DESIGN CONTROL PLAN

28686948

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

METRO RAIL PROJECT

GUIDELINES FOR THE PREPARATION OF SAFETY AND SYSTEM ASSURANCE ANALYSES

SCRTD 5-001

March 1987

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L I S T   O F   E X H I B I T S

ACKNOWLEDGMENTS

The SCRTD Metro Rail Guidelines for the Preparation of Safety and System Assurance Analyses were prepared primarily from information contained in previously published material.

The chapters on Safety Analyses were prepared based on System Safety Analysis: A Description of the Formats and Methodologies for System Safety Analysis of Fixed Guideway Transit Systems, prepared for the Urban Mass Transportation Administration, Office of Safety and Product Qualification, by Booz, Allen & Hamilton, January 1981, Contract No. DOTUM-60-80-C071004.

The chapter on Failure Mode, Effects, and Criticality Analysis was based on the Society of Automotive Engineers (SAE) Aerospace Recommended Practice 926, Issued September 15, 1967.

The chapters on Preventive Maintenance Schedules and Corrective Maintenance Analysis were based on documentation prepared by the Budd Co. and Westinghouse for the Miami/Baltimore vehicle procurement. Additional material was based on maintainability analyses prepared by Westinghouse for the STARS AC propulsion project for the Urban Mass Transportation Administration, Contract No. DOTUM 60-82-C-71145.

1.0 INTRODUCTION

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Contained in this document are the guidelines for preparation of many of the safety, reliability, and maintenance analyses required from Metro Rail systems contractors. Where referenced in the appropriate Contract Specifications Book, the use of the specified approach to conducting the identified analyses is a contractual requirement.

1.1 PURPOSE

The purpose of this document is to present uniform formats and methodologies which will be used for safety and system assurance analyses prepared by Metro Rail systems contractors. The goal of making the Metro Rail system as reliable, maintainable, and safe as possible can be more easily accomplished if safety and system assurance analyses for all contracts are conducted in the same manner and displayed in the same format. Even though the analyses presented will not apply identically to each system or contract, the uniform set of formats and methodologies should result in more streamlined processing of the information.

1.2 SCOPE

The guidelines contained in this document provide the formats and methodologies for conducting the following analyses:

- Preliminary Hazard Analysis
- Subsystem Hazard Analysis
- Interface Hazard Analysis
- Operating Hazard Analysis
- Failure Mode, Effects, and Criticality Analysis
- Corrective Maintenance Analysis.

Guidelines for a standard approach and format presentation are also provided for the following:

- Critical/Catastrophic Items List
- Preventive Maintenance Schedules.

This document does not present guidelines for other analyses such as:

- Reliability Analyses, Block Diagrams, and Models
- Fault Hazard Analysis
- Systems Effectiveness Analysis
- Single Point Failure Summaries.

Those analyses, if required, will be submitted in a format selected by the contractor and approved by the SCRTD.

Not all analyses are required Contract Deliverable Requirements List (CDRL) items for all contracts. However, nothing precludes contractors from conducting additional analyses they may deem necessary for the safe, reliable, and maintainable design of their products. For example, even though a preliminary hazard analysis (PHA) may not be identified as a contract deliverable, the contractor may find that development of the PHA is a prerequisite requirement to the successful conduct of other hazard analyses.

Following this introduction, Chapter 2.0 presents an overview of the safety, reliability, and maintenance analyses, their purpose, and interrelationships. Chapters 3.0 through 10.0 discuss each of the subject analyses.

2.0 OVERVIEW OF THE ANALYSES

2.0 OVERVIEW OF THE ANALYSES

Chapter 2.0 presents an overview of safety, reliability, and maintenance analyses, their interrelationships, and key definitions.

2.1 GENERAL

A major objective of the Metro Rail system is to provide safe and reliable transportation. Achieving this objective requires the SCRTD to pay close attention to the safety and systems assurance elements of all facilities, systems, and equipment.

In a safety program for an emerging transit system, safety hazards are identified throughout the design, construction, fabrication, installation, testing, and preoperational phases. The SCRTD has established a safety program designed to eliminate and/or control hazards. Hazards that cannot be eliminated in the design are to be controlled by providing safety devices, warnings, and information, and providing adequate written and oral instructions to prevent accidents.

The safety analyses required from contractors are part of a formalized program to identify and eliminate and/or control hazards. Specifically, the safety analyses provide for the:

- Identification of hazards
- Determination of the probability and severity of the potential accident
- Timely awareness of hazards for those who must resolve them
- Traceability and control of hazards through all phases of a system's life cycle.

Safety analyses are an essential part of the preventive aspect of the safety program. Safety analyses primarily identify and describe hazards that might arise from flaws in the design and operation of a system or subsystem. Thus, a safety analysis is vital to the development of a system in which hazards must be eliminated or controlled to an acceptable level.

Safety analysis techniques that investigate effects begin with a bottom or lower-level event or occurrence and proceed upward to determine what effect the lower-level event has on the total system. This approach uses what is often referred to as a "bottom-up" technique, based on inductive reasoning.

Safety analysis techniques that investigate causes begin with a selected top-level event or occurrence and proceed downward to determine all of the elements which contribute to the occurrence of the top-level event. This approach uses what is often referred to as a "top-down" technique.

