Southern California Rapid Transit District

METRO RAIL PROJECT

System Design

Criteria & Standards

VOL. 1

SYSTEMWIDE

RTD

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SCRTD METRO RAIL SYSTEM DESIGN CRITERIA & STANDARDS

SYSTEM DESIGN CRITERIA AND STANDARDS

VOLUME: I SECTION: FOREWORD

REVISION RECORD

NOTICE NUMBER	CR NO/REV	DATE APPROVED	AFFECTED	COMMENTS
1	None/1	-------	Foreword General Contents Vol. I - V Summary Contents Vol. I	Replaces 6/30/83 issue. Format corrections and revisions to Contents pages.

FOREWORD

The Metro Rail Project, undertaken by the Southern California Rapid Transit District (SCRTD), will have a significant role in the future development of the Los Angeles region. As part of the 1976 Regional Transportation Development Program, Metro Rail is designed to help solve the increasing transportation problems of Los Angeles' high-density urban center - the regional core.

SYSTEM DESCRIPTION

The Metro Rail line will be a conventional two-track, steel wheel, steel rail system. The initial segment will be approximately 18 miles long and will serve the central business district, Wilshire Boulevard, Fairfax, Hollywood, and North Hollywood areas. On December 20, 1982, SCRTD adopted the route and station locations shown on the following figure.

The initial line is being designed with future line extensions in mind. Seven Metro Rail corridor extensions have been analyzed to estimate the effect of additional travel demand on the initial line. The ultimate regional system under consideration is a 150-mile rapid transit system, to be developed on an incremental basis. Different types of transit - light rail, bus-on-freeway, rail rapid transit - will be evaluated as each extension is planned. The most appropriate type will be selected, but in some cases, the system design will allow upgrading to other types of high-capacity transit as demand increases.

A basic policy of the SCRTD Board of Directors is that the Metro Rail System be designed with the flexibility to connect with any of the seven corridors and be able to accommodate increased patronage from additional future corridors. This policy ensures that the initial 18-mile system will accommodate line extensions without major cost or disruption to existing services.

The Metro Rail system can be described in terms of its four system elements: ways and structures, yard and shops, station, and sub-systems.

- Ways and structures: Ways and structures consist of the major fixed facilities of the system, including the tunnels and trackwork. The initial segment will be entirely underground, primarily in mined tunnel.

- Yard and shops: The main yard and shops constitute the facilities required to store and maintain Metro Rail transit vehicles and to provide maintenance to the system's physical plant and equipment. These facilities will be located southeast of Union Station.

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Metro Rail Project

- Stations: Stations provide riders access to the trains from the street level. Stations include stairs, escalators, elevators, a platform area for boarding and leaving trains, and a mezzanine area for fare collection. The stations also provide space for such elements as train control equipment and ventilating equipment. The stations will be constructed by the cut-and-cover method.

- Subsystems: The subsystems are the operating equipment portions of the system, such as the passenger vehicles, train control and communications equipment, traction power, and fare collection equipment. The passenger vehicles will be similar to those currently in use in modern U.S. rail rapid transit systems. It will comfortably carry approximately 76 seated or 94 standing passengers. Trains will consist of up to six passenger vehicles, and will be run by one operator. Automatic devices will be provided for routine operating functions and to ensure safe operations.

PROGRAM DEVELOPMENT

When Metro Rail goes into operation, it will have passed through the five conventional stage of rapid transit development: (1) planning and alternatives analysis; (2) preliminary engineering/environmental impact analysis; (3) final design; (4) construction, manufacturing, and installation; and (5) operational testing.

The first phase ran from 1977 to 1980. Since June 1980, SCRTD has been engaged in the preliminary engineering (PE) phase. This phase has three major objectives: (1) to define and resolve major design and engineering issues; (2) to provide precise location and design data for detailed environmental analysis; and (3) to produce reliable cost estimates. Upon completion of the preliminary engineering phase and the commitment of necessary capital funding, the final design phase will commence. This will be followed by a four-to-six year construction period culminating with system inspection and testing.

One of the major project documents developed during the PE phase is the design criteria. The criteria define detailed functional requirements for all aspects of the Metro Rail System, and will determine the direction taken by the final designers of the various facilities and subsystems elements. The Metro Rail Project System design criteria and standards are presented in five volumes, as follows:

- Volume 1, Systemwide--Contains criteria that affect the whole system, including contract drawing standards, fire/life safety, system safety, security, and system assurance.

- Volume 2, Civil/Structural--Contains civil and structural criteria for all facilities (tunnel, stations, yard and shops), and functional criteria for certain specific elements (trackwork, yard and shops).

- Volume 3, Station--Contains criteria, primarily architectural, for stations.

- Volume 4, Mechanical/Electrical--Contains criteria for mechanical and electrical elements of the facilities' heating, ventilating, and air conditioning; plumbing; facilities electrical; elevators and escalators; and miscellaneous criteria for several other subjects, such as corrosion control, and noise and vibration control.

- Volume 5, Subsystems--Contains functional criteria for the passenger and auxiliary vehicles, train control and communications, traction power and distribution, and fare collection.

It should be recognized that none of these volumes stands alone, and that criteria in more than one volume will apply to the design of any particular system facility or equipment element. A summary table of contents for each individual volume is included in the foreword to that volume as an aid to the designer.

SCRTD METRO RAIL PROJECT SYSTEM DESIGN CRITERIA AND STANDARDS

VOLUMES I THROUGH 5

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* Revision to Section distributed April 1985

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VOLUME I, SYSTEMWIDE

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SCRTD METRO RAIL SYSTEM DESIGN CRITERIA & STANDARDS

SYSTEM DESIGN CRITERIA AND STANDARDS

VOLUME: 1 SECTION: 1

REVISION RECORD

NOTICE NUMBER	CR NO/REV	DATE APPROVED	AFFECTED	COMMENTS
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SCRTD METRO RAIL PROJECT DESIGN CRITERIA

Volume 1, Section 1

CONTRACT DRAWINGS

SCRTD METRO RAIL SYSTEM DESIGN CRITERIA

Volume 1, Section 1, Contract Drawings

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1.1 PURPOSE

These criteria establish, define, and clarify procedures and standards to be used for Southern California Rapid Transit District drawings. The intent of these criteria is the establishment of guidelines to assure that all drawings have a uniform appearance and reflect high quality workmanship. Drawings for facility segments shall be prepared in accordance with Sections 1.1 through 1.21. Drawings for systems equipment shall be prepared in accordance with Section 1.21.

The material presented herein must be referred to frequently to ensure that the intended results are obtained. Periodically, these criteria will be reviewed, updated, and revised to incorporate improvements.

Engineers and drafters are responsible for ensuring that these criteria are implemented and that the drawings show the information completely and clearly but without unnecessary embellishment.

1.2 DEFINITIONS

SCRTD - Southern California Rapid Transit District.

General Consultant (GC) - Joint venture of Daniel, Mann, Johnson and Mendenhall/Parsons, Brinckerhoff, Quade and Douglas/Kaiser Engineers/Harry Weese and Associates, who will provide overall project management to plan, organize, direct, and coordinate the work to be performed in support of the Metro Rail Project.

Design Consultant - Engineer and Architect firms preparing the project drawings.

Design Office - A generic term that includes the General Consultant and Design Consultants.

Drawings - Conceptual, Preliminary, Standard, Directive, Project, and As-Built Drawings as defined below.

Conceptual Drawings - Drawings prepared during the Conceptual Design Phase.

Preliminary Drawings - Drawings prepared during the Preliminary Design Phase.

Standard Drawings - Drawings, usually prepared by the General Consultant, defining facilities which will be repetitively used throughout the SCRTD System. Standard Drawings may be used as Project Drawings.

Standard Abbreviations, Symbol, and General Notes Drawings - Drawings defining the standard nomenclature which will be used on the SCRTD System. The drawing(s) shall be the first drawing(s) of each design discipline.

Directive Drawings - Drawings defining the general arrangement or configuration of facilities. They are for the guidance of the Design Office and may not be used as Project Drawings.

Final Project Drawings - Drawings that will be presented to the construction contractor as contract documents.

As-Built Drawings - Project Drawings modified to reflect changes made during the construction phase of the work and approved by SCRTD.

Project Number - Number assigned to an individual construction project.

Addendum (Addenda) - Written or graphic instruments, issued during the bidding period, which modify or interpret the bidding documents, including drawings and specifications, by additions, deletions, clarifications, or corrections. As such, addenda become part of the contract documents when the construction contract is executed.

Change Order - A written order to the contractor, issued after the execution of the contract, authorizing a change in the work.

In-Progress and Pre-Final Project Drawings - Drawings submitted to the General Consultant for the In-Progress and Pre-Final Design Review.

1.3 DRAFTING MEDIUM

1.3.1 General

The General Consultant will supply the medium for some drawings whereas the Consultant will be responsible for others as noted below.

1.3.2 Size

Except for some special drawings, e.g., Record of Survey Maps, or where the size of the drawing is controlled by other agencies, all drawings shall be 22 inches by 34 inches (ANSI Standard Size D). In any event, all Project Drawings shall be 22 inches by 34 inches. All Project Drawings are subject to half size reduction.

1.3.3 Format

Drafting medium for project drawings will be one of five standard formats:

- Cover Sheet - Standard size with border and SCRTD logo only.
- Title Sheet - Standard size with border line only and showing key plan and general construction site plan.
- Detail Sheet - Standard size with border line and title block and used for index, symbols, boring logs, plans, elevations, sections, and details.
- Plan and Profile Sheet - Standard size border line and title block, and a profile grid on the lower half of the sheet.
- Cross Section Sheet - Standard size with border line and title block, and 10 x 10-to-the-inch grid occupying detail space.

1.3.4 Availability

A. Cover Sheets and Title Sheets, preprinted with generally applicable information, will be provided by the General Consultant. They will be drafting film.

B. Detail Sheets and Plan and Profile Sheets, with preprinted border line, title block, and grid, will be provided by the Consultant on drafting film. Standards for developing the sheet will be supplied by the General Consultant.

1.3.5 Conceptual and Preliminary Drawings

The drafting medium for Conceptual and Preliminary Drawings shall be high quality vellum. If it becomes feasible to use a Conceptual or Preliminary Phase Drawing on vellum as a Project Drawing, the drawing may be reproduced photographically onto drafting film by the Design Office.

1.3.6 Standard, Directive, and Project Drawings

Drafting medium for these drawings shall be three-mil, double-mate, drafting film. These drawings may be drawn on vellum and reproduced photographically onto drafting film. All ink shall be undiluted permanent drafting ink.

1.3.7 Screening of Existing Conditions

Existing conditions on Project Drawings shall be shown in contrast to proposed work by the screening process producing 85 lines per inch with 50% light.

1.3.8 As-built Drawings

Same medium used for Project Drawings.

1.4 TITLE BLOCK

1.4.1 Lettering

Freehand lettering shall be vertical single-stroke, upper-case, Commercial Gothic; unless indicated otherwise herein, it shall be 1/8" high. Leroy lettering shall be vertical upper-case, in ink, using template sizes and line widths indicated below.

1.4.2 Revisions Block

The revisions block is covered in detail in Section 1.11, REVISIONS, of these criteria.

1.4.3 Reference Names

The first and middle initials and full last name shall be handwritten in ink with a No.2 pen by the designer, draftperson, checker, in the respective signature blocks identified by the words: Designed, Drawn and Checked. One person cannot serve as both designer and checker.

1.4.4 Date

A. The date to be shown on Conceptual and Preliminary Drawings and In-Progress and Pre-Final Project Drawings shall be the submittal date. On Final Project Drawings the date shall be that on which the Engineer's Architect's stamp and signature is affixed.

B. The date shall be shown in soft pencil on Conceptual and Preliminary Drawings and In-Progress and Pre-Final Project Drawings in vertical letters 5/32" high with a line width of 0.021", but shall be shown in ink using Leroy No. 140C template and No.1 pen on Final Project Drawings. The date shall be shown thus: 12 JUN 83. The month shall be abbreviated by the first three letters.

1.4.5 Engineer's or Architect's Stamp

A. An Engineer's or Architect's stamp shall be imprinted on Project Drawings in accordance with the law governing the practice of Engineering or Architecture in the State of California. Each drawing shall bear the stamp of the responsible engineer or architect.

B. The management of the Design office preparing Project Drawings shall determine the responsible individual who is to stamp drawings.

C. Stamps on drafting film shall be imprinted using a quick-drying, non-smudge ink especially made for printing on glass or plastic. Name and number shall be legible.

1.4.6 Design Office

A blank block has been provided for use by the Design Office. The full name of the Design Office shall be printed in this space above a line labeled "Submitted by". The Engineer or Architect whose stamp is on the drawing shall sign his name as shown on the stamp on the line labeled "Submitted by".

1.4.7 Drawing Title

The drawing title shall be centered and include no more than four lines as follows:

A. Line 1 shall show the basic rapid transit line or the subject of a SCRTD Standard or Directive Drawing, as follows:

LA CBD TO N. HOLLYWOOD

or

MECHANICAL STANDARD

B. Line 2 shall indicate the structure, operation, or equipment, such as:

VERMONT/WILSHIRE STATION
or
UTILITIES REARRANGEMENT PLAN
or
LINE SECTION VENTILATION FANS

C. Avoid the use of an indefinable title, such as "TYPICAL SECTION." Title should identify the significance of the subject shown, for instance:

TYPICAL PAVEMENT SECTIONS
TYPICAL INVERT SECTION

D. Lines 1 and 2 shall be inked with Leroy No. 240C template and a No. 3 pen.

E. Lines 3 and 4 may be used to indicate in more detail what is shown on the drawing and where it is located. For example, Plan and Profile Drawings shall show the limiting cross streets or the limiting stations. These lines shall be inked with a Leroy No. 200C template and a No. 2 pen.

1.4.8 Drawing Distinction

Each drawing title should have its distinct label for identification. When several drawings depict similar data, and no other qualifications are available for distinguishing the sheet, then the distinction, shall be made by labeling each such sheet consecutively as Sheet 1, Sheet 2, etc., within the titles.

1.4.9 Sufficiency of Drawing Title

When only a single view is shown on the sheet, or one obvious main view takes up most of the sheet space and miscellaneous details related thereto are included on the sheet, then the Title Block drawing title will be sufficient to identify the view shown and this title should not be repeated under the drawn view, nor a variant thereof used.

1.4.10 Scale

The scale shall be inked with a Leroy No. 140C template and a No.1 pen. The drawing scale shall be noted numerically, e.g., 1" = 100' or 1/4 = 1' -0. If more than one scale is used on a drawing, except Plans and Profile Sheets, the entry in this block shall be "AS NOTED". If drawing is not drawn to scale, the entry in this block shall be "NO SCALE".

1.4.11 Contract Number

The Contract Number shall be inked with a Leroy No. 175C template and a No.2 pen.

1.4.12 Drawing Number

Project, Standard and Directive Drawings shall be identified as prescribed herein:

A. Each drawings number, shall be composed of two segments. The first segment shall identify the subject of the drawing by the codes listed in Table 1-1.

B. The second segment shall be a numerical digit starting with 001 for the first drawing of a subset and progressing consecutively for the subject or discipline. Each subject/discipline listed in Table 1-1 shall be considered a subset.

1.4.13 Sheet Number

The sheet number defines the drawings in consecutive numerical order in the set of project drawings.

1.5 DRAWING ORIENTATION

1.5.1 General

A. Drawings shall be oriented so that the stationing progresses from left to right across the sheet. The stationing will begin in the Central Business District (CBD) and increase as it progresses in a westerly direction toward North Hollywood. The standard North Arrow shall be displayed in the upper right corner of all plan drawings.

Table 1-1

DISCIPLINE CODES FOR STANDARD AND DIRECTIVE DRAWINGS

Subject	CODE		
	Contract Drawing, Except Standard	Standard Drawing	Directive Drawing
Architectural	A	AS	AD
Automatic Train Control	Q	QS	QD
Civil	C	CS	CD
Communications	N	NS	ND
Control Surveys	W	WS	WD
Electrical	E	ES	ED
Elevators and Escalators	H	HS	HD
Fare Collection Equipment	F	FS	FD
General Information	G	GS	GD
Interface (among other subjects)	X	XS	XD
Landscaping	L	LS	LD
Life Safety	B	BS	BD
Mechanical	M	MS	MD
Mechanical/Electrical	D	DS	DD
Right-of-Way	R	RS	RD
Soil of Geology	K	KS	KD
Structural	S	SS	SD
Subway Structural	Y	YS	YD
Trackwork	T	TS	TD
Traction and Auxiliary Power	P	PS	PD
Utilities	U	US	UD

B. All plan view drawings in a set shall be oriented in the same general direction.

C. The set of Project drawings shall be carefully organized so that the designer's intent can be read easily. Related ideas should be grouped together in an orderly arrangement. Each drawing shall be laid out with ample space between drawing items to ensure sufficient space for unanticipated details.

1.6 LETTERING

1.6.1 General

All lettering shall be of sufficient weight and clarity that it can be easily read from a print that has been reduced to half scale of the original drawing. On any one sheet uniformity shall be maintained. Letter sizes and line widths shall be as specified herein.

1.6.2 Lettering Type

A. Unless otherwise specified, all lettering within any drawing shall be of one of the following types:

1. Vertical, freehand, single-stroke, Commercial Gothic, using either all soft pencil or all ink.

2. Inclined, freehand, single-stroke, Commercial Gothic, using either all soft pencil or all ink.

3. Leroy, vertical or inclined, in ink.

4. Typewritten, provided the typed letters are a minimum 1/8" in height.

B. Except for typewritten text, only one type of lettering shall be used in the body of any one drawing. Notes may be typewritten irrespective of the type of lettering used elsewhere in the body of type drawing.

1.6.3 Main Titles

For main titles use uniform height capital letters. Lettering shall be 1/4" high with a line width of 0.035" or inked with Leroy Np.240C template and a No.3 pen.

$\frac{1}{4}$" 240C-3PEN

1.6.4 Subtitles

For subtitles use uniform height capital letters.. Lettering shall be 7/32" high with a line width of 0.026" or inked with Leroy No. 200C template and a No.2 pen.

$\frac{7}{32}$" 200C-2PEN

1.6.5 Underlining

Underline all titles with a single line having the same weight as the lettering used.

1.6.6 Miscellaneous Notes and Dimensions

A. Freehand Lettering:

1. For general notes and miscellaneous descriptive notes and dimensions, freehand lettering may be all upper-case or all lower-case on each drawing.

2. When using lower-case lettering, capitalize the first letter of proper nouns, specific titles, trade names, and the first word of each sentence or notation. Lettering shall be all vertical or all inclined. Height of upper-case lettering and capitals shall be 5/32"; lower-case lettering shall be 4/5 the height of the capital letters. Line thickness shall be 0.021".

B. Leroy Lettering:

1. For general notes and miscellaneous descriptive notes and dimensions, Leroy lettering may be used. It shall be all upper-case, vertical or inclined, in ink. Lettering size shall be Leroy No. 140C template using a No. 0 pen.

2. Use double spacing to separate successively numbered notes.

1.6.7 Fractions

A. Fractions shall have the division line horizontal. The height of the fraction shall be twice the height of the associated integers, upper-case lettering, or capitals.

B. If freehand lettering is used, the criteria of Section 1.6.6A pertains to the integer. The number of the fraction shall be 1/8" high.

C. If Leroy lettering is used, the criteria of Section 1.6.6B pertain to the integer. The number of the fraction shall be Leroy No. 120C template using a No. 0 pen.

$$a - \cdot - 23\frac{5}{8} - \cdot - 2a$$

1.6.8 Orientation

A. All lettering shall read from the bottom or right edge of the sheet; in no case shall it be carried more than 15 degrees counterclockwise past vertical.

B. All lettering guidelines shall be non-reproducing. Guidelines are to ensure that the letters will be of uniform size, and to make certain that all the words are on parallel, equally spaced, horizontal or vertical lines.

1.7 LINEWORK

1.7.1 General

A. All linework shall be of sufficient clarity to be read easily from a print which has been reduced to one-half the linear dimensions of the original drawing. Similar lines denoting a structural outline, a centerline, etc., shall have uniform widths whenever and wherever they are shown within a set of project drawings. Linework shall have appropriate gradations of width to give line contrast, e.g., between structural outline and dimensions. Tape shall not be used on Project Drawings.

B. For the best possible reproduction, linework shall be kept dense, clean, and sharp. All linework must be kept separated to prevent its running together on a reproduction. In some cases, a slight exaggeration of a dimension may be necessary to keep the desired separation of lines. Keep in mind that all drawings will be reduced to half size eventually.

1.7.2 Line Width

A. Types and widths of lines which are recommended for drawings are shown in Section 1.7.5.

B. Arrow heads may be open or solid but must be clear.

1.7.3 Conflicts

All lettering and numbering must be kept clear of linework. Linework must not be drawn through a dimension.

1.7.4 Screening of Existing Condition

See Section 1.3.7.

1.7.5 RECOMMENDED LINE WIDTHS

DESCRIPTION	Drawn smaller than 1" = 40' or ¼' = 1' - 0			Drawn at or larger than 1" = 40' or ¼" = 1' - 0		
	LINE WIDTH	PEN NO	EXAMPLE	LINE WIDTH	PEN NO	EXAMPLE
Primary Outlines	0.021"	1		0.026"	2	
Secondary "	0.017"	0		0.021"	1	
Hidden "	0.017"	0		0.021"	1	
Dimensions and Grid Lines	0.013"	00		0.013"	00	
Center Lines	0.013"	00		0.013"	00	
Section Lines, Match Lines, and Right-of-Way Lines	0.035"	3		0.035"	3	
SCRTD Track Lines (Single Track-Two Rails)	0.035"	3		0.035"	3	

1.8 DIMENSIONS, SCALES, AND ABBREVIATIONS

1.8.1 Unit of Measure

A. The appropriate unit of measure shall be defined on the drawings for all dimensions. When a feet-and-inches dimensions. When a feet-and-inches dimension is given, the inch marks shall not be indicated. Examples of dimensioning in feet-and-inches are as follows:

Overall dimension	600' - 0
Column spacing	37' - 6
Wall thickness	10"

B. When the decimal system is used for dimensions, elevations, alignments, inverts, slope designations, etc., the number shall always be written to two decimal places. For coordinate system, the number shall always be written to three decimal places. If the number is less than one foot, a 0 shall be placed in front of the decimal point. Examples of the decimal system are as follows:

Dimension	37.50'
Elevation	654.54
Slope	6.50%
Coordinate	441,646.146

C. Reinforcement spacing shall be specified without the inches abbreviation, e.g., #4 @ 18.

D. Project Drawings shall employ the dimensional systems for specific drawing items as noted below:

1. Civil and Utilities Drawings. The decimal system shall be used for coordinate systems, elevations, gradients, points on horizontal and vertical alignments, survey information, inverts and slope designations. The feet-and-inches system shall be used for all other purposes.

2. Structural, Architectural, Mechanical, and Electrical drawings. The decimal systems shall be used for specific elevations and the feet-and-inches system for all other layout dimensions and details.

1.8.2 Location of Dimensions

A. Dimensions shall be shown in only one location in the set of drawings and referred to from other drawings if necessary for clarity.

B. Particular care shall be taken to avoid use of duplicate or unnecessary dimensions.

C. All dimension figures, and notes shall be place above the dimension line when read from the bottom or the right edge of the sheet. Placement of dimensions outside the view is desirable. However, in the interest of clarity and simplicity, it may be necessary to place some dimensions within the view.

D. When a dimension is not drawn to scale, the dimension shall be followed with the following notation: N.T.S.

E. Non-reproducing guidelines shall be used for all dimension figures. All numerals and decimal points shall be carefully lettered and properly spaced.

1.8.3 Scale

A. The basic scale used on each drawing shall be noted in the title block. On a drawing where various scales are used, the scale box of the title block shall read "AS NOTED", and the scale of each view shall be shown directly below the title of the view. Scales shown in the drawing shall be in capital letters 5/32" high with a line width of 0.021" or Leroy No. 140C template and a No. 1 pen. Scales for particular types of drawings are outlined in later sections of these criteria.

B. A 1½" x 1½" square area immediately above the right end of the title block shall be left clear on all Project Drawings for the subsequent placement of a "Half Size" stamp.

C. The scale for a drawing or a drawing view shall be selected to assure clarity of a print when it has been reduced to one-half the linear dimensions of the original drawing and to allow for reasonable space between views. Within a set of drawings compatible multiples shall be used wherever possible, e.g. 1/8", 1/4", 1/2", 1" = 1' -0 or 3/16", 3/8", 3/4", 1½", 3" = 1' -0.

D. If an elevation, section, or detail is shown schematically and it is not intended to specify the scale, the view shall be noted "N.T.S." under its title; or in the case of an entire drawing not drawn to scale the "N.T.S." scale be shown only in the SCALE block.

E. Graphic scales shall always be shown on project or vicinity maps.

1.8.4 Abbreviations and Graphic Symbols

A. The abbreviation of words on Project Drawings shall be held to a minimum to ensure clarity and to lessen the chance of an abbreviated word being misinterpreted. The abbreviations shown in the Standard Drawings are the only ones approved for use on SCRTD Project Drawings. If it is absolutely necessary to abbreviate another word, the word must be added to the applicable standard abbreviation drawing.

B. Graphic symbols other than those shown on the Standard Drawings shall be in accordance with the following:

1. Reinforced Concrete: Manual of Standard Practice for Detailing Reinforced Concrete Structures, ACI Manual 315.

2. Structural Steel Detailing: AISC "Steel Construction Manual" and AISC "Structural Shop Drafting Text Book".

3. Welding Symbols: American Welding Society "Standard Welding Symbols".

4. Mechanical Symbols: ASHRAE Standard and current accepted practice.

5. Electrical Symbols: IEEE Standards and current accepted practice.

C. The following drafting techniques/aids are prohibited for Project Drawings only:

1. Shading
2. Adhesive Overlays
3. Splicing

1.9 SECTIONS

1.9.1 Transit Line Sections

A. Nomenclature:

Transit line sections, including earthwork sections, shall be referred to as cross sections.

B. Identifying Symbols and Titles:

These sections will not be cut on the plan but will be identified by station title as follows:

STA. AR 327+00

C. Orientation:

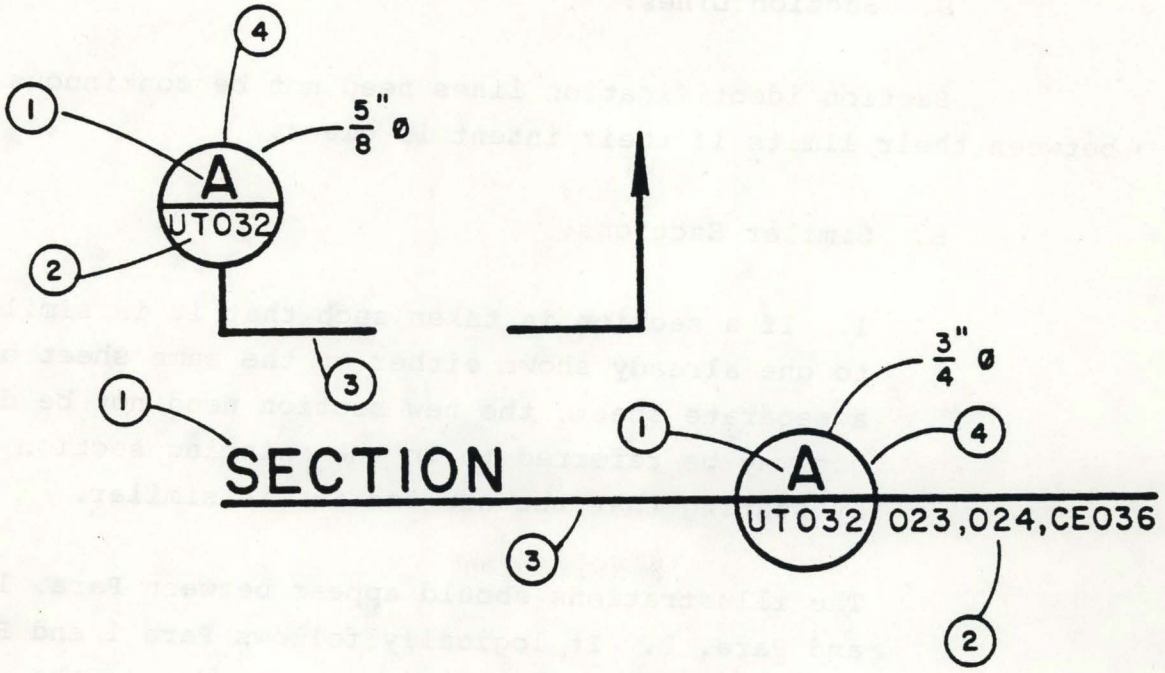
Cross sections shall be portrayed looking ahead on line, i.e., in the direction of increasing stationing. When more than one cross section is drawn on one sheet, the cross sections shall be arranged so that the section stations increase from the bottom to the top of the sheet and from left to right.

1.9.2 Engineering and Architectural Sections

A. Identifying Symbols and Titles

1. The following identifying symbol and section title shall be used for engineering and architectural sections and shall be shown on the Standard Abbreviations, Symbols and General Notes drawings for each discipline.

2. The section designating character shall be shown in the upper half of the circle. The sheet on which it is drawn shall be shown in the lower half. In section title, all sheets on which the section is identified shall be shown outside the circle, below the line and to the right.



1-Leroy #240C template, #3 pen
2-Leroy #120C template, #1 pen
3-#3 pen
4-#2 pen

B. Orientation:

Whenever possible, sections shall be taken looking to the right, ahead on line, or down. Wherever practical, a section that is drawn on the sheet on which it is identified shall be drawn in the immediate vicinity of its identification symbol.

C. Designation:

Sections shall be designated by capital letters. Wherever practical, sections shall be listed consecutively, A, B, C, etc., from left to right and from top to bottom on the sheet on which they are drawn.

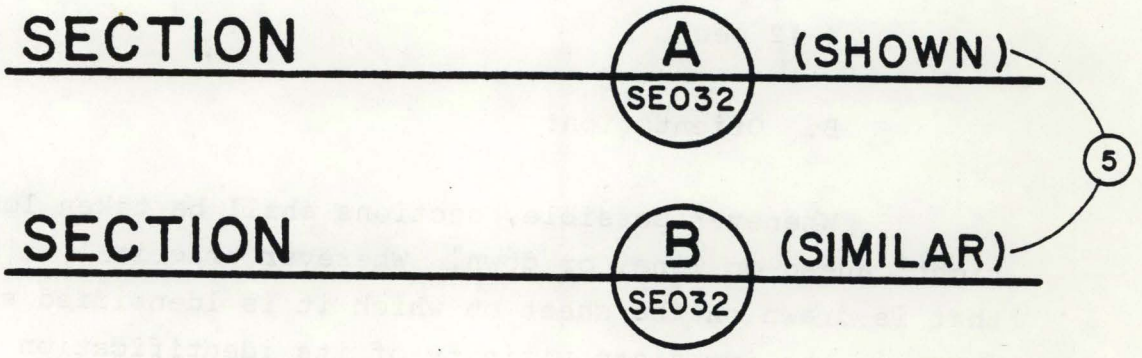
D. Section Lines:

Section identification lines need not be continuous between their limits if their intent is clear.

E. Similar Sections:

1. If a section is taken such that it is similar to one already shown either on the same sheet or on a separate sheet, the new section need not be drawn but may be referred to in the existing section view by stating that the new section is similar.

The illustrations should appear between Para. 1. and Para. 2. It logically follows Para 1 and Para 2 refers to "as B above" which appears in the illustration.



5-Leroy #175C template, #2 pen

2. The word 'similar' may also be expanded to explain how it is similar, such as (similar, but opposite hand) or (similar, except as noted). In designating a similar section, always use a different letter, as B above, and not the initial letter with an accent, e.g., A'. The use of the word "same" is to be avoided.

F. Sub-sections:

Sections should be cut where necessary to show work requirements. Avoid repetitive information. No need to cut full sections where sub-sections will suffice to illustrate a new view. Either cross-referencing to a previously drawn full section can convey the work requirements adjacent thereto, or the plan or elevation make obvious the relationship of the sub-section to a full section. Further, the sub-section, by itself, has the advantage of highlighting the difference in detail.

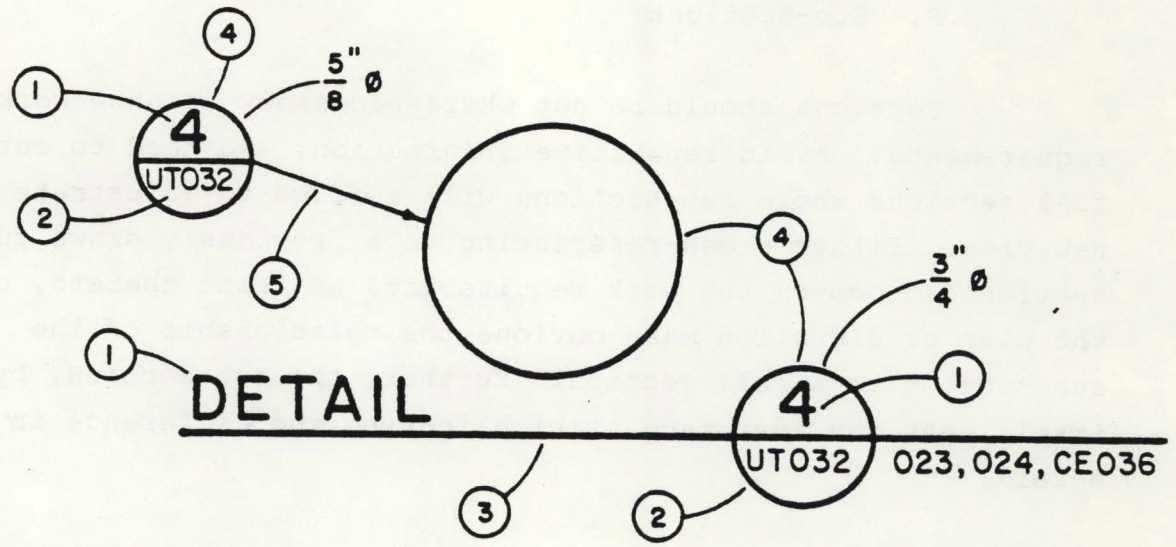
1.10 DETAILS

1.10.1 Detail Limits

Details will be identified by encircling the area to be clarified and connecting this circle with the detail symbol.

1.10.2 Identifying Symbols and Titles

The following identifying symbol and detail title shall be used for engineering and architectural details and shall be shown on the Standard Abbreviations, Symbols and General notes sheet for each discipline:



1 - Leroy #240C template, #3 pen
2 - Leroy #120C template, #1 pen
3 - #3 pen
4 - #2 pen
5 - #1 pen

The detail designating character shall be shown in the upper half of the circle. The sheet on which it is drawn shall be shown in the lower half. In the detail title, all sheets on which the section is identified shall be shown outside the circle, below the line and to the right.

1.10.3 Orientation

The orientation of the detail drawing shall be identical that of the plan, elevation, etc., where it is identified. Wherever practical, a detail which is drawn on the sheet on which it is identified shall be drawn in the immediate vicinity of its identification symbol.

1.10.4 Designation

Details shall be designated by numerals. Wherever practical, details shall be listed consecutively: 1,2,3, etc. from left to right and from top to bottom on the sheet on which they are drawn.

1.11 REVISIONS

1.11.1 Applicability

These instructions pertain to revisions of Project Drawings, Standard Drawings, and Directive Drawings. They cover revisions made to Standard Drawings during design, during advertising (by addendum), and after award of the construction contract (by change order). They cover revisions made to other Project Drawings by the Design Office during advertising and after award of the construction contract. And they cover revisions made to Directive Drawings by the originator.

1.11.2 Limits and Identification

Except as noted in Section 1.11.3, a heavy freehand bubble shall be drawn in pencil around the revised area on the back of the drawing. A 3/8" triangle or diamond (See below) in which the revision designation is shown shall be placed on the front of the drawing, touching the bubble. When another revision to the same sheet is required, the existing bubble(s)

shall be removed and a new bubble, triangle or diamond, and numerical revision designation shall be added. The preceding triangle(s) or diamond(s) shall remain to provide a continuous record of revision.

1.11.3 Standard Drawing

A. Prior to Baselining

1. Standard Drawings shall be revised only by the General Consultant. The design office shall request changes to Standard Drawings on Change Request forms supplied by the General Consultant.

INITIAL ISSUE

2. Subsequent revisions shall be made using

for the first revision,

for the second revision, etc.

3. Entries shall be made in the Revision Block, working upward. In the Revisions Block, a numerical subscript shall be used to the right of the triangle to identify the number of changes made. Revisions made to Standard Drawings prior to baselining shall not be bubbled.

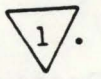
4. When a Standard Drawing is released by the originator, either as the initial issue or as a subsequent issue, a zero shall appear under the abbreviation "REV." in the Drawing Number Block.

B. Revisions After Baselining

1. Revisions after baselining shall be made as indicated in Section 1.11.2, with the following exceptions:

a. During Design Phases but Prior to Advertising

Revisions shall be identified by the numeral "1" in a triangle, as follows:



. In the Drawing Number Block a "1" shall be entered, in pencil, under the abbreviation "REV.", and an entry shall be made in the Revision Block using the next available line.

In the Revision Block, a numerical subscript shall be used to the right of the triangle to identify the number of changes made.

b. During Advertising

The instructions of Section 1.11.3A apply except that the symbol shall be diamond: 

If no revision was made during design, the first revision shall be Revision 1, if a revision was made during design, it shall be Revision 2. Subsequent revisions shall be identified by numerals in sequential order. Revisions shall be reflected both under the abbreviation "REV." in the Drawing Number Block, in pencil, and in the Revision Block.

c. After Award

The instructions of Section 1.11.3B apply except that the symbol shall be a triangle with the apex up:

1.11.4 Other Project Drawings

Prior to baselining of Project Drawings, the Design Office may control revisions by its own internal procedure. At baselining of the project drawings (i.e., preparation for advertising), the Design Office shall remove all prior revision data from the Revision Block.

A. Revisions shall be made as indicated in Section 1.11.2.

B. Baselined Project Drawings

Project drawings, except Standard Drawings, submitted for advertising (initial issue) shall be identified as revision "0". In the Drawing Number Block, under the abbreviation "REV.", a zero shall be entered in pencil using a Leroy No. 175C template and vertical lettering. See Section 1.4.10. No entry shall be made in the Revision Block.

C. Revision during Advertising

The instructions of Section 1.11.3B shall apply except that the first revision shall always be Revision "1".

D. Revisions after Award

The instruction of Section 1.11.3B shall apply.

1.11.5 Directive Drawings

Directive drawings shall be revised only by the originator. The instructions of Section 1.11.3 apply.

1.11.6 Title Block

Revision Block

A. In the Revision Block of the Title Block the revision designation, and the date of the revision shall be shown. Prior to the baselining of the drawing, the initials of the individual originating the change, and the initials of the approver shall be shown. If possible, the approver should be the individual whose stamp appears on the drawing; in any event he shall be a registered engineer or architect, as appropriate. Following the baselining of the drawing the addenda/change request number and the Contract Change Order number (when appropriate) authorizing the change should be shown.

B. The description of the revision shall be as complete as the space allows. The first word of the description shall always be the past tense of a verb.

C. The first revision shall be made on the lower line of the revision box, followed by the second revision above it. Should the revision box become filled, then extend the revision box upward into the body of the drawing. Should space within the body of the drawing not be available, then the data listed in the lower revision space shall be erased, as required, and the new revisions be included in these erased spaces.

D. Lettering criteria for miscellaneous descriptive notes shall apply for revisions. Entries shall be in ink.

E. Drawing No. - Rev. Block

The revision designation shall be shown in the "REV." block to the right of the Drawing No. Omission of this Revision Number while the drawing is being revised may be used as a check to ensure that the drawing is not printed before the revision has been completed.

1.11.7 Maintaining Updated Drawings

When a Project Drawing change is made by change notice not accompanied by a re-issue of the Project Drawing, the revision shall be made to the Project Drawing nonetheless at the same time to maintain an up-to-date status of the drawing. When the drawing is re-issued at some later date, all revisions not previously identified shall be described with that issue. The bubble(s) of all previous revisions shall be dashed.

1.1.12 LAYOUT CONTROL

1.12.1 Horizontal Control

A. The individual main-line tracks shall be designated "R" (right) and "L" (left). The "R" track shall be the main-line track carrying SCRTD System trains in the direction of

increasing line stationing. The alignment control of all "R" SCRTD System lines shall be based on and referenced to the SCRTD Primary Control Survey Monuments. All "R" lines shall be stationed throughout their length and form the basic control for all other SCRTD System facilities.

B. The alignment of other SCRTD System lines and structure layout lines need not be defined by detailed geometry where their geometry can be defined from the "R" line by offsets. If the "R" and "L" tracks are not parallel and in other locations where off-setting from "R" track is not feasible, the "L" track shall have separately defined geometry beginning and ending with station equalities to the "R" line.

C. The control for all other SCRTD System features shall be based on and referenced to the "R" lines.

1.12.2 Vertical Control

A. SCRTD system profile elevations and other vertical control shall be based on the SCRTD Primary Control Survey Monuments.

B. Structural slab depressions, etc., may be referred to datum plane (finish floor elevation) where convenient. In these cases the datum shall be based on the SCRTD Primary Control Monuments.

1.13 PROJECT INFORMATION

1.13.1 Preliminary Line Design

A. The General Consultant will coordinate the activities of groups which are responsible for route location, control surveys, right-of-way acquisition, and utilities relocation. Those responsible for control surveys will prepare photogrammetric manuscripts in strip form (strip maps).

