (Height or Width) Between Platform and Train

3. Causes:

- Design/construction oversight
- Absence of effective configuration coordination.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Minor to severe injuries to individuals who get their feet caught in the gap or who trip while entering or exiting train.

C. PREVENTION MEASURES

- Provide minimum gap between platforms and train doors
- Establish procedure for operator to visually check train from cab prior to departing station.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the platform design to be coordinated with the track layout and vehicle static and dynamic outline to provide an acceptable interface between the platform and vehicle (SDCS Vol. 1, 3.3.2).

HAZARD NUMBER: 3.3.4

SYSTEM: Stations SUBSYSTEM: Entrance, Mezzanines & Platforms

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Persons Sitting On or Placing Objects On Top of Parapet

3. Causes(s):

- Design of parapet surface promotes sitting or placement of objects.

4. Triggering Events:

- Sitting individual leans back too far or get accidentally pushed
- Individual accidentally pushes object.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Patron falls from elevated area to lower area resulting in minor to severe injuries or loss of life
- Injuries to individuals hit by objects falling from elevated areas.

C. PREVENTION MEASURES

- Provide barriers around elevated areas to reduce hazardous conditions
- Design parapet slope to lean away from lower level
- Provide signage prohibiting sitting or placing objects on top of parapet.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the screening of passarelles or pedestrian walkways over the trackway (SDCS Vol. 1, 3.3.2)

HAZARD NUMBER: 3.3.4 (continued)

SYSTEM: Stations SUBSYSTEM: Entrances, Mezzanines & Platforms

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the balustrade top be sloped away from the vertical circulation elements and visual openings to prevent objects being placed upon them (SDCS Vol. 1, 3.3.2)

- Provision for clear, legible, and well-illuminated signing and graphics located in a manner within the station which enhances the safety and convenience of patrons (SDCS Vol. 1, 3.3.2).

HAZARD NUMBER: 3.4.1

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Failure of Escalator to Stop or Reverse in Times of Emergencies

3. Causes(s):

- Station personnel panic (i.e., forget to stop or reverse escalators)
- Malfunction of escalator controls/design oversight.

4. Triggering Events:

- Station emergency (e.g., fire on platform) requiring immediate evacuation.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to passengers who are unable to evacuate stations in an expeditious manner and escape danger (i.e., fire).

C. PREVENTION MEASURES

- Establish procedure and training to ensure that proper emergency evacuation actions are performed in a timely manner
- Provide emergency controls for escalator
- Provide interlock between escalator controls and emergency alarms.

D. RESOLUTION: ACCOMPLISHED BY:

- Development of an Emergency Preparedness Plan (EPP) (SDCS Vol. 1, 2.6.1.1)
- Development of a Public Emergency Personnel Training Program (SDCS Vol. 1, 2.9.2.2) and an Employee Training Program (SDCS Vol. 1, 2.9.2.3)

HAZARD NUMBER: 3.4.1 (continued)

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for escalator emergency stop buttons at upper and lower landings (SDCS Vol. 4, 6.6.1)

- Provision for automatic safety devices that stop the escalator and activate an alarm (SDCS Vol. 4, 6.6.7).

HAZARD NUMBER: 3.4.2

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Escalator/Elevator Malfunction or Failure

3. Causes(s):

- Design oversight
- Improper installation/maintenance
- Power failure.

4. Triggering Events:

- Power failure.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Death or serious injury to patrons who cannot escape a station during a fire or smoke conditions
- Minor injuries to patrons as they fall when escalator or elevator stops or moves abruptly.

C. PREVENTION MEASURES

- Provide alternative vertical circulation elements for emergency exiting
- Provide preventive maintenance for escalators and elevators
- Provide emergency back-up power for elevators

D. RESOLUTION: ACCOMPLISHED BY:

- Sufficient exit lanes are provided to evacuate the station in 6 minutes or less (SDCS, Vol. 1, 2.2.5)

HAZARD NUMBER: 3.4.2 (continued)

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD maintainability requirements for the transit system including a maintenance program (SDCS Vol. 1, 5.3.1) quantitative and qualitative design requirements (SDCS Vol. 1, 5.3.2), maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5), and human factors considerations (SDCS Vol. 1, 5.3.6).

HAZARD NUMBER: 3.4.3

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Person Gets Clothing Caught On Moving Escalator

3. Causes(s):

- Design deficiency
- Patron negligence.

4. Triggering Events:

- Patron falls and/or gets clothing caught on escalator.

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Serious injuries due to continuously moving escalator.

C. PREVENTION MEASURES

- Provide emergency escalator controls for public use
- Ensure escalators are within the coverage of CCTV
- Conduct periodic inspection and maintenance of escalator combs.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for escalator emergency stop buttons at upper and lower landings (SDCS Vol. 4, 6.6.1)
- Provision for CCTV surveillance of entrance and exit points of escalator (SDCS Vol. 5, 3.11.1)
- Provision for automatic safety devices that stop the escalator and activate an alarm (SDCS Vol. 4, 6.6.7), including sensors to detect a limb or shoe caught in the combplate or by the handrail (SDCS Vol. 4, 6.6.7)

HAZARD NUMBER: 3.4.3 (continued)

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for escalator control from a set of start, stop, speed, and direction buttons located in the machine room control panel, escalator dock panels, and the Central Control Facility (SDCS Vol. 4, 6.6.6).

HAZARD NUMBER: 3.4.4

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Improper Physical Dimensions of Stairs, Elevators, Escalators or Wheelchair Ramps (i.e., Sloping, Riser Height, Width, Depth, and Hand-Rails and Inadequate Run-Off Space at Ends)

3. Causes(s): Design, and construction/installation oversight

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification III)

- Minor injuries to patrons, including visually impaired and handicapped, who slip, trip, or fall as a result of unsafe conditions.

C. PREVENTION MEASURES

- Design and construct safe stairs, elevators, escalators and wheelchair ramps in accordance with industry standards and in conformance with applicable building codes and Fire/Life Safety Criteria

- Establish and conduct quality assurance testing and inspection program for facilities prior to revenue service.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the design and construction of safe stairs and escalators in accordance with industry standards, applicable building codes and Fire/Life Safety Criteria (SDCS Vol. 1, 3.3.3; 3.3.4)

- Establishment of SCRTD quality assurance requirements for a quality assurance program (SDCS Vol. 1, 5.4.1), warranties (SDCS Vol. 1, 5.4.2) and quality program content (SDCS Vol. 1, 5.4.3).

