

Southern California Rapid Transit District

METRO RAIL PROJECT



SAFETY PROGRAM

REVISION 1

OCTOBER 1988

POLICY STATEMENT

The policy of the Southern California Rapid Transit District (SCRTD) Board of Directors is that safety shall be of primary importance throughout the development and implementation of the Metro Rail system, from preliminary engineering through revenue operations.

A safety program, incorporating patron, employee, contractor, and equipment safety, shall be established, documented, and implemented. SCRTD, consultant, and contractor personnel charged with safety program implementation shall maintain technical independence from design and construction engineers and those charged with operating the transit system.

The designs of Metro Rail facilities and equipment shall comply with all applicable codes and regulations. Modern system safety management practices and engineering technology shall be used to ensure that the system achieves a level of safety that eliminates or minimizes the occurrence of all accidents.

Construction activities shall comply with applicable codes and regulations. SCRTD, consultant, and contractor personnel and visitors to construction sites shall comply with all occupational, health, and safety requirements to minimize the possibility of accidents. The general public and local residents shall be protected from construction-related hazards. Proper insurance coverage shall be maintained at all times.

The Metro Rail system shall be operated and maintained to the highest transit industry standards. All personnel shall be properly trained and tested, and strict operating rules and procedures shall be enforced at all times. SCRTD personnel and outside agencies shall be prepared to react to any emergency. All accidents shall be properly reported and investigated, and actions taken to preclude a recurrence.

The General Manager of the SCRTD shall have the authority to execute these policies and implement the safety program defined herein. All program participants shall comply with the requirements of this plan as applicable to their contracts for the Metro Rail Project.

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1.0 INTRODUCTION

1.0 INTRODUCTION

The primary goal of the Metro Rail system is to provide safe, reliable, and cost-effective transportation. The SCRTD's policy, from the highest levels of management, is that safety be a primary consideration throughout the evolution of the Metro Rail system, from preliminary engineering through revenue operations. To fulfill the obligation of this policy, all applicable codes and regulations, augmented by modern system safety engineering technology and industry standards, are used to ensure that the system achieves a level of safety that eliminates or minimizes the occurrence of all accidents. Toward this end, the SCRTD has established a comprehensive system safety program.

System safety is the application of operating, technical, and management techniques and principles to the safety aspects of a system throughout its life to reduce hazards to the lowest practical level through the most effective use of available resources.¹ The Metro Rail system safety program focuses on designing and operating the system to protect patrons, employees, and equipment by systematically identifying hazards, and then eliminating or controlling those hazards throughout all phases of the project, from preliminary engineering through revenue operations.

Within the system safety program, the SCRTD has also developed a construction safety program to protect the public, workers, or visitors at the construction site and property during construction activities, and to reduce losses due to accidents. While many construction safety requirements are defined by the California Occupational Safety and Health Administration (Cal-OSHA) and local, state, and federal regulations, the SCRTD has in some cases specified safety requirements that are more stringent than those of regulatory agencies.

The system safety program and its adjunct construction safety program encompass all activities directly related to safety on the Metro Rail Project, and the

1 System Safety Glossary, June 1986, U.S. Department of Transportation, Transportation Systems Center.

discussion in the following chapters of this plan focuses on these two programs. Other project activities, particularly in the areas of systems assurance (quality assurance, reliability, and maintainability) and security, complement and reinforce these programs and enhance system safety, but a detailed discussion of those activities is outside the scope of this plan.

Following this Introduction, the plan contains five chapters:

- Chapter 2.0 describes the organization of the Metro Rail safety function and describes the roles and responsibilities of participants
- Chapter 3.0 summarizes the evolution and major activities of the Metro Rail system safety program
- Chapter 4.0 identifies major safety features that have been designed into the Metro Rail system
- Chapter 5.0 describes elements of the Metro Rail construction safety program
- Chapter 6.0 identifies the plans and procedures that will be developed to enforce safety requirements during Metro Rail revenue service operations.

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2.0 METRO RAIL SAFETY ORGANIZATION

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2.1 TRANSIT SYSTEMS DEVELOPMENT DEPARTMENT

The SCRTD's Transit Systems Development (TSD) Department is responsible for all activities related to the design, procurement, construction, and activation of the Metro Rail system, including meeting cost, quality, schedule, and performance objectives. Transit Systems Development staff involved with design, construction, procurement, and testing decisions affecting safety include Systems and Construction Safety, Systems Design and Analysis, Rail Facilities Engineering, and Construction Management personnel.

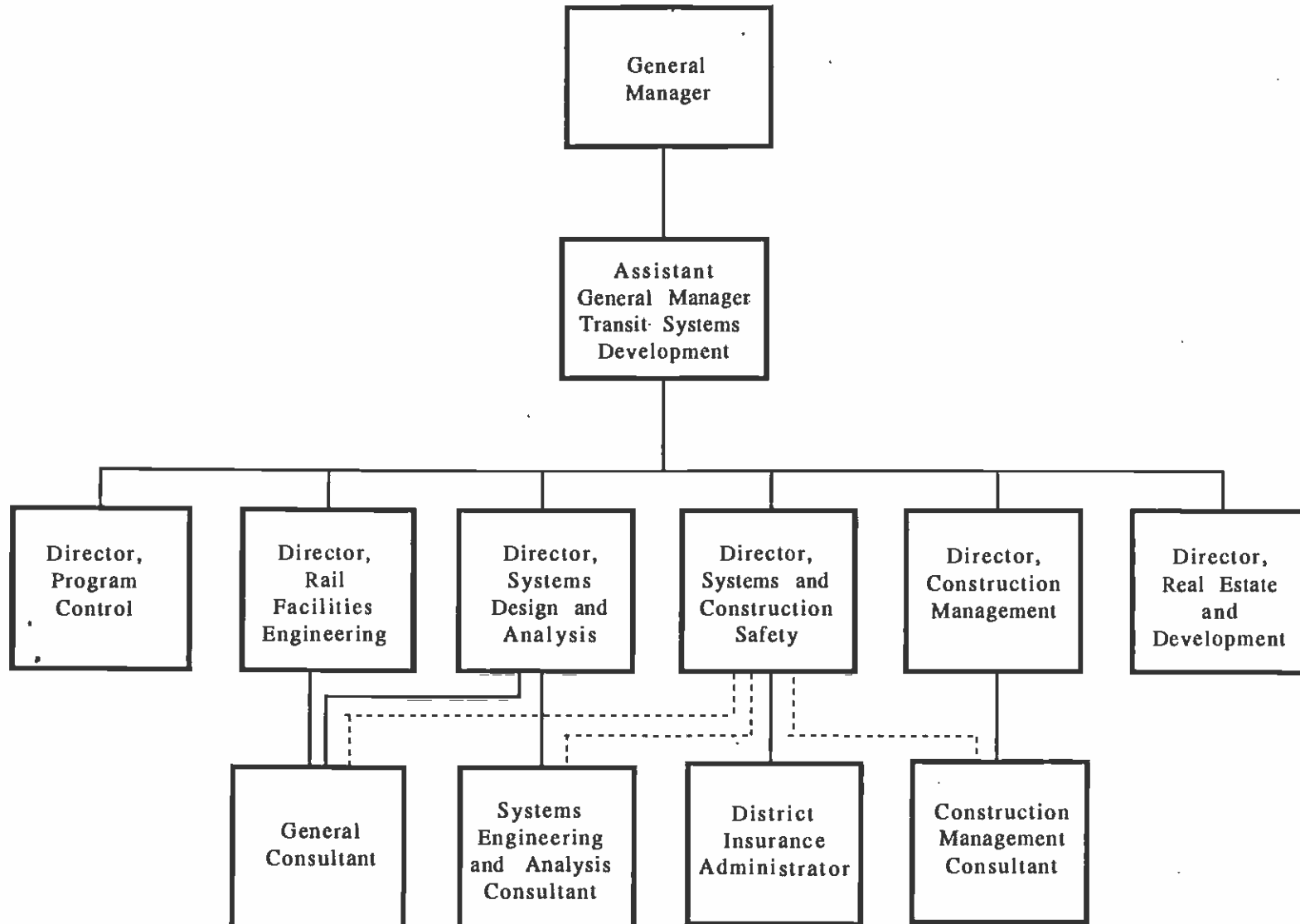
To assist in administering the Metro Rail Project, TSD has retained the services of four consultant organizations: a General Consultant (GC); a Systems Engineering and Analysis (SE&A) Consultant; a Construction Management (CM) Consultant; and an insurance consultant, the District Insurance Administrator (DIA). The TSD Department and its consultants constitute the core Metro Rail Project team, as shown in Exhibit 2-1. In addition, the project team includes Metro Rail committees established to provide expertise in specific project areas; these committees consist of representatives from the TSD Department and its consultants and, as appropriate, from other SCRTD departments and outside agencies.

This section identifies the safety-related responsibilities of project team members, and also identifies outside agencies with safety-related involvement in the project.

Within the SCRTD Transit Systems Development (TSD) Department, the Director of Systems and Construction Safety has overall responsibility for the system safety program. The Director, Systems and Construction Safety (SCS), directs all phases of the Metro Rail safety program, including construction safety on the job site, system safety, fire/life safety, and the insurance requirements of the project. The duties of the SCS Director include:

- Organizing and coordinating the implementation of the Metro Rail safety and security programs
- Establishing safety and security goals and standards

EXHIBIT 2-1
Metro Rail Core Project Team



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NOTE: Dashed line (---) denotes support relationship.

- Overseeing, guiding, and supporting activities which may be required to execute the system safety and security program throughout all phases of the Metro Rail Project
- Managing the safety certification program, which is designed to evaluate and document the system's readiness for revenue service from a safety viewpoint
- Overseeing the Metro Rail insurance program, including loss prevention surveys, activities relating to the bond packaging program, and procurement of insurance for contractors and subcontractors
- Providing for the independent and objective review of all plans and procedures, design criteria, specifications, technical proposals, drawings, Contract Data Requirements List (CDRL) items, and Change Requests from a safety perspective
- Directing the preparation of all construction and test emergency management procedures
- Overseeing all emergency drills, disaster simulations, safety training courses, and industry safety peer reviews
- Chairing and participating on Metro Rail committees dealing with fire/life safety, security, safety certification, and construction safety.