1.13.2 Detailed Line Design

The General Consultant will make available to the Design Office the following information:

A. Strip Maps:

The strip maps will show the preliminary horizontal alignment, control points, grid coordinates, control ties, existing topography, and right-of-way limits in the design area, usually at a scale of 1" = 40'.

B. Strip Profiles:

The strip profiles will show the preliminary vertical alignment, control elevations, and the ground profile in the design area, usually at a scale of 1" = 40' horizontal and 1' = 10' vertical.

C. Typical Transit Line Sections:

Typical cross sections based on the preliminary alignment will be shown through the design area.

D. Record of Utilities:

A record of all known utilities will be provided. In critical portions of the design area, these utilities will be shown on strip maps and/or strip profiles.

E. Soils Report:

A preliminary and/or final soils report will give subsurface information in the design area and show location of borings and boring logs.

F. Recommendations:

Recommendations for final route location, design speed and expected superrelevation, utilities relocations, etc., will be presented in a preliminary design report.

1.14 GENERAL PROJECT DRAWINGS

1.14.1 General

The General Project Drawings will be the first drawings in all drawing sets and will be followed by any other subsets that are required for the Project set, in a logical sequence.

1.14.2 Organization

A. Cover Sheet
B. Title Sheet
C. Index of Drawings
D. Layout Index and Cross-Referencing of Drawings

1.14.3 Cover Sheet

The cover sheet, for which an appropriate format will be provided by The General Consultant shall be completed to include the following:

A. Project Title
B. Project Number
C. Date (month and year) of submittal
D. Name of Section Designer

1.14.4 Title Sheet

The title sheet, for which an appropriate format will be provided by the General Consultant will include the following:

A. Project Title and Number
B. General Construction Site Plan
C. Key Map
D. Title and Signature Blocks

1.14.5 Index of Drawings

A. The drawings shall be categorized by design discipline; all drawings shall be indexed. Title shall be exactly the same as shown in the title block of each drawing. Abbreviations not contained in drawing titles shall not be used.

B. Spacings for Index Sheets

1. Use double spacing between each listed drawing. Provide a 1" space between last drawing of design discipline and heading of new discipline.

2. An adequate blank space shall be provided on the last index sheet to permit listing of new drawings that might be generated during the construction phase as design changes occur and are made part of the contract by change order. Assume blank space requirement to be between 5% and 10% of the total index space utilized by the initial issue of Project Drawings.

1.14.6 Layout Index and Cross-Referencing of Drawings

The layout index shall preferably be one sheet showing the alignment through the project area with a graphic indication

of the location of all plan drawings, profile drawings, and/or planed and profile drawings. EAch sheet location indicated on the index shall be given a Plan Sheet number, and this number shall be placed in the upper right corner of each corresponding plan sheet. Thus, in addition to the drawing number defined in Section 1.4.10 each sheet (Existing Conditions Plan, Roadway and Track Alignment, Drainage, etc.) related to a particular section of the line shall have the same number defining its location from the layout index. A cross-reference between Plan Sheet number and drawing number of the project drawings shall be given in tabular form.

1.14.7 Existing Condition Plan

A. These drawings shall be prepared from the strip maps supplied by the General Consultant and/or from survey data, generally at a scale of 1" = 40'. Data shown on strip maps shall be verified by ground survey where necessary to ensure that elevation and dimensional requirements, as well as constructability of the design can be met. The purpose of the existing conditions plan is to serve as the background for the project drawing.

B. Specific information to be shown includes:

Contours and spot elevations.

Existing buildings, street, sidewalks, retaining walls, fences, trees, etc.

Existing property lines and parcel numbers prior to SCRTD acquisition.

4. Names of active commercial businesses and public buildings.

5. Buildings to be demolished or severed, if any.

1.15 CIVIL DRAWINGS

1.15.1 Organization

A. Standard Civil Abbreviations, Symbols and General Notes
B. Survey Monument Control
C. Alignment Plan and Data
D. Typical Sections
E. Construction Stepping Plan
F. Plan and Profile
G. Grading, Paving, and Drainage Plan
H. Pavement Profiles, Details, and Sections
I. Drainage Profiles and Details
J. Project Cross Sections
K. Traffic Signals
L. Regulating Traffic
M. Signing and Pavement Marking
N. Signing and Marking Details
O. Standard Drawings

1.15.2 Standard Civil Abbreviations, Symbols and General Notes

This drawing, which includes abbreviations, symbols and general notes that pertain in general to civil will be provided as a standard by the General Consultant.

1.15.3 Survey Monument Control

This drawing shall include a plan and details of the SCRTD Primary Control Survey Monuments within the project area which will be required for field layout.

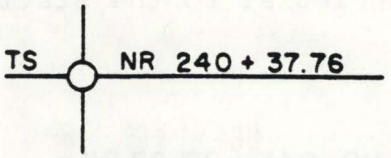
1.15.4 Alignment Plan and Data

A. Scale:

The plan of the alignment shall generally be drawn at a scale of 1" = 40'.

B. Curvature:

1. All points of curvature on the line shall be shown as open circles 1/8 inch in diameter, and shall be identified by a radial line, 0.021" in width or No. 1 pen, to the circle and labeling the line with the station and pertinent abbreviation thus:



2. The radius will be designated thus: R = 2000' Tangent control points shall be shown as open 1/8 inch triangles and points shall be identified by the appropriate abbreviations.

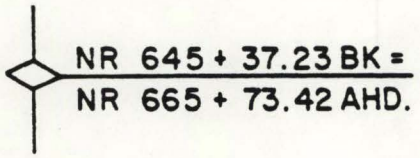
3. For abbreviations and symbols, refer to the Standard Civil Abbreviations, Symbols and General Notes.

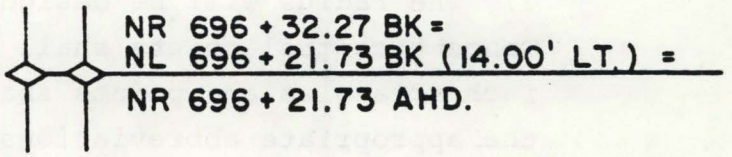
C. Stationing:

1. Each 100 foot station shall be identified by a mark 1/4 inch long. Each 500-foot and 1000-foot station shall be designated by the full station number. Station numerals shall be 7/32" high with a line width of 0.026" or ink using Leroy No. 140C template and a No.1 pen.

2. Stationing requires no more than two decimal places. Coordinates require no more than three decimal places.

3. Station equalities shall be shown as a 1/8 inch open diamond. The equation shall be shown on a line. 0.021" in width or No.1 pen, drawn perpendicular to the stationed line, thus:





D. Stations:

1. The outline of rapid transit stations shall be shown by one inch long dashed lines, separated by a 1/8 inch space; line width shall be 0.026" or a No.2 pen.

2. Track lines shall be shown continuous through the station. The station shall be titled "XXXXXX Station" in or near the station outline using 7/32" high letters with a line width of 0.026" or ink using Leroy No. 200C template and a No.2 pen.

E. Streets:

Streets and highways adjacent to transit lines shall be identified by pavement lines. For street names use ¼" high letters with a line width of 0.035" or ink using Leroy No. 240C template and a No.3 pen.

F. Match Lines:

Each sheet shall bear a match line near each end, drawn perpendicular to the rapid transit line alignment, preferably at a full 100-foot station. The line shall be made up of a long dash and two short dashes, repeated. The long dash shall be 1.5 inches along with 0.10 inch space, and the short dashes are to be 0.25 inch long with 0.10 inch space. The width of the line shall be 0.035" or No.3 pen. The match line shall be labeled, e.g., MATCH LINE STA AR 620+00, in letters and numbers on the outside of every perpendicular match line using ¼" high letters with a line width of 0.035" or ink using Leroy No. 240C template and a No.3 pen.

G. Alignment Data:

Alignment data shall be arranged in tabular form showing horizontal control points. The tables shall be arranged by rapid transit line and shall read from top to bottom. Tables shall contain the stationing and coordinates of each point as indicated in Section 1.15.4C. Curve data shall be shown.

1.15.5 Typical Sections

Typical sections of the SCRTD alignment, railroad trackway, highway and street modifications, and parking lots, properly dimensioned and described by stationing limits, shall be dran at scale of not less than ¼" = 1' -0.

1.15.6 Construction Stepping Plan

If required, a construction stepping plan shall be prepared showing the availability or various portions of the construction site.

1.15.7 Plan and Profile

A. Plan:

1. General:

Line Designation, Curvature, and Stationing shall be as described previously except that points of curvature and equations shall be identified only by point symbols and proper abbreviations. Stationing shall be omitted at such points. The scale normally shall be 1" = 40' horizontal but may also be that used for Grading, Paving, and Drainage Plan described in Section 1.15.8.

2. Stations:

The outline of each rapid transit station shall be as described in Section 1.15.4D. Track lines shall be shown continuously through the station. The station shall be titled as described in Section 1.15.4D. Parking areas shall be outlined in a single, solid line with a line width of 0.021" or No.1 pen.

3. Roadways:

If frontage roads, access roads, relocated roads and streets, etc., are to be constructed, those roads and streets shall be shown by solid lines with a line width of 0.021" or No.1 Pen defining the edges of the proposed alignment. Termination of existing road or street shall be designated by a single, solid, wavy lines. If a bridge is shown, either over the rapid transit line or another railroad or road, the bridge shall be outlined by a solid line, 0.021" in width or No.1 pen. The centerlines of roads and structures shall be shown as defined in Section 1.7.

4. Railroads:

If existing railroads are to be relocated, the new alignment of tracks shall be shown by a line made up of a long dash and a short dash repeated. The long dash shall be 1.0 inch long, and the short dash shall be 0.05 inch long with 0.05 inch space. The width of the line shall be 0.26" or No.2 pen.

5. Utilities:

Utilities shall not be shown on this plan.

6. Political Subdivisions:

City and county lines shall be shown by a line made up of a long dash and a short dash, repeated. The long dash shall be 0.80 inch long, and the short dash shall be 0.10 inch long -- the pattern repeats along each one inch of line. The width of line is to be 0.035" or No.3 pen. Show names of City and County in appropriate locations.

7. Streets and Railroads:

Show names of major streets and highways and names of railroads. Lettering shall be as described in Section 1.6.

8. Match Lines:

Each sheet shall bear a match line as described 1.15.4.

B. Profile:

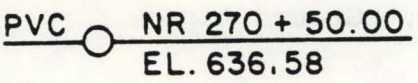
1. Profile Grid:

The vertical scale of the profile shall be 1" = 10' if the horizontal scale is 1" = 40'. If the horizontal scale is 1" = 20', the vertical scale shall be 1" = 5'. Elevations shall be entered on the left and right side of each profile grid and at breaks. The heavy horizontal lines shall be assigned values which are multiples of 10 feet or (5 feet if vertical scale is 1" = 5'). Stationing labels shall be entered at the bottom of the profile grid every 100 feet. The numbers for stationing shall be 3/16" high with a line width of 0.026" or Leroy No. 175C template and a No.2 pen. Elevations shall be 5/32" high with a line width of 0.021" or Leroy No. 140C template and a No.1 pen.

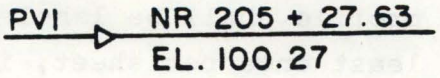
2. Track Profile:

a. The track profile shall be shown by a single solid line with a line width of 0.035" or No.3 pen, top edge of which defines the top-of-rail. Significant points defining

changes in grade shall be shown by an open circle 1/8 inch diameter. These points shall be identified by a vertical line, 0.021" in width or No.1 pen, drawn to the circle showing the station, elevation, and the pertinent abbreviation, thus:



b. Profile tangent intersections shall be identified by open 1/8 inch triangles. A vertical line, 0.021" in width or No.1 pen, shall be drawn to the triangle, and the station, abbreviation (PVI), and elevations shall be shown thus:



3. Track Profile Notes:

The profile shall be labeled "top of Rail" at least once on each sheet. The rate of grade of vertical tangents shall be labeled above each tangent, thus:

+2.50%, using "+" for ascending slopes in the direction of increasing stationing and "-" for descending slopes in the direction of increasing stationing. The length of vertical curve shall be shown below the profile and as near the PVI as practical. All letters and numbers shall be 5/32" high with a line width of 0.021" or Leroy No. 140C template and a No.1 pen.

4. Ground Line:

The profile of the existing ground along the centerline of rapid transit line shall be shown by a freehand, dashed line, 0.021" in width or No. 1 pen. If the transit line crosses a body of water, the extreme high and low water surface elevations and the profile of the bottom, if it is known shall be shown. This profile shall be labeled "existing ground line", at least once per sheet, in letters 5/32" high with a line width of 0.021" or Leroy No. 140C template and a No.1 pen.

The profile of the proposed ground along the centerline of the rapid transit line shall be shown by a solid line, 0.026" in width or No.2pen. This profile shall be labeled "finished ground line", at least once per sheet, in letters as described above for the existing ground line.

5. Structure Type:

If the rapid transit line is at grade, in cut, or on fill, no special delineation of structure type shall be made, except that retaining walls shall be shown with lines identifying tops of walls and tops of footings.

If the rapid transit line is on an aerial structure or bridge, the piers, abutments, and the bottom of the spanning structure, shall be shown by a solid line, 0.021" in width or No.1 pen. Where the rapid transit line is in subway or tunnel, the top and bottom of the structure, inside and outside, and the portals shall be shown by solid lines, 0.021" in width or No.1 pen.

6. Stations:

Each transit station shall be drawn to scale. The top, bottom and ends of the station shall be outlined with solid lines, 0.026" in width or No.2 pen. Interior lines for stations shall be solid lines 0.021" in width or No.1 pen. Track line shall be shown continuously through the station. The station shall be titled as described in Section 1.15.4D.

7. Overpasses and Underpasses:

If streets, highways, and railroads cross over or under the rapid transit line, the centerline intersection shall be shown using a light centerline symbol, and the section of the structure shall be indicated in solid lines, 0.021" in width or No. 1 pen. The name of the street, highway, and railroad shall be noted vertically along the centerline symbol in letters 5/32" high with a line width of 0.021" or Leroy No. 140C template and a No.1 Pen. If the structure exists, it shall be labeled "existing".

8. Utilities:

All major underground utilities lines, such as sewers and water mains, shall be shown in profile crossing the rapid transit line.

9. Match Lines:

Match lines shall be designated as in Section 1.15.4. In addition, the elevation of the profile grade shall be shown at the match line.

10. Profile Grade Elevations:

Profile grade elevations at even 50 foot intervals and at each end of vertical curves and at the beginning and end of the project shall be shown along grid lines at the bottom of the profile grid.

1.15.8 Grading, Paving, and Drainage Plan

A. Purpose:

The primary purpose of grading, paving, and drainage plans is to define construction along the trackway and at parking lots, access roads, city and county streets, highways, etc., adjacent to the rapid transit line. These drawings are for construction of new or restoration of existing facilities.

B. Scales:

1. 1" = 20' desirable

2. 1" = 40' minimum

C. Information Shown:

1. Plan shall show structure outlines, street lines, walls, easement and temporary and permanent needs lines, sidewalks, curbs, alleys, catch basins, manholes, fences, guard rails and other

surface features to be constructed or affected by Metro Rail Project construction. Typical sections, existing and new elevations, cross sections or cross section information, type of pavement, curbs and other details for areas to be paved, or repaved or restored, shall be shown or referenced to other plans. Elevations of street surfaces to be matched shall be indicated. The pay limits.of areas to be constructed or restored shall be clearly defined and shall include a reasonable area outside the limits of excavation, approximately 15 feet, or more, and areas damaged by utilities relocations(s).

2. Drainage information shall include layout of new and relocated storm sewer facilities. Show size and material of pipes and types of channels and gutters. Cross reference shall be made to profiles and details on other drawings.

3. If construction does not extend beyond roadway limits and does not involve restoration and replacement of curbe, include centerline profile and, at intervals of 50 feet and breaks in grade, show original and proposed elevations at points on profile and at edge of restoration. Include existing elevations at flow line.

4. Plans of new curbs shall include centerline elevations and elevations at each curb line showing flow line or top of curb line unless profiles are shown on Pavement Profiles, Details and Section drawings.

5. If restoration includes adjoining sidewalk, with or without curb, show areaways, window walls, doorways, SCRTD gratings and other pertinent surface features and existing and proposed elevations in sufficient detail to indicate clearly slope and warping of sidewalk to assure that areas are properly drained.

6. Show control elevations at the tangent points of the street corners or fillets, and at points to be matched.

7. Breaks in grade in excess of 0.50% require a vertical curve, and both breaks in grade and vertical curves shall be noted.

8. Locate and note trees to be saved.

9. Unless notified to the contrary by the General Consultant, disturbed areas not to be otherwise altered shall be restored to match the adjoining properties, alleys, and streets.

10. Unless otherwise shown, restoration work on local streets and highways shall conform to the terms of Agreements, between SCRTD and the agencies and municipalities involved. SCRTD standards and criteria shall be followed for construction on SCRTD right-of-way.

11. Contours defining finished grades and finished pavement elevations shall be drawn as solid lines 0.021" in width or No.1 pen. Every 10 foot contour (e.g. 940, 950, 960) shall be drawn as a heavy solid line, 0.026" in width or No.2 pen. The

contour interval shall not exceed two feet, and each contour shall be labeled at least once on each sheet.

12. Easement and permanent and temporary needs lines shall be coordinated with the SCRTD Right-of-Way and Agreements Section and shall be sufficient for SCRTD's facilities, utilities, roadway and railroad rearrangements, access and construction. All points shall be shown in tabular form on this drawing or on a separate drawing. Tables shall contain the number and coordinates of each point. When easement and needs lines become too extensive and obscure other information to be shown on this plan, it may be advisable to show all property information on a separate RIGHT-OF-WAY plan. If included, the RIGHT-OF-WAY plan sheets shall be placed at the end of the General Project Drawings.

1.15.9 Pavement Profiles, Details and Sections

Profiles and miscellaneous sections and details for roadways, streets, curbs, driveways, and parking lots required to define vertical elements shown on pavement and grading plans shall be indicated on these drawings. Details shall not be drawn at scales less than ½" = 1' -0. Sections shall not be less than ¼" = 1' -0. Pavement profiles shall be drawn as described under requirements for Plan and Profile drawings.

1.15.10 Drainage Profiles and Details

A. Major storm sewer profiles shall be drawn at 1" = 40' of 1" = 20' horizontally and 1" = 10 or 1" = 5' vertically.

B. Show types of manholes, catch basins, and inlets. Indicate location of manholes, catch basins, and inlets by station and offsets from baselines established for the project or other dimensions. Indicate material, diameter, bedding, slope and length of pipes.

C. Invert elevations for pipes at drainage structures and elevation of grates and manholes covers shall be shown.

D. Cross-reference shall be made to plan drawings and details not shown on standard drawings.

1.15.11 Project Cross Sections

A. Cross sections at uniform intervals shall be drawn to indicate construction details and limits or earthwork. Use scale not smaller than 1" = 10' horizontally and 1" = 10' vertically.

B. Trackway and roadway cross sections shall be perpendicular to the centerline of the "R" track or center of roadway and generally shall be taken at 50 foot intervals and at sharp breaks in the terrain. In terrain where the difference in elevation between the profile grade line and the ground surface varies uniformly, cross sections may be taken at 100 foot intervals.

C. Utilization of data from required ground survey is preferred to interpolation of existing contours for showing existing ground line.

1.15.12 Traffic Signals

Prepare drawings for temporary and permanent traffic signals as per requirements of the governing municipality or the California Department of Transportation (CALTRANS).

1.15.13 Regulating Traffic

Traffic regulating must be described in Division 1 GENERAL REQUIREMENTS of the Project Specifications Book. If a drawing is necessary, it shall consist of plan views of appropriate scale and show the traffic staging and traffic detours which have been coordinated, with and approved by, local authorities or CALTRANS. Street and sidewalk areas to be decked for some duration during construction shall be indicated. Disposal and storage areas might also be indicated.

1.15.14 Signing and Pavement Marking

Signing and marking plans shall be drawn for all parking lots and roadways per SCRTD criteria and latest standard drawings, per CALTRANS or local requirements for city or county facilities.

1.15.15 Signing and Marking Details

Non-standard or special signs and pavement marking shall be drawn with sufficient detail and dimensions to enable the contractor to prepare templates for fabrication and/or installation.

1.15.16 Standard Drawings

At-grade standard drawings shall be used as much as possible. Standard plans shall be included in the project drawings set; and tracing or copying of details shall be avoided.

1.16 UTILITIES DRAWINGS

1.16.1 Organization

A. Standard Utilities Abbreviations, Symbols, and General Notes
B. Composite Plan of Existing Utilities
C. Utilities Rearrangement Plans, Profiles, and Details
D. Composite Plan of Utilities Rearrangements
E. SCRTD Electric Service (SES) Plan and Profiles and Details
F. Street Lighting Plan and Profiles and Details
G. Standard Drawings

1.16.2 Standard Utilities Abbreviations, Symbols and General Notes

The Standard Utilities Abbreviations, Symbols and General Notes drawings will include abbreviations, symbols and general notes that pertain to utilities. These drawings will be provided by SCRTD.

1.16.3 Composite Plan of Existing Utilities

A. Purpose:

Composite plans of utilities shall be prepared which show the interrelationship of existing utilities and streets in the project area. Utilities shall be designated as existing or abandoned, and the type, size and material of each shall be indicated using the symbols shown on the Utility Abbreviations, Symbols and General Notes Standard Drawings. Where the size warrants, facilities shall be drawn accurately to scale. The centerline of the utility will be used for scale reference.

B. Utilities to be Shown:

The following utilities including their ancillary facilities shall be plotted on the drawings:

1. Aerial and underground power facilities
2. Steam mains
3. Water mains
4. Sanitary, storm, and combined sewers
5. Aerial and underground telephone facilities
6. Gas mains
7. Aerial and underground cablevision facilities
8. Pipeline company pressure mains
9. Aerial and underground telegraph facilities
10. Aerial and underground street light and traffic signal facilities
11. Railroad communication and signal cables

C. Utility Designations:

1. Line designation shall be placed in space between specific utility facility. If congested, flag horizontally and perpendicular to right or left borders. When descriptive information is required, place directly above that specific utility facility.

2. Flag all sewer manholes, Leroying top (RIM) and invert in the manner described in the utility abbreviation and notes shown on the Standard Drawings.

3. For line designations and necessary descriptive information use the following:

a. 1" = 40': 1/8" high letters with a line width of 0.021" or ink using Leroy No. 120C template and a No.1 pen.

b. 1" = 20': 5/32" high letters with a line width of 0.021" or ink using Leroy No. 140C template and a No.1 pen.

4. Lines outlining existing utility facilities shall be 1½ inches along with a 1/10 inch space between lines, 0.021 inch in width or No.1 pen. Major underground utilities, 24" and larger on scale 1" = 20' and 36" and larger on scale 1" = 40', shall be shown with a double line, 0.021 inch in width or No.1 pen. Major aerial (overhead) lines shall have a line width of 0.026 inch or No.2 pen.

D. Scale:

Preferred scale is 1" = 20'. Where utilities are sparse, a scale of 1" = 40' may be used.

E. General:

Line Designation, Curvature, Stationing, Streets and Match Lines shall be as described previously, except that points of curvature and equations shall be identified only by point symbols and proper abbreviations. Stationing shall be omitted at such points.

1.16.4 Utilities Rearrangement Plans, Profiles, and Details

A. Purpose:

Utilities rearrangement plans, profiles, and details shall be prepared based upon coordinated agreements with utilities owners and as authorized by SCRTD, including utilities relocation work to be performed by other than the facility contractor. Facilities of more than one utility owner may be shown on a set of utilities rearrangement plans provided details of each utility network are clear and the plans are not congested. These drawings are for construction of new and restoration of existing utilities or to show utilities work to be done within the project area by the utilities owners.

B. Scales:

1. For plan drawings, the preferred scale is 1" = 20', and the minimum scale is 1" = 40'. Whenever possible, the scale of the rearrangement plan shall match the scale of the composite existing utilities plan.

2. For profile drawings, the preferred scales are 1" = 10' horizontal and 1" = 10' vertical. Other horizontal and vertical scales are acceptable depending on length, size, and depth of utility, drawing space available; and amount of information to be shown on the drawing.

3. For detail drawings the preferred scales are ¼" = 1' -0. ½" =1' -0. or 3/4" = 1' -0.

C. Information Shown:

1. In areas affected by construction, prepare utilities rearrangement plans, profiles and details for:

a. Sanitary and Combined Sewers
b. Water mains
c. Gas mains
d. Aerial and underground electrical facilities.
e. Aerial and underground telephone facilities.
f. Aerial and underground telegraph facilities.
g. Cablevision facilities.
h. Other utilities as necessary.

2. Utilities rearrangement plans shall show only that work pertaining to the utility or utilities indicated by the plan title. it is preferred, where scales allow, that rearrangement plans be prepared using screened copies of the composite existing utility plans for the base sheets. Utilities shall be designated using the symbols shown on the Utilities Abbreviations, Symbols, and General Notes included in the Standard Drawings. The type, size, material and owner of each utility shall be indicated by the use of the appropriate abbreviations shown on the Standard Drawings.

3. Utility designation placement shall be as described in Section 1.16.3C.

4. Proposed utility lines shall be solid line, 0.021 inch in width or No.1 pen. Major underground utilities and aerial lines shall be drawn as described in Section 1.16.3C.

D. General:

Line Designation, Curvature, Stationing, Stations, Streets, and Match Lines shall be as described in Section 1.15, except that points of curvature and equations shall be identified only by point symbols and proper abbreviations. Stationing shall be omitted at such points.

1.16.5 Composite Plan of Utilities Rearrangements

A. Purpose:

Composite plans of Utilities Rearrangement shall show all existing facilities and temporary and permanent rearrangements; include new and relocated storm sewer facilities; traffic signal facilities and street lighting facilities. These drawings are to ensure that no conflicts are inadvertently designed into the project and that adequate space is available for construction of each utility.

B. Scale:

The preferred scale is 1' = 20', and the minimum scale is 1" = 40'. The sale of the composite rearrangement plans shall match the scale of the rearrangement plans if possible.

C. General:

Composite plans of Utilities Rearrangements shall be prepared using screened copies of the composite plans of existing utilities for base sheets.

These plans shall shown all utility rearrangements with sufficient designations to identify each utility line and structure, the storm sewer system, the street lighting system, the SES system and the traffic signal system. Descriptive notes and information and manhole, catch basin, and inlet rim and invert elevations shall not be repeated on the composite plans.

1.16.6 SCRTD Electric Service Plan and Profiles, and Details

Prepare plan and profile and detail drawings of the SES duct line and manholes to be constructed within the SCRTD right-of-way. These drawings shall be drawn per SCRTD criteria and latest standard drawings and directives and per Power Company requirements.

1.16.7 Street Lighting Plans and Details

Prepare plan and detail drawings for temporary and/or permanent street lighting in accordance with requirements of the governing municipality and/or CALTRANS.

1.16.8 Standard Drawings

Utilities Standard Drawings shall be used as much as possible. Standard Drawings shall be included in the project drawings set; tracing or copying of details shall be avoided.

1.17 STRUCTURAL DRAWINGS

1.17.1 General

There will be three basic groups of SCRTD structures; a project might contain any combination of the following groups and sub-items.

A. Structures that follow the alignment such as subway cut-and-cover line, tunnel, aerial line, subway stations, aerial stations and at-grade stations.

B. Appurtenant facilities such as entrances, ventilation shafts, pump shafts, emergency exists, sub-stations, and buildings.

C. Special grade separation structures such as overpasses and underpasses, retaining walls, drainage structures, and utilities structures.

1.17.2 Organization

Project drawings sets will not necessarily include all of the sheets listed below, depending upon the types of structures involved and the site conditions. The general order of arrangement shall be adhered to; omit those drawings not applicable:

A. Standard Structural Abbreviations, Symbols, and General Notes.
B. Location Plan and Logs of Borings.
C. Construction Structures Criteria.
D. Underpinning and Protection.
E. General Structural Arrangement.
F. Aerial and/or Subway Structure Control Schedules.
G. Standard Structural Drawings.

H. Structural Plans.

I. Structural Elevations, Sections and Details.

J. Structural Steel Framing Plans.

K. Structural Steel Schedules and Details.

L. Appurtenant Structures.

M. Special Structures.

N. Miscellaneous Iron and Steel.

1.17.3 General Structural Notes

The Standard Structural Abbreviations, Symbols, and General Notes sheet will include abbreviations, symbols, and notes that pertain to the structural drawings.

1.17.4 Location Plan and Logs of Borings

A. Scale:

1. Horizontal 1" = 40'

B. Information Shown:

1. The streets, major buildings and outline of transit structure. Boreholes shall be located and numbered according to the soils report prepared by the Geotechnical Consultant.

2. Logs of borings will be shown on separate drawings prepared by the Geotechnical Consultant.

1.17.5 Construction Structures

These sheets will be for use by the Contractors in arranging and designing their temporary decking and temporary support systems. Included will be criteria for decking loads; sheeting and bracing loads; analysis and design; lateral

pressures caused by soil, water, and surcharge; tiebacks; excavation and bracing procedures; allowable bearing values; observation installations; and cofferdam arrangements.

1.17.6 Underpinning and Protection

The scale of underpinning drawings shall be selected to suit the particular building being underpinned. Drawings shall be complete in detail and shall clearly describe and indicate the method of underpinning to be used or the protection wall systems that might be required. Loads on existing columns and walls to be underpinned shall be shown.

1.17.7 General Structural Arrangement

A. In plan, the outline of structure shall be super-imposed on a simple outline of the street system. Scale: 1" = 40', preferable, or 1" = 20'.

B. In profile, the ground surface at the centerline of structure, the outline of structure, and the track profile grade line shall be shown. If the profile grade lines of adjacent tracks are not the same, profiles of each track shall be shown. The elevation of top of low running rail shall be shown to the nearest one-hundredth of a foot at significant locations. Scale: 1" = 10' (1" = 5' if horizontal scale of 1" = 20' is used).

1.17.8 Aerial and Subway Structure Control Schedules

These drawings will show in tabular form the basic data for construction. Standard forms with headings and instruction for use will be provided by the General Consultant.

1.17.9 Standard Structural Drawings

The standard structural drawings will include standard aerial structures, standard subway structures, and standard structural elements of aerial stations. Detailed information will be presented in tabular form with required plans, sections, etc., and will be provided by the General Consultant.

1.17.10 Structural Plans

A. These drawings shall show the concrete outline and reinforcing details necessary to supplement those which are shown on elevations, sections and details. Show clearance dimensions, tie'ins, joints, openings, rooms, etc. Drawings shall be arranged in sequence starting with lowest level, e.g., foundation plan or track level plan, and progressing to roof level. Scales used shall be 1/8" = 1' -0 or ¼" = 1' -0.

B. In some instances structures might be represented by combinations of plans, elevations, sections, and details on the same drawing.

1.17.11 Structural Elevations, Sections, and Details

Views shall be referenced to the structural plans and shall show concrete and reinforcing adequate for detailing of reinforcing steel. Usual scales shall be ¼" = 1' -0, 3/8" = 1' -0 or ½" = 1' -0.

1.17.12 Structural Steel Framing Plans

Show plan of columns, girders, beams, framing relationships, and designation of structural steel members. Scales used shall be 1/8" = 1' -0 or 1/16" = 1' -0.

1.17.13 Structural Steel Schedule and Details

Include schedules for columns, girders, and beams in tabular form, and details for joints and splices, end bearings and connections, stiffeners, anchor bolts, studs, base plates, bolting and welding, etc. Scales used will vary from ¼" = 1' -0 to 1½" = 1' -0.

1.17.14 Appurtenant Structures

This grouping pertains to entrances, ventilation shafts and fan rooms, emergency exits, pump stations, etc., which are contiguous to the transit line or station structure. Plans, elevations, sections, and details for each may be shown in the order outlined above or on the same sheet as space needs dictate. Scales: 1/8" = 1' -0 to 1½" = 1' -0.

1.17.15 Special Structures

This grouping includes overpasses, underpasses, non-standard retaining walls, drainage structures, substations, utilities structures, and other miscellaneous structures not otherwise categorized. Scale shall be selected to suit structure, varying from 1/8" = 1' -0 to 1 - ½" = 1' -0.

1.17.16 Miscellaneous Iron and Steel

Include details for doors and frames, railings and handrails gratings and support members, ladders and stairs, anchor bolts and inserts, etc. Standards will be provided by SCRTD where feasible. Scales vary from ¼" = 1' -0 to 3" = 1'-0.

1.18 ARCHITECTURAL DRAWINGS

1.18.1 General

A. Abbreviations, Material Indications, and Symbols shall comply with the standards shown on the schedule sheet which will be provided by the General Consultant.

B. Formats for Door Schedules and Finish Schedules shall comply with those shown on the Standard Schedule sheets which will be provided by the General Consultant.

1.18.2 Organization

Project drawings will not necessarily include all of the sheets listed. The general order shall be adhered to for uniformity.

A. Schedule of Abbreviations, Material Indications, and Symbols.
B. Site Plans
C. Floor Plans
D. Door Schedules and Finish Schedules
E. Reflected Ceiling Plans
F. Exterior elevations
G. Longitudinal and Transverse Sections
H. Interior Elevations
I. Detail Plans, Sections and Elevations
J. Wall Sections
K. Small Scale Details
L. Large Scale Details.

1.18.3 Scales

A. Site Plans:

The scale of site plans shall be that engineering scale which will clearly show desired information.

1' = 40" desirable
1" = 20' when this scale is used on civil drawings

B. Plans:

The scale of floor plans, roof plans, and reflected ceiling plans shall be 1/8" = 1' -0.

C. Elevations:

The scale of interior and exterior elevations shall be 1/8" = 1' -0 or ¼" = 1" -0.

D. Sections, Details, and Detail Plans:

Scales to be used shall be 1/8" = 1' -0, ¼" = 1'0. ½" = 1'0, 3/4" =1' -0, 1½" = 1' -0 or 3" = 1' -0.

1.19 MECHANICAL DRAWINGS

1.19.1 Organization

A. Standard Mechanical Abbreviations, Symbols, and General Notes.
B. Plan
C. Drawings
D. Sections
E. Details

1.19.2 Standard Mechanical Abbreviations, Symbols and General Notes

Mechanical symbols, ASHRAE Standards, and current accepted practice shall be indicated.

1.19.3 Plans

A. Line sections shall be drawn to the scale 1" = 40'.

B. Drawings:

Drawings of plumbing, drainage, heating, ventilation, air conditioning, fire protection, portable water, and other mechanical systems shall be drawn to the scale of 1/8" = 1' -0.

C. Section:

All sections of the above systems shall be drawn to the scale of 1/8: = 1' -0.

D. Drawings (Special):

Toilets shall be enlarged to a scale of ¼" = 1' -0 or ½" = 1' -0.

E. Details:

Details of mechanical systems shall be drawn to a scale of ¼" = 1' -0. Details of special mechanical systems and parts of systems, shall be drawn to that scale which will clarify the intent of the design.

1.20 ELECTRICAL DRAWINGS

1.20.1 General

A layout Index drawing shall define general electrical requirements between contract limits, and the detail drawings and schedules shall define all requirements in specific remaining areas such as line sections, stations, ancillary rooms, traction power substations, gap breaker stations, auxiliary electrical rooms, and shafts.

1.20.2 Organization

Project drawings will not necessarily require all the sheets listed below, depending on structure involved. The general order shall be adhered to for uniformity, omitting those drawings not applicable. Standard and directive drawings as required will be supplied by the General Consultant. Electrical drawings shall consist of:

A. Plan drawings which illustrate all electrical systems shall include:

1. Lighting and illuminated sign plans
2. Power distribution and Fare Collection plans
3. Public address, supervisory and control, telephone systems, and fire and intrusion plans.
4. Wayside and line section plans including sections and details.
5. Grounding and cathodic protection plans.

B. Diagram drawings shall include:

1. One-line diagram to describe electrical power system and describe its short circuit characteristics.

2. Riser diagrams for supervisory and control, public address, closed circuit TV, telephone system, fire and intrusion, and fare collection systems.

3. Logic diagrams where functional definition of the system is required.

C. Detail Drawings shall include:

1. Major room layouts (auxiliary electric rooms, train control room, traction power substation, etc.).

2. Wall elevation in auxiliary electric rooms, train control room and traction power substation where needed to position several equipments or components within a limited area.

3. Detail drawings showing methods of installation, equipment configuration, fixture mounting, etc.

4. Layouts of facilities terminal cabinets, if any.

D. Schedules: Conduits, cables, motor control center, lighting, and distribution panelboards.

E. Supervisory and control drawings shall include site specific S & C circuit diagrams developed from General Consultant supplied directive drawings. Terminal numbering scheme shown on directive drawings shall be followed to develop site specific drawings.

F. Facility systemwide interface drawings shall include detail layouts of facility systemwide boxes, terminal strip and protector block schedules, etc. Details required for the interface of two different contracts shall be defined. Terminal numbering scheme shown on directive drawings shall be followed to develop site specific drawings.

1.20.3 Electrical Standard Plan Symbols, Diagram Symbols and Notes

General Consultant will provide this drawings to the Design Office as a standard drawing to be included in the project drawings set.

1.20.4 Site Plan or Entry Plan

A. Scale: 1" = 20'

B. A plan view of the structure divided into numbered structural units shall be shown. Indicate the general layout of structures, and show project limits, major facilities, and sufficient stationing.

C. Sectional views and details necessary to clearly define structures presented on Key Plans shall be adequately referenced.

1.20.5 Detail Drawings

A. Scale: 1/8" = 1' -0 for plan drawings.

B. Electrical drawings of the station areas, traction power substations, gap breaker stations, ancillary rooms, auxiliary electrical room, and any other areas shall be used to show the location of the following: embedded conduits and receways; recesses; slots; sleeves; channels switchboards;

panelboards; junction boxes; cable raceways; normal and emergency lighting fixtures; signs; switches; receptacles, transformers; control and disconnect equipment; grounding facilities; feeds for heating, ventilating, and pumping equipment; escalators; and elevators.

C. Detail drawings shall identify each room and space, and show the calculated foot-candles level for each room and space and the location of conduit for auxiliary electrical, traction power, train control, and communication facilities. Include a one-line diagram from the incoming power service through all sub-panel boards.

D. Section views and details, scale ¼" = 1'0" shall be added by the Design Office which clearly illustrate conduit arrangement and define details necessary for installation.

1.20.6 Conduit Schedule

A schedule which separates the auxiliary electrical, communications, train control, and traction power conduit requirements shall be included with drawings.

1.20.7 Panelboard Schedule

A panelboard schedule shall be prepared for all main and sub-panel boards. Schedules shall be as illustrated on directive drawings.

1.20.8 Standard Drawings

General Consultant will provide Standard Drawings which describe repetitive electrical requirements. Additional drawings as necessary to facilitate installations within the project shall be produced by the Design Office. Standard Electrical Drawings applicable to the project shall be included in the project drawings.

1.21 STANDARD DRAWINGS

A. Standard Drawings have been developed for use on the SCRTD Metro Rail Project for repetitive items in order to obtain uniformity in materials, geometrics, arrangements, details and procedures, and in some instances, such as for utilities, to express prior approval of interested agencies.

B. The applicability of any item shown on a Standard Drawing included in the Project Drawings shall be determined by the Contractor through reference to the other Project Drawings and by the requirements of the Specifications.

C. All Standard Drawings applicable to the contract work shall be included in the Project Drawings. Tracing or copying of standard items shall be avoided. Items not applicable in a particular contract shall not be crossed out or indicated that they are not in the contract; these drawings to be interpreted in a similar manner as would be done for Standard Specifications.

D. A Standard Drawing shall remain identified in the title block as STANDARD and by the title of the subject matter:

EXAMPLE: CIVIL STANDARD

SYSTEM DESIGN CRITERIA AND STANDARDS

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REVISION RECORD

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1	3-001/1	2/84	Entire Section	Replaces 6/30/83 issue.
2	3-001/	1/30/84	2.3.6.2.5• 2.3.6.2.7 •	
3	4-024/	4/18/84	2.3.4.3.2 •	
4	4-039A/	6/27/84	2.3.4.2.1 (c)	
5	3-001A/	4/18/84	2.3.5.2.2 2.5.3.6.1	
6	4-038/	8/21/84	2.2.6.2.1	
7 (see next page)				

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11	5-012/	2/8/85	2.2.2.9.1 2.2.5.2.1 B 2.2.5.2.4 2.2.5.3.4 C 2.2.5.3.6 2.2.5.3.7 2.2.5.3.8 Figure 2-1	
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13	5-035/	5/15/85	Table of Contents 2.2.6.4.1 2.3.6.3 2.3.6.3.1 2.3.6.3.2 2.4.6.1 2.5.2.3 2.5.4.4. 2.5.4.4.1 2.5.4.4.2 2.8.5.3.1 2.8.5.3.2	
14	5-041/	8/09/85	2.8.4.1.3	
15	5-078/	10/30/85	2.2.5.5.5	
16	5-091	1/24/86	2.4.4.2	Paragraph was Deleted. p.54

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			2.3.7.2.3	P. 44 Deleted
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24	7-016/	10/19/87	2.7.2.5 2.7.2.5.1 2.7.9.2 Table of Contents	p. 76 Added Paragraph P. 76 Added Paragraph P. 82 Deleted Security P. ii
	8-023/	04/11/88	2.2.5.3.14 Table of Contents	P. 23 Added Paragraph P. i

SCRTD METRO RAIL PROJECT DESIGN CRITERIA

Volume 1, Section 2

FIRE/LIFE SAFETY

VOLUME I, SECTION 2, FIRE/LIFE SAFETY

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GLOSSARY

AATCC	American Association of Textile Chemists and Colorists
ANSI	American National Standard Institute
ASTM	American Society of Testing and Materials
BTU	British Thermal Units
CAC	California Administrative Code
CALOSHA	California Occupational Safety & Health Administration
CC	Central Control Facility
CP	Command Post
CPUC	California Public Utilities Commission
CSS	Central Supervising Station
CTS	Cable Transmission Subsystem
db	Decibel
DTS	Data Transmission Subsystem
EMP	Emergency Management Panel
EP	Emergency Preparedness
EPP	Emergency Preparedness Program
ETS	Emergency Trip Station
FAA	Federal Aviation Administration
FD	Fire Department
FLS	Fire/Life Safety
FLSP	Fire/Life Safety Program
GC	General Consultant
IEEE	Institute of Electrical and Electronics Engineers
LA	Los Angeles
LACo	Los Angeles County
METRO	Metropolitan
MR	Metro Rail
MRP	Metro Rail Project
MRS	Metro Rail System
NEC	National Electric Code

VOLUME I, SECTION 2 FIRE/LIFE SAFETY (Cont'd.)