Safety analyses can be used qualitatively or quantitatively. A qualitative analysis is a review of factors affecting the safety of a system. Possible conditions and events and their consequences should be considered to determine whether they could cause or contribute to injury or damage. The objective is to achieve maximum safety by eliminating or controlling all significant hazards.

A quantitative analysis is a mathematical assessment of an actual or potential event, such as an accident. Quantitative evaluations can be used to establish absolute or relative frequencies of occurrence. A quantitative analysis must always be preceded by a qualitative analysis. Therefore, any mention of a quantitative analysis implies that a qualitative analysis will also be performed.

2.2 INTERRELATIONSHIPS

To appreciate the utility of the safety and system assurance analyses described in this document, it is useful to understand their interrelationships and when they should be applied during the project life cycle.

Exhibit 2-1 shows the interrelationships of the safety and systems assurance analyses, the inputs to and the outputs from the analyses. As seen in Exhibit 2-1, the analytical process has two major components:

- Safety
- System assurance.

The major input to the safety related analyses and the Failure Mode, Effects, and Criticality Analysis (FMECA) comes from the design data, drawings, operational plans and concepts, and from the experience of the analyst. System assurance related analyses also require input from operations, maintenance, and testing plans and experience.

Safety analyses identify hazards that need to be satisfactorily resolved, either by elimination or control. System assurance analyses identify the shortfalls and deficiencies in operations, maintenance, and testing which could affect safety, and assist in the development of appropriate manuals and procedures. The ultimate goal is the same

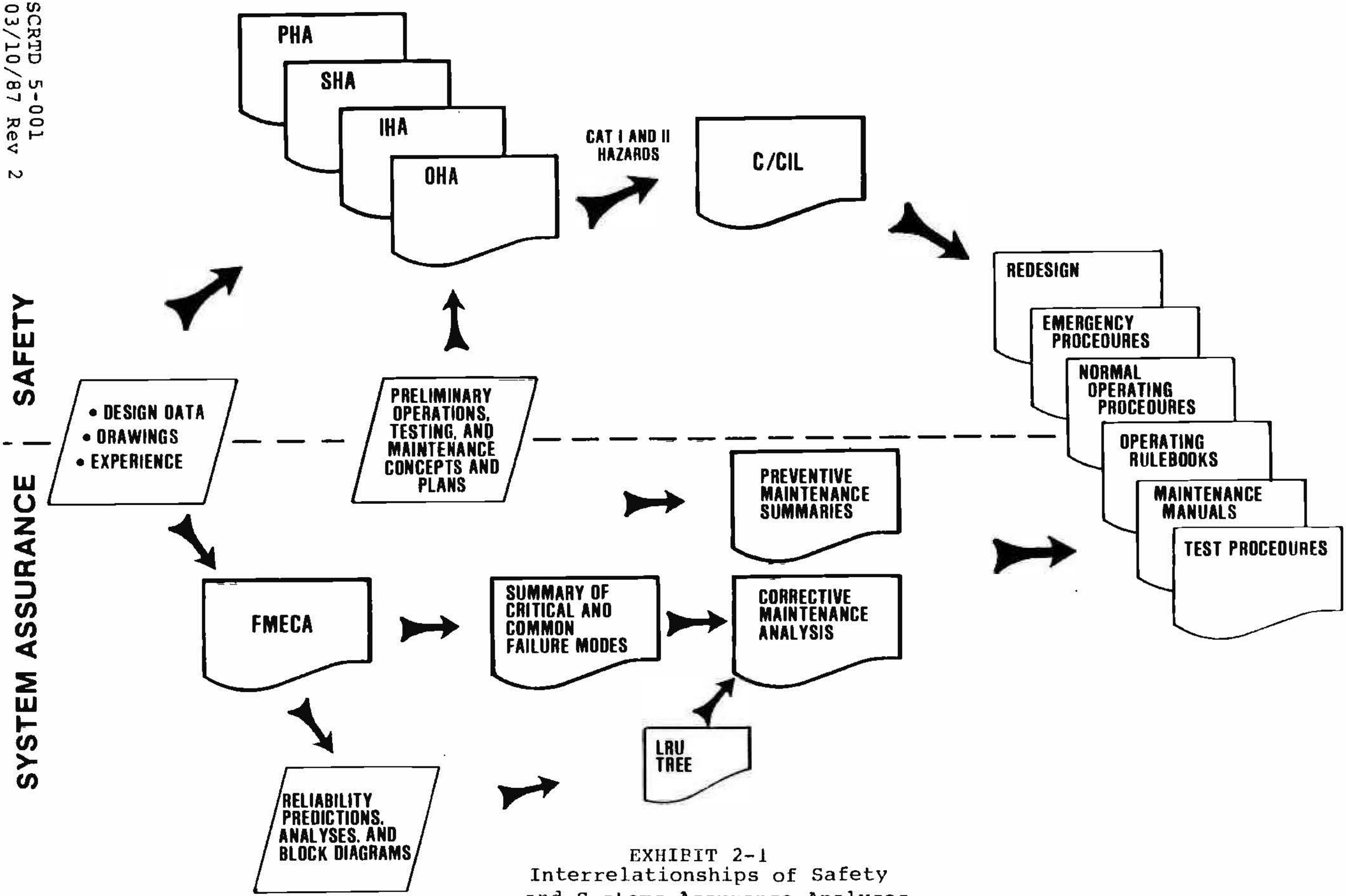


EXHIBIT 2-1
Interrelationships of Safety and Systems Assurance Analyses

-- to make the system as safe, reliable, and maintainable as possible.

