SAFETY CERTIFICATION

THE

GENESIS OF A SAFETY CERTIFICATION

PROGRAM

FOR

RAIL TRANSIT SYSTEMS

RTD

PRESENTED TO

SELF-REGULATION THROUGH SAFETY CERTIFICATION

SESSION

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SAFETY CERTIFICATION

THE
GENESIS OF A SAFETY CERTIFICATION
PROGRAM
FOR
RAIL TRANSIT SYSTEMS

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FOREWORD

Transit systems are faced with the challenge of ensuring that they can operate safely and are prepared to respond to a potential emergency in a coordinated and cohesive manner. This presents a formidable task in determining the process by which operational safety is verified before a system begins revenue service.

A transit system must be as error free as possible in determining its degree of safety; not by a process of trial and error, but by a prior decision based upon factual evidence. This "factual evidence" is a Safety Certification Program.

The essence of this paper is to provide the genesis of a Safety Certification Program directed toward achieving certification of the safety worthiness of transit operations based on factual evidence.

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LIST OF EXHIBITS

1.0 INTRODUCTION

The overall objective of a Safety Certification Program is to ensure that the system safely transports patrons in revenue service. Toward this end, the certification program must achieve the following objectives:

- Document design decisions involving safety
- Encourage the identification of safety issues
- Integrate safety into the design review, inspection, audit, integration, and pre-revenue and testing programs
- Provide Safety Certification Program visibility to senior management
- Ensure that transit system management focuses on safety decisions
- Demonstrate to Federal, State, and Local Agencies (as appropriate) that the transit system is properly managing the certification program
- Emphasize the importance of and ensure a formalized approach toward the certification process.

Safety certification may be defined as the process of verifying satisfactory compliance against a set of formal safety requirements. The safety certification program should document that:

- Safety requirements designed into transit system elements are, in fact, incorporated into the final product
- Critical safety activities are accomplished and verified
- Responsible program participants certify the above in writing.

Exhibit 1-1 identifies the typical flow of a System Safety Program that provides the key elements of the certification process.

2.0 DEFINITION OF SAFETY CERTIFICATION

One of the first questions to be asked by organizations responsible for certification of safety worthiness in a transit system is: What exactly is "Safety Certification"? There are diverse opinions and interpretations of safety certification used throughout the country at various rail rapid transit systems. One general definition could be:

> Safety Certification - An iterative process whereby a written statement or statements are issued testifying that all steps have been taken to ensure that Operational Safety has been achieved by a transit system providing a safe environment for patrons, employees, emergency services personnel, the general public, and property.