NFPA	National Fire Protection Association
NST	National Standard Thread
PA	Public Address
PVC	Polyvinylchloride
RMS	Root-Mean-Square
SCRTD	Southern California Rapid Transit District
TBD	To be determined
UBC	Uniform Building Code
UFC	Uniform Fire Code
UL	Underwriters' Laboratories
Vac	Alternating Current Volts
Vdc	Direct Current Volts

FOREWORD

The following 9 subSections of Section 2 Fire/Life Safety (FLS) Criteria represent the criteria developed by consensus of the FLS Committee to establish minimum levels of protection from fire, smoke, explosion, or panic due to these causes.

These subSections have been previously distributed as a separate document. The FLS Committee concurrence is based on the following statements:

- This criteria is based on the Central Control (CC) facilities being contained in a building housing other transit authority activities such as administrative offices.
- Security operations may include both bus and rail activities.
- Lossy line coverage shall be provided throughout stations and tunnels. This will negate the need for fixed radio access at EMP's.

In addition, the following items have been recognized as needing further development but have been deferred for policy, specifications, or Standard Drawings:

2.4.1.1 Reference to method or means of dealing with children, elderly and handicapped will be addressed in the Emergency Preparedness Plan (EPP).

2.4.2.3 Allowable smoke emission levels for materials and assemblies will be in specifications - require review and approval by the Committee.

2.4.2.5.1 Tests for toxicity will be added as they become more available or materials will be excluded or limited by specifications (i.e., PVC-polyurethane).

2.4.2.7 The use of full scale tests were deleted based on high cost. The intent is to utilize materials found most acceptable through standard tests or by other transit test programs. Selection may be indicated by specific choice in specifications.

VOLUME I, SECTION 2 FIRE/LIFE SAFETY, (Cont'd.)

2.7.2.1.9 The methods of providing required information during emergency operations for the dedicated FD area at CC will be determined during final design.

2.7.6.5 The FD frequencies north and south of the mountains will be examined before design of radio subsystem.

2.8.5.6 The halon concentration for under-floor and rooms will be stipulated in specifications.

Items of FLS Criteria unresolved at the time of this publication are: None

Any changes in this Section will require FLS Committee action, as well as project document control procedures.

VOLUME I, SECTION 2

FIRE/LIFE SAFETY

2.1 INTRODUCTION

2.1.1 POLICY

The fire/life safety criteria contained herein are founded on the premise that the following policies exist. These policies are:

- The FLS Committee, in accordance with the FLS Committee Charter, shall formulate and concur upon the FLS criteria contained herein.
- The FLS criteria will utilize, to the maximum extent possible, existing state and local codes and regulations, and federal guidelines in the preparation of the criteria.
- Once prepared and concurred upon, the FLS criteria will become the prevailing requirement for fire/life safety in the construction and operation of the Metro Rail Transit System.

2.1.2 OBJECTIVE

In the development of the Metro Rail Transit System, of primary consideration is the provision of safe and reliable movement of the SCRTD patrons. The patrons must perceive the System as safe and secure, if the System is to be successful. The FLS Safety Program (FLSP) must achieve this goal. Additionally, the reconciliation of local and state codes and federal guidelines is necessary.

To provide the desired level of fire/life safety within design and cost constraints, the FLSP must utilize approaches which are useful in providing other Metro Rail System (MRS) needs. The "dynamic" characteristic of the MRS requires well thought out preparation of compatible FLS provisions.

2.1.3 SCOPE

This document has been developed to establish FLS criteria for guidance in final engineering. The

document presumes the progressive development of a comprehensive and detailed program of FLS needs as the MR program progresses through engineering into construction and operation. It is anticipated that more detailed information will be provided by specification and standard drawings during the final design.

These criteria identify the major needs of fire/life safety in the following areas:

- o Station Facilities
- o Trainway Facilities
- o Passenger Vehicles
- o Vehicle Yard and Maintenance Facilities
- o System Fire-Life Safety Procedures
- o Communications
- o Central Control Facility
- o Inspection Maintenance and Training

2.1.4 ORIGIN

2.1.4.1 A FLS committee was formed by mutual agreement of the participating parties and evidenced by a Charter setting forth that agreement. Members of the Committee include representatives of:

- o LA City and LA County Fire Departments
- o Southern California Rapid Transit District (SCRTD) safety and engineering personnel
- o FLS sub-consultant
- o General consultant
- o L.A. County Sheriff, Los Angeles City Police Department, and SCRTD transit police

2.1.4.2 These FLS criteria were developed, reviewed and revised by the Fire/Life Safety Committee. The criteria were adopted by consensus of the Fire/Life Safety Committee

and confirmed by the SCRTD as minimum Fire/Life Safety standards for the Metro Rail Project.

2.1.4.3 The FLS criteria are based in part on local and state codes and regulations, federal guidelines, and recognized standards. Where these documents are utilized they shall, as referenced in whole or in part, apply as if fully incorporated in this document.

2.1.5 APPLICATION

The FLS criteria shall govern the FLS characteristics of the designs and FLS operational procedures of all elements of the MR System.

2.1.6 COMPLIANCE

2.1.6.1 The prime responsibility for coordination of the FLS criteria to all other criteria, procedures, specifications, or designs shall be with the organization having responsibility for the design or document being prepared.

2.1.6.2 The FLS committee shall develop and implement a review process as necessary to ensure conformance with the criteria.

2.1.6.3 The review process shall enable all participating fire departments to exercise their responsibility as the delegated authority in Title 19, California Administrative Code (CAC).

2.1.6.4 SCRTD and their contractors (including consultants) shall be responsible for establishing and monitoring a document control system to ensure submittal to the FLS committee of all relevant designs, specifications, criteria, and procedures for the Metro Rail Project (MRP).

2.1.7 REVISION

2.1.7.1 The FLS committee shall, by consensus, review, revise, and apply the FLS criteria.

2.1.7.2 The SCRTD and responsible organizations shall present to the FLS committee suggested revisions to the FLS

criteria if changes in the MRP evaluation results in changing the conditions, assumptions or data upon which the original FLS criteria were based.

2.1.8 REQUEST FOR SPECIAL CONSIDERATION

2.1.8.1 The FLSC may review and may approve request for special consideration to the FLS criteria when sufficient evidence has been presented to ascertain that the alternative meets the intent of the criteria.

2.1.8.2 The SCRTD and other responsible organizations shall be required to advise the FLS committee when any deviation from FLS criteria occurs in any design, specification, or procedure.

2.1.9 CODES AND STANDARDS

Applicable Codes and Standards include:

(A) Uniform Building Code (UBC), 1979

(B) California Administrative Code (CAC), Title 8

(C) California Administrative Code (CAC), Title 19

(D) California Administrative Code (CAC), Title 24

(E) IEEE 383, 1974

(F) Los Angeles County Building Code

(G) Los Angeles County Fire Code (LACO Fire Code)

(H) Los Angeles City Building Code

(I) Los Angeles City Fire Code (LA Fire Code)

(J) NFPA 101, Life Safety Code

(K) NFPA 70, National Electric Code (NEC)

(L) Other NFPA National Fire Codes (as applicable)

(M) Other city and county codes and standards as applicable

(N) California Public Utilities Commission (CPUC) General Orders

2.1.10 DOCUMENTS

Applicable Project Documents include:

(A) Configuration Management Program Plan

(B) System Safety Criteria & Program Plan

(C) System Security Criteria & Program Plan

(D) System Assurance Criteria & Program Plan

(E) Systemwide Design Criteria

(F) Subway Environmental Design Handbook, Volume I, 1975

(G) Emergency Preparedness Plan Outline

(H) LAFD Master Plan

(I) LACo Water Ordinance 7834

2.2 STATION FACILITIES

2.2.1 GENERAL

2.2.1.1 Application

2.2.1.1.1 This section is applicable to all transit stations.

2.2.1.1.2 This section shall also be applicable to appurtenant facilities including traction power substations and gap-tie stations along the trainway which may or may not adjoin stations.

2.2.1.2 Occupancy

2.2.1.2.1 The primary purpose of a station is its use by transit patrons who normally remain in a station for a period of time no longer than necessary to await and enter a departing transit vehicle, or to exit the station after

arriving on an incoming transit vehicle. In its entirety, it essentially functions as a means of accessing and egressing transit vehicles.

2.2.1.2.2 The station public occupancy shall consist of all areas in which patrons may be allowed to enter, and shall include the full length of corridors, stairways, ramps, and passageways required for emergency egress.

2.2.1.2.3 The station ancillary occupancy shall consist of all spaces other than station public occupancies (Section 2.2.1.2.2).

2.2.1.3 Codes and Standards

The design of stations and their appurtenances shall conform to California Administrative Code (CAC) Title 24, California Administrative Code (CAC) Title 19, California Administrative Code (CAC) Title 8, California Public Utilities Commission (CPUC) General Orders except as specifically set forth in this chapter, and Uniform Building Code (UBC), 1979, as applied by Title 24, CAC.

2.2.1.3.1 Where more than one code, standard, or criterion is applicable, the most restrictive shall govern except as indicated in this chapter.

2.2.1.3.2 Unless specifically stated in local regulations or ordinances, each code and standard shall be the latest edition or issue and the most recent revision, amendment, or supplement in effect at the date of notice to proceed with design on each project.

2.2.2 BASIC CONSTRUCTION OF STATIONS

2.2.2.1 Underground Construction

Building construction for underground stations shall be not less than Type I construction as defined in the UBC.

2.2.2.2 At- or Above-Grade Construction

DELETE

Where stations have floor levels at or aboveground level, that portion which is above ground shall be not less than Type II-FR construction as defined in the UBC.

2.2.2.3 Enclosure Requirements

Enclosure of normal patron use stairways and escalators and protection of floor openings are not required within areas of the station public occupancy. Stations having more than two levels below grade or more than 80 feet to the lowest level from grade will require protected level separation or other protection features to provide safe egress regardless of exit time calculations.

2.2.2.4 Fire Separations: Public Occupancy Areas

Fire separations shall be provided and maintained as follows:

2.2.2.4.1 Station public occupancy shall be separated from station ancillary occupancy by minimum 2-hour fire-rated construction. Exception: A maximum of 2 station agents, supervisors, or information booths may be located within station public occupancy areas when constructed of approved noncombustible materials and limited in floor area to 100 square feet each. Automatic fire protection systems installed in the area in which the booth is located shall extend into the booth.

2.2.2.4.2 Station public occupancy shall be separated from power substations and transformer vault areas in station ancillary occupancies by 3-hour fire-rated construction.

2.2.2.4.3 Station public and ancillary occupancies shall be separated from nontransit occupancies by 3-hour fire-rated construction.

2.2.2.5 Fire Separations: Ancillary Areas

Fire separations within station ancillary areas shall be provided to separate individual occupancies as follows:

2.2.2.5.1 Electrical equipment areas which contain transformers and traction power equipment shall be separated from all other occupancies by 3-hour fire-rated construction.

2.2.2.5.2 Vaults of not less than 3-hour fire-rated construction shall be constructed for oil-insulated electric transformers and shall meet the NEC requirements for vault construction, including door and sill requirements.

2.2.2.5.3 Electrical equipment rooms, electric rooms, battery rooms, train control and communication rooms, and trash rooms shall each be separated from other occupancies by 2-hour fire-rated construction.

2.2.2.6 Protection of Openings

2.2.2.6.1 Openings in 3-hour fire-rated separations shall be protected by labeled 3-hour fire-rated (Class A) assemblies.

2.2.2.6.2 Openings in 2-hour fire-rated separations shall be protected by labeled 1½-hour fire-rated (Class B) assemblies.

2.2.2.6.3 Openings in 1-hour fire-rated separations shall be protected by 1-hour fire-rated (Class B) assemblies.

2.2.2.6.4 Fire-rated assemblies protecting openings in fire-rated separations shall be automatic or self-closing. Automatic closing assemblies protecting openings into station public occupancies shall be activated by approved detection devices, responding to products of combustion other than heat. Alternatively, automatic closing assemblies may be released by heat-actuated devices alone where a separate smoke barrier is provided. Installation shall be in accordance with UBC Section 4306.

2.2.2.7 Protection from Flammable and Combustible Liquid Intrusion

The requirements of Section 2.3.2.3 for protection of underground guideways shall be applied to underground stations.

2.2.2.8 Materials

2.2.2.8.1 All structural assemblies and building appurtenances shall conform to Type I structures as defined in UBC Chapters 5, 17, and 18.

2.2.2.8.2 Combustible adhesives and sealants may be used when the requirements of Section 2.2.2.9 are met.

2.2.2.8.3 All elevators and escalators shall be constructed of non-combustible materials and conform to CAC Title 24 and Title 8.

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2.2.2.9 Interior Finishes

Interior finishes of all surfaces exposed to the interior of the building, including fixed or movable walls and partitions, columns, and ceilings, shall meet UBC Chapter 42 requirements for interior finishes as follows:

2.2.2.9.1 Interior finishes shall be Class I for all exit access routes and exits. In transit stations, the platforms and mezzanines shall be considered exit access routes for the purpose of determining interior finish requirements.

2.2.2.9.2 Interior finishes in all other areas shall be UBC Chapter 42 Class I or Class II.

2.2.3 VENTILATION

2.2.3.1 General

2.2.3.1.1 Provisions shall be made for emergency ventilation for the protection of patrons and employees from fire and products of combustion.

2.2.3.1.2 Normal and emergency ventilation may be necessary to preserve the safety of underground facilities in the event of intrusion of toxic or flammable gasses. Emergency back-up power supply shall be available to enable gas purging in the event of an area-wide utility power outage.

2.2.3.1.3 Ventilation shaft terminals at grade shall be located as follows:

A. Openings for blast relief shafts, and underplatform and smoke exhaust shafts at grade shall be separated by a minimum horizontal distance of 40 feet from the closest station entrance, surface emergency stair doorways, unprotected outside air intake or other openings, or from each other.

Where this distance is not practical, the horizontal distance may be reduced to 15 feet if the closest blast relief or underplatform and smoke exhaust shaft terminal is raised a minimum of eight feet above the station entrance, emergency stair doorway and unprotected outside air intake or other opening, or the underplatform and smoke

exhaust shaft terminal is raised a minimum of eight feet above the blast relief shaft terminal.

B. The minimum distance between the edges of adjacent openings for outside air intake shafts protected by smoke dampers and blast relief shafts or underplatform and smoke exhaust shafts shall be as follows:

$D = 0.25 \times (L_1 + L_2)$

Where: d = minimum distance in feet between the edges of the adjacent openings.

L_1 and L_2 = lengths in feet of the adjacent parallel sides of the openings.

Note: These requirements are also currently reflected in Volume 4, Section 1.7.1.10.2.

2.2.3.2 Emergency Air Criteria

2.2.3.2.1 The ventilation systems shall be so designed that in a fire emergency the air temperature upper limit in exit pathways shall not exceed 120°F. See design model in the Subway Environmental Design Handbook, Vol. 1, 1975.

2.2.3.2.2 Emergency ventilation systems shall produce airflow rates so as to provide a stream of noncontaminated air to patrons in a path of egress.

2.2.3.3 Emergency Ventilation Fans

2.2.3.3.1 Ventilation fans used for emergency service, their motors, and all related components exposed to the ventilation airflow shall be designed to operate in an ambient atmosphere of 300° F for a period of at least 1 hour. Use of safe areas of refuge will require longer periods.

2.2.3.3.2 Local fan motor starters and related operating control devices shall be isolated from the ventilation airflow by a separation having a fire-resistance rating of at least 2 hours.

2.2.3.3.3 Fans used for emergency ventilation shall be single or dual-speed, reversible, or capable of changing the direction of airflow by means of dampers.

2.2.3.3.4 Fans required for emergency operation shall be capable of satisfying emergency air-velocity criteria in either supply or exhaust modes.

2.2.3.3.5 Thermal overload protective devices shall not be provided on motor controls of fans used for emergency ventilation. Circuits shall be designed to maintain current to the emergency fan motors without operation of protective devices (unless excess current is sensed simultaneously with a no-air-flow signal).

2.2.3.3.6 Two independent electrical supplies shall be provided for each of the emergency fans. Automatic transfer shall be provided in the event the normal supply source fails.

2.2.3.4 Ventilation Control

2.2.3.4.1 Operation and fail-safe verification of proper operation of emergency fans shall be effected from Central Control (CC) with supply-off-exhaust indication provided for each fan, as well as from a local control isolated as in Section 2.2.3.3.2.

2.2.3.4.2 Controls shall also be provided at the EMP capable of operating the ventilation system in all modes. This location and the local control shall override control from CC.

2.2.3.4.3 Emergency ventilation shall be designed to operate in full coordination with the trainway ventilation system.

2.2.3.4.4 Emergency ventilation systems shall be controlled in all operating modes; locally, from the EMP, and from CC.

2.2.3.5 Ventilation Systems: Ancillary Areas

2.2.3.5.1 Ancillary area ventilation systems shall be arranged so that air is not exhausted into station public occupancy areas. Controls for shut-down of ancillary area ventilation systems shall be provided at the EMP.

2.2.3.5.2 Battery storage or similar ancillary rooms in which hydrogen gas or other hazardous gases may be released shall require mechanical ventilation and shall be ventilated in accordance with NFPA 91 and as follows:

(A) Exhaust ducts from battery rooms shall not connect with duct systems used for other purposes.

(B) Exhaust system operation shall be proven by means of an air-flow switch, from which a no-air-flow signal produces an alarm at a continuously attended location and will cause battery charging serving the affected area to be de-energized.

2.2.4 ELECTRICAL REQUIREMENTS

2.2.4.1 Code Requirements

Electrical equipment and wiring materials and installations within stations shall conform to the requirements of NEC and, other than for traction power, shall satisfy the following requirements:

2.2.4.1.1 Materials manufactured for use as conduits, raceways, ducts, boxes, cabinets, equipment enclosures, and their surface finish materials shall be capable of being subjected to temperatures up to 932° F for 1 hour, and shall not support combustion. Other materials when embedded in concrete are acceptable.

2.2.4.1.2 All conductors shall be insulated. Copper ground wires may be bare. All thicknesses of insulation and all thicknesses of jackets shall conform to NEC.

2.2.4.1.3 Insulation shall conform to Article 310 of NEC and be moisture- and heat-resistant, carrying temperature ratings corresponding to the conditions of application and in no case lower than 194° F.

2.2.4.1.4 Wire and cable used in operating vital train signal circuits and power circuits to emergency fans, lights, etc., shall pass the flame-propagating criteria of IEEE 383 and have a minimum short circuit time of five minutes in the flame test of the IEEE 383. Such tests shall be performed with the wire and/or cables protected as they will be when installed.

2.2.4.1.5 All conductors shall be enclosed in their entirety in conduits, or enclosed raceways, boxes and cabinets, except in traction power substations, electrical equipment rooms, train control rooms, or communications rooms. Conductors in conduits or raceways may be embedded in concrete or run in concrete electrical duct banks. Conductors shall not be installed exposed or surface-mounted in air plenums which may carry air at the elevated temperatures accompanying the fire-emergency conditions.

2.2.4.1.6 Overcurrent elements which (a) are designed to protect conductors serving emergency equipment motors (fans, dampers, pumps, etc.), emergency lighting, and communications equipment, and (b) which are located in spaces other than the main distribution system equipment rooms, shall operate on magnetic principles and shall not depend upon thermal properties for operation.

2.2.4.1.7 Wiring for fans essential for emergency ventilation service shall meet the requirements of Section 2.2.4.1.4.

2.2.4.1.8 Conductors for emergency lighting, communications, etc., shall be protected from physical damage by transit vehicles or other normal transit system operations, and from fires in the transit system by suitable embedment or encasement, or by routing such conductors through areas of low fire potential (light hazard).

2.2.4.1.9 Switches, electrical outlets, and lighting fixtures installed in areas where batteries are installed/charged shall be explosion-proof, conforming to NEC.

2.2.5 MEANS OF EGRESS

2.2.5.1 Public Occupancy Areas

The transit station shall comply with the provisions of applicable building codes and NFPA 101 Chapters 5 and 8, except as set forth below.

2.2.5.2 Occupancy and Occupant Load

2.2.5.2.1 The occupant load for a station shall be determined based on an emergency condition requiring evacuation of that station load to a point of safety. The station occupant load is defined as follows:

- o Calculated train load
- o Entraining load (on platform awaiting train)

(A) The calculated train load is the number of passengers on trains simultaneously entering the station during the peak 15-minute period. The following limitations to the calculated train load are followed:

- o No more than one train will unload at any one track to a platform.
- o The load on any single train is limited to the maximum train capacity.
- o The calculated train load can be no less than the maximum passenger capacity of a single train.

(B) The entraining load is equal to the number of passengers that would accumulate on the platform in the time period equivalent to four headways during the peak 15-minute operating period. This entraining load is constrained as defined in paragraph 2.2.5.2.2 (A).

2.2.5.2.2 Special Conditions and Design Considerations

(A) Access to the platform and/or the station must be operationally constrained to a platform net area occupancy equivalent to 4 square feet per person. For anticipated platform entraining loads that

would result in area occupancies of less than 4 square feet per person, the calculated platform load will be limited to the net platform area divided by 4 square feet per person. The minimum total exit width in feet shall be equal to this platform load divided by 50 patrons per foot of exit width.

(B) Notwithstanding other provisions in Section 2.2.5.2, exiting shall be provided, as a minimum, to accommodate the equivalent of 7 square feet per person; i.e.,

$$\text{Minimum Total Exit Width (Feet)} = \frac{\text{Net Platform Area}}{\text{7 Sq. Ft./Per Person}} \times \frac{1}{\text{50 Persons Per Foot of Exit Width}}$$

(C) Special design consideration shall be given to stations directly servicing areas where events occur that result in abnormal patron loads. These would include such areas as arenas, sports complexes, and convention centers. Consideration of controlled access to platforms may be necessary to provide appropriate safety levels.

2.2.5.2.3 If there are side platform stations, each platform shall be considered separately. At center platform stations, arrival of trains from both directions, plus their entraining loads, shall be considered.

2.2.5.2.4 At mezzanines or multi-level stations, simultaneous platform loads shall be considered for all exit paths passing through that area.

2.2.5.3 Number and Capacity of Exits

2.2.5.3.1 An exit is defined as a protected enclosure separated from all other spaces of a transit station or other structure by construction or equipment to provide a protected way of travel to the exit discharge.

Exit capacities shall be calculated on the basis of 22-inch wide exit lanes. Width shall be measured in the clear at the narrowest point except that individual handrails may project 3½ inches into the required width. Fractional lanes shall not be counted in measuring exit capacities except that 12 inches added to one or more lanes shall be counted as ½ a lane.

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2.2.5.3.2 There shall be sufficient exit lanes to evacuate the station occupant load as defined in paragraph 2.2.5.2.1 from the station platforms in 4 minutes or less (see Figure 2-1 "Emergency Exit Capacity Calculation").

2.2.5.3.3 The station shall also be designed to permit evacuation from the most remote point on the platform to a point of safety in 6 minutes or less.

Figure 2-1

EMERGENCY EXIT CAPACITY

CALCUATIONS

Station _____

Occupancy Load _____

Exit Lanes and Capacity Provided

Platform to Mezzanine

Stairs	_____	x	_____	Lanes x	_____	PPM =	_____	PPM
Escalators	_____	x	_____	Lanes x	_____	PPM =	_____	PPM
Emergency Stairs	_____	x	_____	Lanes x	_____	PPM =	_____	PPM
				TOTAL			_____	PPM

Through Fare Barrier

Fare Gates	_____	x	_____	Lanes x	_____	PPM =	_____	PPM
Service/Emergency Gates	_____	x	_____	Lanes x	_____	PPM =	_____	PPM
				TOTAL			_____	PPM

Fare Barrier to Safe Area

Stairs	_____	x	_____	Lanes x	_____	PPM =	_____	PPM
Escalators	_____	x	_____	Lanes x	_____	PPM =	_____	PPM
Emergency Stairs	_____	x	_____	Lanes x	_____	PPM =	_____	PPM
				TOTAL			_____	PPM

Figure 2-1 (Cont'd.)

EMERGENCY EXIT CAPACITY TESTS

Test 1

Evacuate station occupant load from station platform(s) in 4 minutes or less.

$$W_1 \text{ (waiting time at platform exits)} = \frac{W \text{ (occupancy load)}}{\text{Exit Capacity}}$$

$$W_1 = \frac{\_\_\_\_ \text{ Persons}}{\_\_\_\_ \text{ PPM}} = \_\_\_\_ \text{ Minutes}$$

Test 2

Evacuate station occupant load from the most remote point on the platform to a point of safety in 6 minutes or less.

Walking Time for Longest Exit Route

$$T = T_1 + T2 + T3 + T4 + T5$$

T_1 (platform) =	____ Feet	____ FPM =	____ Minutes
T_2 (platform to mezzanine) =	____ Feet	____ FPM =	____ Minutes
T_3 (mezzanine to fare barrier) =	____ Feet	____ FPM =	____ Minutes
T_4 (fare barrier to safe area) =	____ Feet	____ FPM =	____ Minutes
T_5 (grade) =	____ Feet	____ FPM =	____ Minutes

T = ____ MINUTES

Test 2 (Cont'd.)

Additional Waiting Time at Platform Exits

W_1 _____ - T_1 _____ = _____ Minutes

Additional Waiting Time at Fare Barrier

Occupant Load at Mezzanine = Occupant Load - Emergency Stair 4 Minute Capacity

- _____ - _____ = _____ Patrons

W_2 (Mezzanine Occupant Load Gate Capacity)

_____ Persons _____ PPM = _____ Minutes

W_2 _____ - W_1 _____ = _____ Minutes

Additional Waiting Time at Mezzanine Exits

$$W_3 = \frac{\text{Mezzanine Occupant Load}}{\text{Exit Capacity}}$$

$$W_3 = \frac{\text{___ Persons}}{\text{___ PPM}} = \text{____ Minutes}$$

W_3 _____ - W_1 _____ = ____ Minutes

Total Exit Time

T _____ + (W_1 - T_1) _____ + (W_2 - W_1) _____ +

(W_3 - W_1) _____ = _____ TOTAL MINUTES

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2.2.5.3.4 To calculate this evacuation time, the walking travel time should be tabulated using the longest exit route and travel speeds indicated in paragraph 2.2.5.3.5. To this time should be added the following factors:

(A) (W_1-T_1) The waiting time at the vertical elements at platform level minus the longest walking travel time at platform level.

(B) (W_2-W_1) The waiting time at the fare collection barriers minus the waiting time at the platform vertical circulation elements.

(C) (W_3-W_x) The waiting time at the vertical or horizontal circulation elements from mezzanine to grade minus the waiting time at the mezzanine vertical circulation elements or fare collection barrier, whichever is greater.

(D) (W_4-W_x) The waiting time, if any, at any additional constriction minus the greatest previous waiting time. (Repeat for all additional constrictions.)

Note: The total of any of the factors in (A) through (D) above cannot be less than zero.

2.2.5.3.5 The capacity in persons per minute (ppm), travel speeds in feet per minute (fpm), and requirements for exit lanes shall be as follows:

(A) Platforms, corridors, and ramps of 4 percent slope or less: Exit corridors and ramps shall be a minimum clear width of 5 feet 8 inches. In computing the number of exit lanes available, 1 foot 6 inches shall be deducted at each platform edge and 1 foot at each sidewall.

Per exit lane: Capacity - 50 ppm
Travel speed - 200 fpm

(B) Stairs, stopped escalators, and ramps of over 4 percent slope: Exit stairs shall be a minimum clear width of 3 feet 8 inches. Exit ramps shall be a minimum clear width of 6 feet. Stopped escalators may be considered as emergency exits of 2-lane capacity provided they are of nominal 4 feet width; of 1½ lane capacity provided they are of nominal 2 feet 8 inches width; and one-lane capacity if less than 2 feet 8 inches width.

Per exit lane "up" direction: Capacity - 35 ppm
Travel Speed - 50 fpm*

Per exit lane "down" direction: Capacity - 40 ppm
Travel Speed - 60 fpm*

(*Indicates vertical component of travel speed)

(C) Doors and gates: Exit doors and gates shall be a minimum of 3 feet wide.

Per exit lane: Capacity - 50 ppm

(D) Fare collection gates qualifying for use in exit paths shall be electrically deactivated to assume an acceptable exit mode in the event of a power failure or through a manual or remote control actuation.

(1) Bi-parting gates when deactivated shall provide a clear unobstructed aisle, a minimum of 20 inches in width, mounted between consoles that do not exceed 3 feet 3 inches in height.

Per gate: Capacity - 50 ppm

(2) Turnstiles, a minimum of 20 inches in width, having a bar positioned to have maximum height of 3 feet which, when deactivated, will free wheel in the exit direction. Consoles shall not exceed 3 feet 3 inches in height.

Per gate: Capacity - 25 ppm

(3) Gates fitted with approved panic hardware and opening in the direction of exit travel, with minimum nominal width of 3 feet.

Per gate: Capacity - 50 ppm per exit lane

Fare gates not qualifying for use in exit paths shall be prominently marked "Not an Exit."

2.2.5.3.6 From each platform there shall be a minimum of 2 exits not less than 100 feet apart. Platform exits shall be

stairs, escalators stopped or moving in the direction of egress to mezzanine level, emergency stairs, doorways, corridors, or walkways to a point of safety. Routes from platform ends into the underground trainway may not be considered as exits for calculating exiting requirements.

2.2.5.3.7 There shall be a minimum of 2 exits from each mezzanine. Exits shall be separated by a minimum distance of 40 feet.

2.2.5.3.8 No point of the station platform(s) or mezzanine(s) shall be more than 300 feet from an exit.

2.2.5.3.9 All exit measurements shall be to a point of access to the exit.

2.2.5.3.10 Exits other than fare collection gates shall provide for at least 50 percent of the exit capacity in any fare barrier.

2.2.5.3.11 A point of safety shall be defined as any at-grade area beyond any structure; any exit having a fire-rated enclosure which discharges to an at-grade area beyond any structure; or a passageway that affords equivalent protection.

2.2.5.3.12 In addition to the exits specified to obtain compliance with the foregoing requirements, means of ingress shall be provided from each trainway to the platform.

(A) Two 2 feet 10 inches wide stairways, or other arrangement having equivalent capacity, shall be provided at each end of the platform, arranged to provide full capacity exiting from either trackway.

(B) Gates at the top of each stairway shall swing in the direction of access to the platform, and shall provide clear opening width not less than 3 feet.

(C) Gates, stairs, and landings shall conform to requirements of NFPA 101 and applicable building codes.

(D) For ends of platform where calculated capacity exits emanate within 25 feet from an end of platform, the access points and the exit may be integrated.

2.2.5.3.13 Vertical circulation elements shall be comprised of stairs or stair/escalator combinations. Escalators shall not account for more than half of the units of exit at any one level in the public area.

2.2.5.3.14 Because of the possibility of maintenance or malfunction, one escalator at each station shall be considered as being out of service in calculating egress requirements. The escalator chosen shall be that one having the most adverse effect upon exiting capacities.

2.2.5.4 Station Ancillary Occupancy Areas

Means of egress shall be arranged in accordance with applicable codes and regulations, except that for the purpose of this criterion, exits from station ancillary occupancy areas into station public occupancy areas shall be considered as discharging into a protected passageway leading directly to a point of safety.

2.2.5.5 Emergency Lighting and Exit Signs

2.2.5.5.1 Station structures shall be provided with an emergency lighting system in accordance with UBC except as otherwise noted in this chapter.

2.2.5.5.2 Emergency lighting systems shall be installed and maintained in accordance with NFPA Article 700, "Emergency Systems" to provide an illuminance level of one footcandle.

2.2.5.5.3 Exits shall be marked with readily visible signs complying with the requirements of UBC. Where emergency lighting is required, exit signs shall be illuminated from the emergency lighting source.

2.2.5.5.4 Exit lights and essential signs shall be included in the emergency lighting system and shall be powered by an uninterruptible power supply. Emergency fixtures, exit lights, and signs shall be separately wired from the emergency distribution panels.

2.2.5.5.5 Emergency lighting for stairs and escalators shall be designed to emphasize illumination on the top and bottom steps or landings. A minimum of one foot candle of emergency lighting shall be provided throughout the entire run of each stair and escalator (per UBC, Section 3312(a)).

2.2.6 FIRE PROTECTION

2.2.6.1 Protective Signaling Systems

2.2.6.1.1 A fire alarm control system shall be installed in each station facility, conforming to NFPA 72A and 72D, and CAC Title 19.

(A) Fire alarm devices shall be protected by a proprietary system Style D and Style 2, as defined in NFPA 72D, Tables 3-9.1 and 3-10.1.

(B) The station facility fire alarm system shall be electrically supervised and operated on low voltage with battery standby power.

(C) The public address system shall be utilized for sounding required building-audible fire alarm signals from the fire alarm control panel by means of a tone generator preceeding verbal announcements to direct patron evacuation. Audibility level shall be a minimum of 10db over any background noise.

(D) All detector and extinguishing system fire alarm, smoke detection, valve switches, and water flow indicator signals throughout the system shall, when activated, be transmitted simultaneously within the local station and to a central supervising station as defined by NFPA 72D.

(E) The fire alarm control system shall provide means to trip special extinguishing systems and to control ventilation systems in accordance with applicable codes.

2.2.6.1.2 The Emergency Management Panel (EMP) shall include an annunciator panel which shall indicate by audible and visual alarm the activation and location of any fire signal generated at the station facility. It shall also indicate fire system supervisory signals and a fire alarm control panel trouble signal. A minimum of one EMP shall be located in the public area on the mezzanine adjacent to the fare array in the patron assist area in the pathway of the entrance to which the fire department will respond.

2.2.6.1.3 Automatic fire detection devices shall be installed throughout all station ancillary areas where automatic sprinkler protection is not required, including return air and after the filters in air conditioning and ventilation systems serving more than one area.

2.2.6.1.4 The manual fire alarm capability shall be provided by an emergency fire-reporting phone system to be used by the public or employees to report a fire or other emergency.

(A) Emergency phones shall be located adjacent to each fire hose cabinet throughout the station, so that every major section of the transit station has at least 1 such phone.

(B) The emergency phones shall be a dedicated system that alarms at CC. The emergency phone system shall annunciate at CC and indicate the station of origin.

2.2.6.1.5 In the event of an emergency, patron evacuation shall be facilitated through provision of a supervised public address system and actuation of equipment necessary to prepare the station for evacuation.

(A) The public address system shall be operable from the EMP and from CC.

(B) The public address system shall conform to NFPA 72A and 72D. Supervision of the public address system shall be through the station fire alarm control panel.

2.2.6.1.6 Seismic alarm devices and controls shall be provided to detect a seismic event such that it will permit safe stopping of trains entering any zone of the system where a seismic event has occurred. The detection of a seismic event shall be annunciated in CC.

2.2.6.1.7 Gas detection devices shall be provided to detect the presence of methane or other gases entering into the system. Presence of such gases shall be annunciated at CC.

2.2.6.2 Automatic Fire Protection Systems

2.2.6.2.1 Automatic sprinkler protection in accordance with NFPA 13, UBC Chapter 38, and L.A. Plumbing Code shall be provided in all station ancillary areas, except as provided in 2.2.6.2.2. All elevator and escalator pits/machine rooms shall be provided with automatic sprinkler protection. Other exceptions shall be approved by the F/LS Committee.

2.2.6.2.2 Train control and communication rooms shall be protected with an automatic Halon 1301 extinguishing system meeting NFPA 12A and LAFD Requirement 33, activated manually and through the fire alarm control panel by a cross-zoned detection system.

2.2.6.3 Standpipe and Hose Systems

2.2.6.3.1 Class III standpipe system coverage shall be provided throughout the station in accordance with NFPA 14 and UBC Chapter 38. Fire hose outlets shall be located so that any point may be reached, including in and around transit vehicles which may be stopped at the station, with 100 feet of hose and 30 feet of water stream.

2.2.6.3.2 Manual and remote actuation of under-vehicle water spray extinguishing systems shall be provided at stations, supplied from platform standpipe systems. Separately controlled systems shall be provided on each track for lengths along the platform corresponding to each vehicle pair, considering variations in stopping position. Provisions for removing third rail power shall be provided so that power is automatically removed from that Section of track, prior to actuating the under-vehicle extinguishing system.

2.2.6.4 Fire Extinguishers

2.2.6.4.1 Portable fire extinguishers conforming to NFPA 10, CAC Title 19, and LA Fire Code shall be placed at each fire hose location and at other locations as required by hazard type and space utilization. Multipurpose dry chemical extinguishers having a capacity of 10 pounds and rated 4A-30B:C, shall be used, supplemented by 10 pound, 10B:C carbon dioxide extinguishers in rooms used for electrical equipment; except that 10 pound 2A-20B:C Halon 1211 extinguishers shall be provided in train control and communication rooms.

2.2.6.4.2 The maximum travel distance to the nearest extinguisher shall not exceed 150 feet in public areas.

2.2.6.5 Emergency Access To Stations

2.2.6.5.1 Access to station entrances and emergency egress locations shall be from public streets, or an access road with a minimum paved width of 20 feet, with widened 28-foot turnouts wherever emergency vehicles may stop.

2.2.6.5.2 An access road to a station shall be continuous from a public street to a public street, or a 66-foot outside radius turnaround shall be provided.

2.2.6.5.3 The fire department inlet connections for automatic sprinkler and standpipe systems shall be located within 25 feet of vehicular access. Hydrant spacing and locations shall be determined by the FLSC.

2.3 TRAINWAY FACILITIES

2.3.1 GENERAL

2.3.1.1 Application

2.3.1.1.1 The trainway is the structure upon which the transit vehicle will travel and be guided. It is that portion of the transit line included within right-of-way fences, outside lines of curbs or shoulders, underground tunnels, cut or fill slopes, ditches, channels and waterways, and including all appurtenant structures. It lies within the right-of-way, which is land or rights to land, used or held for transit operations or for public way.

2.3.1.1.2 The trainway shall be considered "at grade" where track is placed on grade without supporting structure or roof; "aerial" where the track is placed on an aerial structure; and "underground" where the track is located beneath the surface of earth or water. This Section considers only underground trainways.

2.3.1.1.3 Passengers will not enter the trainway except in the case of the evacuation of a disabled train. Trainway evacuation shall be undertaken only when other means such as train-to-train passenger transfers are not possible. In any case, trainway evacuation shall be undertaken only when traction power has been deenergized and only under the guidance of authorized personnel.

2.3.1.1.4 Employees entering the trainways shall be trained and identified for the situations and duties as necessary and required. They shall receive authorization prior to their entry.

2.3.2 CONSTRUCTION AND PROTECTIVE SEPARATIONS

2.3.2.1 Underground Trainway Construction

2.3.2.1.1 When line sections are to be constructed by the cut-and-cover method, perimeter walls and related construction shall be not less than Type I as defined in UBC.

2.3.2.1.2 When line Sections are to be constructed by a tunnelling method through earth, the structural liner shall be Type I construction.

2.3.2.1.3 Special liner requirements may be imposed to assist control of natural gas intrusion and, where utilized, shall be of noncombustible construction.

2.3.2.1.4 Walkways designated for evacuation of passengers shall be constructed of noncombustible materials. Walking surfaces shall have a slip-resistant design. Open grating surfaces shall not be permitted.

2.3.2.1.5 Noncombustible rail ties shall be used in underground trainways, except at switch or crossover locations where fire retardant, pressure-treated ties may be used.

2.3.2.1.6 Ancillary structures adjoining the trainway, including remote vertical exit shafts and ventilation structures, shall be not less than Type I approved noncombustible construction as defined in UBC.

2.3.2.2 Protection Separations for Underground Buildings

2.3.2.2.1 Ancillary structures and areas within tunnels and tubes shall be separated from trackway areas by 3-hour, fire-resistive construction with all openings protected with approved Class A (3-hour rated) assemblies.

2.3.2.2.2 All nonsystem structures or facilities shall be separated from underground trainway structures by unpenetrated 4-hour, fire-rated construction.

2.3.2.3 Underground Trainway Protection Against Hazardous Substance Intrusion

2.3.2.3.1 Vent or fan shafts utilized for ventilation of subway tunnels shall not terminate at grade on any vehicle roadway or parking lot.