HAZARD NUMBER: 3.4.5

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

A. HAZARD IDENTIFICATION

1. Type: Fire/Life and General Safety

2. Description: Inadequate Lighting on Stairs and Escalators

3. Causes(s):

- Design oversight
- Burnt out bulbs/hard to replace.

4. Triggering Events:

- Emergency evacuation.

B. POTENTIAL ACCIDENT/INJURY (Classification III)

- Minor injuries to patrons who trip and fall because of poor lighting.

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria regarding emergency lighting
- Provide adequate stair/escalator lighting for normal operations
- Establish maintenance program to replace burnt out bulbs as soon as possible
- Design bulb locations for easy maintenance.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for emergency lighting for stairs and escalators (SDCS Vol. 1, 2.2.5.5.5)
- Provision for escalators and stars to be lit to emphasize open circulation wells and transitional components (SDCS Vol. 3, 12.6.3)

HAZARD NUMBER: 3.4.5 (continued)

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD maintainability requirements including a maintenance program (SDCS Vol. 1, 5.3.1), quantitative and qualitative design requirements (SDCS Vol. 1, 5.3.2), maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5) and human factors considerations (SDCS Vol. 1, 5.3.6).

HAZARD NUMBER: 3.4.6

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Excessive Gap Between Floor and Pedestrian Hand-Rails

3. Causes(s):

- Design deficiency
- Improper installation.

4. Triggering Events:

- Children playing near pedestrian hand-rails.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to children who crawl under hand-rail and fall to lower level
- Minor injuries to individuals hit by objects rolling under hand-rail on upper level.

C. PREVENTION MEASURES

- Provide minimal gap between floor and pedestrian hand-rails.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for railings to extend to the floor and to comply with the requirements of the Life Safety Code NFPA-101 and the applicable local codes (SDCS Vol. 1, 3.3.2.G).

HAZARD NUMBER: 3.4.6

SYSTEM: Stations SUBSYSTEM: Vertical Circulation

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Excessive Gap Between Floor and Pedestrian Hand-Rails

3. Causes(s):

- Design deficiency
- Improper installation.

4. Triggering Events:

- Children playing near pedestrian hand-rails.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to children who crawl under hand-rail and fall to lower level
- Minor injuries to individuals hit by objects rolling under hand-rail on upper level.

C. PREVENTION MEASURES

- Provide minimal gap between floor and pedestrian hand-rails.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for railings to extend to the floor and to comply with the requirements of the Life Safety Code NFPA-101 and the applicable local codes (SDCS Vol. 1, 3.3.2.G).

4.0 YARD, SHOPS, AND FACILITIES

SUMMARY OF YARD, SHOPS, AND FACILITIES HAZARDS

Subsystem	Hazard	Type: Fire/Life	Security	System Assurance	General Safety
1. Yard, Shops, and Facilities	1. Fire/smoke	X			
	2. Unauthorized intrusion		X		X
2. Yard and Shops	1. Improper storage/handling of toxic or flammable substances	X			
	2. Ineffective operating procedures for yard train movements				X
	3. Ineffective shop operating procedures				X

HAZARD NUMBER: 4.1.1

SYSTEM: Yard, Shops, and Facilities

SUBSYSTEM: Yard, Shops, and Facilities

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Fire/Smoke in Yard, Shops or Facilities (e.g., Control Tower, OCC, etc.)

3. Causes(s):

- Debris fire
- Train accident (yard only)
- Electrical fire
- Arson.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to fire or smoke.

C. PREVENTION MEASURES

- Conform to applicable Fire/Life Safety Criteria
- Conduct proper inspection and maintenance of tracks, third rail, etc.
- Establish proper safe train movement procedures in yard and shops
- Provide emergency evacuation procedure
- Prevent debris accumulation in yard, shops, and facilities
- Prevent unauthorized intrusion.

D. RESOLUTION: ACCOMPLISHED BY:

- Development of an Emergency Preparedness Plan (SDCS Vol. 1, 2.6.1.1)

HAZARD NUMBER: 4.1.1 (continued)

SYSTEM: Yard, Shops, and Facilities SUBSYSTEM: Yard, Shops, and Facilities

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for adequate fire protection in yard, shops, and facilities including hydrants (SDCS Vol. 1, 2.5.2.1), fire extinguishers (SDCS Vol. 1, 2.5.2.3), sprinkler systems (SDCS Vol. 1, 2.5.4.1), protective signaling systems (SDCS Vol. 1, 2.5.4.2) and standpipe systems (SDCS Vol. 1, 2.5.4.3)

- Provision for ventilation systems within structures including positive mechanical exhaust ventilation (SDCS Vol. 1, 2.5.3.8.1), blower and exhaust system (SDCS Vol. 1, 2.5.3.8.2), and permanent draft stops (SDCS Vol. 1, 2.5.3)

- Provision for yard operation guidelines (SDCS Vol. 2, 3.4.1)

- Provision for controlled access points and the enclosure of storage yards with fencing to prevent unauthorized entry (SDCS Vol. 1, 4.8.1)

- Provision for an employee emergency communication system (SDCS Vol. 1, 2.5.2.4.2).

HAZARD NUMBER: 4.1.2

SYSTEM: Yard, Shops, and Facilities

SUBSYSTEM: Yard, Shops, and Facilities

A. HAZARD IDENTIFICATION

1. Type: Security/General Safety

2. Description: Unauthorized Intrusion

3. Causes(s): Absence of barriers or gates prohibiting intrusion

4. Triggering Events:

- Debris left on tracks
- Equipment vandalized.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Intruders (children, vandals) injure themselves while in yard and shops
- Injuries due to train derailment caused by debris or vandalism to train equipment, switches, yard signals, etc.
- Electrocution of trespassers.

C. PREVENTION MEASURES

- Provide effective barriers/or gates to deny unauthorized entry at all times
- Provide CCTV coverage of yard from tower
- Provide security surveillance of yard, shops and facilities during non-operating hours.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the yard tower to have the maximum view of the yard (SDCS Vol. 1, 3.9.1)
- Provision for controlled access points and the enclosure of storage yards with fencing to prevent unauthorized entry (SDCS Vol. 1, 4.8.1)

HAZARD NUMBER: 4.1.2 (continued)

SYSTEM: Yard, Shops, and Facilities

SUBSYSTEM: Yard, Shops, and Facilities

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for internal security with parts, spares, and other equipment controlled and/or secured (SDCS Vol. 1, 4.8.1)

- Provision for yard areas to be fenced as outside material storage areas, parking areas, gate area, to be sufficiently illuminated to discourage any trespasser or vandal (SDCS Vol. 2, 3.7.10).