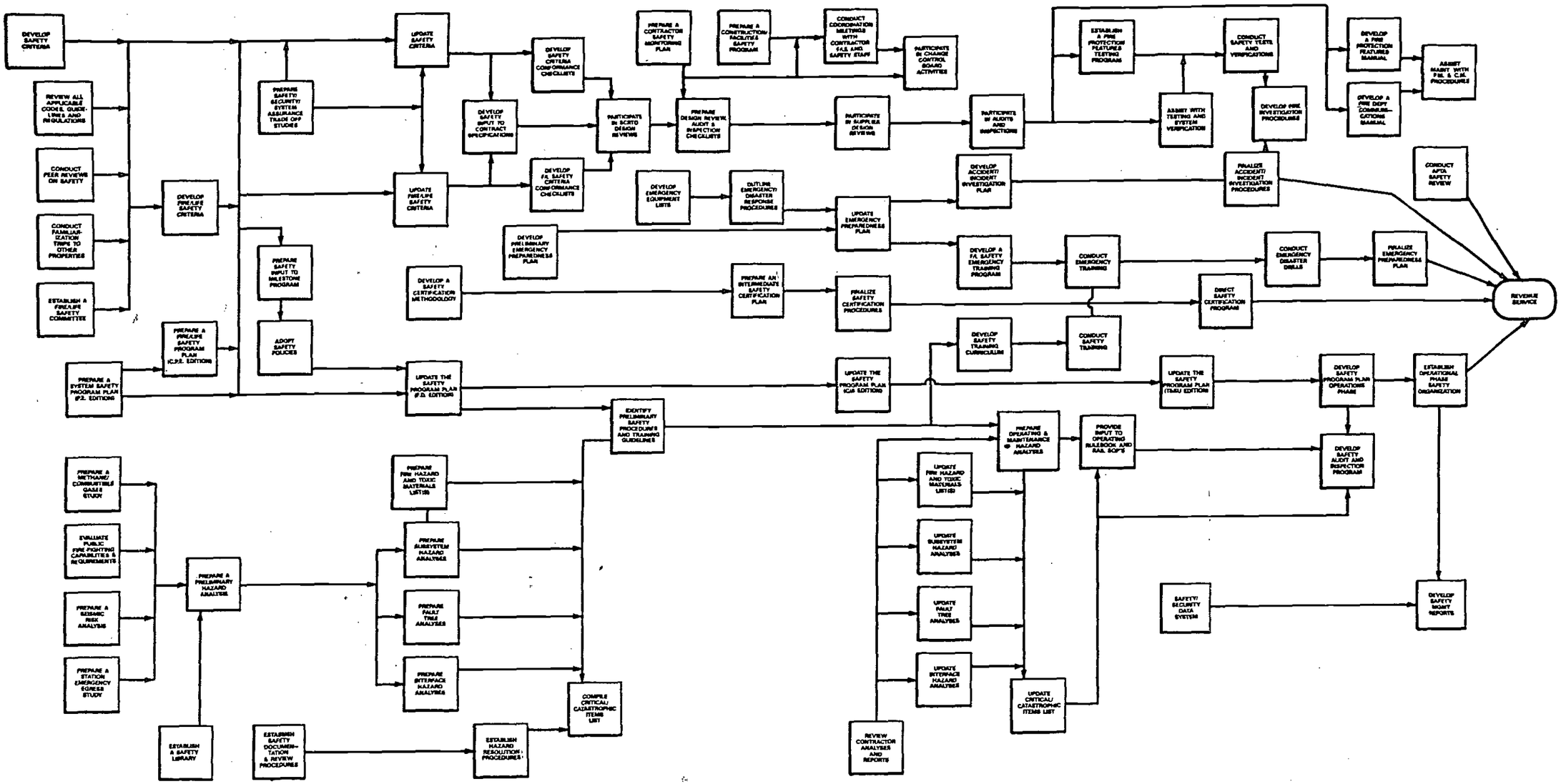


EXHIBIT 1-1

TYPICAL SYSTEM SAFETY PROGRAM AND CERTIFICATION FLOW CHART

How to objectively accomplish safety certification is the purpose of this paper.

It should be emphasized at this point that Safety Certification (as described herein) applies only to transit system operational safety. It intentionally excludes the occupational safety aspects of construction personnel, general and special construction safety practices and procedures, and qualifications/history of construction equipment and contractors. The certification process is concerned only with the elements that most affect the operational characteristics of the transit system, i.e., operating system elements, facilities, critical subsystems, operating procedures, verification safety tests, and responsible organizations.

3.0 SAFETY CERTIFICATION BACKGROUND

It is important to understand the genesis of Safety Certification and why it has come to play such an important role in the development of a rail rapid transit system and what implication it has during a modification of, or addition to, an existing transit system.

Assigning specific responsibility for verification (by means of certification) of operational safety for a rail rapid transit system is a relatively new concept. Traditionally, rapid transit systems in the United States have regulated their own operations. External regulation and safety certification requirements have

typically dealt with such issues as meeting building codes, fire protection and suppression requirements, occupational safety standards during construction of facilities, and accident investigation. This type of regulation has historically been imposed at all levels: local (city/county codes), state (various state transportation authorities), and federal (e.g., OSHA -- Occupational Safety and Health Administration and NTSB -- National Transportation Safety Board); but not necessarily uniformly from transit property to transit property.

Advances in technology (automatic train control, computer assisted communications/data transmission, etc.), the applications of this technology to urban rapid transit, and the development of safety and systems assurance techniques in the aerospace industry have all contributed to greater emphasis on system safety in rail rapid transit operations. This safety concern was first formally regulated by a state agency when the California Public Utilities Commission was given jurisdiction by legislation over the Bay Area Rapid Transit District in San Francisco and Oakland.

3.1 State of California Public Utilities Commission Involvement

The California Public Utilities Commission (CPUC) issued its first general order regarding the Bay Area Rapid Transit District (BART) in 1967. Since 1972, when the BART system opened, the CPUC has issued several "special orders" regarding the operations of BART. These special orders deal with such matters as days of operation,

hours of operation, and operating routes. The decisions that resulted in the issuance of the special orders by the CPUC are based on investigations "on the Commission's own motion into (BART's) safety appliances and procedures." Several of the decisions were in response to accidents while others have dealt with the implementation of new systems, procedural modification, safety training, reliability, and quality assurance/quality control programs.