The applicability of these analyses is tied into various stages of the project life cycle:

- The planning stage begins with the decision to build and ends at the onset of preliminary design.
- The design stage begins at the onset of preliminary design and ends when the design is finalized and ready to go into production.
- The procurement/installation stage begins when the fabrication or construction of equipment and facilities starts, and ends with the installation, final inspection, and testing.
- The integration/test/checkout stage begins when the equipment is installed, extends throughout the period of system test and checkout, and ends when the system begins revenue operation.

Exhibit 2-2 shows the timeframe in the life of a project when each safety and system assurance analytical technique provides the most benefit. It should be understood that the number of in-process submittals of an analysis will vary and depend on the nature, complexity, and duration of the system contract and its life cycle.

2.3 DEFINITIONS

The major output of the safety analyses and FMECA is the identification and evaluation of hazards and critical failure modes. It is important to provide a uniform interpretation of the severity and probability of the hazards and the criticality of failure modes.

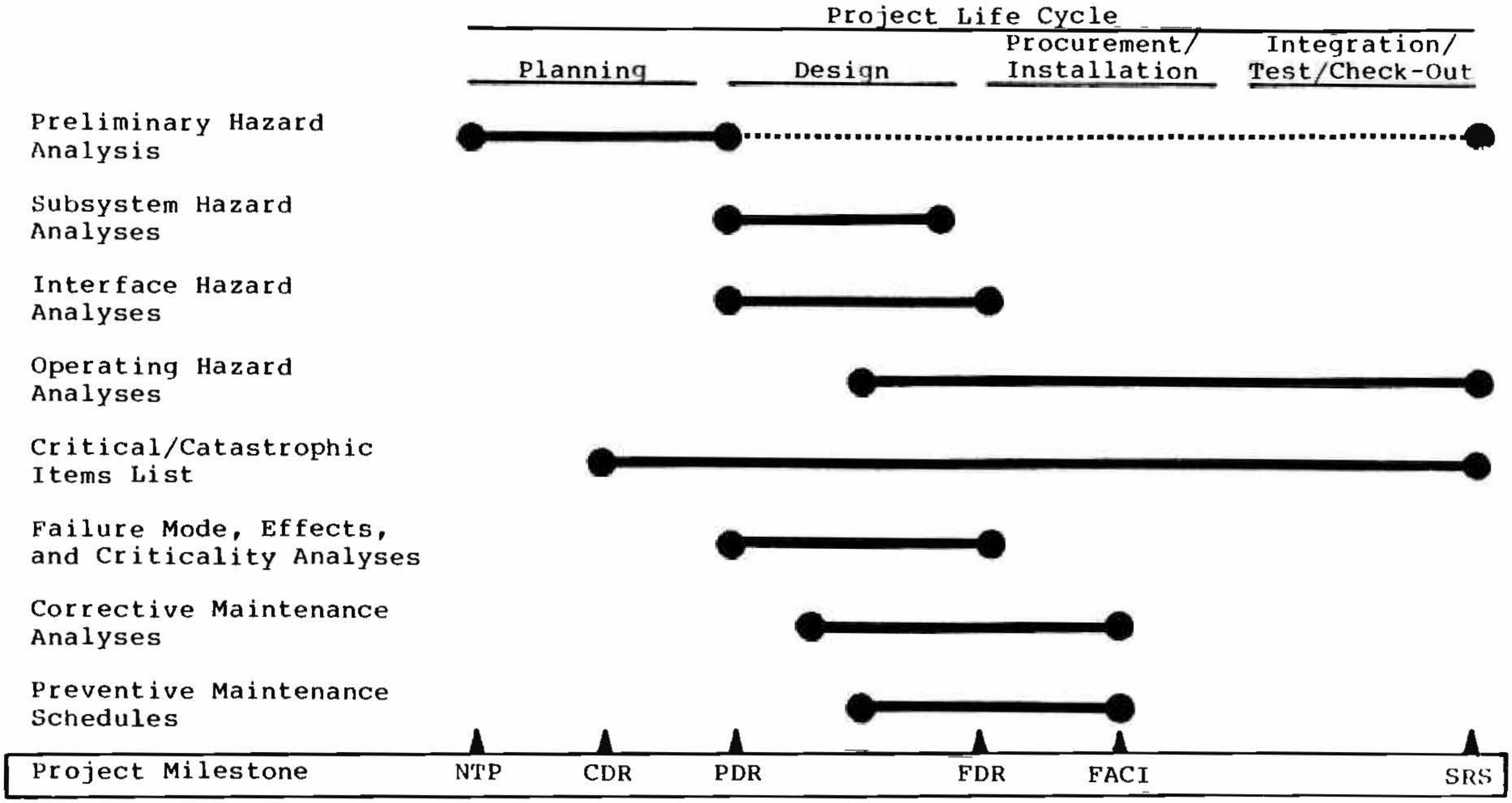
Therefore, the categories of the severity and probability of hazards and the criticality of failure modes are described below.