2.3.2.3.2 Vent and fan shafts may terminate in the median strips of divided highways or on sidewalks designed to accept such shafts, or in open space areas, provided that their location at the level of the median strips, or sidewalk, or open space, is protected by a concrete curb. This curb shall be of sufficient elevation to exclude drainage into the shaft, but in no case shall the height be less than six inches.

2.3.2.3.3. Installation of underground hazardous substance storage tanks and related piping shall not be permitted directly over any transit system subsurface structure, or within 25 feet (measured horizontally) from the outside wall of such subsurface structure. (See 2.3.2.3.5 for tanks in or under existing buildings.)

2.3.2.3.4 Installation of underground hazardous substance storage tanks and related piping, located in the area between 25 feet and 100 feet (measured horizontally) from the outside wall of any transit system subsurface structure, and within that same area such tanks and related piping which are within two feet (measured vertically) below the lowest point of subsurface structure excavation, shall meet the following requirements:

(A) Tanks shall be of double wall construction.

(B) Tanks shall be equipped with an approved automatic leak detection and monitoring system.

(C) Tanks shall be provided with an approved corrosion detection system.

(D) Installation, maintenance and inspection shall conform to the requirements specified by the authority having jurisdiction.

2.3.2.3.5 Existing underground hazardous substance storage tanks located in or under buildings which are directly above a subsurface transit structure, or within 25 feet (measured horizontally) from the outside wall of the subsurface transit structure, shall be removed. Where it is not possible to remove tanks, such tanks shall be abandoned in accordance with provisions of the authority having jurisdiction.

2.3.2.3.6 Facilities dispensing hazardous substances from underground tanks where such tanks are located in the area within 100 feet (measured horizontally) from the outside wall of the subsurface transit structure, shall comply with the following:

(A) The surface around pump islands shall be graded or drained in a manner to divert possible spills from entering subway vent gratings, entrances, or exits.

(B) Appropriate continuous drains across driveways, ramps, and/or curbs of at least six inches in height shall be provided to separate facilities from adjacent subway property.

(C) No connection (such as venting or drainage) of any storage tanks and related piping of hazardous substances to a fixed subsurface transit structure shall be permitted.

(D) Points of dispensing for hazardous substances shall not be located less than 50 feet from the nearest opening to the subway system.

2.3.2.3.7 Other fill or dispensing points for hazardous substances shall be subject to restrictions as prescribed in 2.3.2.3.6.

2.3.3 TRAINWAY TRACTION POWER AND FACILITY WIRING

Traction power elements associated with the trainways are the contact rail, its supports, and other wayside equipment. Traction power substations and gap tie stations are covered in Subsection 2.2, Station Facilities.

2.3.3.1 Protective Coverboard

2.3.3.1.1 The protective coverboard provided on all contact rail Sections shall be securely anchored. Coverboard materials shall be electrically insulating, capable of passing the ASTM E162-78 Radiant Panel Test with a flame propagation index not exceeding 15, and capable of passing the ASTM E662-75 test with a smoke emission optical density index (D_s) of 200 or less in 4 minutes.

2.3.3.1.2 The coverboard shall be capable of withstanding vertical mechanical load cycle and drop tests with loads of 250 pounds distributed over 6" by 12" area at any single location, when supported at maximum design spans and with specified attachment methods without manifesting cracks, splits, points of stress, or breaks and with a permanent deflection of no more than ½ inch. During load cycle, deflection shall not exceed 1½ inches and not exceed 2½ inches with a 12-inch drop test.

2.3.3.1.3 The coverboard shall be permanently and conspicuously marked to provide basic location identification by Section of trainway and electrification feeder zone. Markings should be at ends of station platforms, at each end of each contact rail gap, and at intervals along the trainway not to exceed 500 feet. Marking locations should be coordinated with graphics specified for emergency access points.

2.3.3.2 Contact Rail Appurtenances

Cables connecting the contact rail, pot heads, and energized hardware shall be covered with insulating material and installed so as not to present a tripping or electrical hazard to personnel on the walkway.

2.3.3.3 Signage

Warning signs shall be posted on the access to the trainway at stations, on fences of barriers adjacent to the trainway, or at other locations where nonemployees may attempt to trespass. The warning sign shall clearly state the hazard (e.g., "Dangerous High Voltage 700 Volts") in letter, size, and colors as required by NFPA 70 and Cal/OSHA regulations.

2.3.3.4 Electrical Installations

Wiring, materials, and all electrical installations including traction power or traction power control shall conform to the National Electrical Code (NEC). Facility wiring shall meet the additional requirements established in subSection 2.2 for station facilities.

2.3.3.5 Contact Rail Location

The contact rail shall be located opposite the safety walkway and the station platform.

2.3.4 EMERGENCY EGRESS AND ACCESS FOR UNDERGROUND TRAINWAYS

2.3.4.1 Areas of Safe Refuge

Emergency egress means of evacuating patrons from transit vehicles in tunnels and through tunnels to reach areas of safe refuge shall be provided. The following are defined as areas of safe refuge:

2.3.4.1.1 A public way as defined in 3301(c) of the UBC

2.3.4.1.2 An at-grade area, beyond any structure, leading to a public way.

2.3.4.1.3 A fire exit that is enclosed for its full length to a public way or an at-grade area beyond any structure.

2.3.4.1.4 A trainway safe area of refuge shall meet the following requirements:

(A) A multiple tunnel underground trainway with either a minimum 2-hour rated fire barrier at each tunnel and with openings at each end of cross-passages protected by Class B (1½-hour) fire assemblies; or with a minimum 3-hour rated fire barrier with a common wall between tunnels with openings protected with Class A (3-hour) fire assemblies.

(B) Emergency ventilation facilities shall be provided at each unclosable opening in the fire-rated barrier, as necessary for center platform stations or for special track Sections, of sufficient capability that the effects of a vehicle fire can be prevented from passing beyond the opening for a minimum of 6 hours. (See Section 2.3.5.)

(C) Means shall be available at each point of access to the area of refuge for removal of traction power and for communication with the transit control center. (See Section 2.3.7.)

(D) Egress from and access to this area shall not require returning through the tunnel of fire origin.

(E) Emergency lighting shall be provided. (See Section 2.3.4.7.)

2.3.4.2 Egress Paths

In addition to the requirements specified in Section 2.3.2.1.4, the following identifies features necessary for effective emergency egress of patrons from disabled transit vehicles.

2.3.4.2.1 Safety walks shall be provided on one side of the tunnels, and shall be placed at the height of the vehicle floor (+ 0", -7") to facilitate egress through vehicle side doors. The following additional requirements shall be met:

(A) Level walkways, including ramps having a slope not exceeding 4%, shall have a clear width not less than 2 feet 6 inches, a maximum cross slope toward the trackway of 0.5 % and continuous wall handrails of 1¼ to 1½-inch standard galvanized pipe mounted, 2 feet, 6 inches to 2 feet, 10 inches above the walkway with 3-inch minimum clearance to the wall. No protrusions into the walkway shall extend further than a perpendicular line tangent to the handrail.

(B) Stairs and ramps having a slope in excess of 4% and level walkways on the contact rail side of the trackway shall have a clear width of 2 feet, 10 inches and be equipped with 3-foot, 6-inch high guardrails having an intermediate rail at mid-height. Clear headroom and cross slope shall be as required for level walkways. Stairs shall have a

minimum of 2 risers, equal and not greater than than 7½ inches, and 10-inch treads.

(C) Safety walks shall be brought down to rail elevation at track level at each end of a station platform to provide access to the undersides of vehicles for lengths not less than 15 feet but not greater than 150 feet. Safety walks shall also be brought down to rail elevation at crosswalks. Safety walks on the contact rail side of the trackway shall not be brought below the level of the contact rail coverboard. Where walkways are at track level, guard rails shall be provided to afford vehicle hot shoe level protection.

(D) A clear vertical envelope shall be maintained on the walkway of 1 foot 6 inches at the walking surface, 2 feet from 5 feet to 5 feet 6 inches, and 1 foot 6 inches at 6 feet 8 inches with a worst case static vehicle envelope.

2.3.4.2.2 Track walkways, when utilized for emergency egress, shall have a smooth walking surface, not less than 3 feet 8 inches wide provided between the running rails. The surface shall be flat and free from obstruction, holes, and drainage channels for the required width.

2.3.4.2.3 Crosswalks shall be provided at track level to assure walkway continuity where safety walks are discontinued on one side of the tunnel and continued on the opposite side and where access is required from safety walks and track walkways to emergency stairs or cross-passages. The crosswalks shall be of concrete construction, have a minimum width of 6 feet and a walking surface at top of rail. The crosswalk surface shall be sloped a maximum of 4% from track walkway elevation. Where the crosswalk is to extend to the side of the tunnel with the contact rail, the contact rail shall be discontinued not less than 5 feet from each side of the crosswalk.

2.3.4.2.4 Walkway continuity shall be maintained at special track Sections. Crosswalks shall be provided the full width of all trackways at both ends of special track sections. Safety walks of both trackways shall be located at the exterior walls above the contact rail coverboard. They shall have a clear width of 2 feet, 8 inches, guard rails, and use maximum 4% slope ramps for elevation changes, or both trackways shall be provided

with walkway top-of-rail height a minimum of 3 feet 8 inches from crosswalk to crosswalk.

2.3.4.3 Emergency Exits to the Surface

The emergency exits provide a capability for egress and ingress of emergency personnel. They consist of fire-resistive enclosed stairways and passageways supplementary to access for underground trainways at stations and portals, and are required as follows:

2.3.4.3.1 Emergency exits to the surface shall be provided at intervals not exceeding 1000 feet when trackways are not separated by solid walls or when the trackways are not accessible from each other due to individual tunnel profiles.

2.3.4.3.2 Where trackways are separated from each other by solid walls with the required fire resistance and having cross-passages meeting the requirements of 2.3.4.4, emergency exits to the surface shall be provided:

(A) At unprotected openings in the separating wall away from stations, such as special track locations, and

(B) At maximum 2,000-foot intervals where tunnel separation does not qualify as a safe area of refuge as defined by 2.3.4.1.4.

2.3.4.3.3 Emergency exit enclosures shall be separate from ventilation shafts, although they may be adjacent. Stairs and passageways shall have a minimum clear width of 3 feet 8 inches. Stairways shall have standard handrails or guardrails on each side, landings of length equal to the stair width at the bottom and at not greater than 12-foot vertical intervals, minimum 7-foot headroom, maximum 7½-inch step risers, and minimum 10-inch wide step treads. Doors shall be single-leaf, 4-foot wide, Class B(1½-hour) fire doors, arranged to open in the direction of travel and equipped with self-closing devices.

2.3.4.3.4 Emergency exit discharge shall be to an area of safety as defined in 2.3.4.1, through an opening with a width of 3 feet 8 inches and a height or length of 6 feet 8 inches. The exit will normally be one of the following:

(A) Vertical exit door in a surface kiosk or an adjacent building. Such a door shall be equipped with

panic hardware on the emergency exit stairway side and shall have a minimum fire rating of 1½ hours. Entrance from the outside shall be provided by a key or wrench.

(B) Horizontal exit door or hatch flush with surface level. The flush exit doors shall be of solid steel and shall be counterweighted or spring loaded so that they will open when pressure is put on a panic release bar on the emergency exit stairway side. The force required to open or close the hatch shall not exceed 15 pounds applied at the latch side. The hatch shall be equipped with a hold-open device which shall automatically latch the door in the open position so as to preclude accidental closure. Entrance from the surface side shall be provided by a key or wrench. Where the hatch is in a position subject to pedestrian traffic, an automatic warning bell at the surface shall be activated by foot traffic at the bottom of the stairs or at an intermediate landing.

(C) Exit doors at the surface shall be at locations acceptable to local authorities and shall not be provided in areas subject to vehicular traffic.

2.3.4.4 Cross-Passages

Distance between tunnel cross-passages shall be approved by the FLSC; cross-passage spacing shall not exceed 800 feet, unless authorized by the FLSC. They shall meet the following requirements:

2.3.4.4.1 The sill of a cross-passage opening shall match the elevation of the service walkway or crosswalk to which it connects. The cross-passage shall have a minimum clear, unobstructed width of 6 feet, 6 inches, and it shall have a desirable height of 8 feet and a minimum height of 7 feet. Ventilation and drainage shall be provided.

2.3.4.4.2 Cross-passages may be incorporated in pump or ventilation structures. Where they are a part of a ventilation structure, the passageway shall be separated from the air plenums and sumps and be enclosed by construction with a minimum fire rating of 2 hours. Space for any ventilation or drainage equipment shall be provided exclusive of the 6 feet 6 inches as required in Section 2.3.4.4.1.

2.3.4.4.3 The minimum dimensions of the door opening shall be 3 feet 8 inches wide by 80 inches high. Doors shall be provided at each end and arranged to open into the cross-passages. The doors shall be offset to the same side of the cross-passage.

2.3.4.4.4 Doors, door frames, and hardware shall have a minimum fire rating of 1½ hours (Class B).

2.3.4.4.5 Doors shall be equipped with door closures and passage latch sets to allow opening from either side. All doors and hardware systems shall be designed to withstand an air pressure of 70 pounds per square foot applied on either side of the entire door area.

2.3.4.5 Emergency Exit Doors

Emergency exit doors shall be provided at maximum 500-foot intervals in the common wall separating the trainways in cut-and-cover structures. A single sliding door shall be used with the door and hardware having a minimum fire rating of 3 hours (Class A). The door shall be selfclosing and equipped with pull handles to allow opening from either side.

2.3.4.6 Identification of Exits

Cross-passage and exit doors shall be identified by signs and lights.

2.3.4.7 Emergency Lighting

2.3.4.7.1 Emergency tunnel lighting illumination levels shall not be less than 1 footcandle measured at ground level.

2.3.4.7.2 Emergency lighting at walking surface within emergency exits and cross-passages, and within tunnels at exit and cross-passage doors, walkway stairs, walkway ramps over 4% slope, and crosswalks shall provide illumination at not less than 1 footcandle and all other walking surfaces of means of egress at not less than 1 footcandle.

2.3.4.7.3 Underground trainway emergency lighting shall otherwise conform to requirements for station emergency lighting. (See Section 2.2.5.5.)

2.3.4.8 Emergency Access to Trainway

2.3.4.8.1 In those locations where emergency egress from the trainway is provided, emergency access shall also be provided, meeting the requirements of Section 2.2.6.5.

2.3.4.8.2 At such locations, Command Posts (CP) as defined in 2.3.7.4 shall be provided.

2.3.5 VENTILATION SYSTEMS

2.3.5.1 General

Trainway ventilation systems shall be comprised of normal environmental control systems and emergency ventilation systems. Normal environmental control systems are required to operate continuously or intermittently for the purposes of maintaining safe working conditions for transit employees with duties in the underground trainway, providing makeup air required for transit vehicle passengers, cooling transit vehicles and wayside equipment, and removing flammable gases and vapors as determined to be present in the underground environment. Sufficient normal ventilation shall be provided to meet the requirements of these conditions occurring simultaneously. Emergency ventilation facilities may be used under abnormal conditions to control unusually large gas and vapor penetrations, and under conditions of failure of the normal air handling control systems.

2.3.5.2 Emergency Ventilation System Capability

2.3.5.2.1 In underground trainway fire emergencies, gases and aerosols produced by combustion or arcing may limit visibility and be potentially incapacitating or toxic. An emergency ventilation system shall be provided primarily to control the hazards of smoke and fire gases by safely dissipating and cooling them and directing their path of movement and by supplying fresh air to patrons, employees, and fire department personnel.

2.3.5.2.2 Emergency ventilation capability shall provide control for sufficient time to ensure that life safety objectives, property, and operations protection of SCRTD are adequately met. Emergency ventilation systems shall be capable of controlling air quality for not less than 60 minutes in tunnels having unseparated trainways or lacking cross-passages. With trainways in separated tunnels having cross-passages, emergency ventilation shall control fire effects in the tunnel of fire origin for 60 minutes, and in the unaffected tunnel indefinitely. Where separated tunnels are to be designated as an area of refuge, emergency ventilation shall control the effects of fire indefinitely.

2.3.5.3 Ventilation of Exit Routes from Trainways

Emergency egress between trainways and areas of safety, which will be through stations or through independent passageways and/or stairways shall be protected by ventilation control as follows:

2.3.5.3.1 Egress paths shall remain protected for an additional time, beyond that specified in 2.3.5.2.2 above, determined on the basis of exiting scenarios considering maximum train capacity.

2.3.5.3.2 Exit stair shafts and passageways shall not be used to exhaust air in either normal or emergency ventilation modes.

2.3.5.3.3 Exhaust air shall be discharged sufficiently away from egress discharge points, so that the exhaust will neither enter the stair shafts or passageways, nor impede the discharge of patrons from the exits to areas of safety. Reference 2.2.3.1.3

2.3.5.3.4 Station ventilation systems shall be designed with an operational mode permitting them to function in coordination with the emergency ventilation system. Circuit control and supervision and duplicated power supply shall be provided as necessary for station ventilation systems to properly perform the emergency function.

2.3.5.4 Air Quality Requirements

Ventilation for control of fire effects shall be designed to be adequate in the event of multiple transit vehicle fire involvement and the resultant

generation of combustion products as described in Section 2.2.3.2.

2.3.5.5 Ventilation Equipment Requirements

For emergency ventilation system reliability and versatility, the following equipment and power requirements shall be met:

2.3.5.5.1 Wiring for fans essential for emergency ventilation service shall consist of 2 electrical feeders from 2 separate sources. Power feeders from a utility company furnishing power for fans shall be isolated from each other and shall originate from separate and distinct sources.

2.3.5.5.2 Conductors for emergency power shall be protected from physical damage by transit vehicles or other normal transit system operations and from fires in the transit system by suitable embedment or encasement, or by routing such conductors external to the interior underground portions of the transit system facilities.

2.3.5.5.3 Fans shall be single- or dual-speed and reversible or capable of changing the direction of airflow by means of dampers. The minimum acceptable reverse (supply) flow capacity shall be 90 percent of the forward (exhaust) flow capacity.

2.3.5.5.4 Fans required for emergency operation shall be capable of satisfying emergency air velocity criteria in either supply or exhaust modes.

2.3.5.5.5 Ventilation fans used for emergency service, their motors, and all related components exposed to the ventilation airflow shall be designed to operate in an ambient atmosphere of 300° F for a period of at least one hour. Safe areas of refuge will require longer periods.

2.3.5.5.6 Local fan motor starters and related operating control devices shall be isolated from the ventilation airflow by a separation having a fire-resistance rating of at least 2 hours.

2.3.5.5.7 Thermal overload protective devices shall not be provided on motor controls of fans when used for emergency ventilation. Circuits shall be designed to maintain current to the emergency fan motors when in emergency mode without operation of protective devices

(unless excess current is sensed simultaneously with a no-air-flow signal).

2.3.5.5.8 Sufficient emergency ventilation shall be provided with one of the most critical ventilation fans malfunctioning.

2.3.5.6 Supervision and Control

2.3.5.6.1 Emergency ventilation systems shall be supervised and controlled in all operating modes locally and remotely at both the CC facility and at the station EMP. Local controls and EMP controls shall have primary and secondary overriding capability, respectively.

2.3.5.6.2 Local control shall be from a protected location near the fans separated from other areas by 2-hour fire-rated construction. Access shall be from the trainway and from the street level access adjacent to the fan shaft.

2.3.5.6.3 Power availability on each power source shall be annunciated in the local control room and means shall be provided for manually transferring fan circuits from one power source to the other. When using manual transfer switches, both remote control locations should have similar annunciation and manual switch capability. With automatic transfer switches, the remote control locations shall have a single annunciation that power is available.

2.3.5.6.4 Fan running shall be proven by air-flow sensing devices for each fan for operation in both the supply and exhaust directions. Air movement at 90% of rated air flow shall be required to initiate the fan-running signal for both the high- speed and low-speed modes. Fan speed and direction shall be controlled and status fully annunciated at local and remote control locations.

2.3.5.6.5 Trouble status signals shall be annunciated in the local control room. These signals annunciate high temperature, excess fan vibration, excessive current demand, and loss of current in any phase. A summarized trouble signal shall be annunciated at CC and EMP.

2.3.5.6.6 Control and status annunciation circuits shall be supervised by the fire alarm control panel in a nearby station.

2.3.6 FIRE PROTECTION SYSTEMS

2.3.6.1 Protective Signaling Systems

Protective signaling systems shall be installed as indicated in SubSection 2.2, Section 2.2.6.1.3 for traction power substations, gap-tie stations, unit substations, pump and valve rooms, and in ventilation systems as noted; Section 2.2.6.1.6; and Section 2.2.6.1.7.

2.3.6.2 Standpipe and Hose System

A Class I wet standpipe system shall be installed, to provide protection throughout the underground trainway system, in accordance with Chapter 38 UBC as applicable and the following requirements:

2.3.6.2.1 The standpipe system shall be supplied through direct connections from the public water supplies at station locations, portals, and other access points to the system. Station standpipe supplies and trainway standpipe supplies may be combined.

2.3.6.2.2 Where water supplies divide to feed standpipe systems in two directions, check valves shall be provided at the point of connection to each feed main. When needed for required system reliability, a normally closed bypass may be employed.

2.3.6.2.3 Fire department inlet connections shall be provided at each point of connection to public supplies.

(A) The inlet connection shall be arranged to join the public main supply at street level utilizing the standard valve pit arrangement of NFPA 24, Appendix A, figure A-2-6c, including control valves and check valves.

(B) Inlet connections shall be visible from a public way and comply with the requirements of 2.2.6.5.3.

(C) Graphics identifying the portions of the trackway supplied shall be placed at inlet connection locations.

2.3.6.2.4 Control valves and check valves at points of system supply and subdivision shall only be located at sta-

tions, portals, street level valve pits, and within cross-passages and exit enclosures.

2.3.6.2.5 The trainway standpipe shall be a Class I wet standpipe system capable of providing a minimum of 500 gallons per minute at a residual pressure of 65 pounds per square inch to the most hydraulically remote standpipe outlet.

2.3.6.2.6 Fire hose outlets shall be equipped with 2½-inch NST fire hose coupling thread and be positioned as follows:

(A) 2 outlets shall be provided within each cross-passage between underground trainways and at the trainway level within the enclosure of each emergency exit to the surface.

(B) Outlets shall also be installed in each trainway with locations coordinated with cross-passages and exit enclosures to obtain a spacing not exceeding 250 feet between hose outlets.

(C) In cut-and-cover subway structures, hose outlets shall be provided on each side of the separating common wall, near each exit door.

2.3.6.2.7 All common supply piping shall be sized for a minimum flow of 500 GPM for the first standpipe plus 250 GPM for each additional standpipe, the total not to exceed 2500 GPM.

2.3.6.2.8 Standpipe system control valves shall be supervised from the fire alarm control panel in an adjacent station by means of valve-position indicators. One valve-position indicator signal shall be provided for each valve within each fire-rated enclosure (series wired indication circuit). Valves which are to be normally closed shall be supervised in that position.

2.3.6.3 Fire Extinguishers

2.3.6.3.1 Portable fire extinguisher with a minimum rating of 4A-30B:C, 10 pound capacity and UL approved, shall be provided adjoining each trainway Blue Light Station (BLS). (See Section 2.7.5 for BLS locations.)

2.3.6.3.2 A minimum of one Halon 1211 extinguisher, UL approved, rated 2A-20B:C and having 10 pound capacity,shall be provided in each emergency fan control room.

VOLUME I, SECTION 2 FIRE/LIFE SAFETY (Cont'd.)

2.3.7 EMERGENCY COMMUNICATIONS

2.3.7.1 Emergency Telephones

2.3.7.1.1 Trainway emergency telephones shall be part of the emergency telephone system required in Section 2.7.4.2.

2.3.7.1.2 Emergency telephones shall be provided at Blue Light Station.

2.3.7.1.3 Emergency telephones shall be provided in emergency fan control rooms.

2.3.7.2 Blue Light Stations (BLS)

Blue Light Station requirements for transit stations and trainways are described in Section 2.7.5.

2.3.7.3 Tactical Communications

Fire Department tactical communications capability shall be provided throughout underground trainways, and shall be designed in accordance with the requirements of Section 2.7.3.

2.3.7.3.1 Hard-wired systems shall include fire phone access positions at street level inlet connection locations, trainway entrances to enclosed exits to the surface, at all standpipe hose outlets, and at all BLS locations.

2.3.7.3.2 Where equipment is provided for augmentation of public emergency organization radio channel transmission, receiving and transmitting access facilities shall be provided for each command post location.

2.3.7.4 Command Post (CP) Locations

2.3.7.4.1 Equipment shall be provided for command post locations as described in Section 2.7.2.4.

2.3.7.4.2 Locations shall be established at the station EMP, at portals, and at surface emergency access to trainway (2.3.4.8).

2.3.8 STORAGE OR TAIL TRACK

2.3.8.1 Trackway Sections providing storage areas for trains shall be separated by a 2-hour fire rated partition. Any opening in the partition shall be protected by a 1½ hr. rated assembly.

2.3.8.2 At termination ends, exits to the surface shall be provided.

2.3.8.3 Emergency ventilation shall be provided at each end in accordance with Section 2.3.5.

2.3.8.4 Wet standpipes shall be provided in accordance with Section 2.3.6.2 except that Class III hose cabinets shall be provided not to exceed a spacing of 250 feet.

2.3.8.5 Approved automatic fire detection system meeting Section 2.2.6.1 shall be installed in the trackway.

2.3.8.6 Access shall be provided at both ends of a maximum train length for each trainway Section.

2.3.8.7 A minimum spacing of 6 feet 6 inches shall be provided between trains stored on the same track.

2.3.8.8 Conform to all other requirements for underground trainways as defined in Section 2.3.

2.4 PASSENGER VEHICLE

2.4.1 GENERAL

2.4.1.1 Patrons onboard a vehicle may number up to the maximum capacity in each vehicle, and may include able-bodied adults, children, elderly, and the handicapped.

2.4.1.2 Employees onboard a train will include the train operator and from time to time, as necessary, other supervisory, maintenance, and security personnel.

2.4.2 CONSTRUCTION: MATERIALS AND FIRE BARRIERS

2.4.2.1 Combustible Content

Total combustible content of each transit vehicle shall not exceed a heating value of 60,000,000 BTU (British thermal units) of which no more than 33,000,000 BTU (55%) of the total combustible value shall be permitted above the floor assembly. Each combustible material shall be specifically identified by supplier's name and type, shape and use in the vehicle, and total weight and heating value. The heating values from this list shall be totalled for vehicle interior surface materials (including ducting, etc.), for other interior materials, for exterior materials not underfloor, and for all underfloor materials.

2.4.2.2 Flammability of Vehicle Materials

2.4.2.2.1 Upholstery and other fabric materials shall be tested by FAA Regulations 25.853 vertical test, Appendix F (b), with the following modifications:

(A) The average flame time after removal of the flame source may not exceed 10 seconds.

(B) Burn length shall not exceed 6 inches.

(C) Flaming dripping shall not be allowed.

(D) Fabrics that must be machine washed or dry cleaned must meet the requirements of parts A, B, and C above, after leaching, according to Federal Test Method 191b, Method 5830, or after dry cleaning according to American Association of Textile Chemists and Colorists (AATCC) - 86-1968. Fabrics that cannot be machine washed or dry cleaned must be so labeled and must pass the leaching test as well as parts A, B, and C, after being cleaned as recommended by the manufacturer.

2.4.2.2.2 Seat cushions shall be capable of passing the ASTM E162-78 Radiant Panel Test with a flame-propagation index (I_s) not exceeding 10. Additional provisions are as follows:

(A) There shall be no flaming running or dripping of the material during the test.

(B) Wire mesh screening shall be used (in accordance with Section 5.9.2 of ASTM E 162-78).

(C) A 6-inch pilot flame shall be used with the burner tip situated 1½ inches beyond the frame to prevent its being extinguished.

(D) Aluminum foil shall be used to wrap around the back and sides of the specimen.

2.4.2.2.3 The composite of seat cushions and seat upholstery coverings shall be capable of passing the procedures required in 2.4.2.2.2, with an I_s not exceeding 35.

2.4.2.2.4 Thermal and acoustical insulation, tested in its end-use configuration, and seat frames and seat shrouds shall be capable of passing the ASTM E 162-78 Radiant Panel Test with an I_s of not more than 25, with the additional provisions provided in 2.4.2.2.2.

2.4.2.2.5 Wall and ceiling panels, windscreens, partitions, and ducting (including all materials in air-handling enclosures) shall be capable of passing the ASTM E 162-78 Radiant Panel Test with an I_s not exceeding 35, with the added provision that there shall be no flaming running or dripping.

2.4.2.2.6 Transparencies such as glazing, light diffusers, and windscreens shall be capable of passing ASTM E 162-78 Radiant Panel Test with an I_s not exceeding 100. Testing shall be on the car interior side and when these transparencies are located at the end of vehicles, the exterior side shall be tested as well.

2.4.2.2.7 The floor-covering material placed over the structural floor shall be capable of passing the "Flooring Radiant Panel Test" (NFPA 253) with a minimum critical radiant flux of 0.50 watts/cm². Furthermore, the flooring material shall be tested together with an underlay that may be used. The flooring shall pass this test after being cleaned; the number of such cleanings shall be specified.

2.4.2.2.8 Elastomers, used as door nosing and seals, and window gasketing shall be capable of passing ASTM C 542-78.

2.4.2.3 Smoke Emission of Vehicle Interior Materials

All material listed in 2.4.2.2 shall be tested for smoke emission in accordance with the ASTM E 662-79,

"Smoke Generated by Solid Materials." The optical density, D_s, in both flaming and non-flaming modes, determined in accordance with the test, shall not exceed 200 in 4 minutes.

2.4.2.4 Fire Characteristics of Exterior Vehicle Materials

2.4.2.4.1 Vehicle design shall arrange apparatus external to the passenger compartment, whenever practical, so as to isolate potential ignition sources from combustible material and to control fire and smoke propagation. Where it is necessary to install apparatus in passenger vehicles, suitable shields or enclosures shall be provided to isolate the apparatus from the passenger compartment.

2.4.2.4.2 Battery cases should be spaced well away from combustible materials at the vehicle trucks, and away from under-vehicle sources of high temperatures such as resistor banks and compressors.

2.4.2.4.3 Exterior surfaces of vehicle end caps shall be capable of passing ASTM E 162-78 Radiant Panel Test with an I_s not exceeding 35.

2.4.2.4.4 Vehicle end caps and floor shall be designed to preclude propagation of underfloor fire to vehicle interior.

2.4.2.4.5 Vehicle end caps shall be completely separated from the vehicle interior by vehicle exterior panels, or the void space fully filled with thermal insulation meeting 2.4.2.2.4 and 2.4.2.3 requirements. Additionally, the interior surface of the end caps shall meet the liner material requirements of 2.4.2.2.4 and 2.4.2.3.

2.4.2.5 Toxicity

Those materials and products generally recognized to have high toxic products of combustion shall not be used.

2.4.2.6 Underfloor Fire Separations

2.4.2.6.1 The vehicle floor assembly shall be capable of passing the ASTM E-119 fire endurance test for its classification. The test time period selected shall be equal to that time necessary for safe evacuation of a maximum load of passengers from the vehicle in the worst case situation, or one hour, whichever is greater.

2.4.2.6.2 The test specimen shall be a full-width vehicle section, including a portion of the vehicle walls which extend below the upper surface to the vehicle floor. Specimen shall have an exposed area of 180 square feet. This area may be reduced to meet a length limitation imposed by the size of the test furnace, but the length should not be less than 15 feet. No fewer than 2 typical penetrations shall be included in the test specimen, which should be spaced from each other at a distance no greater than will exist in the actual construction.

2.4.2.6.3 Specimen under test shall be placed within the combustion chamber with a clearance not less than 8 inches from the furnace wall.

2.4.2.6.4 Test specimen shall be loaded to represent a crush passenger load.

2.4.2.6.5 Conditions of acceptance for this test shall be those required for unrestrained assembly.

2.4.3 ELECTRICAL REQUIREMENTS

2.4.3.1 General Construction

All motors, motor control, current collectors, and auxiliaries shall be a type and construction suitable for use on fixed trainway transit vehicles.

2.4.3.2 Gap and Creepage

2.4.3.2.1 Electrical circuits and associated cabling shall be designed with gap and creepage distance between voltage potentials and car body ground in accordance with the environmental conditions to which the circuits and cabling will be subjected.

2.4.3.2.2 The air-gap distances between voltage potentials and ground in enclosed, clean, dry environments shall comply with the requirements specified in the following documents:

UL 508 - For voltages up to and including 300 V ac or dc

NFPA 130 - For voltages above 300 V ac or dc

In selecting air-gap distances, special consideration shall be given to the presence of contaminants encroaching upon the normal free air environment.

2.4.3.2.3 Creepage distance for voltage potentials to ground shall comply with the requirements specified in the following documents:

UL 508 - For voltages up to and including 300 V ac or dc
NFPA 130 - For voltages above 300 V dc or ac.

In other than ordinary enclosed environments, creepage distances shall be modified according to the anticipated severity of the environment.

2.4.3.3 Propulsion Motors

2.4.3.3.1 Motors shall be rated and tested per American Standard for Rotating Electric Machinery for Rail and Road Vehicles, IEEE 11.

2.4.3.3.2 Motor leads shall have an insulation suitable for the operating environment and shall be so supported and protected as to offer the least possible chance of mechanical damage. Motor leads where entering the frame shall be securely clamped and shall fit snugly so as to prevent moisture from entering the motor case. Drip loops shall be formed in motor leads so as to minimize water running along the lead onto the motor case. Motor leads shall be sized according to IEEE S-135 or using 150% rms current, whichever is greater. The rms current shall be based upon continuous round-trip operation of an AW2 consist between and including Union Station and North Hollywood Station, operating at PL-1, stopping at stations, and observing speed restrictions and the service braking rates. Primary voltage shall be 700 V dc in propulsion and 750 V dc in electric braking. Intermediate station dwell time shall be 20 seconds, and terminal station turnback time shall be 120 seconds.

2.4.3.4 Motor Control

2.4.3.4.1 Motor control shall be rated and tested per American Standard for Electrical Control Apparatus for Land Transportation Vehicles, IEEE 16.

2.4.3.4.2 Control equipment enclosures shall be arranged and installed to provide protection against moisture and mechanical damage.

2.4.3.4.3 Metal enclosures that surround arcing devices shall be lined with insulating material approved by the authority having jurisdiction, with the exception that lining

will not be required when the arc chutes extend through the enclosure and vent the arc to the outside air. Adequate shields or separations shall be provided to prevent arcing to adjacent apparatus and wiring.

2.4.3.5 Power Resistors

2.4.3.5.1 Self-ventilated resistors shall be mounted with air space between resistor elements and combustible materials. Heat-resistant barriers shall extend beyond resistor supports, horizontally, to ensure protection from overheated resistors, where necessary. Forced ventilated resistors shall be mounted in ducts, enclosures, or compartments of noncombustible material and shall be mounted with air space between the resistor enclosure and combustible materials. Provisions shall be made to filter the air where the operating environment is severe.

2.4.3.5.2 Resistors and heating circuits should incorporate protective devices for the following failures:

(A) Failure of ventilation air flow.

(B) Failure of temperature controls.

(C) Short circuit in supply wiring.

2.4.3.5.3 Resistor elements shall be electrically insulated from the resistor frames, and frames shall be insulated from supports. When forced ventilation is provided, the resistor leads shall be securely separated and cleated for protection in the event of loss of air circulation of the ventilation system. Leads shall be routed or protected from resistor heat.

2.4.3.5.4 The current value used in determining the minimum size of resistor leads shall include an appropriate safety factor based on the load current seen by the lead under the most severe normal duty cycle.

2.4.3.6 Current Collection

2.4.3.6.1 Clearance or shielding shall be provided between any part of the current collector assembly that is at line voltage and any other portion that is at ground potential. The shielding material shall be noncombustible.

2.4.3.6.2 The minimum size of current collector leads shall be determined by adding the sum of the maximum expected

auxiliary loads to the propulsion motor loads. For a propulsion system equipped with regenerative capability, the regenerative load must be included with the motor load.

2.4.3.7 Wiring

2.4.3.7.1 Single conductor wiring and conductors forming part of a multi-conductor cable between control group enclosures shall be suitably sized per NEC.

2.4.3.7.2 Conductor sizes shall be selected by determining RMS currents in the conductors and by considering maximum allowable voltage drops. They shall be no smaller than minimum sizes in 2.4.3.7.1.

Conductors shall be de-rated for grouping and for ambient temperature greater than manufacturer's design value, in accordance with criteria specified by NEC.

2.4.3.7.3 Electrical insulation for wiring and power cable shall be capable of passing the following tests:

(A) Wires for lighting auxiliary circuits and for control, signal, and other low-voltage (less than 100 Vac and 150Vdc) functions shall meet the requirements of IPCEA 5-19-81 (with Amendment FR-1) paragraph 6.19.6, or of Underwriters Laboratories Standard 44 for thermosetting insulation and UL Standard 83 for thermoplastic insulation.

(B) Power cable shall meet the requirements of IEEE Standard 382-1974, Section 2.5, with the additional requirement that circuit integrity continue for 5 minutes after the start of the test.

(C) All other electrical insulation shall meet suitable tests for the proposed use.

2.4.3.7.4 Conductors of all sizes shall be provided with mechanical and environmental protection and shall be installed in any one or combination of the following ways:

(A) In flexible metallic conduit or raceways.

(B) In non-metallic raceway ducts or flexible tubing suitable for vehicle wiring.

(C) In cable boxes.

(D) As non-metallic sheathed cable suitable for wiring.

Sufficient firestops shall be provided in raceways, at floor penetrations, at entrances to or exits from major components, and at changes of direction to control the spread of fire. Wires connected to different sources of energy shall not be cabled together or run in the same conduit, raceway, tubing, junction box, or cable unless all such wires are insulated for the highest rated voltage in such locations. Wires connected to electronic control apparatus shall not touch wires connected to a higher voltage source of energy than control voltage.

Conduits, electrical metallic tubing, non-metallic ducts or tubing and all wires with their outer casings shall be extended into devices and cases where practical. They shall be rigidly secured in place by means of cleats, straps, or bushings to prevent vibration or movement and to give environmental protection. Connections and terminations shall be made in a manner to assure their tightness and integrity.

Conductors and enclosures of any kind shall be protected from the environment and from mechanical damage.

2.4.3.8 Overload Protection

2.4.3.8.1 A main automatic circuit line breaker or line switch and overload relay for the protection of the power circuits shall be provided. If a circuit breaker arc chute is utilized, it shall be vented directly to the outside air.

2.4.3.8.2 If cartridge-type fuses are used in addition to the automatic circuit breaker, they shall be installed in approved boxes or cabinets. If railway-type ribbon fuses are used, they shall be in boxes designed especially for this purpose and shall be equipped with arc blowout aid. Third rail shoe fuses mounted on the shoe beams shall be mounted so as to direct the arc away from grounded parts.

2.4.3.8.3 Circuits used for purposes other than propelling the vehicle shall be connected to the main cable at a point between the current collector and the protective device for the traction motors. Each circuit or group of circuits shall be provided with at least one circuit

breaker or a fused switch or fuse located as near as practicable to the point of connection of the auxiliary circuit, except that such protection may be omitted in circuits controlling safety devices.

2.4.3.9 Battery Installation

The design of battery installation and circuitry shall include the following:

(A) Minimal use of organic materials, particularly those having hygroscopic properties.

(B) Fire-retardant treatment for organic materials used.

(C) Battery chargers designed for protection against overcharging.

(D) Use of smoke and heat detectors, if appropriate.

(E) Use of an emergency battery cut-off switch, if appropriate.

(F) Isolation of battery compartment from car interior using non-combustible materials as defined in ASTM E136 if appropriate.

2.4.3.10 Testing and Maintenance

2.4.3.10.1 Qualification testing shall be performed by the equipment manufacturer in accordance with tests specified by the SCRTD.

2.4.3.10.2 Periodic maintenance shall be performed in accordance with maintenance manuals furnished by the equipment manufacturer. The frequency of maintenance shall be based upon operating experience.

2.4.4 VENTILATION AND HEATING SYSTEMS

2.4.4.1 Control of Ventilation Equipment

Vehicles shall have provision for control of all ventilation equipment throughout the train from the controlling cab, in the event of a fire.

2.4.4.2 Heater Protection

2.4.4.2.1 Heater forced air distribution ducts and plenums shall incorporate over-temperature sensors, fusible links, or means of detecting insufficient air flow.

2.4.4.2.2 Heater elements shall incorporate protective devices for the following failures:

(A) Failure of the ventilation air flow

(B) Failure of the temperature controls

(C) Short circuits in supply wiring

2.4.5 EMERGENCY EGRESS AND ACCESS MEANS

2.4.5.1 Emergency Exits

2.4.5.1.1 All vehicles' side doors and end doors shall have capability for use as emergency exits. They shall be designed to be operable by patrons under emergency conditions, including the loss of electrical power to these doors.

2.4.5.1.2 At least one vehicle side door on each side and both end doors shall be designed to be openable from the outside by rescue personnel during power loss.

2.4.5.1.3 A means of exiting from the vehicle to the trackway from side doors and ends of the train shall be provided.

2.4.5.2 Protective Enclosures Between Vehicles

During design, consideration shall be given to equipping the end doors between all vehicles with protective enclosures that will provide interim protection against smoke in trainway tunnels and aid patrons in making

intervehicle transfers through a moving train during emergency conditions.