In fact, except for San Francisco (MUNI), all rail rapid transit systems in the State of California are, or are expected to fall under, the regulatory authority of the CPUC (California Public Utilities Commission).

Other states including Maryland (Baltimore Regional Rapid Transit system and Washington Metropolitan Area Transit Authority), Florida (Metropolitan Dade County Transportation Administration), and Georgia (Metropolitan Atlanta Rapid Transit Authority) have state agencies that have authority over transit systems, but none has presently exercised such authority to the extent that the CPUC has in California. These state agencies presently play an "oversight" role while the CPUC exercises direct regulation.

3.2 Federal Involvement

The federal responsibility for safety regulation of rail rapid transit systems presently lies with the United States Department

of Transportation's Urban Mass Transportation Administration (UMTA). This responsibility was determined after a series of court actions between the Chicago Transit Authority (CTA) and the Federal Railroad Administration (FRA). In 1974, the FRA published revised regulations having to do with railroad accident reporting under the authority of the Railroad Safety Act of 1970.

The FRA's definition of "railroad" in the 1974 regulation included "rapid transit", "subway", and "elevated lines". The new regulations required additional monthly and annual reports to the FRA reflecting on the safety of railroad operations, subject to civil and criminal penalties for failure to comply. Urban mass transit systems such as the CTA, however, were already subject to UMTA safety considerations as a condition for receiving funding.

The FRA regulations, which sought to include mass transit within their scope, thus appeared to constitute a further, and possibly even conflicting, regulatory network beyond that which was already imposed by U.S. DOT/UMTA. In 1975, the CTA filed suit against the FRA seeking a determination that the CTA was not a railroad within the meaning of the Railroad Safety Act of 1970 and therefore was not subject to the FRA regulations. The U.S. District Court for the Northern District of Illinois, Eastern Division, decided in favor of the FRA. However, this decision was reversed in 1977 by the U.S. Court of Appeals for the Seventh Circuit Court (Case No. 77-1137). The Circuit Court of Appeals held that legislative

history conclusively demonstrates that Congress had no intention of covering rapid transit systems in the 1970 Act and that the CTA is not a "railroad" as the term is used in the Railroad Safety Act of 1970, and hence not subject to the FRA railroad regulations. The court further stated in its opinion that although UMTA does not have enforcement power identical to that of the FRA, it does have the ultimate sanction; that is, UMTA can withhold funds.

4.0 SAFETY CERTIFICATION PROGRAM

4.1 The Need for a Safety Certification Program

A transit system must have some means of assuring itself or others that it is operationally safe for patrons, employees, emergency services personnel, the general public, and property. This can only be accomplished by a systematic and rigorous process that ensures that the transit system is designed, constructed/procured, tested, and operated to a carefully prepared set of criteria and standards.

Regardless of the transit system's reasons for "Safety Certification", either to fulfill a regulating agency's requirements or for their own safety assurance, the need for a formalized process exists. The following sections of this paper will provide the basic elements of "Safety Certification".

4.2 Safety Certification Program

Any transit system's Safety Certification Program should:

- Verify that the contract specifications and drawings properly reflect all safety requirements included in the design criteria

- Verify that the end product(s) delivered by suppliers and contractors properly reflect all safety requirements included in the contract specifications

- Verify that the transit system develops necessary safety related management programs and safety related procedures required by a System Safety Program Plan.

The Safety Certification Program should encompass certification of equipment, facilities, plans, and procedures and include as a minimum the following areas:

- Systemwide Elements -- Which include the vehicles, train control system, communications, fare collection, traction power, fire protection and suppression systems, and auxiliary vehicles.

- Fixed Facilities -- Which include stations, line segments, the yard and shop(s), and the Central Control Facility (CCF);

equipment installed in a station, such as HVAC equipment, escalators and elevators, lighting, etc., is considered part of the facility.

- Safety, Security, System Assurance, and Operational Plans and Procedures -- Which include items such as the Emergency Preparedness Plan, Training Programs, Accident Investigation Procedures, the Operators Rulebook, etc.

The focus of the Safety Certification Program should permit the transit system to assure itself and any regulating agency (if applicable) that the transit system can safely operate in revenue service. It should be recognized at this point that safety certification should continue throughout a transit system's life by periodically reassessing operations, modifications, and/or system extensions.