2.3.1 Hazard Categories

Hazard severity categories are defined to provide a qualitative measure of the worst potential consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, system, subsystem or component failure, or malfunction as follows:

- Category I (Catastrophic): A hazard that may cause death or system loss

EXHIBIT 2-2
Schedule Showing Effective Application Point for
Safety and System Assurance Analyses



NTP = Notice to Proceed
CDR = Conceptual Design Review
PDR = Preliminary Design Review

FDR = Final Design Review
FACI = First Article Configuration Inspection
SRS = Start of Revenue Service

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

- Category III (Marginal): A hazard that may cause a minor injury, minor occupational illness or minor system damage

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

The assessment of the hazard should also include a probability of occurrence. Assigning a quantitative probability to a potential hazard is generally not possible early in the design or planning process. A qualitative hazard probability can be derived from research, analysis, and evaluation of historical safety data from similar systems.

The qualitative probability of occurrence which is to be assigned in conjunction with the severity categories is described in the following table.

Probability of Occurrence

Probability of Occurrence Ranking	Descriptive Word	Frequency of Occurrence	
		Specific Individual Item	Fleet or Inventory
A	Frequent	Likely to occur frequently	Continuously experienced
B	Reasonably Probable	Will occur several times in life of an item	Will occur frequently
C	Occasional	Likely to occur sometime in life of an item	Will occur several times
D	Remote	So unlikely, it can be assumed that this hazard will not be experienced	Unlikely to occur but possible
E	Extremely Improbable	Probability of occurrence cannot be distinguished from zero	So unlikely, it can be assumed that this hazard will not be experienced

2.3.2 Criticality Categories

For the purposes of the FMECA, criticality categories are defined to provide a qualitative measure of the potential consequences of a failure, as follows:

- Category 1: Failure which may result in system shutdown or loss of life
- Category 2: Failure which may result in a delay or personal injury
- Category 3: Failure which may result in excessive unscheduled maintenance
- Category 4: Failure which may result in nondisabling loss of assembly function.

2.3.3 Systems And Subsystems

A system is defined as "a composite, at any level of complexity, of personnel, procedures, materials, tools, equipment, facilities, and software. The elements of this composite entity are used together in the intended operational or support environment to perform a given task or achieve a specific production, support, or mission requirement."

A subsystem is defined as "an element of a system that in itself may constitute a system." Depending on the nature and scope of the contract or subcontract, the connotation of system and subsystem may differ. For example, if the SCRTD conducts an Interface Hazard Analysis (see Chapter 5.0), the system would be the 'Metro Rail' and the subsystems could be the 'passenger vehicle' and the 'wayside equipment.' If the vehicle contractor conducts an IHA, the system would be the 'passenger vehicle' and the subsystems could be the 'propulsion subsystem' and 'friction brake subsystem.' If the propulsion supplier conducts an IHA, the system would be the 'propulsion system' and the subsystems could be the 'traction motors' and the 'gear reducer and coupling.'

3.0 PRELIMINARY HAZARD ANALYSIS

3.0 PRELIMINARY HAZARD ANALYSIS

Chapter 3.0 describes the nature and purpose of the Preliminary Hazard Analysis (PHA). A format with appropriate definitions and an example of the PHA are also presented.

3.1 PURPOSE

System safety will have an effect on the entire life cycle of the Metro Rail system, from preliminary engineering through operations. The preliminary hazard analysis is the first safety analysis performed. It is defined as a systematic listing and assessment of conditions which could potentially affect the safe operation of the Metro Rail system. The PHA uses the bottom-up approach to identify hazards and to relate them to the entire system.

The PHA is a comprehensive study of the system as a whole in its operating environment. The PHA is updated throughout the program; therefore, the information it provides should be thought of not as preliminary but rather as broad in nature and covering all elements of the system.

Determining potential hazards early in the planning stage by performing a PHA minimizes the need for costly design changes in later phases. Because the scope of the PHA encompasses the total system, it serves as a basic hazard analysis framework from which other hazard analyses and safety evaluations can be provided and monitored.

The purposes of conducting a PHA are to:

- Develop scenarios of hazardous situations which could exist within the Metro Rail system; evaluate the effects of the hazards and the potential injuries to people and damage to equipment; and propose possible means by which the hazards can be eliminated or controlled.

- Document the history of incorporating safety improvements during the system development; identify feasible alternatives for preventing hazards; and provide a history explaining why certain procedures were needed and developed.

- Provide the basic framework for incorporating lower-level analyses (i.e., subsystem hazard analysis, operating hazard analysis) into larger, more comprehensive analyses covering the entire system.

- Provide the basis for developing or revising manuals of rules and procedures.

3.2 APPROACH

A PHA consists of the following three activities:

- Hazard identification
- Hazard assessment
- Hazard resolution.

The process used to accomplish each of these three activities is discussed below.

3.2.1 Hazard Identification

The three most common methods of identifying hazards are:

- Use of hazard checklists in conjunction with the review of design and operational schemes

- Examination of conceptual design and operational schemes using the analyst's experience to postulate hazards

- Examination of information and data from similar systems.

The hazard checklist is merely a listing of hazards that are generic in nature and could appear in a variety of systems. The hazard checklist should be used to stimulate the safety analyst's thoughts on what hazards may exist in the system and their effects.