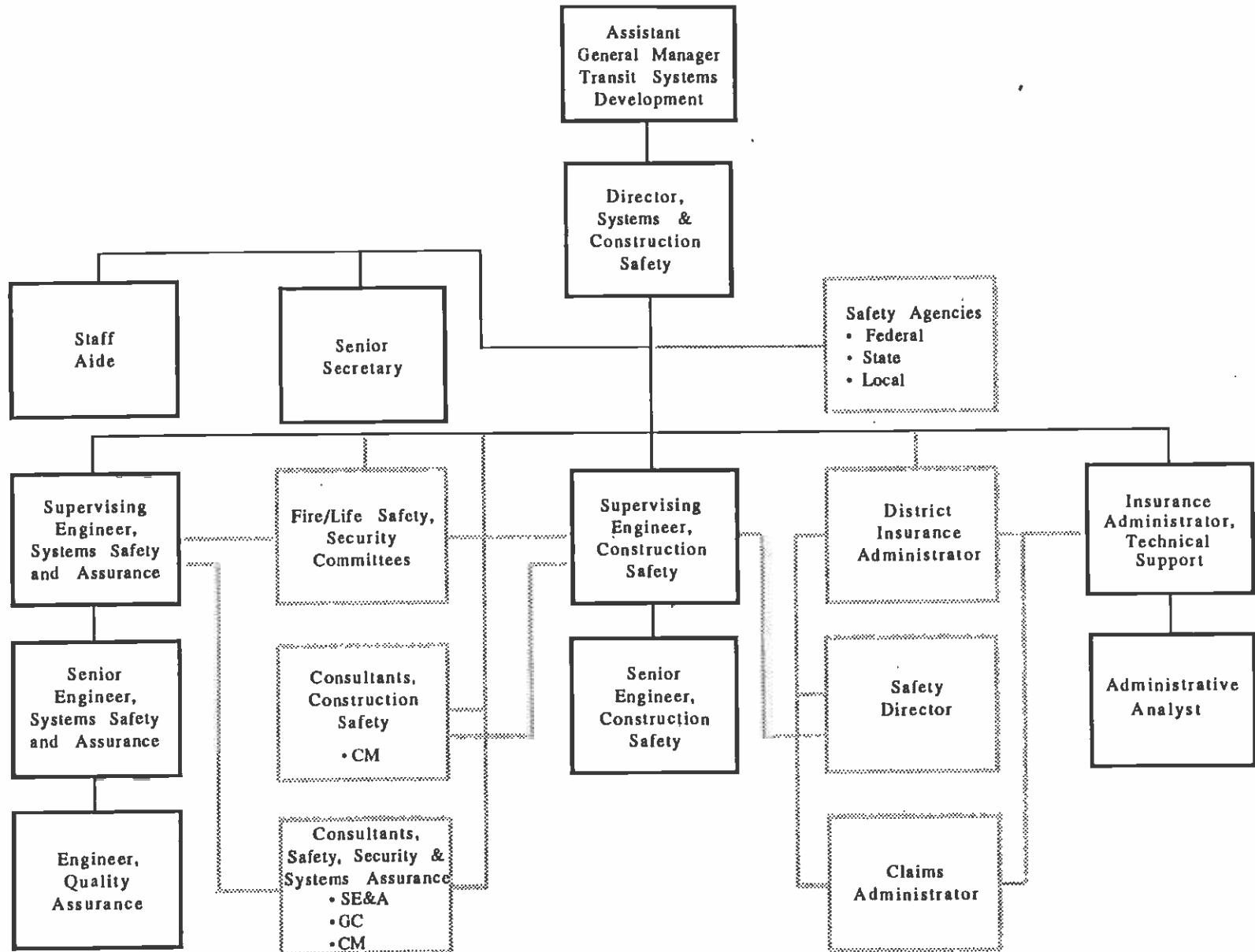
As shown in Exhibit 2-2, there are three functional groups within the SCS Office:

- Systems Safety and Assurance
- Construction Safety
- Technical Support.

The Systems Safety and Assurance group's responsibilities include:

- Establishing system safety and security goals and standards
- Overseeing, guiding, and supporting activities required to execute the system safety and security program throughout all phases of the Metro Rail Project

EXHIBIT 2-2
 Metro Rail Systems and Construction Safety Organization



NOTES:
 Highlighted boxes indicate groups/personnel belonging to Systems and Construction Safety.
 Dashed line (-.-) denotes support relationship.

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- Analyzing procedures, rules, and practices to ensure adequate hazard control
- Participating in design reviews and planning sessions pertaining to safety, security, system assurance, operations, maintenance, and training
- Assessing safety and security-related information from other properties to identify safety improvements for the Metro Rail system
- Auditing design changes and construction/procurement activities to ensure that the safety and/or security requirements of the Metro Rail system are being maintained
- Developing emergency preparedness plans and procedures for use in response to emergencies during system tests and evaluations.

The Construction Safety group's responsibilities include:

- Monitoring the effectiveness of the construction safety and security program
- Evaluating the safety-related aspects of construction procedures and manuals prepared by the CM Consultant
- Reviewing bid packages, CDRL items, and Change Requests from a construction safety perspective
- Overseeing emergency preparedness activities during construction to ensure consistency and conformance with SCRTD requirements
- Monitoring the reporting of accidents and incidents during construction and assisting in coordinating emergency responses
- Assisting in processing claims for accidents and incidents occurring at construction sites
- Auditing inspection records and reviewing inspection reports for conformance with safety regulations and SCRTD safety requirements.

The Technical Support group's responsibilities include:

- Establishing and marketing the Owner-Controlled Insurance Program (OCIP)

- Conducting preconstruction surveys
- Monitoring job-site safety conditions
- Developing recommendations for safety training programs
- Monitoring the activities of the DIA, CM Consultant, and construction contractors
- Analyzing loss control and prevention data and developing actions to mitigate the most serious and costly claims
- Monitoring and reporting on the status of worker's compensation and public liability/ property damage claims programs.

2.2 CONSULTANTS

The Metro Rail Project is supported by four consulting organizations which provide additional expertise to the project.

The General Consultant (GC) is responsible for the design of the system and preparation of all contract documents. Within the GC's organization, a safety and assurance group, independent from design engineers, has been established to oversee the GC's safety, security, and system assurance activities. The group's specific safety activities include:

- Developing and publishing systemwide design criteria for fire/life safety, system safety, security, and system assurance
- Reviewing all design documents (drawings, specifications, criteria) from a safety perspective
- Preparing special studies to evaluate alternative designs from a safety perspective
- Preparing detailed hazard analyses to support design engineers
- Evaluating all proposed design changes with respect to safety
- Participating in the safety certification program in areas related to design
- Reviewing all safety-related operating procedures for consistency with design requirements.

The GC on the Metro Rail Project is Metro Rail Transit Consultants, a joint venture of Parsons, Brinckerhoff, Quade & Douglas, Inc.; Daniel, Mann, Johnson & Mendenhall; Kaiser Engineers Corporation; and Harry Weese & Associates.

The Systems Engineering and Analysis (SE&A) Consultant is responsible for systems engineering activities, such as operations and maintenance planning; project management assistance; test program development; and independent safety, security, and system assurance reviews. The SE&A Consultant is also responsible for passenger vehicle procurement management. The SE&A Consultant's specific safety activities include:

- Preparing system safety program plans and management procedures
- Preparing system-level hazard analyses
- Assisting the SCRTD with managing the safety certification program
- Reviewing system safety analyses and design documents submitted by the GC and systems contractors
- Assisting the SCRTD in preparing operating rules and emergency procedures needed for revenue service.

The SE&A Consultant is Booz, Allen & Hamilton Inc.

The Construction Management (CM) Consultant is responsible for managing the construction of all facilities and the procurement of all equipment except for the passenger vehicles and fare collection equipment. Within the CM Consultant's organization, a Safety and Security Manager has been designated to oversee construction-site safety and security responsibilities. The CM Consultant's specific safety activities include:

- Preparing construction safety plans and procedures
- Managing and enforcing the construction safety and security program
- Reviewing system safety analyses and design documents submitted by the GC and various systems contractors
- Assessing the loss control actions identified by the District Insurance Administrator

- Ensuring development and implementation of construction emergency response procedures
- Providing safety support for pre-construction surveys
- Performing or ensuring performance of construction site occupational safety and health, environmental tests and safety inspections
- Participating in the safety certification program by providing necessary documentation
- Reviewing all safety-related operating procedures for consistency with final system configuration.

The CM Consultant is PDCD, a joint venture formed by the Ralph M. Parsons Company; Dillingham Construction, Inc.; and DeLeuw Cather & Company.

A District Insurance Administrator (DIA) has been retained as consultant for SCRTD's Owner-Controlled Insurance Program (OCIP). The DIA is responsible for procuring insurance for construction contractors and subcontractors (Workers' Compensation and Employer's Liability, Liability and Excess Liability, and All Risk Course of Construction); servicing insurance claims; administering a bond packaging program for eligible minority/women subcontractors and providing loss-prevention services, including:

- Recommending changes for improving safety or meeting regulatory safety compliance to the CM Consultant
- Assisting in the development of construction-site emergency response activities; participating in training sessions and drills; ensuring the SCRTD's liability is minimized by appropriate emergency response procedures; and providing program status reports
- Performing pre-construction surveys to identify, record, and catalogue pre-existing construction conditions in order to minimize the SCRTD's liability on future claims
- Supporting the CM Consultant by reviewing inspection reports to ensure consistency with the loss control program.

The DIA on the Metro Rail Project is a joint venture formed by Fred S. James & Company of California, Inc.; Okasaka, Ortiz & Ciocatto Insurance Associates; and Kadowaki Associates International Corporation.

2.3 COMMITTEES

To ensure supportive interaction among the Metro Rail Project team, other SCRTD organizations, and representatives of outside agencies, several working committees have been established. The committees act as review boards of ongoing technical activities and provide a forum for coordinating design, procurement, construction, operations, and maintenance issues.

A permanent Fire/Life Safety Committee (FLSC) has been established to facilitate the interchange of information, develop fire/life safety criteria, and make evaluations and recommendations relative to fire and public safety. The FLSC is chaired by the SCS Director and includes representatives from the GC, the CM and SE&A Consultants, and the:

- City of Los Angeles Fire Department
- Consolidated Fire Protection District of Los Angeles County.

The FLSC was established by a charter signed by the SCRTD, the Board of Fire Commissioners, and the Los Angeles County Fire Chief on September 8, 1983. The FLSC meets on a regularly scheduled basis.

A permanent Security Subcommittee to the FLSC has been established to facilitate the exchange of information and make recommendations and evaluations relative to rail system security. The Security Subcommittee is chaired by the SCS Director and consists of representatives from the GC, the CM and SE&A Consultants, and the:

- SCRTD Transit Police
- Los Angeles City Police Department
- Los Angeles County Sheriff's Department
- Los Angeles County Coroner/Medical Examiner's Office.

The Security Subcommittee meets on a regularly scheduled basis. Periodically, joint meetings of the FLSC and Security Subcommittee are held to review topics of mutual concern.

The Metro Rail Operations and Maintenance (O&M) Committee coordinates the exchange of information and establishes policies relating to operation and maintenance of the Metro Rail system. The O&M Committee is chaired by the TSD Manager of Systems Engineering and Analysis and includes representatives from the TSD Systems Design and Analysis Office and SCS Office; SCRTD operating departments (Rail Transportation, Facilities Maintenance, and Equipment Maintenance); and the GC, and CM and SE&A Consultants.

A Metro Rail safety certification program (see Chapter 3.0) has been established to ensure that all Metro Rail facilities, equipment, operational and maintenance procedures, and training programs are systematically reviewed for compliance with safety requirements and are certified by the SCRTD on a timely basis prior to the start of revenue service. The Safety Certification Review Team is responsible for the review, evaluation, and approval of all safety-related documentation. The Review Team is chaired by the SCS Director and consists of voting representatives from the TSD Offices of Systems Design and Analysis, Rail Facilities Engineering, and Construction Management; SCRTD operating departments (Rail Transportation, Facilities Maintenance, and Equipment Maintenance); the SCRTD Risk Management Department; and the Transit Police. The Review Team is supported by representatives from the GC, CM and SE&A Consultants, and the FLSC.