4.3 Certification Basis

A properly developed safety certification program should have four major ingredients as the basis of the certification program:

- All appropriate codes, guidelines, and standards must be reviewed to provide the basis for safety considerations in the design criteria

- The design criteria must be used as a basis for verifying that all specifications and drawings are in conformance with the criteria

- All end products (facilities and equipment) must be verified against the contract specifications and drawings (including all approved engineering changes)

- Use of a System Safety Program Plan in ensuring that necessary verification test and safety plans and procedures are developed for operational service.

4.4 Safety Certification Program Development

A Safety Certification Program should be incrementally developed commensurate with the transit system's phases of development. There are three basic steps that reflect the different phases:

- Development of the Safety Certification Methodology during the early engineering design phase

- Development of the Safety Certification Plan during the final design phase

- Development of Safety Certification Procedures during the construction/acquisition phase

This three-step approach will ensure that the program is developed in a coordinated manner. Program participants will agree on the process described in each step before proceeding. The intent of this document is to outline the approach toward certification, the general responsibilities of parties involved, and a plan of action to further develop the program. The Safety Certification Plan, normally developed during Final Design, provides a more detailed treatment of specific responsibilities of the program participants, and develops documentation requirements. Safety Certification Procedures are normally prepared during the Construction phase, to coordinate efforts with design reviews, inspections, audits, tests, and system verification.

After the transit system has completed each of the documents, they should be presented to the regulatory agency (if applicable). In this way, the regualtory agency will be kept informed of the specifics of the program, while leaving the day-to-day responsibility for administering the Safety Certification Program to the transit system.

4.5 Safety Review Team

Each transit system should assemble a group of knowledgeable persons to function as a "Safety Review Team" (SRT). This team should be responsible for safety review, compliance assessment, and making recommendations to the transit system's management

regarding certification of the system's elements. These individuals should be specifically identified in the Safety Certification Plan. Additionally, they should have specific expertise in a safety-related function and may represent the following organizations:

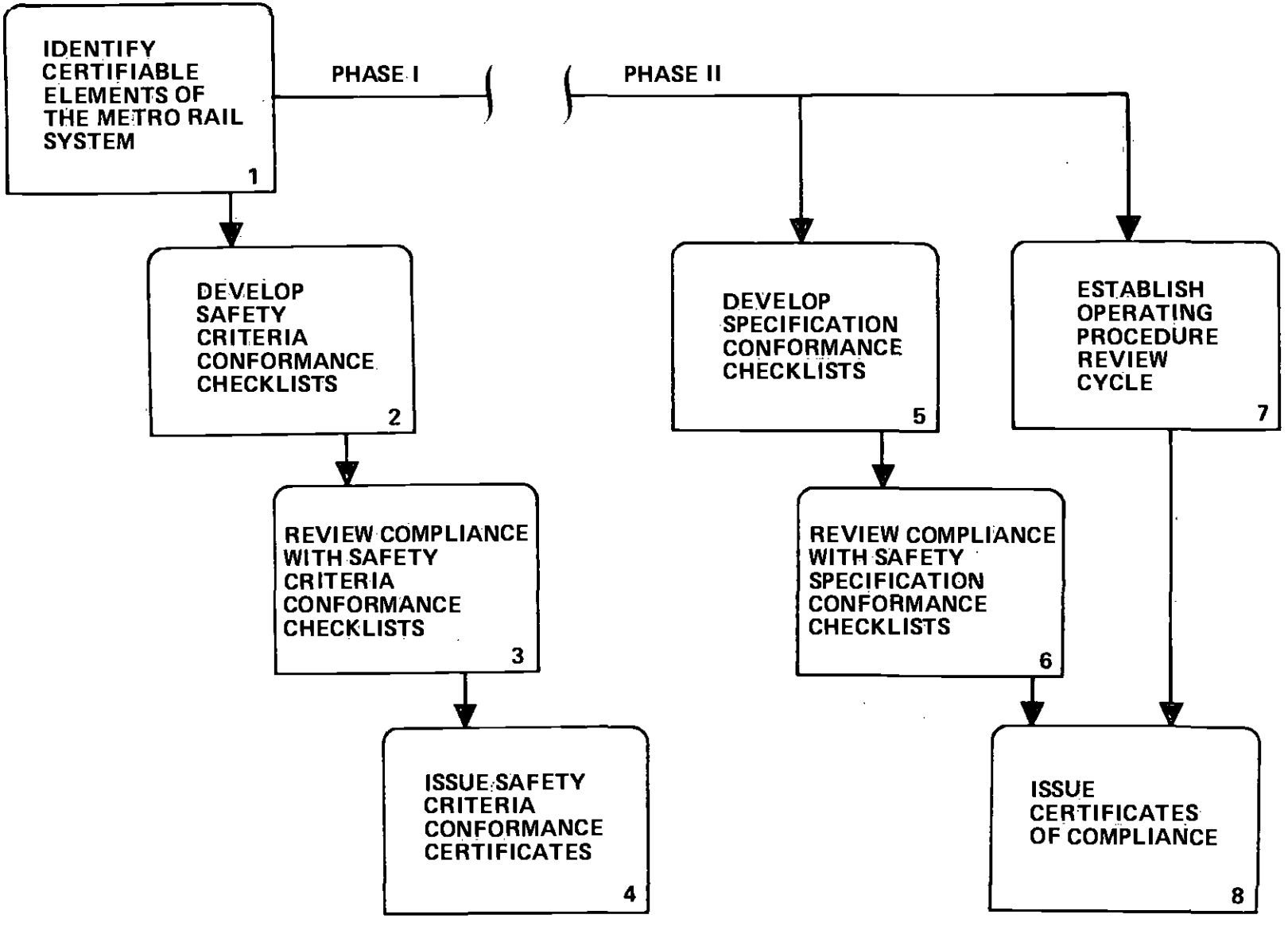
- Safety
- Systems Engineering
- Operations
- Maintenance
- Construction Management
- Fixed Facilities.