HAZARD NUMBER: 4.2.1

SYSTEM: Yard, Shops & Facilities SUBSYSTEM: Yard and Shops

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Improper Storage/Handling of Toxic or Flammable Substances

3. Causes(s):

- Absence of proper storage areas
- Lack of policy or procedures regarding storage and handling of such substances
- Lack of proper training regarding storage and handling.

4. Triggering Events:

- Substance ignited or released into public areas.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to explosion, fire, smoke, or toxic fumes.

C. PREVENTION MEASURES

- Provide proper storage areas
- Provide procedures for safely storing and handling hazardous substances
- Provide training regarding storage and handling.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the storage and handling of toxic or flammable substances in accordance with local codes (SDCS Vol. 1, 2.5.3.6).

HAZARD NUMBER: 4.2.2

SYSTEM: Yards, Shops & Facilities SUBSYSTEM: Yards & Shops

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Ineffective Operating Procedures for Yard/Shop Train Movements

3. Causes(s):

- Poor documentation of operating procedures
- Inadequate procedural training
- Lack of compliance and enforcement.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to train/train collisions, derailments, trains impacting people, etc.

C. PREVENTION MEASURES

- Establish and document proper operating procedures for yard train movements
- Provide initial and periodic training on these procedures
- Actively enforce compliance.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for yard operating procedures for train movements (SDCS Vol. 2, 3.4.1).

HAZARD NUMBER: 4.2.3

SYSTEM: Yard, Shops & Facilities SUBSYSTEM: Yards & Shops

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Ineffective Shop Operating Procedures

3. Causes(s):

- Poor documentation
- Inadequate training
- Lack of compliance and enforcement.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to improper use of maintenance equipment or storage/stacking of parts and materials.

C. PREVENTION MEASURES

- Establish and clearly document proper operating procedures for shop maintenance operations
- Provide initial and periodic training
- Actively enforce compliance.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for proper operating procedures for shop maintenance operations (SDCS Vol. 2, 3.9.2).

5.0 PASSENGER VEHICLE

SUMMARY OF PASSENGER VEHICLE HAZARDS

Subsystem		Hazard	Type: Fire/ Life	Security	System Assurance	General Safety
1.	Vehicle-wide	1. Fire/smoke in vehicle	X			
		2. Protrusions/ sharp edges				X
		3. Ineffective procedures for manual train operations				X
2.	Car Interior	1. Broken/cracked windows			X	
		2. Absence of priority seating for elderly and handicapped				X
3.	Couplers, Draft Gear & Bars	1. Coupler separation or failure			X	
4.	Doors	1. Unsafe opening and closing of doors			X	
5.	Propulsion/ Braking Control	1. Inadequate braking			X	
		2. Excessive vehicle acceleration/deceleration or jerk				X
6.	Trucks & Suspension	1. Truck/truck component failure			X	

SUMMARY OF PASSENGER VEHICLE HAZARDS
(Continued)

Subsystem	Hazard	Type: Fire/ Life	Security	System Assurance	General Safety
7. Operator Controls and Displays	1. Unauthorized Use		X		
	2. Control panel failure/ malfunction			X	

HAZARD NUMBER: 5.1.1

SYSTEM: Passenger Vehicle SUBSYSTEM: Vehicle-Wide

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Fire/Smoke in Vehicle

3. Causes(s):

- Electrical short in vehicle component (e.g., propulsion motors, etc.)
- Debris fire
- Arson
- Train accident (collision or derailment).

4. Triggering Events:

- Use of highly flammable or toxic materials in car interior.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life and severe injuries due to fire, smoke or toxic fumes.

C. PREVENTION MEASURES

- Conform to applicable Fire/Life Safety Criteria
- Establish procedure for safe and prompt evacuation.

D. RESOLUTION: ACCOMPLISHED BY:

- Development of an Emergency Preparedness Plan (EPP) (SDCS Vol. 1, 2.6.1.1)
- Provision for emergency egress and access including the use of the vehicle side and end doors as emergency exits (SDCS Vol. 1, 2.4.5.1.1)

HAZARD NUMBER: 5.1.1 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Vehicle-Wide

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for ventilation control of the passenger vehicles from the controlling cab in the event of a fire (SDCS Vol. 1, 2.4.9.1)
- Provision for fire extinguishing apparatus in each car as required (SDCS Vol. 5, 1.5.2)
- Provision for public address system speakers in each vehicle (SDCS Vol. 1, 2.4.7.1), and devices in each car by which passengers may alert and communicate with the train operator in emergencies (SDCS Vol. 1, 2.4.7.3).

HAZARD NUMBER: 5.1.2

SYSTEM: Passenger Vehicle SUBSYSTEM: Vehicle-Wide

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Protrusions/Sharp Edges

3. Causes(s):

- Design or manufacturing oversight
- Result of vehicle collision/derailment.

4. Triggering Events:

- Patrons hurriedly enter/exit train during peak-hour periods
- Patrons on platform forced against vehicle
- Vehicle crowding
- Excessive vehicle acceleration, deceleration, or jerk.

B. POTENTIAL ACCIDENT/INJURY (Classification III)

- Minor injuries to patrons as they hit or bump into sharp edge or protrusion.

C. PREVENTION MEASURES

- Design and manufacture smooth corners on all portions of the car body where patrons can be expected to come in contact
- Repair all damage to car body after an accident before putting it back into service.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the interior of the passenger vehicles to have no sharp corners, edges, or protrusions which could cause personnal injury (SDCS Vol. 5, 1.5.2)

HAZARD NUMBER: 5.1.1 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Vehicle-Wide

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for visual inspection of passenger vehicle equipment (SDCS Vol. 5, 1.4.5).

HAZARD NUMBER: 5.1.3

SYSTEM: Passenger Vehicle SUBSYSTEM: Vehicle-Wide

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Ineffective Procedures for Manual Train Operations

3. Causes(s):

- ATC failure or malfunction
- Non-routine operations.