The use of conceptual design and operational schemes to postulate a hazard is the second method used in hazard identification. The validity of using this method to identify hazards depends heavily upon the proficiency and experience of the analyst. To use this approach, the analyst should review design data which describes the system to be analyzed and gather information from both design and operational personnel. The analyst should then use intuition, imagination, and logic to identify hazards which could exist in the system. Questions to answer during the process typically take the form of "What would happen if . . .," or "How can specific equipment fail?" and the like.

The examination of data from similar systems is the third method used to identify hazards. This approach basically consists of researching accident/injury data from other transit systems. Sometimes the data reports list the causes of the accident or injury. If they do, the analyst should readily identify the hazards. If causes are not given, the analyst must use available information to help identify similar hazards that could exist in the system.

In a typical PHA, the analyst should use all three methods listed above to identify possible hazards in the system.

3.2.2 Hazard Assessment

After a specific hazard has been identified, the next step is to assess its impact on the system. First, however, it is necessary to define the events which must be present in order for the hazard to precipitate an accident. Triggering events can occur normally in the operation or they can be abnormal occurrences or "mistakes." The presence of the hazard and the occurrence of the triggering event lead to a potential accident.

For example, a hazard such as "train door opens at a location that does not have a platform" could be caused by a false "train berthed" signal being detected by automatic train operation, together with a door open command either falsely or by the train operator. When this hazard is coupled with a triggering event ("a passenger who does not recognize the situation and exits the train through the open door") the situation becomes more serious. Unless some corrective action is taken, an accident in which passengers step or fall onto the guideway is likely to occur.

After a hazard is developed into a potential accident by defining a triggering event, the hazard scenario should be judged by the analyst to be in one of the four hazard severity categories and one of the five probability categories as defined in section 2.3.1.

3.2.3 Hazard Resolution

Hazard resolution is defined as either the elimination or control of hazards. Elimination of the hazard merely implies that the probability of occurrence of the hazard is so low as to be extremely improbable. For all practical purposes it can be assumed that the hazard will not be experienced. Controlling a hazard requires the probability of occurrence of the hazard be lowered to an acceptable level. In either case, the severity of the hazard remains unchanged. Although elimination of hazards is the ultimate goal, it is often impractical to achieve because the most significant method of eliminating a hazard is to design it out of the system. Therefore, control of a hazard is the most widely used form of hazard resolution.

To identify the hazard resolution, the safety analyst (having developed a hazard scenario) should propose alternative methods of preventing an accident from occurring.

These methods should consist of suggestions for eliminating or controlling the hazard. The suggested alternatives could be either design or procedural changes, or both.

The four sequential steps for hazard resolution are:

- Design for minimum hazard. The major effort throughout the system development process should be to ensure inherent safety through the selection of appropriate design features.

- Safety devices. Known hazards that cannot be eliminated through design selection should be controlled at an acceptable level through the use of appropriate safety devices.

- Warning devices. Where it is not possible to preclude the existence or occurrence of an identified hazard, devices should be employed for the timely detection of the condition and the generation of an adequate warning signal.

- Special procedures. Where it is not possible to reduce the magnitude of a hazard through design or the use of safety and warning devices, special procedures, training, and/or precautionary instructions should be developed.

After the alternative solutions are listed, the actual resolution of the hazard should be determined and documented in the PHA. Although the hazard resolution is not always one of the proposed alternatives, traceability of safety decisions should be provided by documenting the selected resolution.

3.3 FORMAT

Exhibit 3-1 provides the format for the Preliminary Hazard Analysis. An explanation of various format headings is given below.

- Contract and No.: The title of the Procurement Specifications Book and the contract number designation (e.g., Passenger Vehicle; A650, or Automatic Train Control; A620, or Fare Collection; A660).

- System and Subsystem: Descriptive titles which relate to sections or functions referenced in the specifications should be included, consistent with the previous discussion in Section 2.3.3.

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Preliminary Hazard Analysis

Contract: ____________ No.: ____________	Hazard No.: ____________
System: ____________	Date: ____________
	Revision: ____________
Subsystem: ____________	Page ______ of ______
	Prepared By: ____________

Hazard Identification

Description:

Cause(s):

Triggering Event:

Potential Accident/Injury

Hazard Category____________

Prevention Measures

Design:

Safety Device(s):

Warning Device(s):

Procedure(s):

Resolution

Design:

Safety Device(s):

Warning Device(s):

Procedure(s):

- Hazard No.: A unique alphanumeric reference number assigned by the contractor. These numbers on the hazard analysis forms should be identical to those used for identifying hazards on the Critical/Catastrophic Items List.

- Date: The date the hazard analysis will be submitted to the SCRTD.

- Revision: Letters should be revised each time the hazard form is changed or updated. The initial submittal is A, subsequent submittals are B, C, D, etc.

- Page: Sequentially number each page of the submittal.

- Prepared By: The name of the individual who prepared the analysis should be indicated.

- Description: An immediate condition which could lead to an accident involving potential injury, death, or equipment damage.

- Causes: Those events that contribute to the presence of the hazard.

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

- Potential Accident/Injury: The anticipated accident/injury that may occur if both the hazard and the triggering event are left uncorrected.

- Hazard Category: A combination of the qualitative measure of the worst potential consequence resulting from the hazard, and its probability of occurrence (e.g., IA, IIB, etc.). The severity and probability of occurrence rankings are defined in section 2.3.1.