5.0 SAFETY CERTIFICATION PROCESS

To facilitate an understanding of a Safety Certification Program, the safety certification process presently contemplated for the Southern California Rapid Transit District (SCRTD) is used as a representative example. It is an appropriate example as it contains all of the necessary ingredients of a certification program. Exhibit 5-1 indicates briefly the certification process. As is evident in the exhibit, the certification process is a two-phase program designed to ensure that:

- The design criteria related to safety are properly incorporated into the appropriate contract specifications

EXHIBIT 5-1
SCRTD METRO RAIL
SAFETY CERTIFICATION PROCESS



- The safety requirements included in the the contract specifications are properly included in the final end products, and, further, that safety-related plans and procedures are developed, reviewed, and approved prior to revenue service.

5.1 Identify the Certifiable Elements of the Metro Rail System

The first step of safety certification is to identify those system elements that need to be certified. A preliminary list of certifiable elements of the SCRTD Metro Rail system is shown in Exhibit 5-2. The elements are identified primarily by contract in the areas of systems and fixed facilities. Plans and procedures have been segregated into the functions of Safety and Training.

5.2 Develop Safety Criteria Conformance Checklists

Within the SCRTD Metro Rail Project, a Fire/Life Safety Committee has been formed to oversee the design, construction/acquisition, testing, and start-up activities that relate to fire/life safety issues. The Fire/Life Safety Committee has established the Metro Rail Fire and Life Safety Criteria, which form the basis for fire/life safety requirements throughout the system's design and operations.

During the Preliminary Engineering Phase, systemwide safety, security, and system assurance criteria were developed.

EXHIBIT 5-2

PRELIMINARY LIST OF CERTIFIABLE ELEMENTS

System Elements

Vehicles

Train Control

Communications

Fare Collection

Traction Power

Fire Protection and Suppression Systems

Auxiliary Vehicles

Fixed Facilities

Yard and Shops (including transportation function)

Emergency Response Equipment

Yard and Shop to Union Station Line

Union Station Station

Central Control Facility

Union Station to Civic Center Line

Civic Center Station

Civic Center to 5th and Hill Line

5th and Hill Station

5th and Hill to 7th and Flower Line

7th and Flower Station

7th and Flower to Wilshire/Alvarado Line

Wilshire/Alvarado Station

Wilshire/Alvarado to Wilshire/Vermont Line

EXHIBIT 5-2

PRELIMINARY LIST OF CERTIFIABLE ELEMENTS

(Continued)

Fixed Facilities (Continued)