4. Triggering Events:

- Stalled or berthed train ahead.

B. POTENTIAL INJURY (Classification I)

- Loss of life or severe injuries due to train collision or derailment.

C. PREVENTION MEASURES

- Provide reliable ATC system
- Conduct proper testing and maintenance of ATC system
- Provide proper operator training for manual operations.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for a Manual Train Operating (MTO) mode to permit the train operator to accelerate and decelerate the train manually (SDCS Vol. 5, 2.8.11)

- Provision for an emergency "ATP cutout" to permit manual train operation by the train operator in the event that any ATP failure occurs such that the train is rendered non-operative (SDCS Vol. 5, 2.8.11)

HAZARD NUMBER: 5.1.3 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Vehicle-Wide

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for maintenance and testing of vehicle ATC apparatus including receiver coils with built-in test coils and portable and vehicle ATC simulators and test units (SDCS Vol. 5, 2.11.5)
- Provision for a reliable ATP system (SDCS Vol. 5, 2.3.5).

HAZARD NUMBER: 5.2.1

SYSTEM: Passenger Vehicle SUBSYSTEM: Car Interior

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Broken/Cracked Windows

3. Causes(s):

- Vandalism
- Train accident.

4. Triggering Events:

- Patrons being shoved or pushed onto glass while in vehicle or on platform.

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Injuries to patrons who hit broken/cracked windows.

C. PREVENTION MEASURES

- Enforce proper crowd behavior in vehicles and on platforms at all times
- Do not permit vehicles with broken/cracked windows to remain in, or enter service
- Provide barriers preventing unauthorized intruders in yard
- Utilize polycarbonate windows.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for windows to be laminated safety glass or coated polycarbonate (SDCS Vol. 5, 1.5.1)
- Provision for the entire yard complex to be fenced off from the general public, except through one "main" gate that will be attended (SDCS Vol. 2, 3.7.10)

HAZARD NUMBER: 5.2.1 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Car Interior

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD maintainability requirements for the transit system including a maintenance program (SDCS Vol. 1, 5.3.1), quantitative and qualitative design requirements (SDCS Vol. 1, 5.3.2), maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5), and human factors considerations (SDCS Vol. 1, 5.3.6)

HAZARD NUMBER: 5.2.2

SYSTEM: Passenger Vehicle SUBSYSTEM: Car Interior

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Absence of (or Inadequate) Priority Seating for Elderly and Handicapped

3. Causes(s):

- Design oversight/deficiency
- Elderly and handicapped seating occupied by others.

4. Triggering Events:

- Abrupt stop by train.

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Minor to severe injuries to elderly and handicapped individuals who fall when vehicle suddenly stops.

C. PREVENTION MEASURES

- Provide a sufficient number of seats especially designed for use by elderly and handicapped individuals
- Provide proper signage indicating seating priority for such individuals
- Establish employee operating procedure and policy for assisting handicapped individuals.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for dedicated space for priority seating and wheelchair patrons in each passenger car (SDCS Vol. 5, 1.5.2)
- Provision for handholds and stanchions to facilitate the movement of elderly and handicapped passengers (SDCS Vol. 5, 1.5.2)

HAZARD NUMBER: 5.2.1 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Car Interior

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for priority seating graphics in vehicles (SDCS Vol. 1, 3.5.6).

HAZARD NUMBER: 5.3.1

SYSTEM: Passenger Vehicle SUBSYSTEM: Couplers, Draft Gear and Draw Bars

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Coupler Separation or Failure

3. Causes(s):

- Design or manufacturing deficiency
- Improper maintenance.

4. Triggering Events:

- Propulsion control failure
- Excessive vehicle acceleration, deceleration, or jerk.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to vehicle passengers as a result of a collision between separated cars.

C. PREVENTION MEASURES

- Conduct periodic inspection and maintenance of couplers
- Conduct proper inspection and maintenance of propulsion system
- Provide operator training on safe vehicle operation
- Incorporate propulsion interlocks.

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD maintainability requirements including a maintenance program (SDCS Vol. 1, 5.3.1), quantitative and qualitative design requirements (SDCS Vol. 1, 5.3.2), maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5), and human factors considerations (SDCS Vol. 1, 5.3.6)

HAZARD NUMBER: 5.3.1 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Copuplers, Draft Gear and Draw Bars

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for automatic emergency brake application on uncoupled cars in case of accidental uncoupling (SDCS Vol. 5, 1.7).

HAZARD NUMBER: 5.4.1

SYSTEM: Passenger Vehicle SUBSYSTEM: Doors

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Unsafe Opening/Closing of Doors (i.e., doors don't open/close or open while in motion, etc.)

3. Causes(s):

- Electrical short in door controls
- Mechanical door failure
- Obstruction sensing feature too sensitive.

4. Triggering Events:

- Patrons near or leaning on doors.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to vehicle passengers falling from vehicle as doors open (or won't close) while vehicle is in motion
- Minor to severe injuries to passengers being caught in door or to those who panic because doors don't open.

C. PREVENTION MEASURES

- Provide emergency door release
- Provide communication link between passengers and train operator
- Conduct periodic inspections and maintenance on door controls
- Provide door/propulsion interlocks
- Provide door closing alarm
- Provide "Do Not Lean On Door" signs in vehicle.

HAZARD NUMBER: 5.4.1 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Doors

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the sounding of warning chimes or bells inside the vehicle before the doors are closed (SDCS Vol. 1, 3.5.1)
- Establishment of SCRTD maintainability requirements including a maintenance program (SDCS Vol. 1, 5.3.1), quantitative and qualitative design requirements (SDCS Vol. 1, 5.3.2), maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 6.3.5), and human factors considerations (SDCS Vol. 5.3.6)
- Provision for door/propulsion interlocks (SDCS Vol. 1, 3.5.1)
- Provision for each vehicle to contain a telephone or other means to permit communication between a patron and the train operator (SDCS Vol. 1, 3.5.4)
- Provision for door apparatus of passenger vehicles to include a door emergency release capability with operation of this device initiating a full service stop (SDCS Vol. 5, 1.5.4).

HAZARD NUMBER: 5.5.1

SYSTEM: Passenger Vehicle SUBSYSTEM: Propulsion/ Braking Control

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Inadequate Braking

3. Causes(s):

- Failure/malfunction of motor control equipment
- Friction brake overload or failure in case of electrical brake failure
- Design deficiency.