2.4 SUPPORTING AND REGULATORY AGENCIES

The Los Angeles City and County Fire Departments, under California Administrative Code (C.A.C.) Title 19, "Public Safety," have jurisdiction over fire and panic safety. Within the Metro Rail Project, fire department personnel represent the State Fire Marshal¹ to enforce the requirements of Title 19. The fire department representatives set requirements relative to system design, construction, and operation for the purpose of minimizing fire and life safety hazards to the public and SCRTD employees. They serve on the FLSC to facilitate the exchange of information and to assist design and construction personnel with fire/life safety issues.

The California Public Utilities Commission (CPUC) has responsibility for safety oversight of rail rapid transit

1 C.A.C. Title 19, Subchapter 1, Part 1, Article 1.12, "Enforcement Agency."

systems within the state.² To fulfill that responsibility, the CPUC monitors the Metro Rail safety program and the certification of the system for revenue service. The TSD Systems Design and Analysis Office conducts regular meetings with representatives from the SCS Office and the CPUC to enable that mission to be accomplished. The CPUC is asked to review and concur with pertinent safety-related documents. The SCRTD complies with General Order 127 with respect to the design of the automatic train control system, passenger vehicles, and communications equipment.³

All accidents, incidents, or unusual occurrences which have caused, or could have caused, impact, collision, derailment, fire, explosion, or other event involving the operation of on-track equipment (standing or moving), including those occurring on passenger loading platforms which caused, or could have caused, property damage or personal injury or death to passengers or employees, must be reported to the CPUC within 24 hours from the time of such event. In the case of holiday or weekend occurrences, such report will be made on the next working day.⁴

The California Occupational Safety and Health Administration (Cal-OSHA), under the provisions of C.A.C. Title 8, has the power to establish safety and health requirements for Metro Rail construction and tunneling activities. Cal-OSHA requirements also affect occupational safety during revenue service. All construction contractors will be required to comply with Cal-OSHA requirements and make Cal-OSHA records and reports available to the TSD Construction Management Office and SCS Office; the CM Consultant; and the DIA.

2 Public Utilities Code, Chapter 5, Article 5, Section 30646.

3 General Order 127, Public Utilities Commission of the State of California, "Regulations Governing the Construction, Reconstruction, Maintenance and Operation of Automatic Train Control Systems With Respect to Train Detection and Separation, Route Interlocking, Speed Enforcement and Right-of-Way Hazard Protection on Rapid Transit Systems."

4 CPUC, Third Interim Order, Bay Area Rapid Transit District, Paragraph 2, Decision No. 84582.

The City Independent Technical Review Committee was charged by Los Angeles City Council President Pat Russell with reviewing the design of MOS-1, with particular emphasis on safety issues related to methane gas. The Committee completed its evaluation in January 1986 and made several recommendations to enhance Metro Rail safety. These recommendations have been adopted by the SCRTD and have been incorporated into Metro Rail plans and specifications. The City Office of the Chief Legislative Analyst will monitor the implementation of these safety requirements at regular quarterly project reviews held by the SCRTD.

The Urban Mass Transportation Administration (UMTA) also has a role in the Metro Rail safety program. Because the Metro Rail Project is in part federally funded, all program planning, including system safety and security, falls under the purview of the Urban Mass Transportation Administration and is subject to their review. UMTA has appointed a Project Management Oversight Consultant (PMOC) to serve as UMTA's agent on the project and provide independent monitoring of the project's status. The PMOC reports directly to UMTA on project progress and problems, including systems assurance and safety issues. The SCRTD reviews the status of the project in monthly reports provided to UMTA and the PMOC. In addition, the SCRTD reviews the safety program as part of quarterly progress reviews held with UMTA.

UMTA has also developed a Safety Information Reporting and Analysis System (SIRAS) to provide information that can accurately characterize safety on urban mass transportation rail transit systems in the United States. The SIRAS Instruction Manual⁵ describes the conditions under which three types of reports must be filed by rail transit authorities and contains the detailed instructions for filling out the various questions of each report form. The SCRTD will comply with all UMTA safety reporting requirements.

The National Transportation Safety Board (NTSB) has the responsibility and authority to conduct investigations of transportation accidents and to make recommendations.⁶ The NTSB must be notified by telephone at the earliest

5 SIRAS Instruction Manual, U.S. Department of Transportation, January 1980, as amended.

6 49 CFR, Part 840, October 1, 1984.

practical time, but not later than 6 hours, after the occurrence of an accident if it results in any of the following:

- A passenger or employee fatality
- Serious injury to two or more crew members or passengers requiring admission to a hospital
- Damage of \$25,000 or more to a train and non-railway property or involving evacuation of a passenger train.

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3.0 EVOLUTION OF THE METRO RAIL SYSTEM SAFETY PROGRAM

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The Metro Rail system safety program has been implemented through a series of planned and integrated activities. The program is built around the systematic identification of SCRTD safety requirements; imposition of these requirements on contractors, consultants, and internally; and verification that all safety requirements have been achieved prior to the start of revenue service. Within the SCS Office, the Systems Safety and Assurance group is responsible for managing and coordinating the implementation of the system safety program.

The program is documented in the Metro Rail's System Safety and Security Program Plan.¹ The program plan identifies the technical and management tasks performed during each project phase to systematically integrate safety and security into all design, construction/procurement, testing, and system start-up activities. A separate System Safety Program Plan - Operations will be developed approximately two years prior to revenue service.

A key element of the safety and security program is safety certification, a program designed to ensure that all elements of a safe transit system are in place prior to the start of revenue service. The safety certification program² is designed to verify that:

- Safety-related design criteria are properly reflected in procurement and construction specifications and directive drawings
- Safety-related requirements in the specifications are incorporated into the final products
- Tests are conducted to verify the ability of equipment and personnel to function safely

1 System Safety and Security Program Plan, Construction/Acquisition Edition, June 1988 (Draft).

2 See SCRTD Metro Rail Project; Safety Certification Plan, Revision 1, March 1988.

- Operating, maintenance, and safety plans, procedures, and training programs are developed and thoroughly reviewed and approved prior to the start of revenue service
- Responsible program participants document the above activities to provide a traceable history of the safety program.

The process of safety certification specifically involves issuance of Criteria Conformance Certificates and Certificates of Compliance that document satisfactory compliance with a formal list of safety requirements. The requirements are developed from the System Safety and Security Program Plan and System Assurance Program Plan,³ and from other documents that define the safety baseline of the Metro Rail system:

- System Design Criteria and Standards⁴
- Contract specification books
- Metro Rail Test Program Plan.⁵

The scope of the safety certification program includes all equipment, facilities, and safety-related procedures and training required for revenue service, including:

- Systemwide Elements - passenger vehicles, automatic train control, communications (fire and security detection, gas and seismic detection, telephone, radio, public address, etc.), fare collection, traction power, and auxiliary vehicles.
- Fixed Facilities - stations, tunnel segments, the yard and shops, the Rail Control Center (RCC), and all equipment, such as elevators and escalators, installed in the facilities.
- Procedures and Training Programs - Emergency Procedures Manual, Transit Police Training Program, Accident/Incident Reporting and

3 SCRTD Metro Rail Project, System Assurance Program Plan, Revision 1, June 1988 (Draft).

4 SCRTD Metro Rail Project, System Design Criteria and Standards, 5 vols., 1983, as revised.

5 SCRTD Metro Rail Project, Test Program Plan, Rev. 1, September 1988.

Investigation Procedures, Operator's Rulebook, Standard Operating Procedures, etc.

The safety certification program is administered by the Safety Certification Review Team.

The safety certification program will result in a complete set of traceable documentation verifying the system as being safe prior to start of revenue operations. This documentation will provide the CPUC with verification of system safety in compliance with CPUC's oversight responsibility. The certification documentation will also provide the Project Management Oversight Consultant and UMTA with verification of design, construction, test, and operational safety efforts.

The following sections of this chapter discuss the evolution of the safety program in the following areas:

- Design criteria development
- Specification preparation
- Procurement and construction monitoring
- Testing.

3.1 DESIGN CRITERIA DEVELOPMENT

Design criteria and standards define detailed functional requirements for all Metro Rail elements. The criteria and standards are presented in five volumes:

- Volume 1 - Systemwide
- Volume 2 - Civil/Structural
- Volume 3 - Stations
- Volume 4 - Mechanical/Electrical
- Volume 5 - Subsystems.

While safety-related requirements are contained in all volumes of the System Design Criteria and Standards, systemwide requirements in the areas of fire/life safety, system safety, security, and system assurance are centralized within Volume 1.

The criteria and standards specify the requirements to be followed by designers and engineers in the design of facilities and the selection of equipment. The criteria and standards are issued to all Metro Rail Project team members. Any changes to the criteria and standards are subject to SCRTD's formal change control process.⁶ The

6 SCRTD Metro Rail Project, Change Control Procedure - Design Documents, August 1988 (Draft).

development of the design criteria and standards was an evolutionary one, beginning with the identification of general criteria and standards early in the preliminary engineering phase of the project. As the project proceeded, the criteria and standards were refined and specified in more detail. The development process was subject to a number of checks and balances, including project-wide reviews of design documents to ensure conformance among requirements, and independent reviews of the safety content of design documents by safety and systems assurance engineers and the Fire/Life Safety Committee.

The System Design Criteria and Standards were based on the preliminary criteria identified in the Metro Rail milestone reports prepared during preliminary engineering; on a review of all applicable codes, guidelines, and standards; on information in the Final Environmental Impact Statement; on the results of numerous technical analyses and special studies; and on information gained from staff experience, peer reviews, and familiarization trips to other rail rapid transit properties.

3.1.1 Milestone Reports

The development of the Metro Rail Project during preliminary engineering was charted in 12 milestone reports, each corresponding to a vital decision point. To obtain public input, extensive community participation programs were established for each of the 12 milestones. The Milestone 7 Report describes plans and criteria to ensure that the Metro Rail system provides safe, secure, and dependable rail rapid transit and discusses major issues of concern to the public.⁷

The criteria and standards contained in Milestone 7 were developed based on the experience of project team members and extensive technical analyses of safety-related issues; reviews of all applicable codes, guidelines, and standards to ensure compliance with regulatory requirements and industry standards⁸; familiarization trips to other U.S. and Canadian transit properties to gain first-hand knowledge of safety needs in underground rail rapid transit systems; and comments solicited during

7 SCRTD Metro Rail Project, Milestone 7 Final Report: Safety, Fire/Life Safety, Security and Systems Assurance, March 1983.

8 SCRTD Metro Rail Project, Review of Codes, Guidelines, and Regulations, November 1982.

industry peer reviews held at SCRTD. A fire/life safety peer review was held on October 14-15, 1981; a system safety peer review was held on June 29-30, 1982.

Milestone 7 was published as a Preliminary Draft Report in November 1982. The draft was submitted to UMTA for review and comment, and was made available to the public at a series of meetings. The report was revised to reflect appropriate suggestions and was adopted by the SCRTD Board of Directors in March 1983.