- Prevention Measures: Actions that can be taken or procedural changes that can be made to prevent the anticipated accident from occurring.

- Resolution: Changes made relative to design and/or procedures to eliminate or control the hazard.

3.4 EXAMPLE

Exhibit 3-2 displays an example of a partially completed PHA.

RTD

METRO RAIL PROJECT
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Preliminary Hazard Analysis

Contract: ______________ No.: ______________

System: Passenger Vehicle

Subsystem: Side Doors

SAMPLE

Hazard No.: A650-001-001

Date: 2-26-86

Revision: C

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Prepared By: A. Hazard

Hazard Identification

Description: Unsafe opening of doors

Cause(s):
Electrical failure in door controls
Mechanical failure of door
Local emergency door release is operated and door opened

Triggering Event:
Patron leaning on door
Tampering with emergency door release

Potential Accident/Injury

Possible loss of life or severe injury

Hazard Category I C

Prevention Measures

Design:
Preclude any single unintentional feed or ground from opening door
Construct doors to withstand forces exerted by patrons
Position emergency release to mitigate inadvertent operation

Safety Device(s):
Interlock door open circuit with zero speed detection
Interlock propulsion with all doors closed indication
Hold doors closed by positive force and interlocking

Warning Device(s):
Provide emergency door release-pull handle signage

Procedure(s):

Resolution

Design:
Provided circuits to preclude unintentional feed or ground. Spec. 10.3.1
Provided doors to withstand external forces, Spec. 7.9.3.D
Located emergency door release at map case, Dwg. V-025

Safety Device(s):
Door/propulsion interlocks provided, Spec. 10.3.4
Door/zero speed interlock provided, Spec. 10.3.4
Positive door locking provided, Spec. 10.3.2

Warning Device(s):
Emergency door release signs provided, Dwg. V-025

Procedure(s):

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4.0 SUBSYSTEM HAZARD ANALYSIS

4.0 SUBSYSTEM HAZARD ANALYSIS

Chapter 4.0 describes the nature and purpose of the Subsystem Hazard Analysis (SHA). A format with appropriate definitions and an example of the SHA are also presented.

4.1 PURPOSE

A SHA should be used to determine hazards that could adversely affect the safe operation of each subsystem. It is similar to a Preliminary Hazard Analysis except that it is confined to a specific subsystem and is more detailed. Therefore, the SHA should be performed after the initial PHA has been completed. Like the PHA, the SHA uses the bottom-up technique to investigate the effects on the subsystem of lower-level events.

The SHA should be performed after the subsystem has been fully defined and detailed design information is available. The level of insight provided by a SHA depends on the extent to which the subsystem hardware configuration is defined. The SHA identifies components and lower-level elements whose performance, degradation, functional failure or inadvertent functioning can cause a hazard.

The results of the SHA should be used to update the PHA and to increase its level of detail. The SHA usually should be performed only once and updated only if the subsystem designs change.

An SHA should be conducted to:

- Identify specific subsystem design features that can potentially impact the safe operation of the system
- Identify areas where design changes are necessary to eliminate or control hazards
- Identify safety-related interfaces between various elements of a subsystem
- Determine a baseline for evaluating safety aspects of proposed design changes.

4.2 APPROACH

A SHA consists of the following three activities:

- Hazard identification
- Hazard assessment
- Hazard resolution.

The process used to accomplish each of these three activities is very similar to the PHA methodology described in section 3.2; the basic difference is in their scope.

4.3 FORMAT

Exhibit 4-1 provides the format for the SHA. The format is identical to the PHA format with the exception of the title. The explanation of various format headings is the same as described in section 3.3.

4.4 EXAMPLE

Exhibit 4-2 displays an example of a partially completed SHA.

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

Subsystem Hazard Analysis

Contract: ______________ No.: ______________	Hazard No.: ______________
System: ______________	Date: ______________
Subsystem: ______________	Revision: ______________
	Page ________ of ________
	Prepared By: ______________

Hazard Identification

Description:

Cause(s):

Triggering Event:

Potential Accident/Injury

Hazard Category ____________

Prevention Measures

Design:

Safety Device(s):

Warning Device(s):

Procedure(s):

Resolution

Design:

Safety Device(s):

Warning Device(s):

Procedure(s):

EXHIBIT 4-2

METRO RAIL PROJECT
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Subsystem Hazard Analysis

Contract: Automatic Train Control No.: A650	Hazard No.: A620-001-001
System: Train Control	Date: 03-20-86
	Revision: A
Subsystem: Wayside Signals	Page 2 of 15
	Prepared By: John Doe

SAMPLE

Hazard Identification

Description: False clear wayside signal displayed

Cause(s): False electrical feed to signal lamp
False electrical feed energizing signal clearing relay
False track circuit energization

Triggering Event: Sneak path insulation breakdown
Train does not shunt track(See IHA)
Electromagnetic interference(See IHA)

Potential Accident/Injury

Train moves into occupied control area, rear end collision

Hazard Category I C

Prevention Measures

Design: Use proven insulation
Use proven logic circuits

Safety Device(s):

Warning Device(s):

Use vital relays, where appropriate
Use separate circuits for red and green aspects

Procedure(s):

Resolution

Design:

Safety Device(s):

> Note: Supplier to indicate how and where in contract preventive measures are implemented.