4. Triggering Events:

- Stalled train ahead
- Inability of control center or operator to detect and react to electrical brake failure in an expeditious manner.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to passengers as a result of train collision or derailment.

C. PREVENTION MEASURES

- Incorporate features that provide immediate notification of electrical brake failure or malfunction
- Conduct periodic inspections and maintenance of propulsion/braking control subsystem and friction brakes
- Design ATP blocks to ensure safe braking distance in presence of specified number of brake failures.

HAZARD NUMBER: 5.5.1 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Propulsion/ Braking Control

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the detection, annunication, and display of braking failures/malfunction for train operator awareness (SDCS Vol. 1, 3.5.7)
- Provision for ATP to provide brake assurance to command emergency braking when service braking does not provide safe deceleration (SDCS Vol. 5, 1.10)
- Establishment of SCRTD maintainability requirements including a maintenance program (SDCS Vol. 1, 5.3.1), quantitative and qualitative design requirements (SDCS Vol. 1, 5.3.2), maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5), and human factors considerations (SDCS Vol. 1, 5.3.6).

HAZARD NUMBER: 5.5.2

SYSTEM: Passenger Vehicle SUBSYSTEM: Propulsion/ Braking Control

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Excessive Vehicle Acceleration, Deceleration or Jerk

3. Causes(s):

- Design deficiency
- Control failure
- Improper operation.

4. Triggering Events:

- Controls call for velocity change
- Emergency or equipment failure induces open-loop braking.

B. POTENTIAL ACCIDENT/INJURY (Classification III)

- Minor injuries to vehicle passengers who fall when train is subjected to excessive acceleration, deceleration or jerk.

C. PREVENTION MEASURES

- Design to accepted industry standards
- Minimize emergency brake applications
- Provide accessible handholds and stanchions
- Provide operator training on safe vehicle operation.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for stanchions, handholds, and protective cushioning as appropriate in the passenger vehicles (SDCS Vol. 1, 3.5.6)
- Provision for acceleration, deceleration, and jerk specifications to conform to accepted transit standards and to take into account the potential for passenger injury due to loss of balance (SDCS Vol. 1, 3.5.9)

HAZARD NUMBER: 5.5.2 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Propulsion/ Braking Control

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the interlocking of the propulsion, brake, and operator control system on the vehicles to prevent undesired movement or excess speed (SDCS Vol. 1, 3.6.4)

- Provision for SCRTD personnel to receive classroom and general on-the-job training on safety features and their use (SDCS Vol. 1, 3.10.1).

HAZARD NUMBER: 5.6.1

SYSTEM: Passenger Vehicle SUBSYSTEM: Trucks and Suspension

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Truck/Truck Component Failure

3. Causes(s):

- Improper maintenance and inspection
- Fatigue
- Wear
- Improper design.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to passengers as a result of derailment.

C. PREVENTION MEASURES

- Conduct periodic inspection
- Conduct periodic overhaul
- Design to accepted industry standards.

D. RESOLUTION: ACCOMPLISHED BY:

- Design trucks and suspension components to industry standards (SDCS Vol. 5, 1.6 and 1.7)

- Establishment of SCRTD reliability requirements including a reliability program (SDCS Vol. 1, 5.2.1), quantitative design requirements (SDCS Vol. 1, 5.2.2), warranties (SDCS Vol. 1, 5.2.3), reliability data (SDCS Vol. 1, 5.2.4), and requirements for system design life and environment (SDCS Vol. 1, 5.2.5)

HAZARD NUMBER: 5.6.1 (continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Trucks and Suspension

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD maintainability requirements for the transit system including a maintenance program (SDCS Vol. 1, 5.3.1), quantitative and qualitative design requirements (SDCS Vol. 5.3.2), maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5) human factors considerations (SDCS Vol. 1, 5.3.6)

- Establishment of SCRTD quality assurance requirements including a quality assurance program (SDCS Vol. 1, 5.4.1), warranties (SDCS Vol. 1, 5.4.2), and quality program content (SDCS Vol. 1, 5.4.3).

HAZARD NUMBER: 5.7.1

SYSTEM: Passenger Vehicle SUBSYSTEM: Operator Controls and Displays

A. HAZARD IDENTIFICATION

1. Type: Security/General Safety

2. Description: Unauthorized Use of Operator Controls

3. Causes(s):

- Absence of barrier preventing intrusion into cab
- Operator allows riders to enter cab.

4. Triggering Events:

- Train controls taken over by unauthorized individual.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to passengers as a result of collision or derailment caused by misuse of train controls or interference with train operator.

C. PREVENTION MEASURES

- Provide effective barrier between train operator and passengers
- Prohibit riders in cab.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the operator cab doors and windows to be lockable (SDCS Vol. 5, 1.5.3.B).

HAZARD NUMBER: 5.7.2

SYSTEM: Passenger Vehicle SUBSYSTEM: Operator Controls and Displays

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description: Failure of Operator Panel to Detect, Annunciate, and Display Conditions Effectively

3. Causes(s):

- Short circuit in operator panel
- Improper human engineering of operator panel.

4. Triggering Events:

- Stalled or berthed train ahead
- ATP cutout/manual operation.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries to passengers as a result of a collision or derailment

C. PREVENTION MEASURES

- Incorporate human engineering features into operator panel
- Conduct periodic inspection and maintenance of operator panel
- Establish procedure for the control center to communicate to operator that his train is not operating properly
- Provide proper operator training for routine and non-routine conditions (e.g., ATP cutout).

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for ergonomic and human engineering design principles to form the basis for efficient arrangement of cab controls (SDCS Vol. 5, 1.5.3)

HAZARD NUMBER: 5.7..2 (Continued)

SYSTEM: Passenger Vehicle SUBSYSTEM: Operator Controls and Displays

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for illumination intensity of the control console and auxiliary control and indicator panel to be adjustable and assure visibility and legibility of the push buttons and indicators under the brightest ambient light conditions (SDCS Vol. 5, 1.5.3)

- Provision for communication between control and the train operator and/or on-board patron (SDCS Vol. 5, 3.5.1.1).