3.1.2 Environmental Assessments

Extensive analyses have been conducted of the environment in which the Metro Rail system will be built and operated, and of the system's potential impacts on that environment. During the preliminary engineering phase of the project, a Final Environmental Impact Statement (EIS) was prepared for the 18-mile alignment running from downtown Los Angeles through Wilshire, Fairfax, and Hollywood to North Hollywood.⁹ In preparing the EIS, numerous technical analyses were conducted of geological, seismological, and hydrological conditions along the system's alignment.

Subsequently, a series of environmental assessments of the MOS-1 system were conducted, including:

- Environmental Assessment: Los Angeles Rail Rapid Transit Project, Union Station to Wilshire/Alvarado, August 1984
- Comments and Responses on the Environmental Assessment for the Los Angeles Rail Rapid Transit Project, Union Station to Wilshire/Alvarado, October 1984
- Re-Evaluation of Environmental Record, June 1986.

In addition, as part of the Congressionally Ordered Re-Engineering Study, a draft Supplemental Environmental Impact Statement/Subsequent Environmental Impact Report (November 1987) was prepared for candidate alignments re-routing a portion of the system away from potential methane risk areas.

9 U.S. Department of Transportation, Urban Mass Transportation Administration, in conjunction with SCRTD, Final Environmental Impact Statement, Los Angeles Rail Rapid Transit Project: Metro Rail, December 1983.

3.1.3 Special Studies and Analyses

As part of the system design process, it was necessary to identify potential fire, seismic, toxic material, and other safety hazards, and to evaluate corrective actions to mitigate the hazards. Examples of these analyses include:

- Analysis of Water Supply at Station Sites, Rolf Jensen and Associates, March 1984.
- Final Report, Environmental Control System, Southern California Rapid Transit District Metro Rail Project, Parsons Brinckerhoff Quade & Douglas, Inc., August 1985.
- Gas Monitoring System Review and Design Recommendations, Metro Rail Transit Consultants, January 1985.
- Metro Rail Project Station Exiting Calculations, Rolf Jensen and Associates, September 1984.
- Report of Subsurface Gas Investigation, Southern California Rapid Transit District, Engineering-Science, May 1985.
- Report of Subsurface Gas Investigation - Southern California Rapid Transit District Metro Rail Project - Wilshire Corridor Alignment, Vols. 1 and 2, Reference Document, Engineering-Science, Arcadia, California, January 1984.
- Revised Water Supply Analysis: MOS-1 Metro Rail Project, Rolf Jensen and Associates, May 1986.
- Seismic Risk Analysis, WBS 12AAM, Lindvall-Richter and Associates, October 1982.
- Station Emergency Egress Study, WBS 13DAM, Volumes I and II, Harry Weese and Associates/Tibbets, Abbott, McCarthy & Stratton, August 1983; and Analysis of Exiting and Fire/Life Safety, Rolf Jensen and Associates, March 1984.
- Station Exiting Calculations, MOS-1, Rolf Jensen and Associates, November 1984, updated December 1985.
- Study of Public Fire Fighting Capabilities and Requirements for the Metro Rail Project, Kaiser Engineers and Gage-Babcock & Associates, August 1983.

- Yard & Shops Fire Water Distribution Systems, Rolf Jensen and Associates, July 1986, updated May 1987.

3.1.4 Independent Review Boards

Metro Rail design and construction plans have been formulated following exhaustive soils and geotechnical investigations conducted over a period of several years. These plans have been subjected to several in-depth internal reviews and have been thoroughly examined by two independent panels of outside experts knowledgeable in the design, engineering, and safety requirements of construction in a gassy and seismic environment. The members of the first panel were appointed by SCRTD; the members of the second panel, the City of Los Angeles Independent Technical Review Committee (ITRC), were appointed by City Council President Pat Russell and Congressman Henry Waxman. Both panels were tasked with a thorough review of the design and safety aspects of the project, with particular regard to methane gas related issues. Both panels commented favorably on the design effort undertaken by SCRTD. Several recommendations to enhance the project's safety were made by the panels, and have been incorporated into project criteria; plans, and contract specifications.¹⁰

3.2 SPECIFICATION PREPARATION

The design of the Metro Rail system meets several fundamental principles:

- Utilizing equipment which has proven safe and reliable in similar applications in other rail rapid transit systems
- Applying the principle of redundancy in design, so that failure of a single component will not be critical to either safety or operational service

10 See Critchfield et al., Independent Review Board Report on Design, Construction, and Operation in Gaseous Areas, prepared for SCRTD Metro Rail Project, September 1985; and Report of the Independent Technical Review Committee: Evaluation of the MOS-1 Portion of the Metro Rail Project, January 3, 1986.

- Establishing quality assurance procedures to ensure that materials, components, and equipment delivered and installed by contractors and subcontractors are inspected and conform to functional and performance requirements
- Developing failure management techniques for rapid response to failures to ensure that reduced levels of service will be maintained in the event of major failures or track blockages.

Specifications and contract drawings, consistent with basic design criteria, were developed incrementally, with SCRTD design reviews at the 30, 60, 85, and 100 percent levels of completion. The design reviews included inputs from transit equipment manufacturers and other transit systems. Safety and systems assurance engineers participated in design reviews of all facilities and systems contract packages, to review the safety aspect of proposed designs and provide input to design engineers. Major systems contracts include a chapter that clearly delineates contractors' safety program requirements.¹¹ For facility contracts, the safety requirements are covered in the Construction Safety and Security Manual, which is incorporated by reference into the contracts.

To ensure that all safety, security, and system assurance requirements are properly incorporated within final contract drawings and specifications, Criteria Conformance Checklists were prepared for each contract package. The checklists are used to independently review each contract before it is issued for bid to ensure all safety-related design requirements have been incorporated. The completed checklists are submitted to the Safety Certification Review Team for review and approval as part of the safety certification program.

Once ready for issue, all contract drawings and contract specifications are subject to SCRTD's change control process.¹²

11 See, e.g., SCRTD Metro Rail Project, Procurement Specification Book, Contract No. A650: Passenger Vehicle, Chapter VI, "Technical Provisions," Section 19, "Systems Assurance Program."

12 SCRTD Metro Rail Project, Change Control Procedure - Construction/Installation and Procurement Contracts, Revision 1, March 1988.

3.3 PROCUREMENT AND CONSTRUCTION MONITORING

To ensure that facilities are built and equipment is manufactured in conformance with all design requirements, including all safety requirements, all contractor work is closely monitored, and quality assurance audits, inspections, and tests are conducted. Monitoring includes review of contractor submittals, and the conduct of design reviews on construction shop drawings and on major system procurements (passenger vehicles, train control, fare collection, and communications systems). Personnel from the SCS Office with consultant support participate in safety-related quality assurance audits, inspections, and tests; participate in all design reviews; and review Change Requests to ensure that they do not degrade the safety of the system. The SCS Director participates in all SCRTD Configuration Control Board meetings.

In addition, to ensure that safety considerations are included in the design of equipment for the Metro Rail system, contract specifications require major systems contractors to implement a system assurance program and conduct safety and reliability analyses.

The system assurance program defines the major safety, reliability, maintainability, and quality assurance tasks the contractor will perform, and the role of the contractor's system assurance personnel as an integral part of the design and manufacturing process. Each contractor's system assurance program is reviewed by consultant staff, the Systems Safety and Assurance group, and the SCS Director. The system assurance program forms the basis for subsequent system assurance audits of contractors.

Major systems contractors are also required to prepare and submit subsystem, interface, and operating hazard analyses. In addition, the contractors are required to compile a list of critical/catastrophic items identified as a result of hazard analyses; failure mode, effects, and criticality analyses (FMECA); or other means.

Contractor's safety and system assurance submittals, including hazard analyses, must be prepared in accordance with SCRTD requirements currently in effect.

All hazard analyses submitted by contractors are thoroughly reviewed by Metro Rail engineers and the Systems Safety and Assurance group, and are then tracked

to resolution in accordance with established procedures.¹³

To ensure that all safety, security, and system assurance requirements specified in contract documents have been incorporated in the fixed facilities and equipment provided to SCRTD, Specification Conformance Checklists have been prepared for each contract. These checklists are used to ensure that all required safety features have been properly incorporated in the final product. The completed checklists are submitted to the Safety Certification Review Team for review and approval.

3.4 TESTING

Throughout construction, procurement, and start-up activities on the Metro Rail Project, a comprehensive test program will be implemented to ensure that:

- Equipment, material, facilities, and software conform to contractual requirements
- Equipment, facilities, software, and personnel function effectively together to provide safe and dependable service.

Because testing is a complex and vitally important element in preparing the Metro Rail system for service, the SCRTD has adopted a standardized approach to conduct, monitor, and coordinate the testing of Metro Rail elements. The requirements of the test program are delineated in the Metro Rail Test Program Plan.¹⁴ The plan will govern all Metro Rail testing, including contractual, materials, system integration, and pre-revenue operations testing. The plan is a certifiable element under the safety certification program, and must be reviewed and approved for safety content by the Safety Certification Review Team. Similarly, all procedures for safety-related tests must be reviewed and approved by the Safety Certification Review Team.

Contractual testing of Metro Rail facilities and equipment will begin during the construction phase and

13 SCRTD Metro Rail Project, Hazard Resolution Program, November 1986.

14 SCRTD Metro Rail Project, Test Program Plan, Rev. 1, September 1988.

continue through pre-revenue operations. Contractors will be responsible for preparing plans and procedures for tests that they are contractually responsible for performing. The CM Consultant will submit the test plans and procedures to TSD for review and approval. In addition, the CM Consultant will develop test and inspection plans and procedures, as required, in support of facility construction contracts for TSD's review and approval, and other test/inspection procedures for the designated construction materials testing laboratory. TSD and consultant staff will review the test results and reports and will provide a written approval or rejection to the contractor. Tests involving safety will be witnessed by appropriate personnel from the SCS Office with consultant support.

System integration testing will be conducted upon completion of the contractual acceptance tests. The system integration testing will be performed to demonstrate the ability of various subsystems and facilities to perform together as a system. Tests which affect system safety will be reviewed independently by the Safety Certification Review Team to ensure that potential hazards are identified and resolved.

The results of all safety-related tests will be submitted to the Safety Certification Review Team for review and approval as part of the safety certification program.

Following all contractual and system integration testing, start-up operations on the Metro Rail system will begin, as described in Chapter 6.0.

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4.0 SAFETY-RELATED DESIGN FEATURES

4.0 SAFETY-RELATED DESIGN FEATURES

The success of a rail rapid transit system depends on its acceptance by the general public. Safety is enhanced when an informed public knows that adequate and thorough safety requirements have been designed and implemented. Design requirements affecting safety are presented in this section for:

- Rail Control Center (RCC)
- Transit Police Dispatch Center
- Communications system
- Automatic train control (ATC)
- Passenger vehicles
- Stations and tunnels
- Electrification.

This chapter summarizes the most important design features that enhance the safety of patrons and employees. Reference should be made to the System Operating Plan¹ and the appropriate design criteria or contract specifications for more detailed information.

4.1 RAIL CONTROL CENTER

The RCC will serve as the nerve center of the Metro Rail system, containing the displays, controls, and communications equipment necessary for central supervision and control of system operations. This equipment will include a system status display, which will provide a schematic representation of train operations on the main line and at the transfer point to the yard; control consoles for the Train Dispatcher, Communications Controller, and Operations Supervisor; and CCTV Operator consoles.