Wilshire/Vermont Station

Wilshire/Vermont to Wilshire/Normandie Line

Wilshire/Normandie Station

Wilshire/Normandie to Wilshire/Western Line

Wilshire/Western Station

Wilshire/Western to Wilshire/Crenshaw Line

Wilshire/Crenshaw Station

Wilshire/Crenshaw to Wilshire/La Brea Line

Wilshire/La Brea Station

Wilshire/La Brea to Wilshire/Fairfax Line

Wilshire/Fairfax Station

Wilshire/Fairfax to Fairfax/Beverly Line

Fairfax/Beverly Station

Fiarfax/Beverly to Fairfax/Santa Monica Line

Fairfax/Santa Monica Station

Fairfax/Santa Monica to La Brea/Sunset Line

La Brea/Sunset Station

La Brea/Sunset to Hollywood/Cahuenga Line

Hollywood/Cahuenga Station

Hollywood/Cahuenga to Hollywood Bowl Line

Hollywood Bowl Station

Hollywood Bowl to Universal City Line

Universal City Station

EXHIBIT 5-2

PRELIMINARY LIST OF CERTIFIABLE ELEMENTS

(Continued)

Fixed Facilities (Continued)

Universal City to North Hollywood Line

North Hollywood Station

North Hollywood Tail Track

Safety Plans and Procedures

Hazard Identification and Resolution Procedure

System Safety Program Plan - Operations

System Safety Department

Emergency Preparedness Plan

Standard Operating Procedures

Emergency/Disaster Procedures

Safety-Related Security Operating Procedures

Operators Rulebook

System Verification and Testing Plan

Pre-operations Test Plans and Procedures

Accident Investigation Procedure

Fire Protection Features Manual

Fire Department Communications Manual

Continuing Safety Certification and Audit Program

Training Programs

Operators Training Program

Central Control Facility Personnel Training Program

EXHIBIT 5-2

PRELIMINARY LIST OF CERTIFIABLE ELEMENTS

(Continued)

Training Programs (Continued)

Yard and Tower Personnel Training Program

Maintenance Personnel Training Program

Transit Police Training Program

Fire Department Training Program

Public Education Program

Other Outside Agency Training (as appropriate)

These criteria sections have been developed after extensive peer reviews of industry experience, special studies, detailed reviews of city and county building and fire codes, NFPA requirements, special analyses of exit capacities and requirements under emergency situations, CPUC general orders, and various industry guidelines and government regulations (IEEE, Cal/OSHA, NEC, etc.). This has resulted in one of the most comprehensive baseline criteria documents relating to safety yet produced in the transit industry. The criteria documents themselves have undergone extensive review by all program participants and numerous outside agencies. Consequently, the criteria documents have been selected as an excellent initial baseline for the Safety Certification Program.

Safety Criteria Conformance Checklists have been developed by the SCRTD for each of the system and fixed facilities' certifiable elements. Each of the checklists cover:

- Fire/Life Safety
- System Safety
- Security (affecting patrons and employees)
- System Assurance (Quality, Reliability, Maintainibility).

Most station and line segment checklists will be similar. The checklists will be based on the SCRTD Metro Rail System Design Criteria and Standards, Volume I, Sections 2, 3, 4, and 5, which respectively cover fire/life safety, system safety, security, and

systems assurance. A representative example of a Safety Criteria Conformance Checklist is shown in Exhibit 5-3.

5.3 Review Compliance with Safety Criteria Conformance Checklists

During the final design review process, the SCRTD will use the checklists to verify that all appropriate design requirements, as identified in the criteria, have been incorporated into the appropriate contract specifications and directive drawings.

Ensuring that the contract specifications and associated drawings conform to the design criteria is the responsibility of the Fixed Facilities and Systems Design departments of Metro Rail. The Safety Review Team (SRT) will have the responsibility to review evidence that the specifications conform to the design criteria. This evidence includes completed checklists and statements from the Fire/Life Safety Committee, Security Subcommittee, and other Systems Design and Fixed Facilities personnel demonstrating proper incorporation of the fire/life safety, system safety, security and system assurance criteria into the appropriate contract specifications. Any discrepancies between the criteria and specifications relating to safety must be identifed and resolved.

5.4 Issue Safety Criteria Conformance Certificates

When the SRT determines that the aforementioned criteria are properly reflected in the contract specifications for a certifi-

EXHIBIT 5-3
SAFETY, ASSURANCE AND SECURITY GROUP
DESIGN REVIEW CHECKLIST

DATE:_____

DISCIPLINE: FIRE/LIFE SAFETY CRITERIA

REVIEW REFERENCE:_____

REQ. I.D.	REQUIREMENT	YES	NO	COMMENT
2.5	VEHICLE YARD & MAINT. FACILITY			
2.5.1.3	Occupancies shown per UBC Table 5a o Vehicle Maintenance - Group H, Div. 4 o Maintenance of Way - Group H, Div. 4 o Yard Tower - Group B, Div. 2 o Operations Facility - Group B, Div. 2			
2.5.1.4	Other facilities per UBC 503			
2.5.2	YARD FACILITIES			
2.5.2.1	Water supply and hydrants per NFPA 24, LAFD Master Plan, and L.A. County Water Ordinance 7834.			
2.5.2.2.1	Access provided to structures, trainways, facilities, yards and outside storage areas.			
2.5.2.2.2	Access per public streets or transit access roads.			
2.5.2.2.3	Access to inside perimeter by transit access roads.			
2.5.2.2.4	Access roads all-weather 20 ft. width widened to 28 ft. at turnouts.			
2.5.2.2.5	Turning radius, vertical clearance, dead-end and access suitable for F.D. apparatus.			