6.0 AUTOMATIC TRAIN CONTROL SYSTEM

SUMMARY OF AUTOMATIC TRAIN CONTROL SYSTEM HAZARDS

Subsystem	Hazard	Type			
		Fire/ Life	Security	System Assurance	General Safety
1. Wayside, Central Control, Vehicle and Yard	1. ATP failure/ malfunction			X	

HAZARD NUMBER: 6.1.1

SYSTEM: Auto. Train Control SUBSYSTEM: Wayside, Central Control, Veh. & Yd.

A. HAZARD IDENTIFICATION

1. Type: System Assurance

2. Description ATP Failure/Malfunction (e.g., Wrong Speed Command, Undetected Train, False Signal Clearing, etc.)

3. Causes(s):

- Design deficiency
- Improper maintenance
- Vandalism
- Fire
- Component failure.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to collision, derailment, or undesired door openings.

C. PREVENTION MEASURES

- Design for failsafe operation
- Provide that no single failure or multiple failure from a single cause can cause a train to respond unsafely
- Provide that failures affecting train safety shall be self-annunciating or self-detecting
- Conduct proper maintenance training of electronic shop personnel
- Establish proper maintenance procedures
- Provide barriers preventing unauthorized access to ATC equipment.

HAZARD NUMBER: 6.1.1 (continued)

SYSTEM: Auto. Train Control SUBSYSTEM: Wayside, Central Control, Veh. & Yd.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the ATC system to be designed to ensure that any malfunction affecting safety will require the system to revert to a safe state (SDCS Vol. 5, 2.4.1)
- Provision for malfunction in the ATP apparatus to be self-detecting (SDCS Vol. 5, 2.4.1)
- Provision for fail-operational design of the ATC such that, to the greatest practical extent, any first failure shall result in the system continuing to be capable of performing its design function (SDCS Vol. 5, 2.4.2)
- Provision for a Maintainability Engineering Analysis of the ATC System (SDCS Vol. 5, 2.11.2)
- Establishment of SCRTD maintainability requirements including a maintenance program (SDCS Vol. 1, 5.3.1) quantitative and qualitative design requirements (SDCS Vol. 1, 5.3.2), maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5), and human factors considerations (SDCS Vol. 1, 5.3.6).

7.0 COMMUNICATION SYSTEM

SUMMARY OF COMMUNICATION SYSTEM HAZARDS

Subsystem	Hazard	Type: Fire/Life	Security	System Assurance	General Safety
1. Voice Communication Equipment	1. Failure/malfunction of equipment	X		X	
2. CCTV	1. Inadequate security surveillance of stations		X		X
3. Data Transmission System	1. Failure to transmit emergency alarms	X		X	

HAZARD NUMBER: 7.1.1

SYSTEM: Communication SUBSYSTEM: Voice Communication Equipment

A. HAZARD IDENTIFICATION

1. Type: Fire/Life and System Assurance

2. Description: Failure/Malfunction of Voice Communication Equipment in Times of Emergencies

3. Causes(s):

- Design problem
- Improper maintenance
- Vandalism
- Improper use training.

4. Triggering Events: Emergency situation (e.g., station fire)

B. POTENTIAL ACCIDENT/INJURY Classification I)

- Loss of life or severe injuries due to patron inability to escape danger and panic during evacuation because of communication breakdown.

C. PREVENTION MEASURES

- Comply with applicable Fire/Life safety criteria
- Provide redundant critical features in communication system design
- Provide proper use training (e.g., drills)
- Conduct periodic inspection and maintenance
- Provide back-up communication equipment

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for communications maintenance and test provisions in the event of a failure in the system (SDCS Vol. 5, 3.22.1)

HAZARD NUMBER: 7.1.1 (Continued)

SYSTEM: Communication SUBSYSTEM: Voice Communication Equipment

D. RESOLUTION: ACCOMPLISHED BY:

- Development of an Emergency Preparedness Plan (EPP) (SDCS Vol. 1, 2.6.1.1)
- Provision for the training of SCRTD and participating agency personnel to function efficiently during an emergency (SDCS Vol. 1, 2.6.9.1)
- Provision for exercises and drills to be conducted periodically to prepare SCRTD and participating agency personnel for emergencies (SDCS Vol. 1, 2.6.9.2).

HAZARD NUMBER: 7.2.1

SYSTEM: Communication SUBSYSTEM: CCTV

A. HAZARD IDENTIFICATION

1. Type: Security/General Safety

2. Description: Inadequate Security Surveillance of Stations During Operating Hours

3. Causes(s):

- Inadequate coverage and quality of CCTV system.

4. Triggering Events:

- Patrons robbed and/or physically assaulted in station.

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Minor to severe injuries.

C. PREVENTION MEASURES

- Provide high quality CCTV equipment in stations
- Provide adequate CCTV coverage
- Provide adequate preventive maintenance of CCTV
- Provide security personnel in stations
- Provide adequate level of observer staffing.

D. RESOLUTION: ACCOMPLISHED BY:

- Installation of CCTV cameras encased in vandal and weather resistant housings having lenses that are easily replaceable with the proper tools (SDCS Vol. 1, 4.4.1) and having the capability of pan, tilt-zoom, camera installation

- Provision for SCRTD Transit Police to increase their area of responsibility to include rail rapid transit law enforcement (SDCS Vol. 1, 4.10.1) and receive transit security training before being assigned that duty (SDCS Vol. 1, 4.10.2).

HAZARD NUMBER: 7.3.1

SYSTEM: Communication SUBSYSTEM: Data Transmission System

A. HAZARD IDENTIFICATION

1. Type: Fire/Life and System Assurance

2. Description: Failure/Malfunction of Data Transmission Equipment to Transmit Emergency Alarms

3. Causes(s):

- Design deficiency
- Component failure.

4. Triggering Events: Emergency situation (e.g., fire in station)

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or injuries to patrons subject to emergency situation because of the inability of Metro Rail personnel to respond.

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Conduct proper inspection and maintenance of data transmission system
- Provide alternate or back-up data transmission system.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for communications maintenance and test provisions in the event of a failure in the system (SDCS Vol. 5, 3.22.1)
- Provision for training of SCRTD and participating agency personnel to function efficiently during an emergency (SDCS Vol. 1, 2.6.9.1)

HAZARD NUMBER: 7.3.1 (Continued)

SYSTEM: Communication SUBSYSTEM: Data Transmission System

D. RESOLUTION: ACCOMPLISHED BY:

- Establishment of SCRTD maintainability requirements including a maintenance program (SDCS Vol. 1, 5.3.1), quantitative and qualitative design requirements, (SDCS Vol. 1, 5.3.2) maintainability data (SDCS Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5), and human factors considerations (SDCS Vol. 1, 5.3.6).