4.1.1 System Status Display

The system status display board will provide a dynamic representation of the status of the ATC system and the traction power contact rail for main-line track and yard leads. The display will be used to monitor the

1 SCRTD Metro Rail Project, System Operating Plan, October 1986; and System Operating Plan for MOS-1, November 1987.

operation of trains and will provide the following indications:

- Track occupancy data at stations, interlockings, and approximately every 1,000 feet of track between stations
- Route alignment and traffic direction
- Operating modes of all trains
- Power status of contact rail segments.

The display board will be deferred for MOS-1. The same system status information for the 4-mile line will be displayed on video display units (VDUs) within the RCC.

4.1.2 Train Dispatcher Console

Equipment at the Train Dispatcher console will allow the Train Dispatcher to execute all ATC and traction power system control actions and to monitor operations on the main line and at the transfer point to the yard. The Train Dispatcher will have the ability to monitor, on VDUs, detailed line or power section schematics and system status displays; and to control switches, signals, train performance, and power distribution equipment. An electronic telephone set will function as a communications keyboard, providing control over radio, telephone, and RCC intercom.

4.1.3 System Communications Console

The System Communications console will be the focal point for control of Metro Rail communications, supervision of station operations and equipment, and monitoring of fire and life safety equipment throughout the system. The System Communications console will contain two workstations. The Communications Controller's workstation will be staffed at all times;² the other will serve as a Fire Department Liaison Position and may be staffed by Fire Department personnel during emergencies.

The Communications Controller's workstation will contain VDUs that display system schematics and provide

2 The position of Communications Controller will be deferred for the MOS-1 system. On the MOS-1 system, the Operations Supervisor will staff the System Communications console and perform all the functions of the Communications Controller.

status and alarm displays and access to control functions for selected equipment and subsystems, including:

- Status display and alarms for the Gas Monitoring and Seismic Activity Detection subsystem, Fire and Emergency Management subsystem, station fare collection equipment, station elevators and escalators, station and mid-tunnel ventilation equipment, AC power supply equipment, and intrusion detectors.
- Remote controls for fare collection equipment, elevators, ventilating equipment, fire suppression equipment, and AC power equipment.

The Communications Controller will have the ability to view selected station areas on CCTV and communicate with any station using the public address (PA) system. An electronic telephone set will function as a communications keyboard, providing control over radio, PA, RCC intercom, and the administrative (ATEL) and emergency (ETEL) telephone lines. All radio and ETEL communications will be recorded.

4.1.4 Operations Supervisor Console

A console with a single workstation will be provided for the Operations Supervisor. The equipment will enable the Operations Supervisor to perform any function available to the Train Dispatcher.³

4.1.5 CCTV Operator Consoles

Closed-circuit television (CCTV) will be used to monitor station conditions. Each CCTV workstation will be equipped with 12 small CCTV monitors, a large call-up monitor, and an electronic telephone set that provides the CCTV Operator with control of station PA systems, station passenger assistance intercom (PAI), the RCC intercom, and ETEL and ATEL lines. CCTV Operators will be able to make video recordings of CCTV images on the call-up monitor.

4.2 TRANSIT POLICE DISPATCH CENTER

Within the Transit Police Dispatch Center at Imperial Station on the Long Beach-Los Angeles light rail line will be a Police Radio Dispatcher console. The console will

³ This console will not normally be used on the MOS-1 system, but will serve as back-up equipment in case of failure at other consoles.

include a controlled-access VDU displaying intrusion detection alarms, a CCTV call-up monitor, and an electronic telephone set which functions as a communications keyboard providing the Police Radio Dispatcher control of radio, intercom, and telephone. It will provide access to ATEL, ETEL, and PAI lines, and direct-line access to area emergency service agencies.

4.3 COMMUNICATIONS EQUIPMENT

Communications equipment for the Metro Rail system will allow immediate notification and response to all normal, abnormal, and emergency situations. The communications system consists of 10 major subsystems.

4.3.1 Radio Subsystem

The radio subsystem encompasses RCC, wayside, passenger station, passenger vehicle, yard, and portable equipment. The radio subsystem will provide two-way radio communications and underground radio coverage of selected emergency service channels. Radios and base station equipment will be provided for operations and maintenance personnel. Frequencies will be compatible with those used by the Transit Police and the Los Angeles Fire Department.

4.3.2 Telephone Subsystem

Several telephone systems will be used for the Metro Rail system: an administrative telephone system for normal daily communication, an emergency telephone system for direct communication by passengers to the RCC, and a PAI to provide patrons hands-free communication with the RCC. Direct-line service will also be provided between the RCC and local emergency and utility agencies.

4.3.3 Public Address Subsystem

The PA subsystem will enable announcements to be made to single and multiple zones within individual and multiple passenger stations and at the yard and maintenance shops. The PA subsystem will also provide for prerecorded announcements.

4.3.4 CCTV Subsystem

The CCTV subsystem will provide a visual display to the RCC of designated areas within each passenger station. CCTV coverage will be provided for station entrances, platform edges, fare vending equipment, and trainway entrances. Video tape recording capabilities will also be available.

4.3.5 Cable Transmission Subsystem

The cable transmission (CTS) subsystem will be the primary means of transmission for the communications system between the RCC and all locations.

4.3.6 Supervisory Control and Data Acquisition Subsystem

The Supervisory Control and Data Acquisition (SCADA) subsystem will enable supervisory control of the ATC system, auxiliary and traction power, the environmental control system (ECS), and other systems and subsystems.

4.3.7 Fire and Emergency Management Subsystem

The Fire and Emergency Management (F&EM) subsystem will provide systemwide fire and intrusion detection, alarm reporting and management, special emergency telephones for fire department use (FTEL), halon fire suppression, and a card-key access control system to various Metro Rail facilities.

An emergency management panel (EMP) will be located at each passenger station. The EMP will provide audible and visual annunciation of fire alarms, fire suppression alarms, gas alarms, intrusion detection, and seismic event alarms associated with the passenger station and adjacent main-line wayside. A telephone providing access to ATEL and ETEL lines, two FTELEs, and a PA microphone will be located at each EMP. Control of selected fire and smoke control equipment will also be available at the EMP, as well as control of selected functions of faregates,⁴ elevators, and escalators.

In addition, an auxiliary EMP will be provided at each mid-line shaft. A Command Post will be provided at station entrances not equipped with an EMP, and at access stairways. Blue Light Stations (BLSs), located throughout the system, will provide local controls--emergency trip stations (ETS)--for deenergizing the contact rail; ETEL, FTEL, and ATEL communications; and, when equipped, undercar deluge control.

4.3.8 Gas Monitoring and Seismic Activity Detection Subsystem

The gas monitoring and seismic activity detection subsystem will provide gas and seismic detection in

4 A barrier-free fare collection system will be implemented on the MOS-1 system.

strategic positions in stations and vent shafts. Alarms and indications will be located in associated train control and communications (TC&C) rooms, at the EMPs, and at the RCC.

The gas monitoring equipment will measure the level of methane gas and hydrogen sulfide in the tunnels and station auxiliary rooms and transmit that data to the RCC, along with an indication of the location at which the measurement was taken. Ventilation equipment will be automatically activated after a pre-set time delay. Portable gas detection equipment will also be provided to locate gas leaks. Seismic event detectors will detect, record, and display a visual representation of earthquakes to the RCC.

4.3.9 Rail Control Center Subsystem

The RCC subsystem will provide equipment which supports other systems, such as traction power, ATC, and ECS. Included at the RCC will be data processing equipment, consoles, voice logging recorders, video recorders, data recorders, displays, and control panels. The major components were discussed earlier.

4.3.10 Power Subsystem

The power subsystem will include battery/rectifier, uninterruptible power supply (UPS), and DC power distribution apparatus for station, wayside, and yard communications equipment, and battery/rectifier/UPS for appropriate SCADA and console equipment at the RCC.

4.4 AUTOMATIC TRAIN CONTROL

Metro Rail trains will normally operate on the main line, in the terminal zones, and between the transfer point and the main line under the control of ATC equipment. ATC equipment will perform the functions of Automatic Train Protection (ATP), Automatic Train Operation (ATO), and Automatic Train Supervision (ATS). These functions will enforce train safety, control train motion, and permit supervision of train operations on the main line. The ATP function will ensure safe train operation; the ATO and ATS functions will be entirely subordinate to the ATP function. The ATP equipment will:

- Enforce speed limits through the use of speed codes along the track, causing the service brakes to be applied whenever a train exceeds the safe speed limit

- Provide brake assurance by commanding the emergency brakes to be applied whenever deceleration is commanded but not confirmed
- Generate track occupancy data to ensure the establishment of safe speed and separation profiles for the trains
- Prevent conflicting train routings or movements
- Ensure route security through interlockings
- Detect broken rails
- Prevent a Train Operator from opening doors unless a train is stopped, and prevent a train from moving when vehicle doors are open.

ATO equipment will control train movements. The equipment will automatically regulate speed by controlling propulsion and brake equipment and perform programmed station stopping functions.

ATS equipment will support the monitoring and direction of train operations. The equipment will communicate train identity, destination, and status information; store and transmit route requests consistent with interlocking availability; enable local control of interlockings and other remotely commanded equipment; and adjust station dwell time.

4.5 PASSENGER VEHICLES

To help minimize the potential for vehicle-related accidents or injuries, numerous safety features are incorporated into the vehicle design. Vehicle electrical, electromechanical, hydraulic, and mechanical system designs use approved redundancy, fail-safe, or fail-operational principles.

4.5.1 Doors

Side doors (and end doors in emergencies) are the appropriate means for patrons to enter or leave passenger vehicles. Safety features include:

- ATP circuitry that prevents the doors from opening while the train is moving and prevents the train from moving when the doors are open. The design also prevents the doors on the side opposite the platform from being opened and

prevents the side doors from being manually pushed open when the train is moving.

- Side door edges with appropriate stiffness to prevent fingers from being inserted between fully closed doors, yet permitting the withdrawal of trapped clothing or articles.
- An audible door warning signal before the doors close.
- Emergency manual door release controls inside the cars and exterior door controls for emergency teams.
- End doors that can be used in emergencies. (Signs will be placed on the end doors to discourage their use at any other times.)

4.5.2 Lighting

Lighting inside passenger vehicles will provide sufficient illumination so that passengers can easily see to read. In the event that primary power is lost, a backup power source will provide emergency reduced lighting.

4.5.3 Communications

To allow patrons to communicate with the Train Operator in an emergency, each vehicle will contain instructions and passenger intercoms to permit communications between a patron and the Train Operator even if power is lost. Trains will contain communications equipment to permit the Train Operator to communicate with the Train Dispatcher or Yard Dispatcher, with Line Supervisors, and with train passengers. The cab will contain a communications control panel for operating the train radio, the train PA system, the patron intercom, and the cab-to-cab intercom; there will also be a patch-through capability for RCC-to-train PA announcements. The Train Operator can communicate with the RCC using his portable radio or the train radio.

4.5.4 Windows

Windows are designed to mitigate hazards caused by objects striking or shattering the windshields, side windows, end windows, and cab windows.