2.4.5.3 Emergency Lighting

Emergency lighting shall be provided throughout the vehicle and arranged at each doorway to provide illumination to the door vestibule and threshold area. Emergency lighting shall provide an illumination level of one footcandle measured at the floor.

2.4.5.4 Emergency Power Supply

Power to emergency lighting and other designated emergency electrical equipment shall be available for a period of one hour in the event of loss of external power. The onboard power supply for designated services shall be supplied from battery units on each vehicle or each dependent pair.

2.4.6 FIRE PROTECTION

2.4.6.1 Fire Extinguishers

Each vehicle shall be provided with at least two UL approved portable fire extinguishers of the 10-pound class, rated at 4A:30BC. Extinguishers shall be located for use by patrons, except that positions which become operators' areas in the front end vehicle may be used as extinguisher locations.

2.4.7 COMMUNICATIONS

2.4.7.1 Public Address System

Each vehicle shall be equipped with public address system speakers by which train operators can communicate emergency information to passengers. Provisions shall be made so that CC can address passengers directly. Audibility level shall be a minimum of 10 db over any background noise.

2.4.7.2 Radio

Direct radio voice communication shall be provided between the train operator and CC.

2.4.7.3 Communication with Train Operator

Devices shall be provided in each car by which passengers may alert and communicate with the train operator in emergencies.

2.4.7.4 Power for Communication Systems

The above communication systems shall be powered by the onboard emergency power supply referenced in Section 2.4.5.4.

2.4.8 EMERGENCY UNCOUPLING OF VEHICLES

A means of manually uncoupling vehicles within a train, both from within and from the exterior, shall be provided.

2.5 VEHICLE YARD AND MAINTENANCE FACILITIES

2.5.1 GENERAL

2.5.1.1 Vehicle yard and maintenance facilities occupancies may include the vehicle maintenance facility, vehicle storage yards, yard train control and communication facilities, yard control tower, maintenance of way facility, component repair facility, operations personnel facility, gap tie station, traction power substations, blowdown facility, vehicle car wash facility, test track, test building, and occupancies ancillary to these facilities.

2.5.1.2 The vehicle yard and maintenance facility occupants are employees or contractors whose work assignment requires their presence in these facilities.

2.5.1.3 For the purpose of interpretation, the vehicle yard and maintenance facilities shall be considered as being comprised by the following occupancies in accordance with UBC Table 5a:

- Vehicle maintenance - Group H, Division 4
- Maintenance of way - Group B, Division 2

- o Yard control tower - Group B, Division 2
- o Operations personnel facility - Group B, Division 2

2.5.1.4 Other facilities, such as the blowdown facility, vehicle wash facility, and test building shall be given appropriate classification where contained in a separate structure. Where these facilities are integrated with major facilities, classified above, the classification will usually be that of the major facility. (See UBC Section 503.)

2.5.1.5 It is anticipated that several of the separate maintenance functions may be located in a single structure. For the purpose of interpretation, the largest area (vehicle maintenance facility) shall determine the requirements for the integrated buildings, except that occupancies separated in the manner set forth in the UBC may be individually classified within a single structure.

2.5.2 YARD FACILITIES

2.5.2.1 Fire Protection Water Supply and Distribution

An adequate, reliable water supply shall be available for fire protection including a sufficient number of properly located hydrants in accordance with Los Angeles Fire Department Master Plan, and Los Angeles County Water Ordinance 7834.

2.5.2.2 Emergency Access

2.5.2.2.1 Emergency access shall be provided to system structures, trainways, facilities, yards, and outside storage areas in accordance with LA Fire Department Master Plan and LA County Fire Code.

2.5.2.2.2 Access to any structure shall be from public streets or transit access roads.

2.5.2.2.3 Access to the inside perimeter of the vehicle yard and maintenance facility area, including yards, shall be by transit access roads.

2.5.2.2.4 Transit access roads shall be a minimum all-weather paved width of 20 feet with a widened minimum of 28 feet at turnouts for emergency vehicles where pumping or aerial apparatus is expected to operate.

2.5.2.2.5 Minimum outside turning radius, minimum vertical clearance, maximum deadend, and access within storage yard suitable for mechanized fire-fighting equipment shall be provided.

2.5.2.3 Fire Extinguishers

Portable fire extinguishers of 10 pound capacity, UL approved and rated 4A-30B:C (dry chemical)/2A-20B:C (Halon 1211), shall be provided, suitably housed and spaced in accordance with LAFD Standards and LACoFD standards. Fire extinguishers shall be provided at each emergency phone location.

2.5.2.4 Alarm and Communication Systems

2.5.2.4.1 Traction Power Emergency Trip Stations (ETS) as described in Section 2.7.5 shall be provided as follows:

(A) Outside each wall where vehicles enter and leave building vehicle maintenance areas.

(B) At ends of storage tracks arrays.

(C) At trackways near normal and emergency entrances to the yard including test track areas.

(D) Other locations, i.e. multiple track direction changes, switch points, etc.

2.5.2.4.2 Provisions shall be made for an emergency communication system to be used by employees for reporting fire, requesting medical aid or other emergencies and shall be located throughout maintenance facilities and yard so that every area has at least one such phone.

2.5.3 STRUCTURES

2.5.3.1 Structural Facilities

Structures shall conform to the UBC and full automatic sprinkler protection shall be provided.

2.5.3.1.1 A Yard Control facility for yard operations, if utilized, shall be constructed and separated in accordance with the CC facility requirements of Section 2.8.2.

2.5.3.1.2 Fire separations shall be provided and maintained to separate occupancies as required by the UBC.

2.5.3.2 Drainage Systems

All drainage systems shall be designed to reduce fire and explosion hazards by the use of noncombustible piping. Where piping is not enclosed, as direct a routing as possible to a safe outside location shall be provided.

2.5.3.2.1 Oil separators, grease and sand traps shall be installed on all floor drainage systems which service maintenance and vehicle storage areas to provide for the extraction of oil, grease, sand and other substances that are harmful or hazardous to the structure or public drainage systems. Where areas are protected by sprinkler systems, a bypass shall be provided around the separator and grease traps. Separators and grease traps shall be of approved design and of sufficient capacity to meet the level of waste discharged from the areas. The separator storage capacity shall be of sufficient size to retain all the sludge between cleanings.

2.5.3.2.2 Periodic maintenance checks and flushing shall be conducted on all drains, oil separators and grease traps to assure that they are clear of obstructions and perform their designed function. Any flammable liquids and greases shall be removed to an area approved for disposal.

2.5.3.3 Floors

The surface of the grade floor of storage or maintenance areas shall be of noncombustible material.

2.5.3.4 Roofs

Roof deck coverings shall be tested in accordance with UBC, NFPA 256, Class A or B, and local codes, and shall be UL listed.

2.5.3.5 Electrical Requirements

2.5.3.5.1 The installation of electric wiring for structure light and power and the installation of all electrical devices not supplying traction power shall be in accordance with NEC; the ANSI C2; and applicable local codes.

2.5.3.5.2 Traction power equipment shall meet the following requirements:

(A) Power rails shall be rigidly secured to suitable insulating supports, properly bonded at joints and properly guarded to prevent contact with personnel. Electrical supply for other than traction power details shall be in accordance with NEC and ANSI C2.

(B) All traction power conductors shall have emergency power shut-off devices in accessible locations.

2.5.3.6 Maintenance Pit Areas

2.5.3.6.1 Where flammable/combustible liquids and/or hazardous materials are used in pit areas and associated below-floor level areas, such areas shall be designed to meet required code provisions (NEC, 2.5.3.8.1, 2.5.3. 8.2).

2.5.3.6.2 Walls, floors, and piers shall be of masonry or concrete.

2.5.3.6.3 Pits shall have at least 2 exits. Steps shall be noncombustible and constructed with no free space underneath.

2.5.3.6.4 Pits and subfloor work areas shall be kept clean. Smoking shall be prohibited in pits and subfloor maintenance areas.

2.5.3.7 Overhead Cranes

All overhead cranes installed in the maintenance area shall adhere to the standard for cranes, and monorails as required by NEC, Article 610.

2.5.3.8 Ventilation

2.5.3.8.1 In all pit areas where undercar maintenance may generate vapors of a combustible nature (e.g., blowdowns of transit vehicles) a positive mechanical exhaust ventilation system shall be provided capable of air changes at the rate of 10 per hour or 1 cfm/ft^2 of pitfloor area, whichever is greater, during normal operation and designed to discharge to the outside atmosphere.

2.5.3.8.2 When a mechanical ventilating system is employed in shop maintenance areas, the ventilating system shall be installed in accordance with NFPA 90A. When blower and exhaust systems are installed for vapor removal, the systems shall be installed in accordance with NFPA 91 (see also UBC).

2.5.3.8.3 Large building open areas will require special considerations for the provision of means for powered smoke and heat venting controlled by zoned sprinkler systems, use of fire partitions and draft curtains, etc.

2.5.3.8.4 Permanent draft stops in sprinklered buildings shall be installed in structures having a height of over 25 feet to top of roof trusses. Draft stops shall be constructed of rigidly supported noncombustible material. (See NFPA 204, UBC, and local codes.)

2.5.4 FIRE PROTECTION SYSTEMS

2.5.4.1 Sprinkler Systems

Sprinkler systems shall be installed in all areas of enclosed structures in accordance with NFPA 13 and local codes.

2.5.4.1.1 Electronic maintenance and control areas shall utilize Halon 1301 systems in accordance with LA County and LA City FD Standards.

2.5.4.2 Protective Signaling Systems

2.5.4.2.1 Automatic Fire Detection Systems conforming to NFPA 72A and 72D shall be installed in each facility structure except where automatic sprinklers are installed.

2.5.4.2.2 Water flow alarm and Section control valve supervision shall be provided for automatic sprinkler connections.

2.5.4.2.3 The fire alarm system shall provide means to supervise and trip special extinguishing systems and to control the ventilation system.

2.5.4.2.4 A fire alarm control panel shall be provided in each principal building or building groups and include a fire management panel provided near the point of emergency access to each principal building or building groups consisting of an annunciator panel from the associated fire alarm control panel.

2.5.4.2.5 The fire alarm system shall be electrically supervised and operated on low voltage with locally sourced standby power (Reference: NFPA 72D). The fire alarm system shall alarm at each separated principal facility of alarm origin and at a central supervising station.

2.5.4.2.6 A public address system, supervised through the fire alarm control panel shall be used for fire alarm in principal maintenance facilities buildings and emergency messages shall be preceded by an audible alarm. An audible fire alarm shall be provided to alert personnel throughout the yard and outside storage areas.

2.5.4.3 Standpipe Systems

2.5.4.3.1 A Class II wet standpipe system complying with the requirements of NFPA 14 and UBC Chapter 38 shall be installed throughout the vehicle maintenance facility, including mezzanine and upper floor areas.

2.5.4.3.2 The spacing of standpipes in the large open areas of the vehicle maintenance facility will require special design consideration to obtain hose stream access around, under and within vehicles.

2.5.4.4 Fire Extinguishers

2.5.4.4.1 Portable fire extinguishers of the type and size specified shall be installed throughout all maintenance facilities buildings:

Multipurpose dry chemical - 10 pound capacity, UL approved and rated 4A-30B:C

Carbon Dioxide (CO_2) - 10 pound capacity, UL approved and rated 10B:C

2.5.4.4.2 Halon 1211 portable fire extinguishers, 10 pound capacity, UL approved and rated 2A-20B:C, shall be installed in areas protected by Halon extinguishing systems.

2.5.5 OPERATIONS AND MAINTENANCE

2.5.5.1 Vehicle Placement

Transit vehicles shall be so placed and tracks shall be arranged to allow a minimum clearance of 3 feet 0 inches between the sides of adjacent transit vehicles and 2 feet 6 inches between the ends of two uncoupled cars. A clear exit path to evacuate personnel from the structure in an emergency shall be provided in accordance with UBC. In storage areas, a minimum of 6-foot access shall be provided on one side of the vehicle.

2.5.5.2 Vehicle Maintenance

2.5.5.2.1 Vehicle electrical systems, including battery circuits, shall be de-energized except in those cases where an energized circuit is necessary to accomplish the required maintenance.

2.5.5.2.2 Transit vehicle batteries shall be disconnected or removed during maintenance operations which require the de-energizing of all electrical circuits.

Exception: Batteries need not be disconnected or removed when the vehicle is equipped with a battery cutout switch which fully isolates the battery and is physically located immediately adjacent to the battery.

When moving batteries, including removal and replacement, precautions shall be taken to prevent short circuits which may result in fires or explosions.

(A) Areas where batteries are charged shall be well ventilated to the outside to ensure that the maximum hydrogen/air mixture that may be generated during charging is held below the lower explosive

limits. In addition, where mechanical ventilation systems are required, they shall be installed in accordance with NFPA 91, Blowers and Exhaust Systems. The battery exhaust ventilation system shall be provided with electrical power and air-flow interlocks that will prevent operation of the battery charger if the ventilation fan motor is not energized or the air velocity in the exhaust duct is less than the designed velocity. The entire electrical system shall be in accordance with NEC, Article 511.

(B) Batteries shall be charged at a rate (amperage and length of charge) that will not produce a dangerous concentration of hydrogen or excessive heat. In addition, the following safety practices shall be followed:

(1) Access to battery rooms shall be limited to qualified personnel only.

(2) Smoking shall be prohibited and open flames, sparks, arcs and other sources of ignition shall be kept away from the immediate vicinity of batteries which are being charged. Appropriate warning signs shall be prominently displayed.

(3) Precautions shall be observed while working near battery terminals. Wrenches and other hand tools shall be used carefully to avoid short circuits.

(4) Brushes used to clean batteries shall have neither a metal frame nor wire bristles.

2.5.5.3 Painting/Cleaning/Paint Removal

2.5.5.3.1 In selecting materials for cleaning and paint removal purposes, nonflammable materials shall be specified whenever possible. The use of flammable or combustible cleaning agents shall be in accordance with NFPA 30 and local codes.

2.5.5.3.2 A location in which painting or cleaning is to be done shall be chosen that will provide good general ventilation, ease of cleanup and convenience.

2.5.5.3.3 Where major cleaning, painting and paint removal operations are being conducted, no concurrent poten-

tially hazardous operations shall be conducted within 50 feet of the area being worked on. Operation and facilities shall conform to NFPA 30 and 33 and local codes.

2.5.5.3.4 The use of heat lamps to accelerate the drying of painted surfaces shall be prohibited unless used as part of an approved drying booth or enclosure in accordance with NFPA 33 and local codes.

2.5.5.3.5 When cleaning or paint removal agents are applied through spray nozzles under pressure, the nozzle shall be of the self-closing type so that, when the hand of the operator is removed, the nozzle will automatically close.

2.5.5.3.6 For touch-up operations, any ignition sources within the areas being worked shall be eliminated; such areas shall be maintained hazard free during the work period.

2.5.5.4 Storage of Painting/Cleaning Liquids

Storage of painting/cleaning liquids shall be in accordance with local codes.

2.5.5.5 Welding

2.5.5.5.1 All welding operations performed on component transit vehicle parts on the transit vehicle shall be in accordance with NFPA 50, 51, and 51B and local codes.

2.5.5.5.2 Welding shall not be done in an area which contains fuel or other flammable or combustible liquids or vapors. No other work shall be permitted within a 35-foot radius of the location of any gas shielded arc welding operation, unless the welding area is vented and enclosed in an approved manner to prohibit flammable and combustible vapors from entering the work area.

2.5.5.5.3 Welding equipment shall have no electrical components other than flexible lead cables within 1 foot 6 inches of the floor.

2.5.5.5.4 Only qualified welders, trained in the techniques and familiar with the hazards involved, shall be permitted to do this work.

2.5.5.6 Industrial Trucks

Industrial trucks shall mean fork trucks, tractors,

platform lift trucks and other specialized industrial trucks and their operation and usage shall be in accordance with NFPA 505, American National Standard Safety Code for Powered Industrial Trucks, ANSI 356.1.

2.5.5.7 Fuel Handling

The storage and handling of liquefied petroleum gas (LP-Gas) shall be in accordance with local codes.

The storage and handling of liquid fuels (gasoline and diesel) shall be in accordance with local codes.

2.5.5.8 Service Stations

2.5.5.8.1 Service station facilities for road or hi-rail vehicles shall conform to UBC, Chapter 9; UFC Article 79, Division IX; and local codes. (See also Section 2.3.2.3.)

2.6 SYSTEM FIRE/LIFE SAFETY PROCEDURES

2.6.1 EMERGENCY PROCEDURES

2.6.1.1 Objective

The SCRTD shall anticipate and plan for emergency situations through development of emergency procedures. These procedures shall be contained in an Emergency Preparedness Plan (EPP).

2.6.1.2 Organization

A committee shall be established consisting of representatives from SCRTD and the participating agencies which serve the SCRTD. The committee shall be charged with the responsibility of guiding the SCRTD and the participating agencies in developing and following the necessary emergency procedures in the areas of fire and life safety that require immediate response.

2.6.2 EMERGENCIES

2.6.2.1 Types of Emergencies

As a minimum the following types of emergencies shall be addressed in the EPP:

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

2.6.3 EMERGENCY PREPAREDNESS PLAN

2.6.3.1 The EPP shall include but not be limited to, the following:

- o Date adopted, reviewed and revised.
- o Statements of policy, purpose, scope and definitions.
- o Identification of participating agencies, top officials, and signatures of executives signing for each agency.

- o Safety procedures during emergency operations.
- o Purpose and operation of Central Control in an emergency.
- o Detailed locations, requirements, purpose, and operation of Command Posts and/or Auxiliary Command Posts.
- o The requirements, purpose, and operation of radio and telephone communications at Central Control, at all stations and access points to the underground facilities, and intermediate points throughout tunnels.
- o Details of the type, amount, location, and operating procedures of Emergency Management Panels (EMP) to include fire detection, fire protection, fire extinguishing equipment, and exit and fan facilities.
- o Emergency procedures for postulated incidents with indentification of agency in command.
- o Maps and plans of complex areas of the system such as long mountain tunnels and multilevel stations at EMP, CC, and graphics at stations.
- o Any additional information and data that may be deemed necessary.

2.6.3.2 The SCRTD shall develop three levels of incident related procedure plans designed to provide an appropriate level of action based on the degree of emergency. The emergency plans shall address regional major disaster conditions which may affect other areas besides the System; systemwide major incidents which will affect systemwide operations; and emergencies, such as small fires or passenger illnesses, which will not affect the systemwide operations and may or may not affect individual train operation.

2.6.4 PARTICIPATING AGENCIES

2.6.4.1 Participating agencies that shall be summoned by the SCRTD to cooperate and assist depending upon the nature of an emergency include:

- o Fire departments
- o Emergency medical service
- o Police departments
- o Utility companies, gas, electricity, telephone, steam
- o Water supply
- o Public works, bridges, streets, sewers
- o Ambulance service
- o Building department

2.6.5 CENTRAL CONTROL (CC)

2.6.5.1 SCRTD shall operate a CC for the operation and supervision of the system.

2.6.5.2 Standards of Operation

2.6.5.2.1 The CC shall be staffed by trained and qualified personnel and utilize the essential apparatus and equipment to communicate with, supervise, and coordinate all personnel and trains operating in the System, and movement of passengers in trains, right-of-way, and stations.

2.6.5.2.2 CC personnel shall be thoroughly conversant with the Emergency Preparedness Plan and trained to employ it effectively whenever required.

2.6.5.3 Emergency Communication Procedures

2.6.5.3.1 Procedures shall be developed for CC to communicate rapidly with participating agencies, such as fire and police, utilizing direct telephone lines used for emergencies involving the system.

2.6.5.3.2 Details shall be developed defining equipment availability and procedures for recording radio and telephone communications during an emergency.

2.6.5.3.3 Procedures shall be developed defining alternate facilities and equipment to be used during an emergency in the event the CC is out of service for any reason.

2.6.5.4 Protection from Fire

2.6.5.4.1 Procedures shall be developed to maintain CC operations in the event of fire or other emergency in adjoining or adjacent structures. (See SubSection 2.8.)

2.6.5.4.2 Procedures shall be developed to minimize detection and extinguishment time for any fire in the CC by effective utilization of fire detection, protection, and extinguishing equipment. (See SubSection 2.8.)

2.6.6 LIAISON

2.6.6.1 Emergency Liaison Personnel

2.6.6.1.1 An up-to-date listing of all emergency liaison personnel from participating agencies shall be maintained by the SCRTD and shall be part of the EPP.

2.6.6.1.2 The listing shall include the full name, title, agency, business telephone number(s), and home telephone number of the liaison person and alternate.

2.6.6.1.3 The list shall be reviewed and confirmed periodically to ensure ability to contact the liaison person without delay.

2.6.7 INCIDENT COMMAND LOCATION (ICL)

2.6.7.1 During an emergency on the System, an Incident Command Location (ICL) shall be established by the person in command for the supervision and coordination of all personnel, equipment and resources at the scene of the emergency.

2.6.7.2 Appointment of Supervising Party

The EPP shall clearly delineate the SCRTD organization or participating agency that is in command and the individuals within each organization who are responsible for supervision, correction, or alleviation of the emergency.

2.6.7.3 Appointment of Liaison Person

Participating agencies should assign a liaison person to the ICL when appropriate.

2.6.7.4 Location of Incident Command

The ICL shall be at a site convenient for responding personnel, easily identifiable, suitable for supervising, coordinating and communicating with participating agencies as requested by the incident commander.

2.6.7.5 Ready Identification of Incident Command Location

Designated markers shall be employed to identify the ICL easily during day or night, and under bad weather conditions. The EPP shall define the specific identification markers to be used for the ICL.

2.6.7.6 Communication Between Agencies

The most effective use shall be made of specified radio channels and telephone to communicate with participating agencies operating at an emergency.

2.6.8 AUXILIARY INCIDENT COMMAND LOCATION

2.6.8.1 When an emergency operation is of such a magnitude to warrant an auxiliary ICL, the person in command shall establish the auxiliary ICL. The specific operation and control responsibility of the auxiliary ICL shall be defined by the command authority before or at time of auxiliary ICL establishment.

2.6.8.2 A participating agency, when not in command shall, when authorized, establish an ICL to assist with the supervision and coordination of their personnel and equipment.

2.6.9 TRAINING, EXERCISES, DRILLS, AND CRITIQUES

2.6.9.1 Personnel Training

SCRTD and participating agency personnel shall be trained to function efficiently during an emergency. They shall be conversant with all aspects of the EPP and the incident command system.

2.6.9.2 Exercises, Drills, and Critiques

Exercises and drills shall be conducted periodically to prepare SCRTD and participating agency personnel for emergencies. Critiques shall be held after the exercises and drills. Procedures shall be developed which assure thorough critiques of emergencies occurring after startup.

2.6.10 RECORDS

2.6.10.1 Written or recorded records and telephone and radio recordings shall be kept at the Central Supervising Station (CSS), and written records at the ICL and auxiliary ICL during fire emergencies, exercises and drills.

2.6.11 REMOVING AND RESTORING TRACTION POWER

2.6.11.1 The EPP shall have a clearly defined procedure for removing and restoring traction power.

2.6.11.1.2 Prior to participating agency personnel operating on the trainway, the traction power shall be removed. Verification procedures for removal shall be established.

2.6.11.1.3 When traction power is removed by activation of an emergency traction power disconnect switch, CC shall be contacted by telephone or radio to give the full name, title, agency, and reason for removal by person responsible.

2.6.11.1.4 When shutdown of traction power is no longer required by a participating agency, control of such power shall be returned to the SCRTD. Procedures for transfer of such control shall be established.

2.6.11.2 Trainway Personnel

During an emergency, the SCRTD and participating agency personnel shall be carefully supervised so that only the minimum number of essential persons operate on the trainway.

2.7 COMMUNICATIONS

2.7.1 GENERAL

Comprehensive and dependable communications are essential for a serviceable and efficiently operated fixed trainway transit system during emergencies.

2.7.2 CENTRAL CONTROL/DEDICATED COMMAND POST RELATIONSHIP

Central Control shall provide the fundamental emergency coordination for all rapid transit facilities by functioning as the CSS in conformance with NFPA 72D. The CC facility shall be equipped to:

- Receive, log, and annunciate fire alarm, trouble alarm and supervisory alarm.
- Receive, record, and log emergency telephone messages.
- Have direct multi-channel radio communication with rail vehicles.
- Have access to appropriate fire and emergency organization radio channels.
- Have direct line telephone communication with each fire jurisdiction dispatch facility.
- Have the capability to use the station public address system to advise and direct patron response to emergencies.
- Have the control capability to prepare stations for evacuation.
- Have capability for emergency removal of traction power.

2.7.2.1.1 An area for fire department operations shall be provided at the CC facility as approved by the fire department and shall provide at that area, access to the following information:

- Emergency telephone and public address system displays

- o Selected fire department radio channels
- o Fire detection and alarm system annunciator displays
- o Sprinkler valve and water flow detector displays
- o Standby power controls and status indicators
- o Ventilation and air handling status indicator and controls

The area shall contain an emergency phone, an administrative phone and a FD transceiver station.

2.7.2.2 Yard Control Tower

The yard control tower shall provide emergency coordination for all transit facilities within the vehicle yard and maintenance facility.

2.7.2.2.1 The control tower shall be arranged to function as CSS and be in conformance with appropriate standards.

2.7.2.2.2 The control tower shall be equipped as required for CC in Section 2.7.2.1, except for station related facilities and requirements of 2.7.2.1.1.

2.7.2.2.3 Two-way voice communication shall be provided between CC and the control tower for coordination of emergency operations within the transit system.

2.7.2.3 Emergency Management Panel

The EMP shall be provided for the purpose of consolidating all necessary on-site control and communication facilities needed for emergency situations.

2.7.2.3.1 Wherever EMP's are required they shall be equipped as set forth in this Section.

2.7.2.3.2 The EMP shall be equipped to function as an ICL and shall contain:

(A) Emergency telephone (see Section 2.7.4.4)

(B) Administrative telephone

(C) Fire phones

(D) Annunciation from the fire and control panel (FCP)

(E) Appropriate ventilation control

(F) Evacuation controls

(G) PA system access (stations only)

(H) Appropriate graphics

(I) Keys necessary for access to all areas of station

2.7.2.4 Command Post (CP)

The CP as prescribed in this Section shall be provided for the purpose of consolidating necessary on-site communications for effective response to trainway emergency situations and shall be located at access points to the system, as required in Section 2.3.7.4.2. Where CP's are required other than at an EMP they shall contain the following:

- o Emergency telephone. (See Section 2.7.4.2.)
- o Fire phone systems, extending individually to each adjacent station or access point. Each system shall include connection points at trainway hose outlets, BLS locations, emergency telephones (except hose cabinets), FD inlet connections, and adjacent CP positions.

2.7.2.5 Auxiliary Emergency Management Panel (AEMP)

The AEMP shall be provided for the purpose of consolidating necessary on-site communications for effective response to trainway emergency situations and shall be located at each midline vent shaft.

2.7.2.5.1 The AEMP shall be equipped to function as an ICL and shall contain:

(A) Emergency telephone (see Section 2.7.4.4)

(B) Administrative telephone

(C) Fire phones

(D) Annunciation from the fire and control panel (FCP)

(E) Appropriate ventilation control

(F) Appropriate graphics

(G) Keys necessary for access

2.7.3 EMERGENCY FUNCTIONS REQUIRING COMMUNICATION

2.7.3.1 Alarm and Notification

Alarm and notification communication facilities shall be provided to advise of an emergency condition for the following interface situations:

2.7.3.1.1 Communications between CC and the following:

- o Patrons in stations and on vehicles
- o Station agents
- o Train operators
- o Other transit personnel (operations/maintenance)
- o Emergency response agencies (fire, police, medical, etc.)

2.7.3.1.2 Communications between station agents and the following:

- o Patrons in stations
- o Transit police
- o Other Transit personnel (maintenance, operations, etc.)
- o CC

2.7.3.1.3 Communications between train operators and the following:

- o Patrons in vehicles
- o CC

2.7.3.1.4 Public emergency organizations to CC.

2.7.3.1.5 Automated fire detection and control equipment to CC (or yard control tower) and EMP.

2.7.3.2 Emergency power removal and train stopping requirements are primarily met through alarm or notification to CC. Where potential hazards require immediate action, on-site traction power removal devices shall be provided.

2.7.3.3 The dispatching communications for public emergency organizations shall be their own equipment.

2.7.3.4 Patron evacuation capability shall be provided in passenger stations including operation of appropriate station facilities and providing patron instructions.

2.7.3.5 Tactical communication is required for each responding organization to provide operations control at the site of an emergency.

2.7.3.5.1 A communication subsystem shall be provided for responding transit personnel that can be dedicated exclusively to this purpose during times of emergency.

2.7.3.5.2 Any transit system facility in which fire department radio communications are not expected to function shall be provided with repeater equipment for transmission and reception for necessary FD radio channels.

2.7.4 TELEPHONES

2.7.4.1 General

The System shall have a telephone network (transit central office exchange) or fixed telephone lines and instruments capable of communication with all stations, structures, offices, power stations and substations, control towers, ancillary rooms and spaces, and locations along the trainway (not normally used by patrons).

2.7.4.2 Emergency Telephone Subsystems

2.7.4.2.1 An emergency telephone subsystem shall be provided for the transit system. The emergency telephone may be used by the public, employees, and emergency personnel.

2.7.4.2.2 The emergency telephone subsystem shall be used for the manual fire alarm function for transit facilities, for medical requests and for other emergencies. As such they shall conform to NFPA 72A and 72D in supervision and alarm feature as described in Section 2.7.4.2.6.

2.7.4.2.3 The emergency telephone subsystem shall also serve employees and emergency personnel with emergency communications from areas removed from public access, along trainways and at wayside equipment locations.

2.7.4.2.4 The emergency telephones shall annunciate at an attended console at CC.

2.7.4.2.5 The emergency telephone subsystem shall annunciate at CC and indicate the origin of the call. The yard control tower emergency telephone subsystem shall identify the origin of the call.

2.7.4.2.6 Operation of any emergency telephone shall require only lifting the hand set. This action shall cause an emergency indication to be displayed and an audible alarm to sound at the associated control console at CC.

2.7.4.2.7 Recordings shall be made of all communications on the emergency telephone subsystem. The subsystem shall have instant replay capability for verification of emergency messages. A separate means shall be provided for origin identification.

2.7.4.2.8 Attendants at CC shall have the capability to initiate calls to any emergency telephone.

2.7.4.3 Fire Department Tactical Phones (Fire Phone)

The fire department phone subsystem shall be utilized to meet requirements for establishment of point to point communication for tactical emergency operations within a local area of the system. Access to this system shall be provided at each of the BLS locations, plug-ins at each FD inlet connection, each hose outlet connection (except hose cabinets in stations), station valve rooms, the EMP's and all CP's.

2.7.4.4 Fire Department Emergency Phones

A separate system of FD Emergency Phones shall be provided to allow dedicated communication from each EMP

and CP to the FD area at CC. The system will incorporate automatic ring-down to CC and selected ring down from CC to each EMP or CP.

2.7.5 BLUE LIGHT STATIONS (BLS)

A location within the trainway, indicated by a blue light, where emergency service or authorized personnel may communicate with the Central Control and disconnect traction power by use of an Emergency Trip Station (ETS).

2.7.5.1 A device shall be provided for tripping contact rail feeder breakers for a specific power zone, which incorporates local mechanical lockout capability.

Activation of the ETS at any BLS shall trip the contact rail feeder breakers for all tracks in the power zone covered by the BLS. CC shall have the ability to selectively restore power on any tracks of the power zone in which the BLS has been activated. Activation of the mechanical lockout capability at the BLS shall preclude restoration of power controlled by the BLS until the mechanical lockout is released.

2.7.5.2 Blue Light Stations shall be provided at the following locations:

A. Ends of station platforms

B. Crosspassages

C. Emergency access points

D. Traction power substations.

2.7.5.3 An emergency telephone shall provide communication to CC. This phone is intended for fire or other emergency uses.

2.7.5.4 Adjacent to each BLS, information shall be provided which identifies the location of that station and the distance to an exit in each direction.

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2.7.6 TRANSIT RADIO SUBSYSTEMS

The radio subsystem consists of central transmitters and receivers (for each channel) operating on different frequencies with all remote transmissions received at the central receiver (or through satellite receivers if provided) and remote units receiving repeated transmissions from the central transmitters. Central transmitters and receivers shall be operable independently of CC (with exception of the cable transmission linked satellite receivers).

2.7.6.1 At least one separate 2-way voice communications channel shall be provided within the radio subsystems of the Transit System for use in emergency conditions.

2.7.6.2 2-way radio voice communications for nontransit system emergency personnel shall be by their own equipment. Repeater facilities for public emergency forces shall be provided throughout underground trainway and stations.

2.7.6.3 At least one radio communications link from CC facility shall be maintained with the most appropriate public emergency frequency.

2.7.6.4 Two channels of radio communications shall be provided for transit police use.

2.7.6.5 Each fire department will be provided with 2 suitable channels.

2.7.7 PUBLIC ADDRESS SYSTEM

2.7.7.1 All trains and stations shall have a public address system for communicating with patrons and employees.

2.7.7.2 Central Control shall have the capability of using the public address system to make announcements on trains and throughout stations.

2.7.7.3 The capability of making announcements throughout the stations on the public address system shall be provided from the EMP and at least one location on the platform.

2.7.7.4 Train operators shall have the capability of making announcements throughout their trains on the public address system. During interruptions of train service

or delays for any reason, the patrons and employees shall be kept informed by means of the public address system.

2.7.7.5 At times of emergency, the public address system shall be used effectively to communicate to patrons, employees, and emergency personnel.

2.7.7.6 The station public address system shall conform essentially to NFPA 72A and 72D. Supervision of the public address system shall be provided through the fire and security subsystem.

2.7.8 PORTABLE POWERED SPEAKERS (AUDIOHAILERS)

2.7.8.1 During emergency operations, portable powered speakers shall be made available.

2.7.8.2 Speakers of this type can be used effectively when it is necessary to transmit a message under circumstances where the natural voice needs amplification.

2.7.9 FIRE/SECURITY SUBSYSTEMS

2.7.9.1 The fire and security subsystems shall consist of the following:

2.7.9.1.1 Automatic fire detection, alarm and supervision.

2.7.9.1.2 Fixed extinguishment equipment actuation, alarm and supervision.

2.7.9.1.3 EMP(s).

2.7.9.1.4 Public address system supervision.

2.7.9.1.5 Intrusion detection, security alarm, and supervision as required.

2.7.9.2 The fire and security subsystems shall be controlled and supervised through a fire control panel, provided in each passenger station or remote facility.

2.7.9.3 Water flow alarm and valve supervision shall be provided for automatic sprinkler and combined automatic sprinkler/standpipe systems.

2.7.9.4 The fire alarm system shall provide means to supervise and trip special extinguishing systems and to control ventilation systems in accordance with applicable standards.

2.7.9.5 The fire/security subsystems shall be electrically supervised and contain battery standby power. The system shall be multi-zoned and capable of using interchangeable combination rate of rise/fixed temperature, smoke, and fixed temperature detectors.

2.7.9.6 The fire alarms, trouble alarms, and supervisory alarms shall be transmitted to CC via the DTS or separate multiplex system (see Section 2.7.11.1).

2.7.10 EVACUATION CONTROL

Remote actuation capability shall be provided for preparation of stations for evacuation, including operation of appropriate station facilities and possibly initiation of pretaped announcements.

2.7.11 SUBSYSTEM FOR INTERFACILITY TRANSMISSION

2.7.11.1 Cable Transmission Subsystem

Transmission of emergency communications between CC and passenger stations, or the vehicle yard and maintenance facility, may be by the Cable Transmission Subsystem (CTS).

2.7.11.1.1 Emergency communication subsystems that can be transmitted via CTS voice channels include radio signals from satellite receivers repeaters, emergency telephones, public address and direct line telephones. The data transmission subsystem (DTS) may be provided consisting of terminals converting data, serial transmissions via the CTS and reconversion to parallel output data.

2.7.11.1.2 When, in addition to train control, traction power status and communication alarms, the DTS is used for transmission of fire and intrusion status and alarm, the DTS provided for fire alarm shall conform to the requirements of NFPA 72D.

2.7.11.1.3 The DTS common to other elements of the transit system may be utilized for fire alarm functions if all requirements of data transmission for the fire alarms are satisfied by this subsystem and no impairment of the fire alarm functions is permitted into the normal use of the common DTS.

2.7.11.1.4 The cable transmission subsystem shall be arranged so that a single loss-producing incident (internal or external to the subsystem) will not result in loss of transmission capability from CC facility to locations preceding the location of the incident.

2.8 RAIL CONTROL CENTER (RCC)

2.8.1 GENERAL

2.8.1.1 The RCC is a controlled space for offices, equipment, and supporting facilities to be used by those persons responsible for train control, communications, and fire and security management. CC is the portion of the facility used for data processing, status reporting, and transit system control, and excludes ancillary spaces and supporting facilities.

2.8.1.2 RCC occupants are employees or contractors whose work assignments require their presence in the RCC.

2.8.1.3 Occupancy classification for the RCC shall be in accordance with the UBC.

2.8.2 BASIC CONSTRUCTION

2.8.2.1 Rail Control Center

The RCC shall comply with Type I fire-resistive construction requirements of the UBC for Group B, Division 2 occupancy.

2.8.2.2 Rail Control Center Building

The building housing the RCC shall conform to the UBC, Type I fire-resistive construction and shall be protected throughout by automatic sprinklers. The RCC shall not be located above hazardous use areas.

2.8.2.3 Fire Separations

Fire separations shall be provided and maintained to separate occupancies as required by the UBC, and are as follows:

2.8.2.3.1 The RCC, including ancillary rooms, shall be separated from uncontrolled public access areas and any other occupancy or building by minimum 3-hour fire-rated construction having protected openings.

2.8.2.3.2 CC data processing and control areas shall be separated from all ancillary rooms by minimum 2-hour fire-rated separations.

2.8.2.3.3 Separation and protection of ancillary areas within the RCC shall be as established for station ancillary areas in Section 2.2.2.5.

2.8.2.3.4 The routing of all cabling to transit system operating areas and other services essential to the operation of the RCC shall be separated from other occupancies and buildings by minimum 2-hour fire-rated separations.

2.8.2.3.5 Openings in 2-hour fire-rated separations shall be protected by labeled 1½-hour fire-rated (Class B) assemblies.

2.8.2.3.6 Openings in 3-hour fire-rated separations shall be protected by labeled 3-hour fire-rated (Class A) assemblies.

2.8.2.3.7 Fire-rated assemblies protecting openings in fire-rated separations shall be automatic or self-closing. Automatic closing assemblies protecting openings into RCC areas shall be activated by smoke detectors at the opening, and by means of a fixed temperature device. Alternatively, automatic closing assemblies may be released by the fixed temperature device alone where a separate smoke barrier is provided. Installation shall be in accordance with UBC, Chapter 43.

2.8.2.3.8 Egress routes commonly serving the RCC and other occupancies shall be separated from the other occupancies by 2-hour fire-rated separations.

2.8.2.3.9 All other protection of vertical openings shall be in accordance with the UBC for Group B, Division 2 occupancies of Type I construction.

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2.8.2.4 Materials

All structural assemblies and building appurtenances in RCC areas shall be of noncombustible materials.

2.8.2.5 Interior Finishes

Interior finishes consisting of all surfaces exposed to RCC areas of the building, including fixed or movable walls and partitions, columns and ceilings, shall meet UBC Chapter 42 Requirements for Class I and Class II interior finishes.

2.8.2.5.1 Interior finishes shall be Class I for all means of egress and the CC area.

2.8.2.5.2 Interior finishes in all other areas shall be Class I or Class II.

2.8.3 MEANS OF EGRESS AND EMERGENCY ACCESS

2.8.3.1 The RCC shall comply with the requirements of the UBC for means of egress in Group B, Division 2 occupancies.

2.8.3.2 The RCC shall be located in a building that is adjacent to existing public streets and other access routes.

2.8.4 BUILDING SERVICES AND UTILITIES

2.8.4.1 Light and Power

2.8.4.1.1 Electrical equipment and wiring materials and installations shall conform to the requirements of NEC, and satisfy the criteria requirements for station facilities, Section 2.2.4 and the applicable local code.

2.8.4.1.2 Emergency lighting shall be provided for all means of egress from and throughout the entire CC area.

2.8.4.1.3 A separate on-site emergency power system shall be provided for the RCC facility such that loss of normal electrical power will not impair any critical CC functions, and shall meet NFPA 71, Section 2 - 2.1.6.(d).

2.8.4.2 Fire Protection Water Supplies

2.8.4.2.1 Site fire flows (water supplies) and hydrants shall be required to conform to LA Master Plan and local codes.

2.8.4.2.2 Standpipe and automatic sprinkler water supplies shall meet the requirements of NFPA Standards 13 and 14 and the local code.

2.8.4.2.3 For RCC within buildings having nontransit occupancies, the RCC standpipe and automatic sprinkler systems shall be supplied from an independent connection to the municipal system.

2.8.4.3 Heating, Ventilating, and Air Conditioning Systems (HVAC)

2.8.4.3.1 RCC HVAC systems shall be physically and operationally separated from HVAC systems serving any other area.

2.8.4.3.2 At least 2 fans and/or air conditioning units shall be provided, sized, and arranged so that either one can serve the RCC.

2.8.4.3.3 Emergency smoke removal capability shall be provided for the RCC. Systems shall be arranged for exhausting with 100% outside air make up. Two full-capacity outside air intakes shall be provided, arranged so as to not be subject to the same source of contamination. A minimum of 6 air changes per hour shall be provided.