Warning Device(s):

Procedure(s):

5.0 INTERFACE HAZARD ANALYSIS

5.0 INTERFACE HAZARD ANALYSIS

Chapter 5.0 describes the nature and purpose of the Interface Hazard Analysis (IHA). A format with appropriate definitions and an example of the IHA are also presented.

5.1 PURPOSE

The Interface Hazard Analysis should be used to determine hazards associated with the integration and interfaces of subsystems. It is similar to both the PHA and the SHA, using the bottom-up technique to identify hazards present in the interfaces among the subsystems.

An IHA should be performed after the initial PHA has identified hazards in the overall system. Such a preliminary IHA considers each of the subsystems as "black boxes" and analyzes the potential hazards that their integration could cause. The initial IHA should be performed concurrently with the SHA so that the hazards can be eliminated or controlled during the design of the individual subsystems. The IHA should be revised, however, after the SHA is complete to ensure that hazards which are present in the actual integration are identified and resolved. The results of the IHA are used to update the PHA. The IHA results are also used as input to the Operating Hazard Analysis in those cases where the hazard resolution requires special procedures.

The purposes of conducting an IHA are to:

- Ensure that hazards associated with subsystem interfaces have been addressed
- Identify hazards that may not have been identified during the SHA
- Identify hazards created by the integration of the subsystems into the total system
- Identify hazards created by one subsystem that could affect the safe operation of other subsystems
- Allow the identification of independent, dependent or simultaneous failures that could potentially affect the safe operation of the system.

5.2 APPROACH

An IHA consists of the following three activities:

- Hazard identification
- Hazard assessment
- Hazard resolution.

The process used to perform an IHA should follow the following steps:

- Step 1 - Identify each of the subsystems contained in the total system.

- Step 2 - Construct a block diagram to indicate how the subsystems functionally interface in the overall system context. Label each block in the diagram with the name of the subsystem it represents.

- Step 3 - List the name of the system being analyzed on the IHA format.

- Step 4 - Using the block diagram developed in Step 2, list the names on the IHA format of two subsystems that interface.

- Step 5 - Using the process described in Section 3.2 on PHA approach, identify the hazards that are present in the functional connection of any subsystem to another subsystem. The output from one subsystem should be analyzed for its effect on the input to any other subsystem. In this analysis, factors to be considered include zero output, degraded output, erratic output, excessive output, mismatched connectors and improper clearances. Typical areas to be analyzed include electrical signals, transmission of torque, etc.

- Step 6 - Continue completing the information required in the IHA format using the same procedures as those described in Section 3.2 for a PHA.

- Step 7 - Repeat Steps 4 through 6 for each subsystem identified in the block diagram.

After the analysis is complete, the results are used as input to expand the PHA or to change subsystem designs, or they should be analyzed further by using the operating hazard analysis (OHA).

5.3 FORMAT

Exhibit 5-1 shows the format for the IHA. The format is identical to the PHA format with the exceptions of the analysis title and the additional subsystem title. The explanation of various format headings is the same as described in section 3.3.

5.4 EXAMPLE

Exhibit 5-2 displays an example of a partially completed IHA.

METRO RAIL PROJECT
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Interface Hazard Analysis

Contract: ____________ No.: ____________	Hazard No.: ____________
System: ____________	Date: ____________
Subsystem: ____________	Revision: ____________
Subsystem: ____________	Page ______ of ______
	Prepared By: ____________

Hazard Identification

Description:

Cause(s):

Triggering Event:

Potential Accident/Injury

Hazard Category____________

Prevention Measures

Design:

Safety Device(s):

Warning Device(s):

Procedure(s):

Resolution

Design:

Safety Device(s):

Warning Device(s):

Procedure(s):

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

Interface Hazard Analysis

Contract: Automatic Train Control No.: A620

System: Train Control

Subsystem: Main Line Track Circuits

Subsystem: Passenger Vehicle

SAMPLE

Hazard No. A650-A620-05-01

Date: 03-22-86

Revision: B

Page 12 of 17

Prepared By: John Doe

Hazard Identification

Description: Train does not shunt track circuit

Cause(s):
False track circuit energization
Rust on rails
Contaminents on wayside
Fault on vehicle

Triggering Event: Infrequent use of track

Potential Accident/Injury

Train moves into occupied control area, rear end collision

Hazard Category I C

Prevention Measures

Design: Use maximum shunt resistance value

Use specified EMI limits from passenger vehicle

Safety Device(s):

Warning Device(s):

Procedure(s): Periodic check of signal level and track circuit sensitivity

Resolution

Design:

Safety Device(s):

Note: Supplier to indicate how and where in contract preventive measures are implemented.

Warning Device(s):

Procedure(s):

6.0 OPERATING HAZARD ANALYSIS

6.0 OPERATING HAZARD ANALYSIS

Chapter 6.0 describes the nature and purpose of the Operating Hazard Analysis (OHA). A format with appropriate definitions and an example of the OHA are also presented.

6.1 PURPOSE

The Operating Hazard Analysis (OHA) is a systematic review and assessment of the activities required in the test, operation or maintenance of equipment to determine those conditions which could lead to injury, death, or equipment damage. The OHA focuses on the human interface with equipment.