4.5.5 Interior Design Features

Passenger comfort and convenience is a major consideration in vehicle design and layout. Seating and

standing arrangements will enable patrons to move safely and easily within either moving or stationary trains:

- Human factors engineering will be used in the design of all vehicle features, including the passenger and operator seats and the cab layout
- Sharp edges and protrusions will be avoided, and protective cushioning will be provided where appropriate
- Stanchions and handholds will be provided
- Within each car, one wheelchair location will be provided which will not interfere with other patron movements
- The seat design and structural requirements will be in accordance with crash-worthiness requirements.

4.5.6 Cab Controls and Indicators

Unusual conditions and system failures, such as propulsion problems, overspeed conditions, door problems, and braking failures will be annunciated in the cab.

Within the cab of each vehicle will be the Train Operator's console, which will include a speedometer, speed limit readout, manual controller, control mode switches, emergency stop controls, indicators, overspeed alarm, door operation controls, and sealed bypass switches and cutouts. The control mode switches will enable the Train Operator to select either the automatic mode or one of three manual modes of operation.

A pushbutton on the Train Operator's console will allow the Train Operator to command an emergency brake application in any mode. The command for an emergency brake application cannot be canceled after the pushbutton has been depressed.

4.5.7 Propulsion and Braking

Propulsion and braking systems are designed so that no single failure can result in an unsafe condition. Except when the train is operating automatically, the Train Operator will control train movement by operation of the manual controller, which will have an integral "deadman" switch. This switch must be continuously activated by the Train Operator to avoid a brake application.

4.5.8 Fire Protection

Stainless steel vehicles with a one-hour fire separation from underfloor equipment will be used. All interior materials will be selected to minimize flame-spread, smoke emissions, and potential toxic gases. Two fire extinguishers will be provided in each car, along with emergency instructions for evacuation.

4.6 ELECTRIFICATION

Electricity will be used to operate the trains and also for other necessary functions and services which are important to patron safety, security, comfort, and convenience. Design of the electrical systems include provisions for the continuation of critical operations during failure of the main power source.

4.6.1 Emergency/Essential Power Supplies

Critical functions that require a constant, uninterrupted power supply will draw their power from a battery set should the main power supply fail. These functions include communications, automatic train control, fire detection, control power, supervisory control, and some emergency lighting.

Essential station functions will be provided with emergency power from a separate power source. Automatic transfer of power will take place within several seconds so that ventilation shaft fans, elevators and escalators, tunnel lighting, and emergency station lighting will continue. Redundant wiring for emergency circuits will be used wherever appropriate for safety reasons. Provisions have been included for plug-in diesel generators at the yard for supplying auxiliary power during emergencies.

4.6.2 Third Rail

Non-conductive, rigid third rail coverboards that meet appropriate fire, smoke, and toxicity requirements will reduce the possibility of patrons or employees inadvertently contacting the third rail.

The third rail will be located opposite safety walks in the tunnels and opposite station platforms. Patrons and employees will be warned of the hazards associated with the third rail by means of appropriate signs.

As described in Section 4.3.7, ETSS will be provided throughout the system to deenergize third-rail power.

4.7 STATIONS AND TUNNELS

Metro Rail stations have been designed to maximize the safety of the patrons and employees. Tunnels also incorporate design features to minimize hazards to maintenance workers and patrons during emergencies.

4.7.1 Stations

Stations will be constructed of non-combustible materials and have been designed to minimize the potential for accidents. Key features include:

- Minimal exposure to traffic hazards at station entrances
- Interior station finishes that comply with Uniform Building Code (UBC) Class I requirements
- Clear, well-illuminated signs and graphics
- Platform edge safety strip and slip-resistant walking surfaces
- Railings and guardrails
- Underplatform refuge area
- Vehicle/platform interface designed for minimal misalignment
- Normal and emergency lighting
- End-of-platform gates
- Exhaust systems for smoke and gases
- Dedicated emergency egress routes.

Elevators, escalators, and stairs are designed to comply with local and state building codes. Elevators will be equipped with intercoms and meet all handicapped accessibility requirements. Elevators will have adequate space for emergency medical equipment, such as stretchers. Escalators will have emergency stop capabilities. Stations have been designed to handle the expected patronage and to enable quick evacuation in an emergency. Escalators have been sited to minimize queuing on the mezzanine and platform levels.

4.7.2 Tunnels

Tunnels have been sized to safely accept the dynamic outline of the vehicle and have proper clearance for safety walks, signals, and standpipes. Tunnel construction will meet UBC Type I requirements. Tunnel liners have been designed to preclude the penetration of gas or other substances. Structural members have been designed to withstand severe earthquake loads. Tunnel materials and rail ties will be non-combustible.

Safety features in tunnels include a continuous safety walk, emergency exits⁵ and lighting, cross passages to the adjacent tunnel, wet standpipe fire suppression system and fire extinguishers.

4.8 YARD AND MAINTENANCE SHOPS

Even though patrons and the general public will not use yard and shop facilities, safety and security has been a focal point of their design. The yard and maintenance shops (including the RCC) incorporate numerous design features to protect employees and property from accidents.

4.8.1 Yard

The entire yard area will be fenced, with access through one main gate. The yard and all parking areas will be well-lighted for safety reasons, as well as to discourage criminal activity. Fire protection equipment will be located throughout the yard. A network of paved interior surface roads will provide access for emergency vehicles, and aisle widths will allow safe access between stored trains. ETSS will be provided at strategic locations. All yard movements will be controlled from the Yard Tower.

4.8.2 Main Shop and M-O-W Building

Maintenance facilities have been designed to minimize hazards to employees. Pits will be protected by removable railings. Emergency eye washes and showers will be provided in appropriate locations (e.g., battery shop). A work environment conducive to safe maintenance practices has been designed (communications systems, lighting, soundproofing, ventilation/dust control, floor coverings, etc.). The facilities will comply with all building codes and fire regulations, and will include modern sprinkler

5 Station distances for MOS-1 preclude the need for mid-tunnel emergency exits.

systems, fire alarms, standpipes, and fire extinguishers. Warning signs and emergency instructions will be provided, along with first-aid equipment in specified shop locations.

4.8.3 Rail Control Center

The Rail Control Center will be located on the second floor of the Main Shop. Because of its importance to the operation of the rail system, particular emphasis has been placed on ensuring that it is operational during all emergencies. In addition to fire alarm and detection and sprinkler systems, a halon fire suppression system will be provided for areas with critical equipment (e.g., computer rooms).

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5.0 CONSTRUCTION SAFETY

5.0 CONSTRUCTION SAFETY

To enhance safety during construction, SCRTD has implemented a construction safety and security program to protect the public, workers on the project, and property during construction of its Metro Rail facilities, and to minimize losses due to accidents and vandalism. The safety program applies to all construction and installation contractors and subcontractors working on the Metro Rail Project site, as well as to SCRTD, consultant personnel, and visitors at the site. The program meets all applicable federal, state, and local regulations and SCRTD safety requirements.

The program's requirements are documented in construction specifications and in the project's Construction Safety and Security Manual.¹ In developing the manual, construction safety programs developed for other U.S. transit properties and for tunnel construction projects in California were reviewed by SCRTD and CM Consultant safety personnel. The manual was reviewed and approved by Cal-OSHA, the Metro Rail Fire/Life Safety Committee, and applicable SCRTD departments and consultants. Changes to the manual are subject to the same level of review and approval as the original document.

Construction specifications require contractors to develop and implement safety and security programs that comply with the requirements of the Construction Safety and Security Manual, as well as with Cal-OSHA, local, state, and federal regulations. The SCRTD and its representatives review contractors' program plans and ensure that contractors implement them and comply with all safety requirements. Details on SCRTD and CM Consultant safety monitoring, surveillance, and reviews are provided in Section 5.2.11 and in the Construction Safety and Security Manual, the System Safety and Security Program Plan, the System Assurance Program Plan, the Resident Engineer Manual,²

1 PDCD, Construction Safety and Security Manual, Revision 2, February 1987.

2 PDCD, Resident Engineer Manual, February 1987.

the QA/QC Procedures Manual,³ and the Inspector Guidelines Manual.⁴

The CM Consultant has overall responsibility for all construction safety and health matters on the project site, and holds each contractor, manager, supervisor, foreman, and employee responsible for all safety, health, and contractual duties. Each contractor is held accountable for safe performance of work by each of its subcontractors.

The CM Consultant is responsible for managing the construction safety and security program, conducting constructibility reviews to ensure safety considerations, monitoring the safety of construction activities, and ensuring compliance with safety requirements. The CM Consultant has the authority to issue stop-work orders to any contractor or subcontractor who fails, or refuses, to take prompt corrective action when given notice of noncompliance with any of the applicable safety requirements.

Each contractor is required to designate a Safety Representative who is responsible for the safe and healthful performance of work by his work force and that of his subcontractors. The Safety Representative's minimum qualifications for tunnel work are established by the Cal-OSHA Mining and Tunneling Unit. The contractors' Safety Representative prepares all accident or injury reports required by the contractor, SCRTD, Cal-OSHA, the DIA, and city or federal authorities. The contractors' Safety Representative makes regular work area inspections and conducts toolbox and foremen safety meetings and safety indoctrinations of all new employees. The Safety Representative also attends a weekly safety meeting with the CM Consultant's Safety and Security Manager, ensures that all required contractor reports are prompt and correct, and investigates all accidents that may require further investigation by the Safety and Security Manager, SCRTD, or the DIA. When necessary, the CM Consultant prepares reports to show steps taken to prevent accidents and develops hazard analyses to determine accident causes and methods for accident prevention.

3 PDCD, QA/QC Procedures Manual, September 1985, Revision 1, February 1987.

4 PDCD, Inspector Guidelines, February 1985, Revision 1, February 1987.

5.1 PRE-CONSTRUCTION REQUIREMENTS

Prior to the start of each construction contract, a number of safety requirements must be met and tasks accomplished. These include the holding of a pre-construction safety meeting, attended by representatives from the TSD Construction Management Office and SCS Office, the contractor and subcontractors, the CM Consultant, the DIA, and Cal-OSHA.⁵ The meeting is held to review contractual safety requirements and the status of contractor compliance with pre-construction requirements. No construction work can begin until the contractor has complied with applicable safety requirements.

5.1.1 Contractual Requirements

The SCRTD requires contractors to know all safety regulations which apply to their contract operations. For example, Cal-OSHA has classified MOS-1 as "gassy"; therefore, all Cal-OSHA requirements for working in a gassy environment apply.⁶ In addition, construction and installation contracts contain specific Metro Rail safety requirements that are more stringent than those of Cal-OSHA, including safety requirements recommended by SCRTD independent review boards and local government officials.

Contractors are required to obtain necessary permits from regulatory agencies, for example:

- Cal-OSHA permits⁷ for construction of trenches or excavations, and the construction or demolition of any building, structure, scaffolding, or falsework more than three stories high.
- Permits required by the City or County of Los Angeles
- Proof of registration with the Division of Occupational Safety and Health prior to commencing work on any building which contains more than 100 square feet of asbestos-containing material.