8.0 POWER SYSTEM

SUMMARY OF POWER SYSTEM HAZARDS

Subsystem	Hazard	Type: Fire/Life	Security	System Assurance	General Safety
1. Substations, Auxiliary Power, and Wayside	1. Fire	X			
	2. Unauthorized intrusion and vandalism		X		X
	3. Emergency evacuation due to traction power loss				X
	4. Passenger panic due to loss/ degradation of AC power				X
	5. Leakage of battery fumes into station	X			
	6. Exposed Third Rail				X

HAZARD NUMBER: 8.1.1

SYSTEM: Power SUBSYSTEM: Substns, Auxiliary Power & Wayside

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Fire in Substation or Auxiliary Power Equipment Room

3. Causes(s):

- Overload
- Component failure
- Arson.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or serious injuries due to fire, smoke, and toxic fumes escaping to populated areas.

C. PREVENTION MEASURES

- Restrict access to substations and auxiliary power equipment rooms
- Comply with applicable Fire/Life Safety Criteria.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the prevention and monitoring of unauthorized access into traction power (SDCS Vol. 3, 14.4.1) and auxiliary power (SDCS Vol. 3, 14.5.1) substations
- Provision for traction power substations and auxiliary power rooms to have individual locks and intrusion alarms (SDCS Vol. 3, 18.9)
- Provision for space in or adjacent to traction power (SDCS Vol. 3, 14.4.1) and auxiliary electrical (SDCS Vol. 3, 14.5.2) substations for ventilation equipment

HAZARD NUMBER: 8.1.1 (continued)

SYSTEM: Power SUBSYSTEM: Substns, Auxiliary Power & Wayside

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for station public occupancy areas to be separated from power substations, transformer vault areas (SDCS Vol. 1, 2.2.2.4.2) and electrical equipment areas by 3-hour fire-rated construction (SDCS Vol. 1, 2.2.2.5.1)

- Provision for automatic sprinkler protection in substations and auxiliary power rooms (SDCS Vol. 1, 2.2.6.2.1)

- Provision for ancillary area ventilation systems to be arranged so that air is not exhausted into station public occupancy areas in either normal or emergency ventilation modes (SDCS Vol. 1, 2.2.3.5.1).

HAZARD NUMBER: 8.1.2

SYSTEM: Power SUBSYSTEM: Substns, Auxiliary Power & Wayside

A. HAZARD IDENTIFICATION

1. Type: Security/General Safety

2. Description: Unauthorized Intrusion and Vandalism

3. Causes(s):

- Failure to provide effective barriers/gates
- Access doors unlocked.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or injuries due to electrical shock to intruders
- Loss of life or injuries related to vandalized equipment.

C. PREVENTION MEASURES

- Provide effective barriers preventing unauthorized access into substations and auxiliary power equipment room
- Provide intrusion detection system for substation and auxiliary power equipment room
- Ensure access doors are always locked.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for the prevention and monitoring of unauthorized access into substations (SDCS Vol. 3, 14.4.1) and auxiliary electrical rooms (SDCS Vol. 3, 14.5.1)
- Provision for traction power substations and auxiliary power rooms to have individual locks and intrusion alarms (SDCS Vol. 3, 18.9).

HAZARD NUMBER: 8.1.3

SYSTEM: Power SUBSYSTEM: Substns, Auxiliary Power & Wayside

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Emergency Evacuation Due to Traction Power Loss

3. Causes(s):

- Third rail failure
- Commercial power outage
- Substation malfunction.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Minor to serious injuries due to tripping and falling while evacuating train in tunnels.

C. PREVENTION MEASURES

- Provide redundant traction power supply
- Provide emergency communication link between stalled trains and central control
- Provide procedure to safely evacuate stalled trains in tunnels
- Avoid evacuation unless outage is prolonged
- Comply with applicable Fire/Life Safety Criteria.

D. RESOLUTION: ACCOMPLISHED BY:

- Development of an Emergency Preparedness Plan (EPP) (SDCS Vol. 1, 2.6.1.1)
- Provision for redundant traction power supply (SDCS Vol. 5, 4.4.4)

HAZARD NUMBER: 8.1.3 (Continued)

SYSTEM: Power SUBSYSTEM: Substns, Auxiliary Power & Wayside

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for communication between Central Control and the train operator and/or on-board patrons (SDCS Vol. 1, 3.5.4).

HAZARD NUMBER: 8.1.4

SYSTEM: Power SUBSYSTEM: Substns, Auxiliary Power & Wayside

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Passenger Panic Due to Loss/Degradation of AC Power

3. Causes(s):

- Substation malfunction
- Distribution fault
- Failure to receive power from utilities.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Minor to serious injuries as a result of patron panic in stations, falling on escalators that stop abruptly and falling and tripping in dark stations.

C. PREVENTION MEASURES

- Provide automatic switching to emergency power supply
- Provide emergency communications link between stations and control center.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for communication between stations and Central Control including emergency telephones (SDCS Vol. 3, 6.3.1), Patron Assistance Intercom (P.A.I.) System (SDCS Vol. 1, 6.3.3), a Public Address System (SDCS Vol. 1, 6.3.7) and radio system (SDCS Vol. 3, 6.3.8).

HAZARD NUMBER: 8.1.5

SYSTEM: Power SUBSYSTEM: Substns, Auxiliary Power & Wayside

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Leakage of Battery Fumes into Station

3. Causes(s): Inadequate ventilation in battery room - fumes escaping into populated areas

4. Triggering Events:

- Ventilation system failure.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Minor to severe injuries due to inhalation of toxic fumes
- Loss of life or severe injuries due to hydrogen explosion.

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Interlock fans and battery chargers
- Provide hydrogen detectors
- Conduct proper inspection and maintenance of battery room ventilation system.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for exhaust ventilation in battery rooms to limit the concentration of hydrogen gas within the space to 1% by volume (SDCS Vol. 3, 14.5.3)
- Provision for indication of ventilation system malfunction to be transmitted to the Central Control Facility (SDCS Vol. 4, 1.9.1).