able element, they will recommend that the element receive a "Safety Criteria Conformance Certificate". The certificate attests to the fact that the specifications reflect and conform with the safety requirements contained in the System Design Criteria. If the SRT believes that specification language or drawings do not comply with the intent of the design criteria, it has the responsibility of withholding its recommendation that the element receive a Safety Criteria Conformance Certificate. A representative Safety Critieria Conformance Certificate is shown in Exhibit 5-4.

5.5 Develop Specification Conformance Checklists

To ensure a logical and orderly flow of information for final certification, the SCRTD will prepare specification conformance checklists. The checklists will identify each of the safety requirements included in each specification. During supplier design reviews, quality and safety audits, inspections, and tests, the SCRTD will use the checklists as a tool to identify, collect, and document the approval of evidence that demonstrates that safety requirements have been achieved.

A suggested format for the Specification Conformance Checklist is shown in Exhibit 5-5. The checklists will be updated as required

EXHIBIT 5-4
SAFETY CRITERIA CONFORMANCE CERTIFICATE

SAFETY CRITERIA CONFORMANCE CERTIFICATE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

METRO RAIL PROJECT

Safety Certification Program

Completion of this Certificate indicates that the specifications and drawings of the Certifiable Element indicated below comply with all applicable SCRTD safety, fire/life safety, security and system assurance criteria.

CERTIFIABLE ELEMENT _____

CONTRACT SPECIFICATION(S) INCLUDED:

- o
- o
- o
- o

EXCEPTIONS NOTED:

Supervisor, Safety and Systems Assurance	Date	Director, Systems Design and Analysis	Date

EXHIBIT 5-5
Southern California Rapid Transit District
Metro Rail Project
Safety Certification Program
Specification Conformance Checklist

Certifiable Element: Vehicle
Subsystem: Operator Cab

	Safety Requirement	Specification Reference	Responsibility	Evidence Timing	Document#	Approved
o	The operator cab shall utilize the full width of the car when in use	9.1.a	Safety Supervisor	PDR, Mock-UP		
o	Operator cab doors shall be lockable from inside and outside and the right side window shall be lockable from the inside only	9.1.b	Safety Supervisor	CDR, Mock-Up		
o	The cab layout shall provide adequate visibility for the operator to the station platform and car interior for control of the train and safety of passengers	9.4	Safety Supervisor	PDR, CDR, Mock-Up		
o	The operator cab shall include as a minimum the following:		Safety Supervisor	CDR, Mock-Up		
	-- Fire Extinguisher	9.5.1.e				
	-- Parking Brake Control	9.5.1.f				
	-- Communications Control Unit	9.5.1.1				
	-- Manual controller with "deadman" feature	9.5.1.o				
o	The surface area of the console shall be non-reflective	9.6.1	Safety Supervisor	CDR		
o	The reading light shall be designed and aimed so as to cause minimum interference with observation of the roadbed when in use at night.	9.6.2	Safety Supervisor	CDR		

when subsequent approved engineering changes reflect an impact on safety. All checklists will be approved for completeness, accuracy, and content by the SCRTD.

5.6 Review Compliance with Safety Specification Conformance Checklists

Each safety requirement on the Specification Conformance Checklist will require evidence that demonstrates its achievement. Some of the evidence will be presented during design reviews, audits, and inspections of the equipment or facilities. Other requirments such as hazard analyses, test plans, and manuals may be contract data requirements list (CDRL) deliverables. Still other safety provisions do not require a formal submittal, but need to be verified to ensure a safe system. Compliance with these requirements will need to be verified and properly documented by SCRTD and Construction Management personnel during design reviews, audits, inspections, and tests. Any discrepancies between end products and the specifications that relate to safety must be identified and resolved.