5 A Cal-OSHA representative attends only when the construction contract falls under the jurisdiction of the Cal-OSHA Mining and Tunneling Unit per Title 8, Part 9, Chapter 1, also known as the "Tom Carrell Memorial Tunnel and Mine Safety Act of 1972."

6 Cal-OSHA Tunnel Safety Orders - Section 8425.

7 Labor Code - Section 6501.5.

5.1.2 Training and Qualification

Training and qualification requirements for contractor safety personnel have been defined and incorporated into contract documents. In addition, general training, qualification, and orientation requirements for construction personnel on the Metro Rail site have been defined.

The SCRTD requires each construction contractor to inaugurate and maintain an accident prevention program that is developed to fit the specific work and its hazards. The program covers, at a minimum, safety training requirements for work in gassy and extrahazardous tunnels, training in the safe performance of job duties, and training in accordance with Cal-OSHA standards for the use and handling of hazardous or toxic materials.⁸

The SCRTD construction safety program also requires contractor personnel to receive orientation and training in procedures for such emergencies as cave-ins, structural failure, earthquakes, fires, toxic gases, explosions, underground rescue, flooding, and bomb threats.

When an employee first begins work on the Metro Rail Project, the contractor is responsible for ensuring that the employee is knowledgeable in the work that is expected to be performed and of its safety requirements, and is physically and mentally capable of performing the work.

Use or possession of substances that cause physical or emotional impairment on the job and contribute to injuries and accidents is cause for removal of the individual.

The contractor is required to provide a Cal-OSHA⁹ certified gas tester on each work shift to continually test the tunnel atmosphere for the presence of gas when work is being conducted in areas considered by Cal-OSHA to be gassy or extrahazardous.

5.1.3 Pre-Construction Surveys

Prior to the award of a construction contract, the DIA contracts for the services of an experienced company to conduct pre-construction surveys of buildings, structures, streets, roads, and bridges in order to ascertain

8 Cal-OSHA Tunnel Safety Orders - Sections 8426 and 8430.

9 Cal-OSHA Tunnel Safety Orders - Section 8424.

their condition prior to start of any construction activity adjacent to the property. The survey documents any pre-existing damage to the structures' interior and exterior in the zone of influence of the construction project. The surveys are primarily intended for use as a defense in liability claims, but also give advance warning of potential problem areas and/or hazardous conditions.

5.2 SAFETY DURING CONSTRUCTION OPERATIONS

The SCRTD recognizes that construction operations may give rise to potential long-term as well as immediate safety problems, and has addressed the appropriate safety requirements necessary to identify and mitigate all such threats. These include the monitoring of horizontal and vertical movement on geological faults and excavation systems, gas and noise monitoring, hazardous waste handling and disposal, fire protection, tunneling and equipment handling, emergency plans and procedures, and personal and public safety.

5.2.1 Personal Safety

The SCRTD safety program requires that every employee wear personal protective equipment where required by Cal-OSHA. Personnel are issued, as appropriate, hard hats, ear protection, eye protection, and protective footwear. Specialized equipment, such as miner's lights and respiratory equipment, are provided as necessary. Employees or visitors who are not wearing prescribed equipment are removed from or prohibited from entering the job site.

5.2.2 Public Safety

The SCRTD is aware of the need to protect the public during construction and ensures that each contractor takes all necessary precautions to prevent injury to the public or damage to property of others, and to take whatever security steps are necessary to prevent theft of, or vandalism to, property in the contractor's care, custody, and control. The protection of the general public is in accordance with California state laws and the laws of the City and County of Los Angeles.

These requirements include precautions against excessive noise levels that may be considered a proximate cause of damages or injury, or contributory to the cause of damage or injury. The contractor ensures compliance with state, city, and county laws for noise curfews in effect in the immediate work areas that may affect the general public.

Contract specifications require construction contractors to take certain measures for the protection of private property adjacent to Metro Rail construction sites. These measures include physical protection, to prevent damage from construction activities; and the installation and monitoring of instruments, to provide an early warning of cosmetic damage or structural failure.

5.2.3 Materials, Tools, Vehicles, and Equipment

SCRTD requires that contractors adhere to the requirements for proper storage and disposal of materials and handling of tools and equipment as delineated in the Construction Safety and Security Manual. Motor vehicles, machinery, and mechanized equipment working underground comply with Cal-OSHA requirements.¹⁰

Where there is reason to believe that a serious hazard exists to employees because of traffic or haulage conditions, a system of traffic control may be required that is satisfactory to the CM Consultant, SCRTD, Cal-OSHA, Los Angeles Police Department, County Sheriff, and California Highway Patrol.

5.2.4 Fire Protection

Recommendations of the National Fire Protection Association and applicable regulations of the City and County of Los Angeles and Cal-OSHA¹¹ form the basis for fire prevention requirements.

A survey is made of the suitability and effectiveness of fire prevention and protection measures and facilities at each project site, and areas with a high fire exposure are identified. These areas are designated as hazardous and require necessary Cal-OSHA and Los Angeles City Fire Department approvals before work begins.

The contractor conducts an inspection (fire watch) of the entire operation immediately after the close of the normal workday to discover any smoldering or incipient fire and to correct any hazardous condition. The inspection also verifies that Cal-OSHA requirements for handling of flammable materials, fire extinguishers, and fire

10 Cal-OSHA Tunnel Safety Orders - Article 16.

11 Cal-OSHA Tunnel Safety Orders - Article 14, General Industry Safety Orders - Article 156, Construction Safety Orders - Article 36.

hazards (including those associated with welding) are being followed.¹² Adequate fire extinguishers and standpipes must be accessibly located and maintained in a clean, operable, and undamaged condition during station and tunnel construction.

5.2.5 Tunneling Activities

The CM Consultant's geotechnical personnel monitor the tunnel face and probe hole drilling results, record observations, and take samples. If it becomes apparent that a fault may exist, work on the face stops until observations, samples, measurements, and analyses can be completed.

Strict adherence to Cal-OSHA Compressed Air Safety Orders is required when tunnel work is carried out under air pressure in excess of atmospheric pressure. Cal-OSHA establishes minimum safety standards for workers in tunnels, shafts, raises, underground chambers, and appurtenant premises during excavation, construction, alteration, repair, renovation, and demolition activities.

SCRTD requires that contractors provide at least seven gas monitoring heads on tunnel excavating machines in prescribed locations, including the heading area, and an additional monitor in the exhaust ventilation line. The monitors must comply with Cal-OSHA requirements.¹³

Contractors are also required to maintain a refuge chamber or alternative escape route within 5,000 feet of the face of a tunnel classified as gassy or extrahazardous or according to any specific requirements stated by Cal-OSHA Tunnel Division. Refuge chambers are equipped per Cal-OSHA requirements.¹⁴

All electrical work in tunnels is performed in accordance with the Electrical Safety Orders, Title 8, California Administrative Code. Where hazardous concentrations of flammable gases, dust, or vapors exist, National Electrical Safety Code Article 59, item 2540.1, is also adhered to.

12 Cal-OSHA Tunnel Safety Orders - Article 14, GISO - Article 156, CSO - Article 36.

13 Cal-OSHA Tunnel Safety Orders - Section 8425 (d).

14 Cal-OSHA Tunnel Safety Orders - Section 8425 (h).

5.2.6 Explosives

The SCRTD does not anticipate any blasting during Metro Rail construction. However, if it is required, Cal-OSHA standards for explosives will be adhered to.¹⁵ Blasting operations or projects will require licensed blasters. The contractor will also obtain permits and licenses as required by the City and County of Los Angeles.

5.2.7 Environmental Monitoring and Hazardous Waste Disposal

Environmental permits for construction have been obtained from the California Regional Water Quality Control Board and from the California South Coast Air Quality Management District. The CM Consultant has supported the SCRTD in obtaining permits. The CM Consultant is responsible for monitoring and documenting compliance with the provisions of the environmental permits. Individual construction contractors and equipment suppliers have been made responsible, in flowdown fashion, for compliance with the provisions of the environmental permits insofar as their activities and equipment may produce adverse environmental effects which are limited by the permits.

Removal and disposal of hazardous materials, including underground tanks classified as hazardous, are accomplished in accordance with federal, state, and local ordinances.

Contractors encountering or suspecting the presence of hazardous materials must promptly take all emergency measures required by any laws and simultaneously notify the SCRTD through the CM Consultant and request instructions. Contractors are not allowed to proceed with work until instructions (which have been approved by the appropriate jurisdiction) from the SCRTD have been provided.

5.2.8 Emergency Plans

The SCRTD requires each contractor to prepare a general plan of action for use in an emergency, and to have that plan reviewed and approved by the CM Consultant and the TSD Construction Management Office and SCS Office. In addition, for work underground, the plan

15 Cal-OSHA Tunnel Safety Orders - Articles 20-24, GISO - Article 18.

must be approved by Cal-OSHA and posted in a place where employees congregate.¹⁶ The plan outlines the duties and responsibilities of each person, including members of the emergency plan team, so that they know what is expected of them in the event of an emergency. The approved plan addresses such items as ventilation controls, fire-fighting equipment, rescue procedures, evacuation plans, communications, and procedures for stabilizing conditions at the site until the arrival of local emergency response authorities. All emergency plans include procedures for fulfilling the following requirements:

- At all tunnels where flammable or noxious gases are encountered or anticipated in hazardous quantities, permissible self-contained breathing apparatus, in number and type as Cal-OSHA directs, must be provided and properly maintained.
- A qualified and trained rescue crew of five persons must be available within 30 minutes for tunnels where flammable or noxious gases are encountered or anticipated in hazardous quantities, or where 10 or more employees are underground during any one shift.

Procedures for the reporting of emergency actions, which include construction accidents involving workers or the public, fires, unusual activities or terrorist threats, are covered in the Construction Safety and Security Manual and Emergency Response Plan.¹⁷ When an emergency results in the destruction of SCRTD or public property in excess of \$10,000 and/or serious injury or loss of life, the General Manager notifies the SCRTD Board of Directors of the incident and provides periodic progress reports until such time as the incident or emergency is resolved.

5.2.9 Construction Site Security

Contractors are required to analyze the need for security on their specific contracts and to develop security programs before commencement of work. The program requires approval by the CM Consultant and the TSD Construction Management Office and SCS Office. Contractors review physical and personnel control; establish procedures, security policies, and hiring practices;

16 Cal-OSHA Tunnel Safety Orders - Section 8426.

17 SCRTD Metro Rail Project, Emergency Response Plan, May 1987.

and address the duties and responsibilities of security personnel. Particular attention is given to protecting SCRTD property, including specialized equipment, from theft and vandalism.

5.2.10 Accidents, Injuries, and Illnesses

Supervisors file accident reports as soon as possible, but not later than 48 hours after occurrence. Damage to equipment or property is reported to the SCRTD and DIA.

Workers' Compensation claims are reported in accordance with Construction Insurance Specification requirements, as indicated in contract specifications.

First aid and medical services for the job-site are provided as required by Cal-OSHA and as specified in the Construction Safety and Security Manual.

5.2.11 Safety Inspections and Audits

Safety and security personnel from the SCS Office and the CM Consultant, augmented as necessary by construction/management engineers, conduct surveillance and formal safety audits to ensure that construction safety requirements are being implemented.