2.8.4.4 Personnel Facilities

The RCC shall contain all personnel facilities necessary so that on-duty operating personnel are continuously available.

2.8.5 FIRE PROTECTION, ALARM, AND COMMUNICATIONS

2.8.5.1 Fire Alarm System

2.8.5.1.1 A fire alarm system complying with the requirements of the UBC and NFPA 72A shall be provided for protection throughout the RCC.

2.8.5.1.2 Manual fire and emergency reporting capabilities shall be provided by an emergency fire-reporting phone system that alarms at CC, with annunciation as a separate zone.

2.8.5.1.3 The fire alarm shall sound an evacuation signal which can be heard throughout the RCC. To facilitate selective evacuation from larger facilities, so that transit system control functions can be maintained to the greatest possible extent, a public address system shall be provided and supervised by the fire alarm system in accordance with NFPA 72A and UBC.

2.8.5.1.4 Water-flow alarm and control valve supervision shall be provided for automatic sprinkler systems.

2.8.5.1.5 The fire alarm system shall provide means to supervise and actuate special extinguishing systems and, where required, to control the ventilation system.

2.8.5.1.6 The fire alarm system shall be electrically supervised and equipped with battery standby power. The CC fire alarm system shall be multizoned and capable of using smoke detectors, combination rate-of-rise/fixed temperature detectors.

2.8.5.1.7 The fire alarms, trouble alarms, and supervisory alarms shall be annunciated in CC in accordance with NFPA 72A.

2.8.5.1.8 The RCC fire alarm system shall be separated from any fire alarm system in other occupancy or building, except that remote alarm annunciation from this system may be provided at locations outside CC approved by the local fire authority.

2.8.5.1.9 If located within a building having other occupancy, the RCC shall be provided with at least one summary alarm for fire or evacuation notification initiated from any part of the building.

2.8.5.1.10 As the central supervising station, CC shall:

(A) Receive and annunicate fire alarm, trouble alarm, and supervisory alarm for all portions of the transit system, except that the maintenance facility may have an independent system.

(B) Have direct dedicated telephone communications with each fire jurisdiction dispatch facility serving any portion of the transit system.

(C) Perform those additional functions as required in other Sections of these criteria.

(D) Contain dedicated area for fire incident commander.

2.8.5.2 Automatic Fire Detection

2.8.5.2.1 Products of combustion detectors, other than heat detectors, shall be installed in all areas of the RCC.

2.8.5.2.2 Products of combustion detectors, other than heat detectors, shall be installed throughout the CC area to activate Halon extinguishing systems.

(A) Detectors shall be installed in all rooms and underfloor spaces protected by a Halon extinguishing system.

(B) The detectors shall be cross-zoned so that activation of 2 zones in any single protected area is necessary for operation of the Halon system.

(C) The activation of a single detector or manual operation of the Halon system shall provide a predischarge alarm signal and appropriate activation of auxiliary devices including release of hold-open devices on doors to ancillary rooms and control of ventilation systems.

2.8.5.3 Fire Extinguishers

2.8.5.3.1 Portable fire extinguishers of the type and size specified shall be installed throughout the RCC.

Multipurpose dry chemical - 10 pound capacity, UL approved and rated 4A-30B:C
Carbon Dioxide (CO_2) - 10 pound capacity, UL approved and rated 10B:C

2.8.5.3.2 Halon 1211 portable fire extinguishers, 10 pound capacity, UL approved and rated 2A-20B:C shall be installed in the CC areas protected by Halon extinguishing systems.

2.8.5.4 Standpipe Systems

Standpipes as required by the UBC and local codes shall be installed in the RCC.

2.8.5.5 Automatic Sprinklers

Automatic sprinkler protection shall be provided throughout the RCC.

2.8.5.6 Halon Systems

2.8.5.6.1 Halon 1301 system protection shall be provided for underfloor areas of equipment rooms and operations rooms in CC. A separate Halon system shall be provided for each room or area. Depending upon configuration, consoles shall be protected with either the associated room or underfloor space.

2.8.5.6.2 Halon system protection shall also be provided for other areas in CC containing critical communications, telephone, and train control equipment and systems, such as tape storage rooms, inverter rooms, etc.

2.8.5.6.3 Halon systems shall be installed in accordance with the requirements of NFPA 12A and LAFD Requirement #33.

2.8.5.6.4 The ceiling of any room protected by a Halon system shall be sealed. Retainers shall be provided in the ceiling assembly to prevent leakage of Halon from the room into the concealed space above the ceiling during operation of Halon system.

2.8.5.6.5 All doors required to remain open to provide for traffic flow in any area protected by a Halon system shall be provided with magnetic hold-open devices arranged to release the doors upon activation of the predischarge alarm Section of the fire detection system.

2.9 INSPECTION, MAINTENANCE, AND TRAINING

VOLUME I, SECTION 2 FIRE/LIFE SAFETY (Cont'd.)

2.9.1 OPERATIONAL PROCEDURES

2.9.1.1 Objectives

The SCRTD shall establish the necessary operational procedures, including the inspection and maintenance program necessary to ensure that all fire/life safety related equipment is in proper condition and all associated personnel are appropriately familiar with fire/life safety related equipment and emergency preparedness plan procedures.

2.9.1.2 Organization

The SCRTD and FD's shall be primarily responsible for accomplishing the above objectives.

2.9.1.3 Functions

The SCRTD and FD's shall develop a program of testing and inspection of fire/life safety related equipment and an operational program to ensure that necessary maintenance and/or repair is performed on all fire/life safety related equipment.

2.9.1.4 Testing and Inspection Program

2.9.1.4.1 The testing and/or inspection program shall be in accordance with applicable Sections of the following documents and requirements of local fire authority:

(A) NFPA 10, Portable Fire Extinguishers

(B) NFPA 12A, Halogenated Fire Extinguishing Agent Systems - Halon 1301

(C) NFPA 13, Sprinkler Systems, Installation of

(D) NFPA 14, Standpipe and Hose Systems

(E) NFPA 70, National Electrical Code (Article 760)

(F) NFPA 72A, Local Protective Signaling Systems

(G) NFPA 72D, Proprietary Signaling Systems

(H) NFPA 72E, Automatic Fire Detectors

(I) LA County Fire Code and LA City Fire Code

(J) CAC Title 19

2.9.1.4.2 The SCRTD and local fire authority shall develop a fire/life safety equipment testing and/or inspection program, and it shall include agreements and procedures to conduct the testing and inspection at regular intervals as prescribed by the appropriate codes. The program shall include testing and inspection requirements and recordkeeping procedures to substantiate and document the program.

2.9.1.5 Maintenance Program

The fire/life safety equipment maintenance programs shall be subject to maintenance and testing as contained in the local fire codes. It shall include, but not be limited to:

- o Manual or portable fire suppression equipment
- o Fire alarms and detection systems
- o Automatic fire suppression systems
- o Auxiliary fire service equipment
- o Emergency communications systems

2.9.2 TRAINING

2.9.2.1 Training Programs

The SCRTD in cooperation with the local fire authority shall establish the training programs and coordinate the fire/life safety services interfaces to educate and/or familiarize employees and emergency personnel with the transit systems's fire/life safety equipment, operations, and emergency procedures.

2.9.2.2 Public Emergency Personnel Training Program

The SCRTD and local fire authority shall assist in developing and implementing a comprehensive joint

training and indoctrination program for emergency personnel which will include but not be limited to the following:

- o Ventilation systems, functions and controls
- o Emergency access facilities
- o Communications procedures and facilities
- o Facilities indoctrination
- o Transit vehicle indoctrination
- o Electrification system
- o System fire control and alarm systems
- o Yard and shop indoctrination
- o Arrangements for fire equipment tests
- o Emergency medical aid procedures and policies
- o Identification of personnel authorized to make decisions in emergencies
- o Emergency procedures plans

2.9.2.3 Employee Training Program

2.9.2.3.1 The SCRTD, in conjunction with the local fire authority, shall develop and implement a fire/life safety employee training program which will include but not be limited to the following:

(A) Emergency procedures plans

(B) System fire control operations

(C) Yards and shops fire brigade training

(D) Test and inspection procedures

(E) Communications procedures and facilities

(F) Facilities indoctrination

(G) Electrification system

(H) Identification of personnel authorized to make decisions in emergencies

2.9.2.3.2 The SCRTD and local fire authority shall also develop and implement a CC operator's training program on all CC functions to be performed during emergencies anywhere within the transit system.

SYSTEM DESIGN CRITERIA AND STANDARDS

VOLUME: I SECTION: 3

REVISION RECORD

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SYSTEM DESIGN CRITERIA AND STANDARDS

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SCRTD METRO RAIL SYSTEM DESIGN CRITERIA

Volume 1, Section 3

SYSTEM SAFETY

VOLUME I, SECTION 3, SYSTEM SAFETY

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VOLUME I, SECTION 3

SYSTEM SAFETY

3.1 INTRODUCTION

This section of the design criteria provides design guidance in System Safety for all aspects and phases of the Metro Rail System.

3.1.1 SCRTD Safety Policy

It is the policy of SCRTD management 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 equals or exceeds that of other rail transit systems.

During the Preliminary Engineering and Final Design phases, safety can be achieved by eliminating, minimizing, or controlling hazards through analysis, review, and design selection. This includes provisions for emergencies such as an emergency communications network, on-site emergency equipment, and access by emergency forces.

3.1.2 Purpose

This document presents the safety criteria. The purpose of the safety criteria is to provide sufficient definition and description of all facets of the safety approach and concept so design engineers and architects have guidance for the proper selection of equipment and design of facilities. Through these criteria, safety considerations shall be integrated into all aspects of design specification preparation, equipment selection, construction, architectural concepts, procedures, and operations.

3.1.3 Program Objective

The objectives of the safety program are the elimination or control of Category I and II hazards as defined in MIL-STD 882A and the assurance that no single point

failure in a dynamic system nor common cause failures result in an unsafe condition.

To achieve these objectives and provide a level of safety that equals or exceeds that of other rail transit systems requires a comprehensive and complete system safety program.

3.1.4 Scope

This document outlines the safety criteria in the following areas:

A. Station and Site

B. Communications

C. Passenger Vehicle

D. Train Control

E. Power

F. Rail Control Center

G. Ways and Structures

H. Operations, Maintenance, and Training.

Materials that meet stringent fire, smoke, and toxicity requirements are essential to the safety and well-being of the public and SCRTD personnel.

3.1.5 Definitions

The definitions in the APTA Lexicon apply unless modified herein.

3.2 SAFETY METHODOLOGY

3.2.1 Hazards

Identified hazards shall be eliminated or controlled using the following hierarchy of hazard resolution:

A. Design for Minimum Hazard

Provisions shall be made in all initial designs for the elimination of hazards. If the identified hazards cannot be eliminated, then the hazards shall be controlled through alternative designs.

B. Safety Devices

Hazards that cannot be eliminated or controlled through design shall be controlled to an acceptable level through the use of fixed, automatic, or other protective safety design features or devices. Provision shall be made for periodic functional checks of safety devices.

C. Warning Devices

When neither design nor safety devices can effectively eliminate or control an identified hazard, devices shall be used to detect the hazard and to generate an adequate warning signal to provide for operating personnel/public reaction. Warning signals and their application shall be designed to minimize the probability of incorrect operating personnel/public reaction to the signals.

D. Procedures and Training

Where it is impossible to eliminate or adequately control a hazard through design or use of safety and warning devices, procedures and training shall be used to control the hazard. Precautionary notation shall be standardized, and certain safety-critical tasks shall require certification of personnel.

3.2.2 Criteria Application

The following criteria are categorized by major systems with subsystems referenced as lower-tier components. Areas that present a high degree of hazard probability are highlighted in each category. This is not an all-inclusive listing, and it is intended that the design engineers use their own system familiarization to detect and/or avoid "building in" any unsafe condition.

Special attention to unsafe conditions shall be given in areas where systems or subsystems interface or where there are overlapping areas of responsibility.

3.3 STATION AND SITE

3.3.1 Station and Site Layout

A station and site layout shall be provided as follows:

A. Site access points shall be located to preclude traffic congestion, and traffic patterns for vehicles and pedestrians shall be clearly marked.

B. Vehicle patterns that cross or result in counter-flow shall be minimized.

C. Patron drop-off zones and taxi stands shall be located to minimize patron exposure to traffic. Patrons shall be able to move directly to the station entrance without crossing traffic lanes.

D. If public parking is provided, spaces shall be set aside for the handicapped at the closest point to the station entrance to minimize their exposure to traffic and to reduce their travel distance.

E. Bus loading and unloading zones shall be located so that patrons do not have to cross traffic lanes.

F. Crosswalks shall be clearly defined and well-marked. Crosswalks and sidewalks shall be provided with slip-resistant surfaces.

3.3.2 Station Architectural Features

A. Signing

Distinct, legible, and correctly located signing shall be provided as follows:

1. Clear and well-illuminated signing and graphics shall be provided in stations. The signing and graphics shall be located in a manner which enhances the safety and convenience of patrons.

Hazard areas are those such as at top of stairs and at top and bottom of escalators.

2. Right-hand traffic shall be encouraged through signing.

B. Architectural Psychology

As a minimum, any design features or vistas which may distract patrons at the head or foot of stairs and escalators shall be avoided.

C. Platform

1. Safety Strip: A platform safety strip shall be provided as follows:

   a. The width of the safety strip shall be 18 inches, which includes the tactile strip and edge material.

   b. The platform edge material shall be slip-resistant and different in color and texture to distinguish it from the main platform area.

   c. A narrow tactile strip two inches or less in width shall contrast with the platform edge and the main platform area. It shall be designed to improve the probability of the safety strip being sensed by the blind.

2. Underplatform Refuge Area: A space shall be provided beneath the platform edge where one can crouch and avoid being struck by a train. The contact rail shall be located on the opposite side of the tracks from the underplatform refuge area.

3. Vehicle/Platform Interface: The horizontal and vertical misalignment between the vehicle doors and the platform edge shall be minimized to reduce the tripping hazard and the possibility for an object or limb to be caught between the vehicle and platform. Alignment shall also reduce the potential for catching and trapping the wheels of a wheelchair.

a. The platform design shall be coordinated with the track layout and the vehicle static and dynamic outlines to provide an acceptable interface between the platform and vehicle. This interface shall minimize horizontal and vertical gaps at the vehicle door threshold. The dimensions shall be a nominal three inches for horizontal gap between platform and vehicle static outline; and a nominal 0.75 inches for the vertical gap downward from the vehicle doorsill.

4. Bumping Hazards: Pedestrians shall not be exposed to bumping hazards on the platforms or public ways.

a. Sufficient clear space shall be provided around overhead and side projections and corners to reduce the potential for bumping and walking into protuberances.

b. Items requiring wall mounting shall be located out of the way of mainstream pedestrian flow and shall be recessed if practicable.

D. Station Walking Surfaces

To reduce the potential of slipping, tripping, and falling, all walking surfaces including the public areas and the ancillary spaces shall be constructed of materials selected for their slip-resistant qualities in both wet and dry states.

E. Walkway Screening

When passarelles or pedestrian walkways are provided over the trackway, the walkways shall be screened.

F. Top of Parapet

The architectural treatment of stairs, escalators, and visual openings may include the use of parapets. The top of the parapet shall be sloped away from the vertical circulation elements and visual openings to prevent objects being placed upon them.

G. Railings/Guardrails

Railings and guardrails shall meet the applicable codes regarding height and loadings. The design shall not permit dropped objects to roll underneath and fall to the lower level(s). Additionally, the following shall be provided:

1. Railings and guardrails shall comply with the requirements of NFPA-101 and the applicable local codes.

2. Glazed railings shall not be installed.

3.3.3 Elevators/Escalators

The following elevator/escalator design considerations shall be provided:

A. Elevators

Federal and state legislation requires elevators in stations to accommodate the elderly and the handicapped. The elevators shall also be sized to meet the requirements of emergency teams.

1. Elevators shall meet the safety requirements in the elevator/escalator code, ANSI A17.1, the handicapped requirements in ANSI A117.1, and Title 24 of the California Administrative Code.

2. Two-way communication from within the elevator cab shall be provided between the patron and the Rail Control Center (RCC).

3. Elevators shall be sized to accommodate a horizontally positioned stretcher of the type carried in emergency vehicles.

4. Remote elevator indicators and controls shall be provided at RCC for emergency operation.

B. Escalators

The following shall be provided to minimize patron confusion and improve circulation.

1. Escalators shall meet the safety requirements in the elevator/escalator code, ANSI A17.1.

2. Signing and graphics shall be provided to enable patrons to determine the direction of escalator motion prior to their arrival at, and well clear of, the landing plate.

3. Status indicators shall be provided.

4. Adequate queuing space shall be provided at both the top and bottom of escalators.

5. Provisions shall be made for safe closure during maintenance and for a minimum of pedestrian flow impairment.

6. An emergency stop capability shall be provided at the top and bottom of escalators and shall meet the requirements of Cal/OSHA.

7. The clearance between the combplate and the steps and the balustrade and the steps shall be such that no shoes, clothing, or other similar articles may be trapped between these elements.

8. Sufficient clearance shall be provided between the structure and escalator moving handrails to prevent hands or clothing from being trapped.

9. Safety devices shall include brakes that assure that the escalator will not move when power is removed and patrons are using the stopped escalator as a stairway.

3.3.4 Stairs

Stair tread-riser relationship shall be one that easily accommodates travel in both directions, is usable under all types of weather, and minimizes the hazard of tripping or falling. Additionally, the following shall be provided:

A. There shall be a minimum of one stair that meets Fire/Life Safety requirements connecting all levels in the public area.

B. The tread-riser relationship shall meet the requirements of NFPA-101.

C. The stairs shall be of a slip-resistant material with an eased nosing that is distinct and meets the requirements of ANSI A117.1 and Title 24 of the California Administrative Code.

D. When gutters/runnels are provided, they shall be protected by the handrails.

E. Handrails shall be continuous and meet the requirements of ANSI A117.1, and Title 24 of the California Administrative Code.

3.3.5 Fare Collection

Controls shall be provided that prevent an excessive number of people from entering the station and descending to the platform, and facilitate emergency egress from stations. The following shall be provided:

A. Remote operation from the RCC shall be provided to permit control of the volume of inbound patrons passing through the fare collection array.

B. In the event of a power loss the fare collection array shall permit free exiting.

C. Remote controls shall be provided to permit free exiting.

D. Provisions shall be incorporated to permit access by the handicapped using wheelchairs.

E. Sufficient exit gates shall be provided to allow rapid and complete discharge of the station occupant load.

3.3.6 Vehicle Approach System

A visual and audible method shall be provided to alert patrons of the impending arrival of a train.

3.3.7 Other Design Features for Station and Site

A. Patron flow patterns shall maintain a right-hand circulation where possible and shall be as simple as practicable.

B. Maps shall be provided showing locations of shutoff controls for water, gas, electricity, and fuel lines. These maps shall be located in the Emergency Management Panel (EMP).

C. Guard and restraining rails, and similar items, shall be installed in specific areas where trains pose a clear danger to patrons, personnel, or equipment.

D. Adequate lighting of stairs and escalators must be provided to promote patron safety.

3.4 COMMUNICATIONS

3.4.1 Closed Circuit Television

Each station shall be designed to function with or without an attendant present. Therefore, electronic surveillance shall be required so that RCC can monitor selected station areas. Closed Circuit Television (CCTV) shall permit RCC to monitor the station and platform to prevent overcrowding. As a minimum, platform edges shall to be covered by CCTV.

3.4.2 Public Address System

A Public Address (PA) system shall be provided as follows:

A. The PA system shall provide RCC full station coverage at a level sufficient to be heard over normal train, equipment, and public noise.

B. The PA system installation shall be designed so that the loss of an amplifier or a single audio loop will not leave any public area without a public address capability. The PA system shall be on an uninterruptable power source.

C. The RCC shall have the capability to communicate with all the stations either singly or as a group.

3.4.3 Telephone Service

A. Emergency Telephone (ETEL) service shall be provided at each passenger station. Emergency phones shall be located at the Emergency Management Panel and Command Post locations, at the Emergency Trip Station (ETS), in the elevator, and at fire hose cabinets. The emergency telephone for ETS locations shall be used for communication with Rail Control Center or Yard Tower.

B. Patron assistance shall be provided by a hands-free intercom service between the patron at the station and RCC. Intercom service shall be located adjacent to fare-vending equipment and at other locations as determined by SCRTD. Intercom operating controls, positions, and locations shall be readily accessible and operable by elderly and handicapped patrons. Dimensions shall be as required in Title 24, Part 2 of the C.A.C.

C. Public pay phones may be provided in both free and paid areas of each station. Public phones shall be located so that they will not interfere with pedestrian flow.

3.4.4 Radio Communications

Radio communications shall be provided as follows:

A. Communication capabilities shall be provided, as a minimum, for:

1. Emergency train operations
2. Police emergency
3. Fire emergency.

B. Emergency radio communications shall be on separate channel(s) and shall be provided to accommodate local fire and Transit Police jurisdictions.

C. An antenna system or other suitable arrangement shall be provided to permit the use of handy-talkies of local fire departments and other emergency service providers.

D. Multiple channel capability shall be provided for emergency transmission in case of transmitter failure.

3.5 PASSENGER VEHICLE

3.5.1 Doors

A. Door Interlocks

A very serious safety condition would exist if doors should open on a moving train or if a train should start moving while the doors are still open. Side door interlocks and detection circuits shall be safety-critical and provided as follows:

1. Summary logic shall prevent side doors from opening until the train is properly berthed and stopped at the platform with friction braking applied and prevent the train from starting until all side doors are closed and locked.

2. The train operator door controls shall be on the same side as the doors being operated.

3. Door edges shall be designed with appropriate stiffness to prevent fingers from being inserted between fully closed leaves, yet permit the withdrawal of trapped clothing or articles.

4. A circuit shall be provided to remove door closing force when an obstruction is met.

5. The design shall prevent doors on the side opposite the platform from being opened unintentionally.

6. A positive door control device shall be provided to prevent side doors from unintentionally sliding open.

B. Door Warning Signal

Patrons shall be alerted when doors are ready to close. An audible warning shall sound inside the vehicle before the doors begin to close. A combination of audible and visual warnings to alert hearing-impaired patrons shall be utilized if practical.

C. Manual Release

Manual release of doors shall be provided as follows:

1. Interior manual door controls shall be provided for use by the patrons.

2. Exterior manual door controls shall be provided on the center set of doors on the vehicle for use by emergency teams with the correct tools/equipment.

3. Interior emergency releases shall be provided for all side doors and be adequately labeled.

4. Exterior side door status lights shall be provided to indicate door is open or unlocked.

5. Intercar doors capable of being locked shall have the capability of being unlocked and opened from the outside.

D. Door Width

Side door openings shall be wide enough to permit use by patrons in wheelchairs.

E. End Doors

End doors shall be provided for safe emergency passage between vehicles. End door design shall provide the following:

1. Signs shall be placed on end doors to discourage patrons from moving between vehicles except in an emergency.

2. End doors shall be wide enough to permit emergency egress of a handicapped person with assistance from others, (i.e., passengers, emergency rescue teams, operating personnel, etc.).

3. End doors on the control cab end of the vehicle shall have suitable and safe exterior step and handholds for egress to ground level.

3.5.2 Inter-Car Closure

Restraining devices shall be provided between adjoining cars of the train to help prevent patrons passing between cars from falling. The space between cars shall be kept to a minimum.

3.5.3 Lighting

The illumination inside a car shall be maintained at a level which permits normal visibility.

A. Interior lighting levels shall be consistent with APTA's "Transit Security Guidelines Manual" of 30 or more footcandles on the reading plane.

B. Emergency lighting shall be provided and powered by a backup system. The minimum level and duration of the lighting shall be one footcandle for one hour.

3.5.4 Communications

On-board communications shall be provided as follows:

A. Each vehicle shall be provided with a patron intercom (IC) system to permit communication between a patron and the train operator. The IC shall be suitably protected from vandalism.

B. Communications capability between RCC and the train operator and from RCC to on-board patrons shall be provided.

C. All vehicles shall be numbered uniquely to provide for positive identification.

D. Operating instructions and vehicle number shall be applied to the sidewall immediately below each remote IC station on each vehicle.

E. Emergency communication capabilities for the vehicle shall be provided with a backup power system.

F. The vehicle intercom operating controls, positions and locations shall be readily accessible to, and operable by, elderly and handicapped patrons.

3.5.5 Windows

The following provisions shall be made to mitigate hazards caused by objects striking and shattering or penetrating windshields, side windows, end windows, and cab windows:

A. The windshields and F-end (the end of a passenger vehicle containing the operator cab) door windows shall be certified to comply with the requirements of ANSI Z26.1, Table 1, Item 1, and pass the following test requirements:

1. ANSI Z26.1 Test 8, Impact, using shot bag dropped from a height of 15 feet.

2. ANSI Z26.1, Test 26, Penetration Resistance, modified to include entire windshield assembly, simulating the impact of a one-pound ball at 80 mi/hr and the impact of a five-pound ball at 50 mi/hr.

B. Side windows, cab side windows, side door windows, and R-end (the end of a passenger vehicle that does not contain the operator cab) door and end windows shall be certified to comply with the requirements of ANSI Z26.1, Table 1, Item 3.

C. Cab door windows (to passenger area) shall be certified to comply with the requirements of ANSI Z26.1, Table 1, Item 1.

3.5.6 Interior Design Features

Seating and standing arrangement shall enable patrons to move easily and safely within a moving or stopped vehicle. In addition, provisions shall be made for priority seating for the elderly and physically disabled, and for locating a wheelchair.

A. Human factors shall be used in the design of the physical features, including the passenger and operator seats and the cab and console layout.

B. Sharp edges and protrusions shall be avoided.

C. Protective cushioning shall be provided on seats as appropriate.

D. Within each car, a location shall be identified for a wheelchair which will not interfere with the other patrons' movements.

E. Windscreens shall be provided at each side door opening with the exception that a windscreen need not be provided at the wheelchair location.

F. Stanchions shall be provided.

G. Handholds shall be provided as part of the transverse seats.

H. Priority seating graphics shall be provided in each vehicle.

3.5.7 Cab Control/Indications

Provisions shall be made whereby the operator can bypass specific functions in order to move a train to a location where patrons may be safely off-loaded or maintenance/emergency services are available.

A. The following conditions and system failures shall be detected and displayed:

1. Overspeed (annunciated as well)

2. Propulsion failures

3. Door(s) open

4. Activation of cut outs and bypasses

5. Electric and friction braking failures

6. Train berthed.

B. Cut outs and bypasses shall be provided for dynamic functions that, upon failure or malfunction, interrupt normal train operations.

C. An external light shall indicate when the vehicle is operated with ATP cut out.

3.5.8 Power/Propulsion

Normal or abnormal/emergency conditions or operations shall not result in unsafe conditions.

A. The manual controller shall have a "deadman" or equivalent capability in the manual mode.

B. The mode selection switch and the manual controller shall be interlocked to assure that the manual controller's capability is locked out from the mode selection switch in the "Automatic" or "Off" position.

C. A current collector/contact rail isolation device, suitable for on-board vehicle storage shall be provided.

3.5.9 Braking

A. Emergency brake control shall be fail-safe to the extent that no single failure or series of common mode or common cause failures can result in less than 75 percent of emergency braking effort per dependent pair being available.

B. When the safety-critical emergency stop circuit is activated, the P-signal and BRK signal circuits and the traction power line breaker shall be opened. The energy stop circuit shall ensure an irretrievable stop after an emergency application is initiated and

ensure that the train is brought to zero speed before it can proceed in any mode of operation.

C. There shall be redundant methods of automatically/manually applying emergency braking.

D. Where carborne ATC does not provide adequate stopping distance to fixed objects and where unprotected manual train operations are routinely utilized, trip stops shall be used to provide safe stopping.

3.5.10 Auxiliary/Electrical

Failures or malfunctions shall not result in unsafe operations or conditions.

A. Approved protection shall be provided against short circuits and overloads.

B. High voltage circuits shall be provided with appropriate identifications in accordance with transit industry standards and codes.

C. High voltage power shall be physically separated from communications circuitry and low voltage control circuitry.

D. HVAC temperature and overload sensors shall be provided.

3.5.11 Other Design Features

The following features shall be included:

A. Anticlimbers shall be located at each end of the vehicle.

B. Patron emergency instructions shall be placed in each vehicle.

C. Emergency equipment to aid in evacuating the vehicle shall be located within the vehicle.

D. Fire extinguishers shall be provided.

E. Exterior lighting shall include vehicle headlights and taillights.

F. The capability for remote uncoupling from within the vehicle shall be provided.

G. A safe method of externally uncoupling vehicles shall be provided.

H. Locations of fire extinguishers, patron intercoms, and door releases shall be clearly marked.

I. Vehicle electrical, electromechanical, hydraulic and mechanical system designs shall use approved redundancy, fail-safe, or fail-operational principles.

J. Restraining devices shall be provided to secure the truck to the carbody.

K. Provisions shall be made to electrically and pneumatically isolate a vehicle that has an operational malfunction, such as stuck brakes or inoperable traction devices, from the remainder of the vehicles within that consist.

3.6 TRAIN CONTROL

The Automatic Train Control (ATC) system shall ensure, to the maximum extent possible, life safety for all conditions of train operation. Both safety of property and operational efficiency shall be maintained and enhanced by the system. The ATC system shall integrate its subsystems functions of Automatic Train Protection (ATP), Automatic Train Operation (ATO), and Automatic Train Supervision (ATS) to meet these objectives.

3.6.1 Automatic Train Protection

The ATP subsystem shall provide fail-safe control and implementation of safety-critical functions, shall be continuous, and shall not be compromised by operation or failure of other systems and subsystems. Failures which affect operation within the ATP subsystem shall be detectable, but shall not compromise safety. However, operations may be degraded if necessary.

The ATP functions shall include:

A. Train Detection

1. Track circuits shall be designed, configured, and applied to ensure detection of stopped and moving passenger trains and maintenance vehicles. To the maximum extent possible, continuous detection of broken rail shall also be required.

B. Train Separation

1. Block design and safe braking distances shall be based on worst case conditions for track, grade, vehicle, loading, and braking performance. Block design shall consider safe braking distance in determining block limits.

2. The design shall ensure that trains on the same track maintain a safe following distance to prevent collisions.

C. Speed Limit Enforcement

1. The ATP design shall ensure that trains normally remain at or below safe speeds determined by block design and are given an automatic brake command if the speed limit is exceeded.

2. Speed limit information shall be transmitted by wayside equipment to equipment on the trains. The vehicle speed limit transmission decoding logic shall respond only to transmitted signals whose characteristics match those of a valid speed limit transmission signal. Both transmitted and actual speeds shall be displayed in the cab. Absence of a valid speed limit transmission shall be interpreted by the vehicle ATC equipment as a zero mi./hr. speed limit.

3. Automatic actuation of vehicle propulsion and braking shall be implemented to prevent undesired movement and excess speed.

4. No operation of and failure within the RCC and the SCADA equipment shall compromise the safety assured by the ATP subsystem.

5. ATP speed enforcement for a fixed restricted speed shall be provided for a submode of manual operation, implemented when no speed limit transmissions are received by the train.

D. Route Security

1. Train movements through interlockings shall be protected by ATP.

2. Trains on crossing/merging of branching routes shall not be permitted to make conflicting moves.

3. The ATP subsystem shall prevent a train that is operating in automatic mode from entering an interlocking whose status is not vitally determined to be safe.

4. The ATP subsystem shall give fail-safe wayside indications of the interlocking status to the train operator.

5. The ATP subsystem shall prevent opposing moves between interlockings for trains operating in automatic mode, and shall provide a "STOP" wayside indication to trains operating in manual mode prior to entering.

E. ATP Cut Out Detection

Cut out of the ATP on any passenger vehicle or train shall require an enabling signal from RCC before ATP bypass can be activated, it may also be cut out by a sealed switch in the cab. When ATP is bypassed, an alarm in the RCC shall be annunciated.

F. Vehicle Door Operation

The design shall inhibit manual operation of vehicle side doors by either passengers or employees when the vehicle is in motion. The design shall also prevent the train from starting until all side doors are closed and latched.

G. Station Platform

The ATP subsystem shall prevent a train in the automatic operating mode from proceeding beyond a

station platform if propulsion power is not continuously available for the train to berth at the next downstream station platform.

3.6.2 Automatic Train Operation

The ATO subsystem shall perform berthing verification at all station platforms, regardless of travel direction. Berthing verification shall ensure that the train is wholly within a station platform area and that all doors will open to a platform.

3.6.3 Automatic Train Supervision

The ATS subsystem shall not directly affect train safety, but it shall meet operational objectives without compromising safety. The ATS subsystem shall include equipment at the RCC for recording alarms and failures/malfunctions, including their time, location, and nature, to facilitate proper response to emergency situations.

3.6.4 Other Design Features

A. Signal aspects, indications, and terminology shall be consistent throughout the ATC system.

B. The ATC system at wayside shall have an emergency backup power supply system to support train control in the event of power loss.

C. Manual mimic boards and controls shall be located in the local train control rooms.

D. When manual operation of a vehicle without ATP is permitted, adequate operational procedures shall be developed to assure safe operation.

3.7 POWER

3.7.1 Emergency Trip Station

An Emergency Trip Station (ETS) shall be provided at selected locations and identified by a blue light. The following provisions shall be made:

A. An ETS shall be located at each end and on each side of the platform, with appropriate signing. The locations shall not be accessible to patrons under normal conditions.

B. An ETS shall be located at each tunnel cross passage, tunnel portals, and special trackwork.

C. ETS shall be located in the Yard, Yard Tower(s), and Yard buildings that require traction power.

D. ETS shall be easily opened.

E. ETS activation shall alarm at the RCC, and the section of contact rail deenergized shall be identified.

F. Yard ETS activation shall alarm at the Yard Tower.

3.7.2 Station Emergency Power Requirements

During power failures, emergency power shall be available at designated locations of each station and for those functions considered critical. Analyses shall be made to determine the site for uninterruptible power throughout the system.

A. Dual primary feeders shall be provided.

B. As a minimum, emergency power shall be provided for the following functions and locations:

1. Functions:

a. Public address
b. Automatic and manual fire suppression systems
c. Fire detection and alarming
d. Security detection and alarming
e. Closed circuit television cameras and monitors
f. Radio
g. Displays depicting vertical circulation element directions
h. Emergency lighting
i. Emergency telephones
j. Automatic train control.

2. Locations (for emergency lighting):

   a. Platform, other levels, entrances
   b. Emergency exit routes
   c. Ancillary rooms and spaces.

3. Locations (for emergency power):

   a. Rail Control Center
   b. Automatic train control and communication equipment rooms at each station
   c. Yard Tower.

3.7.3 Tunnel Emergency Power Requirements

The loss of a single substation or a tunnel feeder shall not interrupt the functioning of safety-critical systems, such as the ventilation system, ETS, telephones and lighting.

Tunnel fans and lighting shall be fed from two separate power sources.

3.7.4 Contact Rail

Provisions shall be incorporated to reduce exposure of patrons and SCRTD personnel to the contact rail.

A. The contact rail shall be located opposite the safety walk and the station platform. Where special trackwork or other installations do not allow locating the contact rail opposite the safety walk, a coverboard shall be used.

B. Patrons and employees shall be alerted to the hazards of the contact rail through signing.

C. Coverboards shall be installed to reduce the possibility of patrons and employees inadvertently contacting the contact rail.

3.7.5 Traction Power

Consideration shall be given to all subsystems comprising the Traction Power system to assure acceptable safe levels of operation.

A. Electrical grounding and lightning protection shall be provided for all traction power subsystems and gap breaker stations.

B. The RCC shall have the capability of operating and controlling essential ac/dc switchgear functions. To aid RCC, there shall be alarms and visual indication of status changes and abnormal conditions associated with traction power substations and gap breaker stations.

C. Remote control of the Yard traction power substation shall be provided at the Yard Tower.

D. The running rail shall have a conduction capability adequate to provide the negative return path for the traction power system.

E. The cable connecting the contact rail to the pothead and specified energized hardware shall be covered with suitable insulating material. This material shall be installed so as not to present an electrical or tripping hazard to people on the trackway.

F. Key locks shall be provided on all manual ac/dc breaker control cabinets.

G. Transformer/rectifier doors shall be provided with power interlock safety switches.

H. All drawout switchgear shall have shutters to protect personnel from accidental contact with live power circuits when the circuit breaker is removed.

I. Circuit interrupting devices which do not have load-break capability shall be equipped with interlocks to prevent unsafe operation.

J. High-voltage terminations shall be protected to prevent accidental contact.

K. Substation monitoring devices for dc equipment enclosed in metal housings shall detect and annunciate the condition when the dc equipment enclosure is grounded or a positive bus is being faulted to the enclosure.

L. Rubber matting of high dielectric strength, or an epoxy coating, shall be provided on the floor around the perimeter of dc conversion equipment and switchgear. This insulation protection shall extend a minimum of four feet. The equipment shall be located such that personnel cannot bridge to grounded surfaces. Otherwise, grounded surfaces shall be insulated.

M. Two means of egress shall be provided from each substation.

N. Traction power zones shall be separated by nonbridgeable gaps.

O. Traction power substations shall have ac receptacles isolated to prevent accidental grounding of the dc power when using test equipment.

3.7.6 Other Design Features

Other design features shall be included as follows:

A. All critical support facilities (e.g., traction power substations, gap breaker stations, RCC power) shall have subsystem status indicators on the RCC mimic board. An alarm shall sound when an equipment failure occurs.

B. The RCC shall have the capability to isolate contact rail sections under normal and abnormal conditions.

C. All electrical power distribution facilities shall be protected from known 100-year flood levels.

D. Equipment provided shall protect against battery overcharging.

E. "Stingers" used in locations such as the maintenance shop shall be of the fail-safe (deadman's switch) type.

F. Battery rooms shall contain a fixed eye and body wash unit meeting Cal/OSHA requirements.

3.8 RAIL CONTROL CENTER

The RCC shall be the focal point for maintaining an overview of train operations, train supervision, and station operation, and also for communicating directions and conditions to operators, maintenance, supervisory, and emergency personnel, and patrons (as required). To accomplish these functions, the following capabilities shall be incorporated into its design.

3.8.1 Communications

Dependable, flexible and redundant communication networks shall be provided to ensure continuous contact with required personnel and patrons.

A. Radio communications system shall be provided as follows:

1. Emergency train operations
2. Police emergency
3. Fire emergency.

These communications shall be recorded and retrained.

B. The RCC shall have a capability for communicating with patrons in stations via a public address system and also have two-way communications with vehicle operators.

C. Patrons and SCRTD personnel shall be able to initiate communication with RCC via the emergency telephone system. These communications shall be recorded and retained.

D. RCC shall have the capability for multiple telephone and radio communications reception, call out, and cross-patch.

E. The radio and emergency telephone subsystems shall be independent to prevent a single failure from causing the loss of both.

3.8.2 Displays

Sufficient displays shall be installed to permit RCC to continuously track the status of trains and critical station functions.

A. Incoming and outgoing safety related messages shall be visually displayed and a hard copy record made and maintained.

B. A means to continuously monitor Fire/Life Safety functions shall be provided.

C. Mimic boards and controls for train control and traction power shall be provided.

3.8.3 Controls

The RCC shall have the capability to respond quickly and in an error-free manner to all conditions.

A. The RCC shall be able to set up train routing, subject to ATP.

B. The RCC shall be able to control traction power functions and isolate contact rail sections.

C. The RCC shall be able to initiate a systemwide ventilation fan regimen and to control individual fans as required.

3.8.4 Alarms

Audible/visual alarms shall be provided for the following, as a minimum:

A. Fire
B. Intrusion
C. Substation power failure
D. Toxic/combustible gas presence
E. Seismic disturbances of system disruptive magnitude
F. Ventilation failure.

3.8.5 Other Design Features

The following design features shall be included in the RCC design.

A. Terminology, size of letters and numbers, and colors as applied to controls, indicators, and signage shall be consistent throughout the RCC system and interfaces.

B. Human factors shall be considered in overall systems design and for individual consoles and components. Areas of concern include grouping of indicators and controls for accurate response and visibility of indicators from the operators' positions. Consideration shall be given to the RCC single operator response in emergency situations.

3.9 WAYS AND STRUCTURES

3.9.1 Yard and Shops

Design features shall be provided to ensure the continuing safe performance of maintenance activities.

A. Shops shall be provided with dual power feeders and/or an emergency power source. If an emergency power source is provided, it shall have adequate reserve to bring all machinery to a safe, shutdown condition where required.

B. The requirement of Cal/OSHA and applicable local codes shall be met in the design of the Yard, shops, and equipment.

C. Maintenance and other auxiliary vehicles, including the hi-rail, shall have positive train protection capability for detection purposes and shall be compatible with ATC train detection.

D. The Yard design shall provide the capability to perform daily safety and operational checks on all trains entering revenue service.

E. Isolated yard tracks shall not be powered inadvertently by bridging.

F. Slip-resistant surfaces shall be provided in all maintenance facilities areas.

G. The Yard Tower shall be able to view the yard.

H. Yard access for vehicular traffic by perimeter road shall be provided.

I. Storage rooms and rooms containing combustible or hazardous materials or high-energy sources/equipment shall be provided with emergency exits.

J. Overhead ac/dc power bus systems shall be protected or recessed to prevent contact with movable maintenance platforms, ladders, or mobile cranes.

K. Emergency eye wash and shower systems and drainage shall be provided for personnel decontamination, and shall be located in the immediate area of the battery or battery charging room(s).