HAZARD NUMBER: 8.1.6

SYSTEM: Power SUBSYSTEM: Substns, Auxiliary Power & Wayside

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Exposed Third Rail

3. Causes(s):

- Safety design deficiency
- Negligence of maintenance personnel (i.e., failure to properly replace cover).

4. Triggering Events:

- Workmen on tracks
- Passenger evacuation along guideway.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or severe injuries due to high voltage shock

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Establish procedure to cut third rail power in those sections where workmen are performing extensive maintenance and to ensure effective replacement of protective covering
- Provide emergency trip switches to locally cut sections of third rail during emergency situations
- Prevent regeneration into line segments where power has been cut off.

HAZARD NUMBER: 8.1.6 (Continued)

SYSTEM: Power SUBSYSTEM: Substns, Auxiliary Power & Wayside

D. RESOLUTION: ACCOMPLISHED BY:

- Installation of circuit breakers to provide isolation of contact rail sections or zones (SDCS Vol. 5, 4.5.4)
- Provision to permit interruption in third rail power by means of emergency trip stations located at designated intervals throughout the system (SDCS Vol. 5, 4.5.4)
- Provision for all circuit breakers controlling power zones to be normally operated remotely from the centrally located control room by means of the supervisory control system (SDCS Vol. 5, 4.5.4).

9.0 FARE COLLECTION SYSTEM

SUMMARY OF FARE COLLECTION SYSTEM HAZARDS

Subsystem	Hazard	Type: Fire/ Life	Security	System Assurance	General Safety
1. Gates	1. Gates don't open in times of emergencies	X			

HAZARD NUMBER: 9.1.1

SYSTEM: Fare Collection SUBSYSTEM: Gates

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Gates Do Not Open in Times of Emergencies

3. Causes(s):

- Design oversight
- Equipment malfunction.

4. Triggering Events:

- Emergency evacuation.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life or serious injuries as patrons are unable to pass through fare gates fast enough to escape danger (i.e, fire).

C. PREVENTION MEASURES

- Comply with applicable Fire/Life Safety Criteria
- Conduct proper inspection and maintenance.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for fare collection gates to have the capacity to be switched to a free-wheeling condition to facilitate emergency exiting (SDCS Vol. 3, 8.7.2)

- Provision for sufficient exit gates to allow rapid and complete discharge of trains (SDCS Vol. 1, 3.3.5)

- Establishment of SCRTD maintainability requirements including a maintenance program (SDCS Vol. 1, 5.3.1), quantitive and qualitative design requirements (SDCS Vol. 1, 5.3.2), maintainability data (SDCA Vol. 1, 5.3.3), manuals (SDCS Vol. 1, 5.3.4), training (SDCS Vol. 1, 5.3.5), human factors considerations (SDCS Vol. 1, 5.3.6).

10.0 AUXILIARY VEHICLES

SUMMARY OF AUXILIARY VEHICLES HAZARDS

Subsystem	Hazard	Type: Fire/ Life	Security	System Assurance	General Safety
1. All Vehicles	1. Fire on vehicles	X			
	2. Unauthorized/ improper use		X		X
	3. Absence of ATP protection				X

HAZARD NUMBER: 10.1.1

SYSTEM: Auxiliary Vehicles SUBSYSTEM: All

A. HAZARD IDENTIFICATION

1. Type: Fire/Life

2. Description: Fire on Vehicles

3. Causes(s):

- Short circuit
- Arson
- Debris/material fire.

4. Triggering Events:

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Injuries due to fire and smoke as the operator is unable to extinguish fire.

C. PREVENTION MEASURES

- Provide on-board emergency fire fighting equipment
- Apply flammability/toxicity restrictions to auxiliary vehicles
- Restrict access to vehicles to authorized personnel only.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for portable, dry chemical fire extinguishers UL approved, 10-pound capacity, and rated 4A-30B: on each tunnel washing and vacuuming train car and each rail car mover (SDCS Vol. 5, 6.10.6)
- Provision for on-board communications apparatus and required radio communications between all auxiliary vehicles and Central Control (SDCS Vol. 5, 6.4.2).

HAZARD NUMBER: 10.1.2

SYSTEM: Auxiliary Vehicles SUBSYSTEM: All

A. HAZARD IDENTIFICATION

1. Type: Security/General Safety

2. Description: Unauthorized/Improper Use

3. Causes(s):

- Absence of barriers restricting vehicle use
- Absence of procedure and training regarding vehicle use.

4. Triggering Events:

- Intruder in yard

B. POTENTIAL ACCIDENT/INJURY (Classification II)

- Injuries to individuals who do not know how to use the vehicles properly
- Injuries to others due to collision with revenue vehicles.

C. PREVENTION MEASURES

- Provide parking area for auxiliary vehicles that restricts unauthorized use
- Provide special vehicle locks or ignitions limiting vehicle use
- Assure on-line detectability of auxiliary vehicles
- Establish policies and procedures regarding vehicle use
- Provide proper training on vehicle use.

HAZARD NUMBER: 10.1.2 (Continued)

SYSTEM: Auxiliary Vehicles SUBSYSTEM: All

D. RESOLUTION: ACCOMPLISHED BY:

- All auxiliary vehicles shall be fully and continuously detectable by the ATC system (SDCS Vol. 5, 6.3)
- Provision for yard and shops to have adequate facilities and equipment to store auxiliary vehicles (SDCS Vol. 5, 6.4.4).

HAZARD NUMBER: 10.1.3

SYSTEM: Auxiliary Vehicles SUBSYSTEM: All

A. HAZARD IDENTIFICATION

1. Type: General Safety

2. Description: Absence of ATP Protection for All Auxiliary Vehicles Operating on Mainline/Yard Tracks

3. Causes(s): Design oversight

4. Triggering Events:

- Interfering operations.

B. POTENTIAL ACCIDENT/INJURY (Classification I)

- Loss of life and injuries due to collision or derailment.

C. PREVENTION MEASURES

- Provide ATP protection for all auxiliary vehicles operating on mainline/yard tracks
- Assure detectability of auxiliary vehicles.

D. RESOLUTION: ACCOMPLISHED BY:

- Provision for ATP protection for all auxiliary vehicles operating on mainline/yard tracks (SDCS Vol. 5, 2.9.1)
- Provision for all auxiliary vehicle to be fully and continuously detectable by the ATC system (SDCS Vol. 5, 6.3).