In addition, representatives from the Fire/Life Safety Committee, DIA, SCRTD Risk Management Department, and Cal-OSHA periodically visit construction sites. Their identification of deficiencies and of required corrective actions assist in ensuring that the safety program is being properly implemented. Formal audits of the implementation of construction safety requirements are also an integral part of the CM Consultant and SCRTD quality assurance and systems assurance programs.

5.3 INSURANCE PROGRAM

Major insurance coverage for the Metro Rail Project has been placed under a loss sensitive rating plan that encourages safe construction and operation practices.

The DIA brings to this project significant expertise gained through participation in other major rail rapid transit construction in the United States and overseas. In support of the safety and loss control program, the DIA assists in the following areas:

- Establishment of Standards. Standards have previously been promulgated for construction. The California Occupational Safety and Health Administration, American National Standards

Institute, National Fire Protection Association, National Electrical Safety Codes, and the Mine Safety and Health Administration represent the minimum standards for the project's construction safety program. These standards have been incorporated into the construction safety program by reference. If required, additional standards and/or procedures are developed to address special conditions encountered on the project.

- Comprehensive Training Program. The DIA assists the CM Consultant in the development of training programs for contractors and new hires in the areas of safety and loss control.

The DIA assists and supports the CM Consultant and the SCRTD in mitigating and limiting the SCRTD's liability against preventable hazards, accidents, and potential illnesses related to construction activities.

The DIA monitors the performance of all construction operations within, and under contract to, the SCRTD in such areas as personnel safety, liability exposure, public safety, fire protection, and emergency planning.

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6.0 OPERATIONS SAFETY

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Prior to the start of revenue service operations on the Metro Rail system, all plans, procedures, and training courses required for system operation will be reviewed for safety content by the SCS Office, and certified under the safety certification program. A pre-revenue test program¹ will simulate all aspects of revenue service and verify:

- The ability of Metro Rail to coordinate plans, rules, procedures, equipment, facilities, and personnel to sustain reliable and safe normal revenue service
- The ability of Metro Rail and outside agencies to coordinate plans, rules, procedures, equipment, facilities, and personnel to provide safety for passengers, employees, and property during abnormal/emergency operations.

The pre-revenue tests will include simulated disaster drills (e.g., fire, earthquake, flood) with outside agencies and SCRTD personnel. All fire/life safety equipment will be tested and certified prior to revenue service.

Operating procedures and training programs will be prepared by various departments within the SCRTD. They will be reviewed for completeness and consistency by the SCS Office.

Any hazards or deficiencies identified during system start-up tests will be assessed and, if necessary, system equipment, facilities, procedures, or training courses will be modified.

During start-up of the system, SCRTD operations personnel will work closely with TSD and consultant staff to ensure a smooth transition to revenue service operations. A System Safety Program Plan--Operations will

1 See SCRTD Metro Rail Project, Test Program Plan, Rev. 1, September 1988, including Appendix C, "List of Systems Integration and Pre-Revenue Tests," Rev. 0, September 1988.

address safety organizations, tasks, and responsibilities during revenue service operations.

Prior to operations, the American Public Transit Association (APTA) Rail Safety Review Board will be requested to conduct a safety review of the Metro Rail system. A panel of senior transit industry professionals with requisite expertise in all aspects of rail operations and safety will assess the ability of the Metro Rail system to safely initiate revenue service. The report will be presented to the General Manager for his disposition.²

The following sections of this chapter summarize the plans and procedures that will be developed to enforce safety requirements during revenue service operations.

6.1 TRAINING

Training will be provided to instill an awareness of potential hazards, hazardous situations, safety practices, and procedures. Training will be provided to operating, maintenance, and supervisory personnel. Training will include procedures for system emergencies and natural disasters to ensure a safe system environment and to enable personnel to respond quickly and effectively. Training programs will ensure that:

- Skills of operating and maintenance personnel are maintained at established levels
- The training and qualifications of operating and maintenance personnel ensure adherence to safety procedures and safe system operation
- Continuing safety education, retraining, and retesting is provided for all personnel
- Outside agency personnel are trained in natural disaster response and participate in simulated disasters and system emergencies
- Passenger vehicle and system availability, performance, and reliability standards and goals are being cost effectively achieved in accordance with established policies, standards, and procedures.

2 See, e.g., Report of the APTA Safety Review Panel for the Tri-County Metropolitan Transportation District of Oregon Banfield Light Rail Project, June 5, 1985.

6.2 OPERATING RULES AND PROCEDURES

The SCRTD will establish standard operating procedures for the conduct of all normal and abnormal operations. Procedures will be developed pertaining to:

- Administrative rules and regulations
- System start-up and shutdown
- Entering and removal of trains from service
- Station operations
- Main-line operations
- Yard operations
- RCC operations
- Abnormal conditions
- Problem reporting
- Revenue collection and processing
- Rail/bus service integration.

All operating and maintenance personnel will be periodically tested for their knowledge of standard operating procedures, rules, and regulations. All Train Operators will be governed by written rules contained in an Operator's Rulebook. Because of the potentially severe consequences of improper operator conduct, certain violations, such as running a red signal or activating a bypass switch without permission from the RCC, will be grounds for disciplinary action.

Metro Rail employees will comply with the SCRTD's comprehensive alcohol and drug abuse policy.³ The policy calls for mandatory drug testing in the event of certain accidents and physical altercations, and provides for discretionary testing in the event of incidents of various types, including disruptive and unusual behavior by an employee.

6.3 EMERGENCY PREPAREDNESS

The SCRTD will develop emergency procedures in anticipation of, and to plan for, emergency situations. These procedures will be contained in an Emergency Procedures Manual (EPM). The EPM will address the following types of emergencies:

- Fire and/or smoke on a train or any other part of the system

3 SCRTD, Comprehensive Alcohol and Drug Abuse Policy, December 1986.

- Fire and/or smoke adjoining or adjacent to the system that threatens the system or disrupts service
- Collision and/or derailment involving one or more cars
- Loss of electric power resulting in a stalled train and/or loss of illumination
- Evacuation of passengers from a station or train
- Panic of passengers
- Disabled and/or stalled trains
- Serious flooding
- Seismic events
- Structural collapse or threat of imminent collapse
- Seepage of flammable, toxic, or irritating products into the system
- Serious vandalism or other criminal acts
- Emergency medical attention required by a passenger
- Extreme weather conditions causing disruption of service.

The EPM will be organized to provide a step-by-step response to each emergency situation. The EPM will include:

- Key contacts and personnel in outside agencies (police, fire)
- Safety procedures to be followed during emergency operations
- Description of the purpose and operation of the RCC in an emergency
- Description of the locations, requirements, purpose, and operation of Incident Command Locations and Auxiliary Incident Command Locations

- Description of requirements, purpose, and operation of radio and telephone communications at the RCC, at all stations and access points to underground facilities, and intermediate points throughout tunnels
- Description of the locations, requirements, purpose, and operation of BLSs/EMPs/CPs, including fire detection, fire protection, and fire extinguishing equipment, and ventilating equipment controls
- Maps and plans of the system.

Exercises and drills will be periodically conducted to prepare personnel from the SCRTD and participating agencies to function efficiently during an emergency.

6.4 HANDBOOKS AND MANUALS

Various manuals and handbooks will be developed to ensure safe system operations and safe maintenance practices. These will include maintenance manuals, which will specify detailed procedures for the safe operation of maintenance equipment. In addition, safety requirements for maintenance personnel working in tunnels, traction power substations, and similar system areas will be documented. Maintenance safety checklists will also be developed to ensure that any safety requirements are checked before an item of equipment is returned to service.

Examples of other manuals and handbooks to be developed include:

- A Fire Protection Features Manual, which will describe the design, proper operation, and maintenance of all fire protection and suppression and emergency ventilation equipment in the Metro Rail system. The manual will be used for training course instruction as well as a basic reference document for Metro Rail maintenance and fire and police personnel.
- A Fire and Police Communications Systems Handbook, which will contain descriptions and instructions on the use of all fire and police communications systems, channels, radios, telephones, etc. The handbook will be used for training course instruction as well as a basic reference document for RCC, Fire, and Police personnel.

6.5 ACCIDENT/INCIDENT REPORTING AND INVESTIGATION

The primary purpose of accident/incident reporting and investigation is to prevent a recurrence of accidents/incidents and thus improve the efficiency of SCRTD operations. An Accident/Incident Reporting and Investigation Procedures Manual⁴ will define SCRTD roles and responsibilities regarding the reporting and investigation of major Metro Rail operational, patron, and employee accidents/incidents. The manual will assist in carrying out assignments in conformance with the requirements of SCRTD Policy Number 28⁵ regarding major accident/incident investigations. In addition, it will provide guidance for handling Metro Rail departmental investigations.

Metro Rail procedures will provide for the timely and effective notification of all SCRTD Metro Rail accidents and incidents to pertinent SCRTD management and staff personnel and appropriate local, state, and federal agencies as required. The notification procedure in conjunction with the type of accident or incident reported will provide the necessary information for the immediate dispatch of an appropriate SCRTD Metro Rail Accident Investigation Response Team (AIRT) to the scene of the accident or incident. The AIRT will function as the SCRTD's liaison with any local, state, or federal accident investigation team and/or effort responding to the accident or incident.

All SCRTD accident/incident data will be recorded and preserved in such a manner that it can be of greatest possible value in the SCRTD system safety program. Accident/incident data will be transferred to pertinent record forms which will be used for efficient accident/incident control administration. These records will be used to develop an SCRTD accident/incident file and report for distribution to pertinent SCRTD management and staff. The report will contain sections covering the accident factual information, a following analytical section, and a conclusions/findings and recommendations section.

4 See, e.g., SCRTD Safety Department, Accident Investigation Procedures Manual, January 1986.

5 SCRTD Executive Policy and Procedure, Policy Number 28, SUBJECT: Accident Investigation, Issued: July 16, 1981.

6.6 OCCUPATIONAL SAFETY

Occupational safety encompasses those activities designed to improve the safety of Metro Rail employees, reduce the SCRTD's liability due to occupational processes or environments, and minimize the likelihood that patron safety might be affected by occupational accidents.

During the design of Metro Rail work spaces, facilities, and equipment, worker safety as well as passenger safety was considered. Examples include lighting in facilities, methods of ingress and egress from pits, and selection of equipment designed to comply with Cal-OSHA and state building codes. In addition, facilities have been designed to provide access for handicapped workers, where applicable. Special studies have been conducted to develop the best human factors and ergonomic considerations with respect to equipment locations, types of surfaces, and operating controls. Drawings and specifications have been thoroughly reviewed to ensure compliance with Cal-OSHA codes and design criteria.

During revenue service operations, the Metro Rail safety program will be directed toward providing a safe and healthful environment for Metro Rail employees, the public, and the community. As described previously, procedures for safe operation and maintenance will be developed; accident reports will be used along with operating hazard analyses to identify and control or eliminate hazards; and training and job certification programs will be conducted. Inspections and surveys will be performed on a regular basis. Regular audits are planned which will analyze each job function for safe practices and procedures, including the use of protective clothing.

Operations and maintenance procedures will conform to all applicable industry standards relating to painting/paint removal, storage of flammable or toxic substances, welding, handling of fuels and industrial trucks.

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