L. Battery racks shall be provided for maximum protection against battery damage, and for ease of accessibility.

M. Remote control of motorized disconnect switches in the storage yard shall be provided in the Yard Control Tower.

N. Rotating or other moving machinery shall be enclosed or properly guarded from personnel contact, and located away from pedestrian flow and maintenance activities.

O. High-temperature equipment and piping shall be properly guarded or covered with approved insulation in locations where contact by personnel or combustibles may occur. Routing of high-temperrature liquids over maintenance activities, personnel areas, or electrical equipment shall be avoided.

P. Adequate clearance shall be provided in the shop area for safe "stinging" operations.

3.9.2 Tunnels

The tunnels shall be sized to safely accept the dynamic outline with clearances of the vehicles, and accommodate other features such as the safety walks, milepost and marker signals. In addition:

A. Continuous safety walks shall be provided throughout the revenue line system. Maintenance walkways shall be provided in non-revenue tunnel trainway areas, meet the requirements of Cal/OSHA Section 3272 and provide a clear envelope two feet wide by six feet, eight inches high. Walkways shall be free of tripping hazards or equipment intrusion into walkway space.

B. Cross passage doors shall be capable of withstanding the transient pressures created by the trains.

C. Cross passages shall provide a standardized location for special equipment, such as emergency trip stations, emergency telephones and fire protection equipment.

D. Ramps or stairs shall be used between safety walks and the track level.

E. Studies shall be performed to determine the need to control water infiltration and flooding.

F. Ventilation shall be provided to aid in the removal of gases, smoke, and other toxic fumes.

G. Pocket or tail tracks in tunnels shall be equipped to deenergize the serving contact rail. This function shall be readily accessible to the train operator.

H. Combustible ties shall not be used in any underground construction unless they are fire retardant and pressure treated.

3.9.3 Guideway

The guideway shall be protected to prevent vehicular or pedestrian encroachment except at designated points of entrance and egress such as stations, surface transit interchange areas, and parking lots. Patron and other public areas shall be physically separated from operational service areas.

A. There shall be adequate provisions for access and egress by emergency vehicles and crews.

B. The design of structures adjacent to the running rails shall be such that the grounding system will limit the potential differences between the passenger vehicles or running rails and any grounded structure or equipment, to protect personnel from dangerous electrical shock.

C. The roadbed shall be designed to allow for rapid drainage of any water from the tracks and along the roadbed.

D. Pocket and tail tracks shall not be powered by bridging of contact rail sections.

E. Visual wayside signals shall be located on or immediately adjacent to the train operator's side of the track.

3.10 OPERATIONS, MAINTENANCE, AND TRAINING

3.10.1 Operations

Safety instructions, warnings, and cautions shall be provided in manuals and operating instructions to alert users to potentially unsafe conditions. These provisions shall include:

A. Train operator actions shall be governed by written directions developed in the form of Rules and Standard Operating Procedures. These rules and procedures shall apply to both manual and automatic train operation modes anywhere on the System.

B. Procedures shall be developed to enable the train operator to minimize risk to passengers and equipment in an emergency situation.

C. Procedures shall be developed to permit the train operator to bypass specific passenger vehicle subsystems in order to safely resume revenue operations after a failure/malfunction.

D. Procedures shall be developed for reporting to the RCC, a safety-critical failure/malfunction occurring

on a train or to wayside equipment which has been annunciated and not corrected.

E. Procedures shall be developed that require a train operator to visually verify that all passenger vehicle doors are clear before closing the doors.

F. Emergency guidelines and operating procedures shall be developed for termination of operations under excessive adverse environmental conditions (wind, flood, earthquake, hazardous gas infiltration including reaction to warning level annunciation and alarm level annunciation).

3.10.2 Maintenance

Consideration shall be given to mitigating surrounding hazards to provide a safe working area. Provision shall include:

A. The safety of personnel shall be provided for during right-of-way maintenance.

B. First-aid facilities shall be provided.

C. Warning signs and barriers shall be provided at vehicle maintenance pit areas in accordance with Cal/OSHA regulations.

D. Equipment maintenance envelopes shall be arranged, by equipment placement, to preclude hazardous interaction between adjacent equipment or components. Adequate space shall be provided for hazardous maintenance activities, such as voltage measurements or equipment operation, with protective covers removed during adjustment.

E. Placement of equipment so that maintenance envelopes do not interfere with or intrude into each other wherever possible.

F. Equipment shall be placed to avoid the intrusion of the maintenance envelope into patron or employee pedestrian flow during maintenance activities. Pedestrian flow shall be able to be routed around hazardous maintenance activities.

3.10.3 Training

Training shall be provided to instill an awareness of potential hazards and hazardous situations as a major factor of safety. Operating, maintenance, control, and supervisory personnel training in system emergencies and natural disasters shall be provided to assure a safe system environment and to enable personnel to respond quickly and effectively in an emergency. The following shall be provided as a minimum:

A. The skills of train operators and maintenance personnel shall be maintained at the established levels.

B. Provisions shall be made for training and qualifying the RCC personnel to ensure adherence to safety procedures and safe system operation.

C. Programs shall be developed for continuing safety education through testing, start-up, pre-revenue, and revenue service.

D. Programs shall be developed for personnel training in natural disaster response and participation in simulated disasters and system emergencies.

E. The operations and maintenance manuals and procedures shall identify and discuss the safety features of equipment and facilities and their use.

SCRTD METRO RAIL SYSTEM DESIGN CRITERIA & STANDARDS

SYSTEM DESIGN CRITERIA AND STANDARDS

VOLUME: 1 SECTION: 4

REVISION RECORD

NOTICE NUMBER	CR NO/REV	DATE APPROVED	AFFECTED	COMMENTS
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2	4-088	2/13/85	4.9.1	
3	5-081	10/30/85	Table I-4-1	Distributed 12/10/85

SYSTEM DESIGN CRITERIA AND STANDARDS

VOLUME: 1 SECTION: 4

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5	6-045/	3/10/87	4.1.1.A & B 4.3.1.D 4.3.2.A 4.3.3.A 4.3.4.A 4.5.3 4.7	P. 1 P. 4 P. 4 P. 7 P. 7 P. 10 P. 12
6	6-037/ 7-004/	7/7/87 7/7/87	4.6.1 4.9.2	P.11 P.14
7	7-017/	10/26/87	4.6.2	P.11

SCRTD METRO RAIL SYSTEM DESIGN CRITERIA

Volume 1, Section 4

SECURITY

09/10/84 Revision 1

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VOLUME I, SECTION 4

SECURITY

4.1 INTRODUCTION

4.1.1 General

Numerous studies and reports have identified the marked increase in crimes and acts of vandalism on mass transit systems in recent years. These problems have resulted in the personal discomfort of employees and patrons, in injury and death, and in increased maintenance and repair costs. As a result, many people have turned away from rapid transit. Consequently, both older and newer transit properties have been making a concentrated effort to improve the level of safety and security on their systems. Measures taken include:

A. Increased use of transit police personnel to patrol stations and the vehicles.

B. Installation of radio communications between operators and the Transit Police Dispatch Center.

C. Installation of closed circuit television (CCTV) to provide coverage of remote areas, passageways, and other station locations not visible to attendants.

D. Installation of an emergency communication network between passengers and operators in the vehicle, between patrons in a station and station attendants, or a means of direct dialing to a security or law enforcement desk.

E. Incorporation of vandal-resistant, low-maintenance materials in the vehicles and in the stations.

F. Presentation of public educational programs.

These techniques have resulted in reduced crime and vandalism. However, when improved security requires extensive alterations to an existing station or vehicle design, it is not as cost-effective as when security is built into the original design. New properties have the opportunity to provide balanced and effective security as part of the total system design. This process began with BART, WMATA, and MARTA and has been further developed in

the newer and refurbished lines in MBTA and CTA, but it is most evident in the emerging properties such as Baltimore and Dade County (Miami).

Security is an essential design requirement in SCRTD's Metro Rail Project and is being approached in a system engineering manner. This document provides the criteria by which balanced and effective security can be achieved.

4.1.2 SCRTD Security Policy and Program Objectives

The Metro Rail System design shall ensure a high level of security for patrons and SCRTD personnel. Facility design and operating procedures shall promote a sense of well-being by patrons and personnel, discouraging acts of crime, violence, and abuse. Security provisions shall also maintain system integrity by discouraging acts of vandalism, theft, and fraud.

4.1.3 Purpose

The purpose of security criteria is to provide sufficient definition and description of all facets of a security concept so design engineers and architects have guidance for the proper selection of equipment and the design of facilities. Through these criteria, security considerations will be integrated into all aspects of the design, equipment selection, architectural concepts, procedures, and operations. Additionally, it will enable trade-off studies to be performed to achieve a balanced, comprehensive level of systemwide security.

4.1.4 Scope

Three documents have been prepared to define the safety, systems assurance, and security criteria. This document outlines the security criteria in the following areas:

A. Station and Site

B. Communications

C. Passenger Vehicle

D. Fare Collection Equipment

E. Rail Control Center

F. Ways and Structures

G. Lock and Keying System

H. Law Enforcement

I. Public Education.

4.2 (NOT USED)

4.3 STATION AND SITE

While no single design feature can be totally effective in creating a secure environment, careful attention to all aspects of the design can have a positive effect in deterring, detecting, and limiting injury and damage caused by criminal activities. The cumulative effect of the following design features is to enhance security as viewed by the patrons and the SCRTD employees.

4.3.1 Site

A. Landscaping

Plantings and site design may offer considerable aesthetic appeal, but can also restrict lines of sight and serve as possible hiding places. As a minimum, plantings and design features shall be coordinated with traffic movements and lines of sight so as not to obstruct or interfere with electronic or visual surveillance or result in a potential hiding place for vandals/intruders.

B. Lighting

The selective use of lighting can increase the patrons' feeling of security while providing better visibility of the surroundings. As a minimum, station sites and parking lots shall be illuminated during hours of darkness and reduced visibility, in accordance with applicable IES standards and APTA security guidelines.

C. Parking

Patrons have a concern for the security of their automobiles when left at the station site. Protected parking (when available) enhances the reality and patrons' perception of security. As a minimum:

1. Parking lots shall be fenced and open-spaced to provide a high degree of visibility by an attendant when present.

2. Controlled access shall be provided whenever possible.

D. Access

A carefully planned, well laid out site and parking area can improve the movement of security forces in and around the station site. As a minimum, traffic patterns and site layouts shall be structured to permit rapid and easy access to all portions of the site and station by police personnel, whether on foot or by vehicle.

4.3.2 Architectural Features

A. Visibility

By making patrons more visible to one another, to SCRTD employees, and to the general public, much of the opportunity for criminal activity is removed. Should criminal activity occur, the high visibility facilitates detection and rapid response by police officers. As a minimum:

1. All levels of the station, including the platform and mezzanine, shall be as open as possible.

2. Columns and other obstructions to visual and electronic surveillance shall be minimized.

B. Lighting

In addition to improving the effectiveness of visual and electronic surveillance, the selective use of high lighting levels in the stations can increase the patrons' sense of well-being and security, while accentuating the fare collection equipment, emergency

cabinets, exit routes, and station amenities. To ensure safety and security in the station in an emergency situation, an emergency power supply shall be an integral part of the electrification system. As a minimum:

1. The illumination of station elements shall be guided by applicable IES standards and APTA design guidelines.

2. Emergency power and lighting requirements shall be developed as part of the overall security and safety requirements (See Table I-4-1).

C. Materials

Vandalism and graffitti are major concerns of the transit industry. They detract from the patrons' perceived security, constitute a major maintenance expense, and in extreme cases, constitute a safety hazard. As a minimum, construction and finish materials shall be graffiti- and vandal-resistant, easily cleaned, and meet the appropriate Fire/Life Safety requirements for flammability, smoke emission, and toxicity.

D. Station Surviellance

It is SCRTD policy that each station be designed to be fully automated, but also designed so it could be staffed. Provisions to provide security in an unstaffed station would therefore require central monitoring of station and platform activity and a two-way method of communication at several locations within the station. As a minimum, CCTV cameras are to be used to cover selected sectors of the station and platform, and are to be monitored at Central Control. This will require multiple monitors for each station.

E. Entrances

Previous studies have shown that patrons perceive entering a station as a high risk. To encourage system use, efforts shall be made to minimize what the patron perceives as risk areas. As a minimum, station entrances shall be well lighted and designed to have high visibility by patrons and the public.

TABLE I-4-1

AREA OF COVERAGE BY CCTV AND VISUAL SURVEILLANCE

	SECURITY LEVEL(1)	VISUAL SURVEILLANCE(2)	CLOSED CIRCUIT TELEVISION	EMERGENCY PHONE(3)	ACCESS ANNUNCIATION	EMERGENCY LIGHT(S)
1. Station Entrance	A	X	X			X
2. Station Closure	A				X	
3. Elevator	A	X			X	X
4. Mezzanine	A	X		X		X
5. Platform	A		X Edges	X		X
6. Fare Vending Equipment	A/C	X	X		X	
7. Fare Gates	A/C	X	X			X
8. Ancillary Areas	C					X
9. Ancillary Area Doors	B	X				X
0. Trainway Entrances	C		X			X
1. Bus Area	A					X
2. Parking Lot	A					
3. Restrooms	B			(CONDUIT ONLY)	X	X
4. Emergency Stairs	B			X	X	X

(1) Security Levels: Station areas have been classified by level of security as a basis for determining the security measures required for protection:

Level A: Open to the public during system operating hours

Level B: Open to SCRTD employees at all times, and to the public under emergency or special circumstances

Level C: Controlled access for SCRTD employees only

(2) Applicable if fixed location station attendant is provided

(3) Reference Volume I - Section 2 for detailed requirements

09/10/84 Revision 1
Rev. 6/86 CR 5-069

F. Concessions and Lockers

Concessions within a station, while offering certain conveniences, are targets for burglaries and a source of trash. Lockers offer little utility to transit passengers since most carry only briefcases and small packages. Bomb scares involving lockers could adversely impact transit service, as well as present a potential safety hazard. It is the SCRTD policy that no concessions other than newspaper vending machines and a public telephone will be considered for installation in transit stations. This does not include equipment associated with fare collection.

4.3.3 Restrooms

Public restrooms at older properties are viewed by patrons as areas that attract nuisances and that may be unsafe. As a minimum:

A. A single occupancy unisex restroom, if required, shall be provided.

B. Conduit for electronic access control of restrooms shall be provided.

4.3.4 Station Closure

A. Entrance

To minimize the opportunity for vandalism or theft during hours of nonrevenue service, stations shall not be left open to the public. Additionally, transit police forces need to be made aware of unauthorized entry. As a minimum, station entrances shall be secured and alarmed during nonrevenue hours.

B. Nonpublic Areas

In order to reduce vandalism and theft and to prevent the public from inadvertent exposure to hazardous conditions, nonpublic areas shall be secured and/or unauthorized entry shall be annunciated (See Table I-4-1). As a minimum:

1. Nonpublic areas shall be secured to preclude unauthorized entry.

2. Where public access is required through ancillary spaces for emergency purposes, access into that area shall be annunciated.

3. Any unauthorized areas along that route shall be secured against inadvertent entry.

4.4 COMMUNICATIONS

4.4.1 Closed Circuit Television (CCTV)

Each station shall be designed to function without an attendant present. Therefore, electronic surveillance shall be required so Rail Control center can monitor the station. Minimum considerations are as follows:

A. All areas as listed in Table I-4-1 shall be covered by CCTV and monitored at the Rail Control Center. All camera locations shall have capability for future addition of pan, tilt-zoom camera installation.

B. Sufficient conduit shall be provided for CCTV coverage of escalators/stairs (top to bottom), patron assistance phones in fare equipment locations, station trackway, and isolated passageways as required. Other areas in each station shall be evaluated to provide the optimum arrangement of the minimum number of cameras: fixed, sequenced, and/or pan, tilt, and zoom.

C. CCTV cameras shall be encased in vandal and weather resistant housings, and the lenses shall be easily replaceable with the proper tools.

D. Cameras shall be mounted as high as possible to maximize the field of view and reduce accessibility by vandals.

E. Camera monitors at the RCC shall have pooled video taping capability.

F. Cameras shall function on emergency power during loss of primary power.

4.4.2 Public Address (PA) System

The PA system may be used to alert patrons to an existing or potential high risk situation. It is also effective in directing patrons in an emergency situation. Although principally used for safety reasons, the PA System does have use for security purposes. As a minimum:

A. The PA System shall provide the station attendant (if provided) and Rail Control Center full station coverage.

B. The PA System shall function on emergency power during loss of primary power.

4.4.3 Patron Assistance Phones and Emergency Phones

Security is improved when a patron can report potentially hazardous or serious conditions quickly and easily to the station attendant (if present) or the Rail Control Center. As a minimum:

A. All emergency telephone messages answered at the Rail Control Center shall be automatically recorded. The patron assistance phone answering positions shall provide a means to record emergency calls at the time it is determined the call constitutes an emergency call.

B. The patron assistance and emergency phone shall function on emergency power during loss of primary power.

4.5 PASSENGER VEHICLE

4.5.1 Materials and Construction

Vehicle vandalism has been a major maintenance cost on transit systems. Besides being unsightly, it also has an adverse impact on the patron-perceived security. In some cases, broken or loose fittings, trim, and seats have resulted in injury. As a minimum:

A. Materials shall be selected on the basis of:

1. Their resistance to vandalism and graffiti

2. Their ability to be cleaned

3. Their ability to meet fire, smoke emission, and toxicity standards.

B. Seat cushions shall be of vandal-resistant material without compromising comfort. Those sections of the seat where comfort is a primary consideration shall be of modular design and easily replaceable with the proper tools.

4.5.2 Windows

Properly sized and installed glazing permits patrons to be viewed by the public, to see between cars, and to see the people on the platforms. This high level of visibility provides an element of security. As a minimum:

A. Glazing shall be made of a clear, impact resistant, hard-surfaced material which is further defined in Volume I, Section 3.5.5, Safety Criteria.

B. Between-vehicle visibility shall be provided by windows at each end of the vehicle.

4.5.3 Communications

On board patrons may be vulnerable to criminal acts. Providing a readily available, easily used, and reliable means to alert the train operator of such acts or problems improves security and acts as a deterrent. Providing a reporting link between the train operator and Central Control permits a quick response to an incident by transit police and other law enforcement personnel. Minimum considerations are as follows:

A. In each vehicle, a means of reliable communication that permits direct communication between the passenger and the train operator shall be installed. The device shall be vandal resistant.

B. A communication capability between the Rail Control Center and the train operator and between the Rail Control Center and the onboard patrons shall be provided.

C. Exterior distress signals that identify the origin of an alarm shall be incorporated in the design.

D. Vehicles shall be uniquely numbered to provide for positive identification.

4.6 FARE COLLECTION

4.6.1 Fare Collection Equipment

Fare collection security in the station is concerned with the protection of the various pieces of fare collection equipment: ticket vending machines, add fare machines, etc. The equipment shall be designed to minimize interference with passenger movement, to limit the opportunity for fare evasion, and to be tamper-resistant. Minimum considerations are as follows:

A. The preferred location for fare collection equipment is under the visual surveillance of the station attendant when provided. The equipment shall be under CCTV surveillance and monitored from the Rail Control Center.

B. The equipment shall be vandal resistant and equipped with tamper and intrusion detection alarms.

C. Fare gates/turnstiles and array barriers shall cause minimum interference with patron movement, meet Fire/Life Safety requirements, and discourage attempted fare evasion.

4.6.2 Revenue Collection

Efficient and expeditious means are desired to remove revenues from the fare collection equipment and to stock coins for change and tickets in that equipment. The station design shall incorporate those features that permit direct movement of money (by carts or whatever means are used to move monies through the station) to the desired transporter (armored car). The facility where the money is collected, separated, and counted shall also be secure. Minimum considerations are as follows:

A. Access to the central fare sorting/counting area shall be tightly controlled and secured from other accessible parts of the facility in which it is housed.

B. Revenue pickup and transportation shall be by the most protected, rapid, and efficient means possible.

C. To the extent possible, all processing and handling of cash, tickets, or items having cash value shall be automated.

D. The revenue collection and processing system shall be as compatible as possible with the existing SCRTD equipment and procedures.

4.7 RAIL CONTROL CENTER

Rail Control Center normally functions as the focal point for a transit security system. Emergency phones, annunciations, and alarms come into Rail Control Center and, in many systems, appear on a printer and/or a CRT. In this manner, those individuals responsible for the safe, secure operation of the transit system are continuously aware of the status of all elements on a real-time basis. Minimum considerations are as follows:

A. The Rail Control Center and Transit Police Dispatch Center shall be able to receive intrusion alarm indications.

B. Separate radio frequencies shall be designated for the transit police.

C. All CCTV areas identified in Table I-4-1 shall be monitored at Rail Control Center.

D. The Transit Police Dispatch Center will have CCTV call-up capability to monitor any CCTV camera

4.8 WAYS AND STRUCTURES

4.8.1 Yards and Shops

A. External Security

The stored vehicles represent a major cost to the system, and vehicle availability is a factor in the

SCRTD's capability to meet operating requirements. As a minimum:

1. The yard and perimeter shall be lighted at a level consistent with IES guidelines, operating and security requirements.

2. The storage yards shall be enclosed with fencing and controlled access points provided to prevent unauthorized entry.

B. Internal Security

The maintenance equipment and spares represent a significant investment. Their availability is essential to minimize system downtime. As a minimum, parts, spares, tools, and other equipment shall be controlled and/or secured.

4.8.2 Right-of-Way (ROW)

A. Access Control

In order to limit theft and damage to equipment and possible injury to unauthorized personnel, access to the ROW shall be controlled. Minimum considerations are as follows:

1. Fencing is to be provided to limit/prevent unauthorized access to the ROW.

2. Secured access points are to be located at regular intervals for use by maintainers and emergency teams.

3. Where the right-of-way adjoins or abuts other public transportation areas, personnel and equipment intrusion warning devices shall be installed.

B. Track Switches

If wayside track switches are vandalized or tampered with, a service disruption or an accident could result. As a minimum, wayside switch facilities shall be protected by tamper-resistant covers and secured by locks or similar devices.

4.9 LOCK AND KEYING SYSTEM

4.9.1 Lock and Keying Concept

To protect equipment against damage, vandalism, and risk to unauthorized personnel, equipment rooms shall be secured. However, authorized personnel should be able to perform their duties and fulfill their responsibilities with a minimum of inconvenience and time. The keying system shall permit a rapid change-out of keys if required by a strike, a civil disturbance, or loss of keys. As a minimum, multiple level master key system shall be provided to permit ease of use and convenience in changing key combinations when necessary.

Critical access areas, which are defined as extremely hazaradous, essential to the system safe operation, or which require restricted access due to the nature of the equipment or value or the product within these areas, shall be equipped with an electronic card access control system which can be monitored and controlled from a central point.

4.9.2 System-Unique Keys

At certain times, personnel from organizations other than the SCRTD may need access to special equipment and facilities within the system. This may include elevator manufacturers representatives who have access keys.

The multiple level master key system to be developed for the SCRTD shall accommodate the system-unique keys such as the elevator access keys without modification. Access to unauthorized areas shall be prohibited by the master keying system.

4.9.3 Vehicle Key

It is necessary to prevent unauthorized entry into the vehicle and possible damage to equipment. As a minimum, entrance to the vehicle's operator's cab by key shall be provided.

4.10 LAW ENFORCEMENT

4.10.1 SCRTD Security Forces

The agency responsible for law enforcement on SCRTD property must be familiar with all facets of transit design, construction and operation and capable of responding quickly to any incident. The existing SCRTD Transit Police have a recognized and established presence in Los Angeles and already have experience in policing transit operations.

The recommended criterion is:

The SCRTD Transit Police are to increase their area of responsibility to include rail rapid transit law enforcement.

4.10.2 Security Training

Rapid transit systems have unique problems, and it is essential that all members of the SCRTD Transit Police force understand and be familiar with them (e.g., communication systems and emergency trip stations).

The recommended criterion is:

SCRTD Transit Police are to receive transit security training before being assigned that duty.

4.10.3 Interface with Local Law Enforcement Agencies

While the SCRTD Transit Police will have primary responsibility for law enforcement within the SCRTD system, there will be situations when the transit police will either be unable to be dispatched immediately because of an emergency elsewhere or when a local agency can respond more quickly and control the situation pending the arrival of the SCRTD Transit Police. Contingencies for such emergencies must be planned.

The recommended criteria are:

The SCRTD Transit Police and the Los Angeles Police Department (LAPD) are to establish and participate in a liaison group to identify contingencies and situations requiring mutual support.

The LAPD is to support the SCRTD Transit Police on an emergency basis.

4.10.4 O & M Personnel Training

Under certain emergency conditions, O & M personnel can be expected to assist the SCRTD Transit Police.

The recommended criterion is:

O & M personnel are to receive periodic security training so that they will be prepared to assist the Transit Police in emergency situations.

4.11.0 PUBLIC EDUCATION

Through continuing school programs and community involvement programs, a positive image of the transit system can be maintained as one means to counteract abuses of transit property. Additionally, such a program can effectively identify risks associated with unauthorized entry onto transit properties.

The recommended criterion is:

A program promoting the SCRTD bus and rapid transit systems is to be developed and presented as part of the school programs and the community awareness programs.

SCRTD METRO RAIL SYSTEM DESIGN CRITERIA & STANDARDS

SYSTEM DESIGN CRITERIA AND STANDARDS

VOLUME: I SECTION: 5

SYSTEM ASSURANCE

REVISION RECORD

NOTICE NUMBER	CR NO/REV	DATE APPROVED	AFFECTED	COMMENTS
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SCRTD METRO RAIL SYSTEM DESIGN CRITERIA

Volume 1, Section 5

SYSTEM ASSURANCE

VOLUME I, SECTION 5, SYSTEM ASSURANCE

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VOLUME I, SECTION 5

SYSTEM ASSURANCE

5.1 INTRODUCTION

5.1.1 Purpose

This section establishes the Criteria for Southern California Rapid Transit District (SCRTD) Metro Rail System maintainability, reliability, quality assurance, human engineering, and configuration management. The purpose of the criteria outlined in this document is as follows:

A. To provide sufficient definition and description of the system assurance characteristics to allow design engineers to select appropriate features and facilities. This document is designed to outline those standards and guidelines that, if followed, will assure that the Metro Rail System achieves the optimal level of dependability.

B. To define the system assurance requirements which will be included in the System Assurance chapters of the Contract Specification Documents.

C. To provide an overall description of the magnitude of system assurance activities so that the costs of the System Assurance Program can be estimated.

5.1.2 Document Structure and Content

This document has been structured to explain the need for, and then to specify, system assurance criteria. The statement that expresses an essential condition, a necessity, a need or a desire of the transit system is called the requirement.

Following each requirement statement is one or more criteria statements. The criteria explains how the requirement will be satisfied; this outlines what the SCRTD will do to assure that the requirement is achieved.

Each criteria statement is individually numbered for ease of identification and revision. These statements are

identified by a letter signifying the category in which the criteria falls:

R = Reliability
M = Maintainability
Q = Quality Assurance
H = Human Engineering
C = Configuration

5.2 RELIABILITY

The reliability achieved by the SCRTD Metro Rail System is directly dependent on the reliability requirements imposed on the system contractors and the emphasis placed on reliability management by the SCRTD. It is intended that the reliability criteria established in this section will ensure procurement of reliable equipment capable of meeting the system operational requirements.[1]

5.2.1 Requirement - Reliability Program

SCRTD management shall establish and maintain an effective reliability program. The program shall be planned, integrated, and developed in conjunction with other design, development, and production functions to permit the achievement of the project goals and objectives.[2] A Program Plan is required to assure the management and technical skills necessary to achieve Metro Rail reliability objectives are applied in a coherent and organized manner.

A. Criteria R1 - Reliability Program Plan - SCRTD

A Reliability Program Plan shall be developed by the SCRTD during Preliminary Engineering and incorporated into the SCRTD System Assurance Program Plan, Task 16DAD. The plan shall identify the organizational elements and the key personnel responsible for managing the overall reliability program. The plan shall also clearly define the related responsibilities for accomplishment of specific reliability tasks.

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[1] See Preliminary Operating Plan, January 1982, Task 13DAA.

[2] See Project Definition and Objectives, December 1981, Task 13 DAG

The Reliability Program Plan shall include:

1. A detailed listing and description of each task
2. The anticipated person-hours required for each task
3. The timing of each task and related milestones
4. The organizational element responsible for each task
5. Identification of reliability problems requiring resolution
6. Procedures for recording reliability problem resolution.

The Reliability Program shall be modeled after MIL-STD-785A, Reliability Program for Systems and Equipment Development and Production.

B. Criteria R2 - Reliability Program Plan - Contractors

Manufacturers of the following system equipment shall be required, by contract, to establish and maintain a Reliability Program and Plan.

1. Vehicle
2. Train Control
3. Fare Collection.

Their plans shall be prepared using the SCRTD System Assurance Program Plan as a guide for style, content and format.

5.2.2 Requirement - Quantitative Design Requirements

An essential prerequisite to the achievement and control of reliability in SCRTD hardware systems and equipment is the quantitative definition of these parameters as design requirements. Contractor compliance with quantitative requirements is necessary to ensure SCRTD procurement of reliable equipment capable of meeting the performance criteria and operational objectives of the rapid transit system. Excessive maintenance costs and operating delays

could be experienced by the Metro Rail System if adequate reliability controls are not imposed on system contractors and rigorously enforced. The reliability requirements shall ensure that all contractors:

- o Design the system optimally
- o Use reliable hardware in critical areas
- o Effectively integrate systems and subsystems
- o Minimize the life cycle cost of the product.

A. Criteria R3 - Reliability Requirements for System Equipment

During the Preliminary Engineering phase of system development, the SCRTD shall develop quantitative reliability requirements for system equipment. These numerical requirements shall be included in the appropriate contractual documents. Without exception, all contractors shall be required to demonstrate the achievement of the requirements to the satisfaction of the SCRTD.

B. Criteria R4 - Reliability Requirements Report

During Preliminary Engineering the SCRTD shall conduct a study to determine the numerical values for the reliability of system components. The requirements shall be published in a report which includes, at a minimum:

1. Reliability allocations for all major system equipment and critical equipment components
2. Model definitions and equations
3. Goals for availability, dependability, and reliability consistent with the System Operating Plan
4. Basis for the goals and numerical requirements.

The requirements shall be defined in terms of Mean Time Between Failures (MTBF), Mean Time Between Service Failures (MTBSF), Mean Cycles Between Failures (MCBF) and failure rates (λ).

C. Criteria R5 - Failure Modes, Effects, and Criticality Analyses

Contractors for the following systems shall be required to prepare and submit a FMECA to identify all critical single point failure modes. The FMECA shall be conducted to the lowest replaceable module:

1. Vehicle
2. Train Control
3. Fare Collection.

D. Criteria R6 - Reliability Analyses

Contractors for the Vehicle, Train Control, and Fare Collection systems shall be required to prepare and submit a Reliability Analysis which shall include, as a minimum:

1. System definitions and related assumptions
2. Functional flow and reliability block diagrams
3. Description of data base and any adjustment factors
4. System and subsystem failure assumptions and predicted MTBF, MTBSF, MCBF, as appropriate
5. Comparison of reliability predictions with allocations in the Reliability Requirements Report (Criteria R4)
6. Impact of operating or design changes on predicted values
7. Definitions of all interfaces, such that every part is identified as being part of a particular subsystem.

E. Criteria R7 - Reliability Demonstration Testing

Contracts shall require the achievement and demonstration of reliability requirements both by analysis and demonstration testing. The contractors for

Vehicle, Train Control, Fare Collection, and Vehicle Propulsion systems shall be required to develop Reliability Demonstration Test Plans.

The Reliability Test Plan shall include:

1. Criteria to be used by the SCRTD for evaluating the equipment under test

2. The failure reporting procedures to be used by the contractor

3. The mathematical verification that the test shall demonstrate the required MTBF, MTBSF, MCBF, and failure rates as specified by contract.

5.2.3 Requirement - Warranties

The reliable operations of subsystems are critical if the Metro Rail System is to meet its operational objectives. Reliability problems with propulsion systems components in the vehicles and with fare collection equipment can be particularly troublesome and result in a deterioration of system availability. Contractors shall be legally bound to ensure that contractual reliability requirements are achieved.

A. Criteria R8 - Failure Rate Warranties

In addition to the time warranties included for specified time periods after acceptance or delivery (Criteria Q3), additional warranty requirements relating to the maximum failure rates on particular components shall be imposed on the following contractors:

1. Vehicle

2. Fare Collection.

5.2.4 Requirement - Reliability Data

SCRTD management shall enforce the reliability requirements incorporated into contractor specifications. The contractor shall demonstrate the achievement or prove the failure of those requirements and track system reliability during testing and revenue service.

A. Criteria R9 - Reliability Data Collection and Reporting System

The SCRTD shall develop a computerized reliability data collection and reporting system capable of tracking compliance with contractual reliability requirements. The data collection formats shall meet the needs of both contractors and the SCRTD. Contractors shall be required to use the format designed by the SCRTD for reporting failures. The data system shall be integrated to the extent possible with other system assurance data collection and reporting efforts, such as maintenance and warranty enforcement.

5.2.5 Requirement - System Design Life and Environment

The components and materials selected for Metro Rail shall be of a quality and design to perform over the life of the system in the southern California environment.

A. Criteria R10 - System Life

The system elements, as described below, shall be suitable for a lifetime of use in the southern California environment, with normal maintenance and overhaul, if required, for the number of years as outlined below:

1.	Vehicle Body	30 years
2.	Train Control System	25 years
3.	Fare Collection System	25 years
4.	Tunnels	100 years
5.	Trackwork	30 years

B. Criteria R11 - System Environment

The system elements shall be capable of being operated, stored, and maintained at specified performance levels without impairment resulting from the impact of the following environmental parameters throughout the indicated range of values:

1.	Air temperature	Minimum 20°F Maximum 110°F Average 66°F

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2. Relative humidity — 24 hour range 45% to 85%

3. Rainfall in 24 hours — Maximum recorded 6.11"

4. Rainfall in 1 hour — Maximum recorded 1.87"

5. Wind speed — Average 10 mph
Maximum recorded 49 mph

6. Seismic activity:

DESIGN EARTHQUAKE PARAMETERS

DESIGN EARTHQUAKE	FOUNDATION CONDITION	DESIGN GROUND MOTION PARAMETERS: ACCELERATION (g) Hor.	ACCELERATION (g) Vert.	VELOCITY (ft/sec) Hor.	VELOCITY (ft/sec) Vert.	DISPLACEMENT (ft) Hor.	DISPLACEMENT (ft) Vert.
ODE	Soil	0.30	0.20	1.4	1.0	1.6	1.0
	Rock	0.30	0.20	0.8	0.6	0.5	0.3
MDE	Soil	0.60	0.40	3.2	2.1	3.3	2.2
	Rock	0.60	0.40	2.9	1.3	1.0	0.7

Duration of strong motion

Operating Design Earthquake (ODE) - 15-20 sec
Maximum Design Earthquake (MDE) = 25 sec (nearby faults);
30+ sec (San Andreas Fault).

DESIGN FAULT PARAMETERS

PARAMETER	SANTA MONICA	HOLLYWOOD
MDE MAGNITUDE	7	6.5
Total slip (average)	2.0 m	1.5 m
dip slip (vertical)	1.5 m	1.12 m
strike slip (horizontal)	1.3 m	1.0 m
Dip of fault plane (assumed)	60° N	45° N
Angle of intersection of fault plane and route alignment	65°	90°
Horizontal crustal shortening normal to strike	1.5 m	1.0 m

7. Air pollution:

- Dust Particulates -
  - Size: 1 to 200 microns
  - Concentration: (max.) 0.248 mg/m³; (avg.) 0.142 mg/m³
- Acid Precipitation: pH of 4.41
- Gases and fumes:

Types		Concentrations	
Carbon monoxide	(CO)	Los Angeles	19 ppm
		Burbank	29 ppm
Sulfur Oxide	(SO_x)	Los Angeles	0.037 ppm
		Burbank	0.028 ppm
Nitrogen Oxide	(NO_x)	Los Angeles	0.44 ppm
		Burbank	0.35 ppm
Ozone	(O_3)	Los Angeles	0.29 ppm
		Burbank	0.35 ppm
Carbon Dioxide	(CO_2)	Can exceed recommended exposure limit of 9,000 mg/m³	

Reference source for the above statistics:

Environmental Parameters Affecting Passenger Vehicle Design, Kaiser Engineers memo, M. Burgess to W. Rhine, August 16, 1982.

Seismological Investigation and Design Criteria, Converse Consultants, May 1983.

5.3 MAINTAINABILITY

In the process of optimizing the design of the transit system, maintainability is a major factor which affects the overall system life cycle cost. Lack of emphasis on maintainability design can result in extensive maintenance costs in future years. The degree of maintainability achieved by the Metro Rail System is directly dependent on requirements imposed on system contractors and the level of management emphasis on maintainability during the design phase of the system.

The primary objectives of the maintainability criteria will be to enhance the transit system's availability, minimize labor and material maintenance costs, vehicle downtime, and the need for specialized or highly skilled maintenance repair persons.

5.3.1 Requirement - Maintainability Program

SCRTD management shall establish and maintain an effective maintainability program. It shall be planned, integrated, and developed in conjunction with other design, development, and production functions to permit the achievement of the project goals and objectives.

A. Criteria M1 - Maintainability Program Plan - SCRTD

During Preliminary Engineering, a Maintainability Program Plan shall be developed by the SCRTD and incorporated into the SCRTD System Assurance Program Plan, Task 16 DAD. The plan shall identify the organizational elements and key personnel responsible for managing the overall maintainability program. The plan shall also clearly define the responsibilities for accomplishment of specific maintainability tasks.

The Maintainability Program Plan shall include:

1. A detailed listing and description of each task
2. The anticipated personhours required to accomplish each task
3. The timing of each task and related milestones
4. The organizational element responsible for each task
5. Identification of maintainability problems requiring resolution
6. Procedures for recording maintainability problem resolution.

The Program Plan shall be modeled after MIL-STD-470, Maintainability Program Requirements for System and Equipment.

B. Criteria M2 - Maintainability Program Plan - Contractors

Manufacturers of the following system equipment shall be required, by contract, to establish and maintain a Maintainability Program and Plan.

1. Vehicle
2. Train Control
3. Communications
4. Fare Collection
5. Traction Power.

Their plans shall be prepared using the SCRTD System Assurance Plan as a guide for style, content, and format.

5.3.2 Requirement - Quantitative and Qualitative Design Requirements

SCRTD management shall identify both quantitative and qualitative maintainability requirements. These requirements shall be incorporated into the appropriate contract specifications. Maintainability analyses shall be used during the design, production, and testing of the equipment to evaluate the degree of achievement of maintainability design requirements.

A. Criteria M3 - Maintenance Concepts

A detailed Maintenance Concept shall be developed and submitted to the SCRTD by the contractors indicated in 5.3.1-B.

The Maintenance Concept shall include a description of how the contractor intends to achieve the maintenance requirements identified in their contract. The Maintenance Concept shall cover the following, as a minimum:

1. Maintenance Levels

a. System repairs done on SCRTD property

b. Module and component repairs done on SCRTD property

c. Module and component repairs done at the contractor's facilities.

2. Maintenance Tasks

a. Scheduled Maintenance

i. Preventive Maintenance
ii. Service Maintenance.

b. Corrective Maintenance.

3. Shop Facilities

a. Union Station maintenance activities

b. Hollywood maintenance activities

c. Component Repair Facilities.

4. Shop Equipment and Tools

a. Furnished by Vehicle/Train Control/Fare Collection Contractor

b. Furnished by Shop Equipment Contractor.

5. Spare Part Requirements

a. Expected Part Life

b. Consumables and Repairables.

6. Skill Levels and Mechanics Required.

B. Criteria M4 - Maintenance Analysis

A Maintenance Analysis shall be developed and submitted to the SCRTD by the Vehicle, Train Control, and Fare Collection contractors.

The Maintenance Analysis shall be submitted iteratively (every 90-180 days) as the design develops. The analysis shall describe all the maintenance tasks

SCRTD personnel may be required to perform on the system. The analysis shall include for each maintenance task, as a minimum:

1. Frequency of task
2. Time to perform
3. Test equipment, tools, and facilities required
4. Crew size and skill level
5. Manuals and instructions needed.

5.3.3 Requirement - Maintainability Data

SCRTD management shall enforce the maintainability requirements incorporated into contractor specifications, demonstrate achievement of maintainability requirements and track maintenance costs during testing and revenue service.

A. Criteria M5 - Maintenance Data Collection and Reporting System

The SCRTD shall develop a computerized Maintenance Data Collection and Reporting System capable of collecting and reporting maintenance statistics. The data collection formats will meet the needs of both contractors and the SCRTD Metro Rail Maintenance Department. The data system shall be integrated to the extent possible with other system assurance data collection and reporting efforts, such as reliability and warranty enforcement.

5.3.4 Requirement - Manuals

SCRTD maintenance department employees shall have detailed instructions that cover the servicing and repair of all Metro Rail system components.

A. Criteria M6 - Maintenance Manuals

All suppliers and contractors shall be required to submit maintenance manuals which contain all the information needed to service, maintain, repair, inspect, adjust, troubleshoot, replace, and overhaul each component or subsystem. Requirements for the

maintenance manuals shall include, but not be limited to:

1. Running Maintenance and Servicing Manuals

2. Heavy Repair Maintenance Manuals

3. Parts Catalogs

4. Test Equipment Maintenance Manuals.

B. Criteria M7 - Manual Format and Size

The manuals shall be designed for continuous, long term service in a maintenance shop environment. All manuals shall be in either pocket size (3-1/2" x 8" x less than 1" thick) or standard size (8-1/2" wide x 11" high). All manuals shall be prepared in accordance with normal commercial standards, using MIL-M-38784 and MIL-M-15071 as guides for format and technical content, respectively.