5.7 Establish Operating Procedure Review Cycle

The contract specifications will provide the baseline for the safety requirements in systems and fixed facilities. The SCRTD's System Safety Program Plan identifies the plans, procedures, and activities the SCRTD must develop or perform prior to revenue

service. The most effective method for assuring that proper content is included is to have a widespread review and comment cycle involving engineering, safety, operations, and maintenance personnel. A formal "Operating Procedures Review Cycle" will be established by the SCRTD to review procedures, manuals, and other documents as they become available in the year or two prior to revenue service. The reviews will usually include input and discussions with OCC supervisors, emergency response personnel (fire and police), maintenance personnel, management, safety staff, and design engineers. Special emphasis will be placed on ensuring that those people who will operate, maintain, and police the transit system have a thorough interaction with the engineers who designed the system.

5.8 Issue Certificates of Compliance

The Construction Manager (and the SCRTD in the case of the vehicle) will provide evidence to the SRT that safety requirements in the contract specifications have been achieved. The SRT is responsible for reviewing the evidence and recommending to transit system management that a certifiable element is considered safe and should receive a Certificate of Compliance. A possible format for the Certificate of Compliance is shown in Exhibit 5-6.

After a safety-related procedure has completed the review cycle and appropriate comments are incorporated, the SRT will recommend that it be issued a Certificate of Compliance.

EXHIBIT 5-6

METRO RAIL PROJECT

SAFETY CERTIFICATION PROGRAM

CERTIFICATE OF COMPLIANCE

Completion of this Certificate indicates that the Certifiable Element indicated below complies with all applicable specification safety requirements and is judged safe for public use/revenue service.

CERTIFIABLE ELEMENT _____

DATE OF CERTIFICATION _____

RESTRICTIONS:

APPROVALS:

Director, Systems Design and Analysis — Date	
Supervisor, Safety and System Assurance — Date	Assistant General Manager, TSD — Date

In the year prior to revenue service, the SCRTD will prepare and distribute periodic reports to interested parties (CPUC, fire departments, police departments) pertaining to the progress of certification.

6.0 SUMMARY

The adoption of a safety certification program similar to that described herein by a transit system should assure the general public, participating agencies, and the transit system itself that all practicable actions have been taken to achieve the objective of a safe operational environment and that revenue service can safely commence.

BIOGRAPHIES OF THE AUTHORS

Biography of Roger W. Wood, Jr.

Roger W. Wood, Jr., is Supervisory Engineer, Safety, Security and System Assurance for the Southern California Rapid Transit District (SCRTD).

In this capacity he is responsible for Safety, Fire/Life Safety, Security, System Assurance, and Maintenance Planning for the Metro Rail Project. He received his B.S. (1965) in Mechanical Engineering from Northeastern University and an M.B.A. (1966) in Business Administration from College of the Holy Cross. Prior to joining the SCRTD he was an associate with Booz, Allen and Hamilton on assignment as Deputy Program Manager to the Maryland Mass Transit Administration for the Reliability, Maintainability, and Safety Program during the development of the Baltimore Region Rapid Transit System. Prior to joining BA&H he was employed by the David Clark Company, ILC Industries, and was president of his own safety consulting firm.

Mr. Wood has 23 years of safety and systems assurance experience in aerospace and transportation. He was instrumental in the development of a special fire survival suit for auto racing and for the U.S. Army, Navy, and Air Force. He has specialized in the evaluation of materials and application programs for hostile environments.

Biography of Thomas J. Tanke

Thomas J. Tanke is Manager, Safety, Assurance, and Security for Raymond Kaiser Engineers, Inc. which is part of the Joint Venture performing General Consultant services for the Southern California Rapid Transit District (SCRTD). In this capacity he is responsible for System Safety, Fire/Life Safety, System Assurance and Security activities in support of the SCRTD Metro Rail Project. He received his B.S. (1966) in Mechanical Engineering from the University of Illinois, M.S. (1969) in Mechanical Engineering from the University of Wisconsin and P.D.D. degree (1973) in Management and Administration from the University of Wisconsin. Prior to working on the SCRTD Metro Rail Project he was Manager of System Integration for the joint venture performing general consulting services to the Houston Transit Program. Prior to that assignment he was Manager, Safety Quality Assurance and Emergency Services for the U.S. Department of Transportation at the Transportation Test Center in Pueblo, Colorado. He has worked previously with government support contractors, constructors, and insurance companies.

Mr. Tanke has 17 years of managment, safety, system assurance, and risk managment experience in transportation, construction and support services. He has specialized in the design of transportation systems and the development and organization of managment programs and systems.