5.3.5 Requirement - Training

Maintenance personnel shall undergo a comprehensive training program for maintaining all system elements. The training shall be sufficient for and compatible with system start up requirements. The training shall provide a level of education and ability to ensure the competent maintenance of the transit system and associated equipment.

A. Criteria M8 - Training of Maintenance Personnel

Contractors shall be required to provide a comprehensive training program for SCRTD maintenance personnel. Contractors shall provide the SCRTD with course materials, instructors, training aids, equipment, and all literature required. The contractor shall train all SCRTD maintenance personnel to a level of competence such that work performed by these personnel will not void any of the warranties or guarantees in effect.

5.3.6 Requirement - Human Factors Considerations

To efficiently service and repair system equipment, SCRTD maintenance personnel must be able to accomplish maintenance tasks in minimum time with minimal effort.

A. Criteria M9 - General Maintainability

The contractors shall incorporate qualitative features into all equipment whenever feasible. MIL-STD-1472C shall be used as a guide, along with the design features in the "Maintainability Checklist" provided in paragraph 15.3.6 of UMTA Report No. IT-06-0027-A "Guideline Specification for Urban Rail Cars", March 1973. A copy of the Maintainability Design Criteria from MIL-STD-1472C is included in Appendix A.

5.4 QUALITY ASSURANCE

The quality of the equipment procured and installed, and the facilities constructed for the Metro Rail Project is highly dependent on the quality assurance programs imposed on contractors/suppliers and the emphasis placed on enforcing those quality requirements by SCRTD management.

Inadequate definition and control of the contractors'/ suppliers' quality programs will increase the chances that the Metro Rail System will end up with unreliable components, requiring excessive system downtime and maintenance costs.

5.4.1 Requirement - Quality Assurance Program

SCRTD management shall establish and maintain an effective quality assurance program. An effective and economical quality program, planned and developed in consonance with reliability, maintainability, and configuration management programs will permit the SCRTD to realize the Metro Rail Project goals and objectives.

A. Criteria Q1 - Quality Assurance Program Plan -SCRTD

A Quality Assurance Program Plan shall be developed by the SCRTD during Preliminary Engineering and incorporated into the SCRTD System Assurance Program Plan, Task 16DAD. The plan shall identify the organizational elements and the key personnel responsible for managing the overall quality assurance program. The plan shall also clearly define the related responsibilities for accomplishment of specific quality assurance tasks.

The Quality Assurance Program Plan shall include:

1. A detailed listing and description of each task
2. The anticipated person hours required to accomplish each task
3. The timing of each task and related milestones
4. The organizational element responsible for each task
5. Identification of quality assurance problems requiring resolution
6. Procedures for recording of quality assurance problem resolution.

The Program Plan shall be consistent with MIL-Q-9858A, Quality Program Requirements.

During Continued Preliminary Engineering, a Quality Assurance Manual shall be developed to provide the detailed procedures necessary for the establishment and implementation of the control features required by these criteria and the SCRTD System Assurance Program Plan.

B. Criteria Q2 - Quality Assurance Program Plan - Contractors

Manufacturers of the following System elements shall be required, by contract, to establish and maintain a Quality Assurance Program and Plan:

1. Facilities
2. Vehicle
3. Train Control
4. Fare Collection
5. Communicators
6. Escalators
7. Elevators
8. Auxiliary Vehicles.

These plans shall be prepared using the SCRTD System Assurance Program Plan and the SCRTD Quality Assurance (QA) Manual as a guide for style, content, and format.

5.4.2 Requirement - Warranties

Equipment and facilities shall be designed so as to minimize its life cycle cost and ensure that the costs of defective or improper building or manufacture are imposed on the contractor.

A. Criteria Q3 - Warranty Requirements

Warranty provisions shall be included in all contracts, both civil and system, to assure that the costs of replacing and repairing defective materials and components are clearly the responsibility of the contractor. In addition to general warranties which cover a time period from acceptance of a facility or piece of equipment, the additional time warranties* shall be included in the vehicle contract:

1. Carbody - 5 years
2. Truck structural elements - 5 years
3. Traction motors, except brushes - 5 years
4. Gear reducers for propulsion subsystem - 5 years

5.4.3 Requirement - Quality Program Content

An effective quality assurance program is required of each contractor to ensure adequate quality of all system elements and components throughout design, development, manufacture or construction, assembly, inspection, test, delivery, and installation.

A. Criteria Q4 - Receiving Inspection

Contractors shall provide for the inspection of all incoming material. Statistical sampling, as defined in Criteria Q5 is acceptable. All material certifications and test reports used as the basis for acceptance by the contractors shall be maintained as Quality Records.

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* These warranties are in addition to the failure rate and reliability warranties outlined in Criteria (R8).

B. Criteria Q5 - Statistical Sampling Plans

Statistical quality assurance sampling used in inspection shall be fully documented and based on generally recognized and accepted statistical quality assurance practices, such as those defined in MIL-STD-105 or MIL-STD-414.

C. Criteria Q6 - Changes to Drawings and Specifications

Contractors shall ensure that all inspection and acceptance tests are based on the latest revision or change to drawings and specifications. An acceptable control system, such as that outlined in Configuration Management Criteria C4 shall be established and maintained by each contractor. The contractor's responsibility for control of changes to drawings and documentation shall extend to suppliers for the contract.

D. Criteria Q7 - Identification of Inspection Status

Contractors shall maintain a system for identifying the progressive inspection status of components or materials as to their acceptance, rejection, or noninspection.

E. Criteria Q8 - Shipping Inspection

Each contractor's Quality Assurance Program shall provide for the proper inspection of products to ensure completion of manufacturing and conformance to contract requirements prior to shipment.

F. Criteria Q9 - Quality Assurance Organization

The organization of each contractor's Quality Assurance Program shall be well defined. Quality assurance personnel shall have sufficient, well defined responsibilities and organizational freedom which encourage the identification and evaluation of quality problems. Organizations selected to build SCRTD equipment and/or facilities shall have a Quality Assurance Program that can initiate, recommend and provide solutions, verify the implementation of the solutions, and control further processing, manufacture, delivery, and installation until proper disposition and compliance with contract requirements has been obtained.

G. Criteria Q10 - Qualification of Personnel

Contractor personnel, consultants, and subcontractors performing inspections, tests, or special processes shall be qualified for such work based on prior experience and training. Records of personnel qualifications shall be maintained and available for SCRTD review.

H. Criteria Q11 - In-Process Inspection

The contractor's Quality Assurance Program shall ensure that all machining, wiring, batching, shaping, and all basic production operations of any type, together with all processing and fabricating of any type, shall be accomplished under controlled conditions. Controlled conditions shall include documented work instruction, inspection and test requirements, adequate production equipment, and any special working environment.

I. Criteria Q12 - Handling, Storage and Delivery

The contractor's Quality Assurance Program shall provide for adequate work and inspection instructions for handling, storing, preserving, packing, marking, and shipping to protect the quality of products and to prevent damage, loss, deterioration, degradation, or substitution thereof.

J. Criteria Q13 - Corrective Action

Contractors shall establish, maintain, and document procedures to ensure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, and defects in material and equipment, shall be promptly identified and corrected.

K. Criteria Q14 - Nonconforming Material

Contractors shall establish and maintain an effective and positive system for controlling nonconforming material including procedures for identification, segregation, and disposition. A Material Review Board consisting of appropriate SCRTD, contractor, Quality Assurance, and design personnel shall be established.

L. Criteria Q15 - Quality Audits

A comprehensive system of planned and periodic audits shall be carried out by the SCRTD to verify contractor compliance with all aspects of the Quality Assurance Program. The audits shall be performed at predetermined periods and by qualified SCRTD managers and consultants. Audit results shall be documented and reviewed by responsible contractor and SCRTD management personnel.

5.5 HUMAN ENGINEERING

Transit systems equipment and facilities shall be designed to provide work environments which foster effective procedures, work patterns, and personnel safety and health, and which minimize discomfort, distraction and any other factors which degrade human performance or increase error. Design shall also be directed toward minimizing personnel and training requirements within the limits of time, cost, and performance trade-offs.

Special emphasis shall be placed on solving the problems of the aged, disabled and handicapped and non-English speaking Metro Rail riders.

5.5.1 Requirement - Human Factors Program

SCRTD management shall establish and maintain a human factors program which will permit the attainment of project goals and objectives.

A. Criteria H1 - Human Factors Program Plan - SCRTD

A Human Factors Program Plan shall be developed by the SCRTD during Preliminary Engineering and incorporated into the SCRTD System Assurance Program Plan, Task 16DAD. The plan shall describe the method for assuring analysis of critical human factors including:

1. Equipment design
2. Passenger acceptance
3. Maintainability

4. Operator controls

5. Operational safety.

The Program Plan shall reference MIL-STD-1472C, Human Engineering Design Criteria.

B. Criteria H2 - Human Factors Program Plan - Contractors

The passenger vehicle contractor shall be required to establish and maintain a Human Factors Program Plan. The plan shall describe the major tasks the contractor will perform during the program, along with a schedule for each.

C. Criteria H3 - Human Factors Report

A report shall be submitted to the SCRTD by the vehicle contractor prior to the Critical Design Review (CDR) summarizing the human engineering effort for the entire program. The report shall include the following:

1. Reasons a particular alternative was chosen or recommended,

2. A description of the major assumptions made concerning human capabilities and limitations, including data ensuring that operator performance and passenger acceptance have been considered,

3. The results of any approved mock-up or simulation program to determine the requirements for layout and design, and

4. The results to date of any analysis performed to determine the requirements for development of specialized training and training equipment.

D. Criteria H4 - Barrier Free Design

Designers shall make specific provisions for the reduction and possible elimination of operating barriers in all Metro Rail elements (passenger stations, vehicles, platforms, fare barriers, operating and maintenance facilities) which impede the mobility of elderly and handicapped patrons and system employees.

References and specific requirements pertaining to accessibility by the elderly and handicapped are contained in Volume III, Section 1 of the System Design Criteria & Standards. Additional requirements pertaining to the accessibility of specific elements of the system are found in the appropriate sections of the criteria and standards.

5.5.2 Requirement - Elderly and Handicapped Accessibility

The SCRTD shall ensure compliance with the regulations pertaining to barrier free design as contained in Title 24, California Administrative Code (CAC), parts 2, 3, and 5, and the U.S. General Services Administration's Minimum Accessibility Standard.

5.6 CONFIGURATION MANAGEMENT

Configuration Management is a discipline applying technical and administrative direction and surveillance to identify and document the functional and physical characteristics of a configuration item; control changes to those characteristics, and record and report change processing and implementation status.

It includes configuration identification, control, status accounting, and audits. Configuration Management is thus the means through which the integrity and continuity of the design, engineering, and cost trade-off decisions made between technical performance, producibility, operability, and supportability are recorded, communicated, and controlled by program and functional managers.

5.6.1 Requirement - Configuration Management Program

SCRTD management shall establish and maintain an effective configuration management program. A formal Configuration Management Plan is needed to assure the management and technical skills necessary to control the transit system configuration are applied in a coherent and organized manner.

A. Criteria C1 - Configuration Management Plan - SCRTD/GC

The General Consultant shall prepare and implement a Configuration Management Plan, based on the Configuration Management Program Plan developed during the

Preliminary Engineering Phase, and approved by the SCRTD. The plan shall identify the organizational elements and key personnel responsible for the over all configuration management program. The plan shall also clearly define the responsibilities for accomplishment of specific configuration management tasks.

The Configuration Management Plan shall be modeled after the criteria outlined in MIL-STD-483-USAF, Configuration Management Practices, Appendix A.

B. Criteria C2 - Configuration Management Program - Contractors

1. The following system equipment contractors shall be required to prepare and maintain a Configuration Management Program that complies with the basic requirements of MIL-STD-483-USAF:

   a. Vehicle

   b. Train Control

   c. Communications

   d. Fare Collection

   e. Traction Power.

2. The configuration management program shall include the elements of:

   a. Configuration identification, including drawing identification and release

   b. Change control

   c. Configuration accountability.

3. Equipment manufacturers shall not be required to modify, expand or replace their existing manufacturing, and change control and reporting systems if they can show, to the satisfaction of the SCRTD, that their existing systems will accomplish the configuration management objectives as defined in contractual documents. Drawing numbering shall be in accordance with the system being established by the GC for the Metro Rail Project.

4. Design consultants, construction contractors, and systems equipment contractors other than those listed in paragraph B.1. above shall demonstrate to the SCRTD that at the time he receives Notice to Proceed he has in place adequate procedures for:

   a. Drawing Release and Control

   b. Change Control

   c. Drawing Number and (if required) Part Numbering Identification

   d. Change Status Reporting.

5. Drawing numbering shall be in accordance with the system being established by the GC for the Metro Rail Project.

5.6.2 Requirement - Document Control

A system for the consistent controls and storage of all incoming documents shall be established by the SCRTD. The system developed shall allow Metro Rail Project personnel to locate, borrow, copy, and return any document to its prescribed filing location.

A. Criteria C3 - Document Control

The GC shall develop and maintain a Document Control Center capable of filing, locating and retrieving all Metro Rail Project documents. Operation of the Document Control Center shall be consistent with and supportive of the requirements of the Metro Rail Project. The Configuration Management Plan and procedures shall include the requirements and procedures for operation of the Document Control Center.

5.6.3 Requirement - Configuration Identification and Control

The SCRTD shall set policies relating to configuration identification, part number, engineering changes, and configuration accountability. Consistent policy and direction will help assure all systems can be successfully integrated.

A. Criteria C4 - Configuration Identification

The contractor's technical documentation shall be capable of defining the approved configuration of system equipment under development, test, production, or operational use. The technical documentation shall identify the configuration to the lowest level necessary to meet production and maintenance requirements. The contractor's release records and documentation shall be capable of determining:

1. The composition of any part number at any level in terms of subordinate part numbers

2. All next assembly part numbers of any part

3. The specification document or drawing number associated with the part number.

B. Criteria C5 - Part Numbers

All part numbers used by the SCRTD or their contractors or subcontractors shall identify a specific item having a specific configuration. All items, beginning with the lowest replaceable or repairable unit, and identified by the same part number, shall have the same physical and functional characteristics, shall be equivalent in performance and durability and shall be interchangeable without alteration to themselves or associated items, other than normal field adjustments.

C. Criteria C6 - Change Control

The SCRTD and its contractors shall apply orderly controls to the management of engineering design changes. The SCRTD and its contractors shall assure that all engineering change proposals are screened at management levels high enough so that only essential changes are submitted. All potential impacts of the change shall be considered including:

1. Safety

2. Reliability

3. Maintainability

4. Human Engineering

5. Scheduling and Cost Impact

6. Test(s) Implications

7. Retrofit Requirements

8. Publications

9. Training

10. Spare Parts.

Engineering changes shall be classified as Class I or Class II, as defined in MIL-STD-480A, Configuration Control of Engineering Changes, Deviations and Waivers. Class I changes shall be processed on a change request form provided by the General Consultant and shall be submitted to the SCRTD for approval prior to implementation. The GC shall submit Class II changes to the SCRTD for concurrence in classification only.

D. Criteria C7 - Configuration Accountability

Contractors shall maintain records such that the configuration of any item being delivered shall be definable in terms of its component part numbers. A serialization and configuration record shall be maintained for all items delivered by a contractor to the SCRTD.

5.6.4 Requirement - Design Reviews and Audits

During the evolution of the design and manufacturing process, the SCRTD shall monitor the contractor's efforts to determine the degree to which the objectives and goals of the Metro Rail System are being achieved. The following design reviews and audits shall be conducted jointly by the SCRTD and the contractors.

A. Criteria C8 - Preliminary Design Reviews

As appropriate for each contractor, a Preliminary Design Review shall be conducted prior to detail design to evaluate the progress and technical adequacy of the selected design approach.

B. Criteria C9 - Other Design Review

Every contractor shall prepare the requested material for submission to In-Progress, Pre-Final, and Final Design Reviews at design milestones determined by SCRTD. Participants shall include contractor, SCRTD and GC staff and others deemed appropriate by the SCRTD. The purpose of the reviews shall be to determine that the item under review is capable of meeting the requirements established in the contract documents.

C. Criteria C10 - Physical Configuration Audit

For major systems equipment as defined in 5.6.1-B, the SCRTD, assisted by the GC, shall conduct a physical configuration audit on the first production unit by formal examination against the production drawings and specifications in order to establish the production baseline.

D. Criteria C11 - Functional Configuration Audit

Functional configuration audits shall be conducted by the system equipment subjected to qualification testing after successful completion of qualification testing. An audit shall also be conducted at the completion of the passenger vehicle performance demonstration testing to verify formally that the vehicle has achieved the performance required by the contract specifications.

E. Criteria C12 - Configuration Status Reporting

As configuration baselines are established throughout the project, the baseline documentation shall be identified and recorded. All approved changes to a baseline shall be recorded and maintained and periodically reported to the SCRTD.

5.6.5 Requirement - Contract Drawings

The SCRTD will need to reference and copy many of the drawings and documents submitted by their contractors. The drawings shall be of appropriate quality and size. More detailed Criteria regarding drawing standards are included in Volume I, Section 1, Contract Drawings.

VOLUME I, SECTION 5 SYSTEM ASSURANCE (Cont'd.)

A. Criteria C13 - Drawing Quality

Drawings shall be of a quality where every line, number, and symbol is clearly legible.

B. Criteria C14 - Drawing Size

Standard drawing size shall be 22" by 34" unless approved by the SCRTD.

C. Criteria C15 - Microfilm

Any microfilm provided shall be 35mm silver halide film and shall be processed to archival standards.

5.7 APPENDIX A

MAINTAINABILITY CHECKLIST

MIL-STD-1472C

5.9.3.5 Sensitive Adjustments - Sensitive adjustment points shall be located or guarded so that adjustments will not be disturbed inadvertently. Suitable hand or arm support shall be provided near the location to facilitate making the adjustment in all cases where the operator is subjected to disturbing vibrations or acceleration during the adjustment operation.

5.9.3.6 Hazardous Locations - Internal controls should not be located close to dangerous voltages, rotating machinery, or any other hazards. If such location cannot be avoided, the controls shall be appropriately shielded and labeled.

5.9.4 Accessibility -

5.9.4.1 Structural Members - Structural members of units or chassis shall not prevent access to or removal of components. Replaceable items shall not be placed in a manner which will make them difficult to remove. Where accessibility depends upon removal of panels, cases, and covers, measures shall be taken to insure that such items are not blocked by structural members or other items.

5.9.4.2 Large Parts - Large parts which are difficult to remove shall be so mounted that they will not prevent convenient access to other parts.

5.9.4.3 Use of Tools and Test Equipment - Check points, adjustment points, test points, cables, connectors, and labels shall be accessible and visible during maintenance. Sufficient space shall be provided for the use of test equipment and other required tools without difficulty or hazard.

5.9.4.4 Rear Access Units - Sliding, rotating or hinged units to which rear access is required shall be free to open or rotate their full distance and remain in the open position without being supported by hand. Rear access shall also be provided to plug connectors except where precluded by any other operational requirements.

5.9.4.5 Relative Accessibility - In determining the relative accessibility of units, those units which are critical to system operation and which require rapid maintenance shall be most accessible. When relative criticality is not a factor, these units requiring most frequent access shall be most accessible.

5.9.4.6 High-Failure-Rate-Items - The physical arrangement of units and components should be such that high-failure-rate items will be accessible for replacement without moving non-failed components or units. Mechanical replacement items shall be removable with common hand tools and simple handling equipment.

5.9.4.7 Skills - Access to units maintained by one technician should not require removal of critical equipment maintained by another technician, particularly where highly specialized skills are involved.

5.9.5 Lubrication -

5.9.5.1 General - Units containing mechanical components shall be designed to permit lubrication of the components without disassembling the unit, or they shall not require lubrication for the life of the unit. Extended fittings shall be provided to lubricate parts not readily accessible or visible.

5.9.5.2 Labeling - Where lubrication is required, the type of lubricant to be used and the frequency of lubrication shall be specified by a label mounted at or near the lube port. A lubrication chart of permanent construction shall be mounted at the operator station of the equipment; individual labels shall not be required when the equipment has only one type of fitting and uses only one type of lubricant.

5.9.6 Unit Cases and Covers -

5.9.6.1 Alignment - Covers or shields through which mounting screws must pass for attachment to the basic chassis of the unit shall have large enough holes to permit the screws to pass without perfect case alignment.

5.9.6.2 Edges and Corners - Edges and corners on cases and covers shall be rounded or otherwise finished to prevent injury to personnel.

5.9.7 Cases -

5.9.7.1 Orientation of Units - The proper orientation of a unit within its case shall be made obvious, either through design of the case or by means of appropriate labels.

5.9.7.2 Removal of Units - When practical, cases shall be designed to be lifted from units rather than units lifted from cases.

5.9.7.3 Size - Cases shall be sufficiently larger than the units they cover to minimize the possibility of damaging wires or other components when the cases are put on or taken off.

5.9.7.4 Guides - Guides, tracks, and stops shall be provided as necessary to facilitate handling and to prevent damage to units and components, and injury to personnel.

5.9.8 Covers -

5.9.8.1 Securing of Covers - It shall be made obvious when a cover is not secured, even though it may be in place.

5.9.8.2 Instructions - If the method of opening a cover is not obvious from the construction of the cover itself, instructions shall be permanently displayed on the outside of the cover.

5.9.8.3 Clearance - Bulkheads, brackets, and other units shall not interfere with removal or opening of covers on units within which work must be performed.

5.9.9 Access Openings and Covers -

5.9.9.1 Application - An access shall be provided whenever frequent maintenance operations would otherwise require removing a case or covering, opening a fitting, or dismantling a component.

5.9.9.2 Self-Supporting Covers - All access covers that are not completely removable shall be self-supporting in the open position. Accesses (and covers) should be devoid of sharp edges to preclude hand injury and clothing damage.

5.9.9.3 Labeling - Each access should be labeled with nomenclature for items visible or accessible through it, nomenclature for auxiliary equipment to be used with it and recommended procedures for accomplishing operations. Accesses shall be labeled with warning signs, advising of any hazards existing beyond the access and stating necessary precaution. If instructions applying to a covered item are lettered on a hinged door, the lettering shall be properly oriented to be read when the door is open. Warning notices shall be clear, direct, and attention getting and of 25 percent larger letter size than any detailed instructions which follow (e.g., Danger! Deadly Shock Hazard! rather than Warning-High Voltage).

5.9.9.4 Physical Access -

5.9.9.4.1 Arm and Hand Access - Access openings provided for adjusting and handling interior items shall be sufficiently large to permit the required operations and where possible, provide an adequate view of the components being manipulated. Access covers shall be equipped with grasp areas or other means for opening them. The dimensions of access openings for arms, hands and fingers shall be no less than those shown in Figure 37. Allowance shall be made for the clearance of the operator's gloved or mittened hand, as appropriate, if the access is located externally

Figure 37. ARM AND HAND ACCESS DIMENSIONS, IN mm (CONCLUDED)

and may require servicing under arctic conditions. If a hazardous condition, such as exposed conductors energized with dangerous voltages, exist behind the access, the physical barrier over the access shall be equipped with an interlock that will de-energize the hazardous equipment when the barrier is opened or removed.

Where physical access is required, the following practices shall be followed in order of preference:

a. An opening with no cover unless this is likely to degrade system performance or safety.

b. A sliding or hinged cap or door where dirt, moisture, or other foreign materials might otherwise create a problem.

c. A quick-opening cover plate if a cap will not meet stress requirements.

5.9.9.4.2 Whole Body Access - See 5.7.8.3

5.9.9.5 Visual Access - Where visual access only is required, the following practices shall be followed in order of preference:

a. An opening with no cover except where this might degrade system performance.

b. A transparent window if dirt, moisture, or other foreign materials might otherwise create a problem.

c. A break-resistant glass window if physical wear, heat, or contact with solvents would otherwise cause optical deterioration.

d. A quick-opening metal cover if glass will not meet stress or other requirements.

5.9.10 Fasteners -

5.9.10.1 General - The number and diversity of fasteners used shall be the minimum commensurate with requirements for stress, bonding, etc. Hand-operated fasteners shall be given preference; those requiring non-standard tools shall not be used.

5.9.10.2 Hinges and Tongue-and-Slot Catches - Optimum use shall be made of hinges and tongue-and-slot catches to minimize the number of fasteners required.

5.9.10.3 Captive Fasteners - Captive bolts and nuts shall be used in situations where dropping such items might cause damage to equipment or create a difficult or hazardous removal problem. Captive fasteners shall be provided for access covers requiring periodic removal. Captive, quick-opening fasteners shall be provided on cases and covers, except where equipment performance would be jeopardized thereby. Whenever feasible, the same type and size of fasteners should be provided for all cases and covers.

5.9.10.4 Size and Quantity - If a hinged access panel or quick-opening fasteners will not meet stress, pressurization, shielding or safety requirements, the minimum number of the largest screws consistent with these requirements shall be used.

5.9.10.5 External-Grip Head - Whenever possible, an external-grip head shall be provided on bolts requiring high torques (to reduce the need to drill out bolts with damaged slots).

5.9.10.6 Accessibility - The heads of mounting bolts and fasteners should be located on surfaces readily accessible to the technician.

5.9.10.7 Common Items - Whenever possible, identical screw and bolt heads shall be provided to allow various panels and components to be removed with one type of tool. Combination bolt heads such as slotted hex head should be selected whenever feasible.

5.9.10.8 Number of Turns - Fasteners for mounting assemblies and sub-assemblies shall require only one complete turn, provided that stress and load considerations are not compromised. When bolts are required, the number of turns needed to tighten and loosen them shall be minimized.

5.9.11 Unit Design for Efficient Handling -

5.9.11.1 Rests and Stands - Rests or stands on which units can be placed should be provided, including space for test equipment, tools, and manuals whenever feasible. When permitted by design requirements, such rests or stands shall be part of the basic unit, rack or console chassis.

5.9.11.2 Extensions - Irregular, fragile, or awkward extensions, such as cables, wave guides, hoses, etc., shall be designed for easy removal from a unit before handling.

5.9.11.3 Weight -

5.9.11.3.1 Lifting -

5.9.11.3.1.1 Limits - The weight limits in Table XXI shall be used as the maximum values in determining the design weight of items requiring one-man lifting, providing the item to be lifted is of convenient configuration (not more than 15 inches (380mm) long, or 12 inches (300mm) high) and handles or grasp areas conform to 5.9.11.5; however, the limits in Table XXI shall be used as the maximum values in determining the design weight of items requiring two-man lifting, providing the item to be lifted is of convenient configuration, handles and grasp areas conform to 5.9.11.5, and the one-man limit, as stated above, is not exceeded for either man.

5.9.11.3.1.2 Labeling - Items weighing more than the one-man lift values of Table XXI shall be prominently labeled with weight indication and lift limitation, i.e., mechanical or two-man lift. Where mechanical or power lift is required, hoist and lift points shall be provided and clearly labeled.

5.9.11.3.2 Carrying - The limits in Table XXI are not applicable to tasks requiring carrying the items of equipment more than five steps. (See 5.11.1)

5.9.11.4 Horizontal Push and Pull Forces - Manual horizontal push and pull forces required, to be applied initially to an object to set it in motion or to be sustained over a period of time, shall not exceed the values of Table XXII, as applicable. Use of the maxima shown in Table XXII, is predicated upon a suitable surface for force exertion, i.e., vertical with rough surface and be approximately 16 inches (400mm) wide between 20 and 50 inches (0.510 and 1.270m) above the floor to allow force application with the hands, the shoulder or the back.

5.9.11.5 Handles and Grasp Areas -

5.9.11.5.1 General - All removable or carried units designed to be removed and replaced shall be provided with handles or other suitable means for grasping, handling, and carrying (where appropriate, by gloved or mittened hand).

5.9.11.5.2 Location - Whenever possible, handles or grasp areas shall be located relative to the center of gravity of the unit to preclude swinging or tilting when lifted. They shall be located to provide at least 2 inches (50mm) of clearance from obstructions during handling.

TABLE XXI. DESIGN WEIGHT LIMITS

HEIGHT OF LIFT FROM GROUND	MAXIMUM WEIGHT OF ITEM
5 ft (1.500 m)	35 lb (16 kg)
4 ft (1.200 m)	50 lb (23 kg)
3 ft (900 mm)	65 lb (29 kg)
2 ft (600 mm)	80 lb (36 kg)
1 ft (300 mm)	85 lb (39 kg)

TABLE XXII. HORIZONTAL PUSH AND PULL FORCES EXERTABLE (INTERMITTENTLY OR FOR SHORT PERIODS OF TIME)

HORIZONTAL FORCE*; AT LEAST	APPLIED WITH	CONDITION (μ: COEFFICIENT OF FRICTION)
25 lb (110 N) push or pull	both hands or one shoulder or the back	with low traction $0.2 < \mu < 0.3$
45 lb (200 N) push or pull	both hands or one shoulder or the back	with medium traction $\mu \sim 0.6$
55 lb (240 N) push	one hand	if braced against a vertical wall 20-60 in. (510-1520 mm) from and parallel to the push panel
70 lb (310 N) push or pull	both hands or one shoulder or the back	with high traction $\mu > 0.9$
110 lb (490 N) push or pull	both hands or one shoulder or the back	if braced against a vertical wall 20-70 in. (510-1780 mm) from and parallel to the panel or if anchoring the feet on a perfectly nonslip ground (like a footrest)
165 lb (730 N) push	the back	if braced against a vertical wall 23-43 in. (580-1090 mm) from and parallel to the push panel or if anchoring the feet on a perfectly nonslip ground (like a footrest)

*May be doubled for two and tripled for three operators pushing simultaneously. For the fourth and each additional operator, not more than 75% of his push capability should be added.

5.9.11.5.3 Nonfixed Handles - Nonfixed handles (e.g., hinged or fold-out) shall have a stop position for holding the handle perpendicular to the surface on which it is mounted and shall be capable of being placed into carrying position by one hand (where appropriate, by gloved or mittened hand).

5.9.11.5.4 Grasp Surface - Where a unit's installation requires that its bottom surface be used as a handhold during removal or installation, a nonslip grasp surface (e.g., grooved or frictional) shall be provided.

5.9.11.5.5. Handle Dimensions - Handles which are to be used with mittened, gloved, or ungloved hands shall equal or exceed the minimum applicable dimensions shown in Figure 38.

5.9.11.5.6 Handle and Grasp Area Force Requirements - Force requirements to operate handle and grasp areas other than controls covered by paragraph 5.4 shall not exceed the values in Figure 15.

5.9.11.5.7 Handle Material - Whenever possible, handles or grasp areas used with bare hands should have surfaces that are not thermally or electrically conductive. The surface should be sufficiently hard to prevent imbedding of grit and grime during normal use.

5.9.12 Mounting -

5.9.12.1 General - Units shall be designed so that they cannot be mounted improperly.

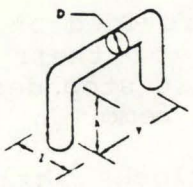
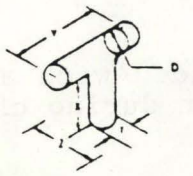
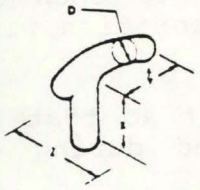
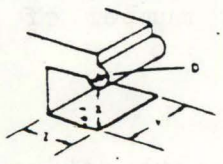
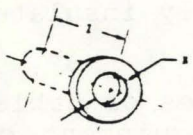
5.9.12.2 Tools - Field removable units shall be replaceable by use of nothing more than common hand tools.

5.9.12.3 Removal - Units should be removable along a straight or slightly curved line, rather than through an angle.

5.9.12.4 Alignment - Guide pins or their equivalent shall be provided to assist in alignment during mounting, particularly on modules that are connectors themselves.

5.9.12.5 Coding - All replaceable items shall be coded (i.e., keyed) so that it will be physically impossible to insert a wrong item. Coding by such means as color or labels shall identify the correct item and its proper orientation for replacement.

FIGURE 38. MINIMUM HANDLE DIMENSIONS

ILLUSTRATIONS	TYPE OF HANDLE	DIMENSIONS IN INCHES (in mm)								
		(Bare Hand)			(Gloved Hand)			(Mittened Hand)		
		X	Y	Z	X	Y	Z	X	Y	Z
	Two-finger bar	1.25 (32)	2.5 (65)	3.0 (75)	1.5 (38)	3.0 (75)	3.0 (75)	Not Applicable		
	One-hand bar	2.0 (50)	4.5 (115)	3.0 (75)	3.5 (90)	5.25 (135)	4.0 (100)	3.5 (90)	5.25 (135)	6.0 (150)
	Two-hand bar	2.0 (50)	8.5 (215)	3.0 (75)	3.5 (90)	10.5 (270)	4.0 (100)	3.5 (90)	11.0 (280)	6.0 (150)
	T-bar	1.5 (38)	4.0 (100)	3.0 (75)	2.0 (50)	4.5 (115)	4.0 (100)	Not Applicable		
	J-bar	2.0 (50)	4.0 (100)	3.0 (75)	2.0 (50)	4.5 (115)	4.0 (100)	3.0 (75)	5.0 (125)	6.0 (150)
	Two-finger recess	1.25 (32)	2.5 (65)	2.0 (50)	1.5 (38)	3.0 (75)	2.0 (50)	Not Applicable		
	One-hand recess	2.0 (50)	4.25 (110)	3.5 (90)	3.5 (90)	5.25 (135)	4.0 (100)	3.5 (90)	5.25 (135)	5.0 (125)
	Finger-tip recess	0.75 (19)	–	0.5 (13)	1.0 (25)	–	0.75 (19)	Not Applicable		
	One-finger recess	1.25 (32)	–	2.0 (50)	1.5 (38)	–	2.0 (50)	Not Applicable		

Curvature of Handle or Edge	Weight of Item	Minimum Diameter	
	Up to 15 lbs (up to 6.8 kg)	D - 1/4 in. (6 mm)	Gripping efficiency is best if finger can curl around handle or edge to any angle of 120 degrees or better.
	15 to 20 lbs (6.8 to 9.0 kg)	D - 1/2 in. (13 mm)	
	20 to 40 lbs (9.0 to 18 kg)	D - 3/4 in. (19 mm)	
	Over 40 lbs (over 18 kg)	D - 1 in. (25 mm)	
	T-bar Post	T - 1/2 in. (13 mm)	

5.9.12.6 Rollout Racks, Slides or Hinges - Units which are frequently pulled out of their installed positions for checking shall be mounted on rollout racks, slides or hinges. Rollout racks should not shift the center of gravity to the extent that the entire rack or console falls. If this possibility exists, the console or rack shall be safely secured.

5.9.12.7 Limit Stops - Limit stops shall be provided on racks and drawers which are required to be pulled out of their installed positions for checking or maintenance. The limit stop design shall permit convenient overriding of stops for unit removal.

5.9.12.8 Interlocks - Where applicable, interlocks shall be provided to ensure disconnection of equipment that would otherwise be damaged by withdrawal of racks or drawers.

5.9.12.9 Braces - Hinged units shall be provided with a brace or other means to hold units in the "out" position during checking or maintenance.

5.9.12.10 Rear Access - Sliding, rotating, or hinged units to which rear access is required shall be free to open or rotate their full distance and remain in the "open" position without being supported by hand.

5.9.12.11 Lay-Out - Units shall be laid out so that a minimum of place-to-place movements will be required during checkout.

5.9.12.12 Covers or Panels - Removal of any replaceable unit shall require opening or removing a minimum number of covers or panels.

5.9.13 Conductors -

5.9.13.1 Cables - Conductors shall be bound into cables and held by lacing tape per MIL-T-43435 or equivalent means.

5.9.13.2 Coding - Cables containing individually insulated conductors with a common sheath shall be coded.

5.9.13.3 Cable Clamps - Long conductors, bundles or cables, internal to equipment, shall be secured to the equipment chassis by means of clamps unless contained in wiring ducts or cable retractors.

5.9.13.4 Length - Cables shall be long enough so that each functioning unit can be checked in a convenient place. Extension cables shall be provided where this is not feasible.

5.9.13.5 Location of Test Cables - If it is essential that test cables terminate on control and display panels, the test receptacles shall be so located that the test cables will not interfere with controls and displays.

5.9.13.6 Access - Cables shall be routed so as to be readily accessible for inspection and repair.

5.9.13.7 Susceptability to Abuse - Cables shall be routed or protected in such a way that they may not be pinched by doors, lids, etc., walked on, used for hand holds, or bent or twisted sharply or repeatedly.

5.9.13.8 Cable Protection - If it is necessary to route cables and wires through holes in metal partitions, the conductors shall be protected from mechanical damage or wear by grommets or equivalent means.

5.9.13.9 Identification - Cables shall be labeled to indicate the equipment to which they belong and the connectors with which they mate.

5.9.14 Connectors -

5.9.14.1 Use of Quick Disconnect Plugs - Plugs requiring no more than one turn, or other quick-disconnect plugs, shall be provided whenever feasible.

5.9.14.2 Keying - Plugs shall be so designed that it will be impossible to insert a wrong plug into a receptacle.

5.9.14.3 Identification - Connecting plugs and receptacles shall be clearly identified by color, size, or equivalent means.

5.9.14.4 Alignment - Plugs or receptacles shall be provided with alignment pins or equivalent devices to aid in alignment and to preclude inserting in other than the desired position.

5.9.14.5 Aligning Pins - Aligning pins shall extend beyond the plug's electrical pins to insure that alignment is obtained before the electrical pins engage.

5.9.14.6 Orientation - Plugs and receptacles shall be arranged so that the aligning pins or equivalent devices are oriented in the same relative position.

5.9.14.7 Coding - Plugs and receptacles shall have durable stripes, arrows, or other indications to show the positions of aligning pins or equivalent devices for proper insertion.

5.9.14.8 Spacing - Connectors shall be spaced far enough apart so that they can be grasped firmly for connecting and disconnecting. Space between adjacent connectors will depend upon the size and shape of the plugs, but shall not be less than 1 inch (25mm), except where connectors are to be sequentially removed and replaced and one inch clearance is available in the plane perpendicular to the remove/replace sequence line.

5.9.14.9 Testing and Servicing - The rear of plug connectors shall be accessible for testing and servicing, except where precluded by potting, sealing, or other requirements.

5.9.14.10 Drawer Modules - Drawer modules designed for "remove and replace" maintenance shall be provided with connectors mounted on the back of the drawer and mated with connectors in the cabinet to accomplish electrical inter-connection between the drawer, other equipment in the rack and external connectors, where feasible. Guide pins or equivalent devices shall be provided to aid in alignment.

5.9.14.11 Simplicity - In electronic equipment, replacement items (e.g., modules and high-failure-rate components) shall normally be provided with simple plug-in connectors.

5.9.14.12 Disassembly and Adapters - Disassembly of connectors for reasons of changing pin connections should be easily performed without special tools. When adapters are required, they shall be capable of being hand-tightened.

5.9.15 Test Points - For purposes of this standard, test points shall be classified as defined in MIL-STD-415. Test provisions and marking shall be as specified in MIL-STD-415.

5.9.15.1 Adjustment - Test points used in adjusting a unit shall be located close to the controls and displays used in the adjustment.

5.9.15.2 Trouble-Shooting - Sufficient test points shall be provided so that it will not be necessary to remove subassemblies from assemblies to accomplish trouble-shooting.

5.9.16 Test Equipment -

5.9.16.1 Storage - Adequate storage space shall be provided within portable test equipment, its handling case, or lid to contain leads, probes, spares, manuals, and special tools, as required for operation.

5.9.16.2 Instructions - Instructions for operating portable test equipment shall be provided on the face of the test equipment, in a lid, or in a special compartment. When applicable, the instructions shall include a reminder to calibrate the equipment before using it.

5.9.17 Failure Indications and Fuse Requirements -

5.9.17.1 Indication of Equipment Failure -

5.9.17.1.1 Power Failure - An indication shall be provided to reveal when power failure occurs.

5.9.17.1.2 Out-of-Tolerance - Displays shall be provided to indicate when equipment has failed or is not operating within tolerance limits.

5.9.17.1.3. Critical Malfunctions - If equipment is not regularly monitored, an auditory alarm shall be provided to indicate critical malfunctions.

5.9.17.2 Fuses and Circuit Breakers -

5.9.17.2.1 General - When required by the system, a positive indication shall be provided to reveal that a fuse or circuit breaker has opened a circuit; labels shall be provided on fuse panels to indicate the rating of each fuse and the area of major equipment serviced by the fuse or circuit breaker.

5.9.17.2.2 Replacement - Fuses shall be readily accessible for removal and replacement. No other components shall require removal in order to gain access to fuses. Spare fuse holders shall be provided; no special tools shall be required for fuse replacement unless required by safety considerations.

5.9.17.2.3 Fuse Rating - Fuse ratings shall be indicated either in whole numbers, common fractions such as 1/4, or whole numbers and common fractions such as 2-½.

5.9.18 Gas and Fluid Line Identification - Gas, fluid, and electrical conduit lines shall be identified in accordance with MIL-STD-1247.

5.8 APPENDIX B

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5. Draft System Specification - Metropolitan Dade County Transportation Improvement Program - Stage 1 Rapid Transit System, Kaiser Transit Group, March 1978.

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