An OHA is applied to the operation of a system, subsystem, or item of equipment, as well as to the activities of testing and maintenance. However, because of the detailed level of the analysis, only one activity can be analyzed at a time. Although an OHA can be performed on either human or automated activities, its primary purpose is to identify and evaluate hazards associated with the man/machine interface. It uses a bottom-up technique to achieve these ends.

An Operating Hazard Analysis differs from the previous hazard analyses discussed in that its standardized format is supplemented with additional data. An OHA consists of:

- A detailed activity description
- An activity sequencing diagram
- An OHA form
- Revised or newly developed procedures.

Because it is complex and performed at a very detailed level, the OHA is time-consuming and could be highly expensive if performed on an unlimited basis. Therefore, an Operating Hazard Analysis should be considered only for areas known or suspected to have a significant impact on the safe operation of the system. These problem areas are determined from previous analyses (PHA, SHA, etc.), the experience of the analyst, or the history of prior use. An OHA can be extremely beneficial when applied to areas such as procedures necessary for passenger evacuation following a collision or derailment.

The results of the Operating Hazard Analysis should provide input to the development of testing, operation, and maintenance procedures. This input is usually in the form of warning or caution devices, special emergency procedures, or revisions to existing or proposed safety procedures or training manuals. The OHA should be performed before and during the integrated testing of a system, whenever a procedural problem is identified, or changes are made to equipment.

The benefits derived from conducting an OHA are:

- Identification of hazards to employees involved in the test, operation or maintenance of equipment
- Identification of hazards to the system and passengers as a result of testing, operation, or maintenance procedures
- Assurance that the hazards associated with the test, operation and maintenance of equipment have been eliminated or controlled
- Allocation of training resources to areas that provide the most benefit
- Documentation of why certain procedures were developed or changed.

6.2 APPROACH

The approach used for performing an operating hazard analysis is described below:

- Step 1 - Identify the activity to be analyzed. Source documentation that can be used to identify activities requiring an Operating Hazard Analysis includes:
  - Preliminary Hazard Analysis
  - Subsystem Hazard Analysis
  - Interface Hazard Analysis
  - Operating procedures
  - Maintenance procedures
  - Test procedures
  - Hazards previously identified on similar transit projects.
- Step 2 - Describe the activity to be analyzed in detail. This detailed description must include identification of the tasks or actions necessary to perform the activity. Additional information to be contained in the description includes:

- Location of the equipment being tested, operated or maintained

- System operating mode at the time the activity is to be performed

- Subsystem operating mode at the time the activity is to be performed

- Identification of any other subsystem affected by the activity.

The description should be sufficiently detailed to allow identification of unsafe aspects of the activity.

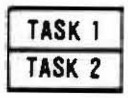
- Step 3 - From the description of the activity, develop an activity sequencing diagram of all the tasks to be performed. The symbology for the sequencing diagram is shown in Exhibit 6-1.

- Step 4 - Complete the operating hazard analysis in the format shown in Exhibit 6-2, using information from both the activity description (Step 2) and the sequencing diagram (Step 3).

- Step 5 - Revise the sequencing diagram (Step 3) to incorporate changes in the task sequencing or additions or deletions of tasks. The revisions to the sequencing diagram should be based upon those items appearing in the accident prevention measures of the OHA format. If it is determined from the operating hazard analysis that any task necessary to perform the activity has hazards associated with it, then the hazards must be eliminated or controlled. The hazard resolution may not be limited to procedural changes, but may also involve design changes or installation of safety or warning devices. In any of these cases, the sequencing diagram should require updating to correctly describe the revised activity.

- Step 6 - Revise the activity description (Step 2) to incorporate the results of the OHA. This should necessitate either revising the written procedure, if it was used as input to the activity description, or ensuring that the activity description and the sequencing diagram are used in the development of new procedures.

EXHIBIT 6-1
Sequence Diagram Symbology

DESCRIPTION	SYMBOLOGY
TASKS WHICH MAY BE PERFORMED IN ANY SEQUENCE, BUT NOT CONCURRENTLY.	
TASKS WHICH MAY BE PERFORMED CONCURRENTLY OR CONSECUTIVELY.	
TASKS WHICH MUST BE PERFORMED CONCURRENTLY.	
TASKS WHICH MUST BE PERFORMED IN A MANDATORY SEQUENCE: (ALL TASKS PRIOR TO AN ARROW MUST BE ACCOMPLISHED BEFORE PROCEEDING TO NEXT TASK.)	

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Operating Hazard Analysis

Contract: ______________________ No.: __________
System: ______________________
Subsystem: ______________________
Activity: ______________________
____

Hazard No.: ______________________
Date: ______________________
Revision: ______________________
Page __________ of __________
Prepared By: ______________________

Task No.	Task Description	Hazard Description	Potential Accident/Injury	Hazard Category	Prevention Measures	Resolution

EXHIBIT 6-2

6.3 FORMAT

Exhibit 6-2 provides the format for the Operating Hazard Analysis. The explanation of various format headings is the same as described in section 3.3 with the exception of those described below.

- Activity is the set of actions (tasks) necessary to test, operate, or maintain equipment which is being analyzed.

- Task Number is the identification number assigned to each action (task) within the activity.

- Task Description is a description of the level to which the work involved in performing the activity is to be analyzed.

6.4 EXAMPLE

Exhibit 6-3 displays an example of the operating hazard analysis of a vehicle tachometer recalibration. When the wheels on a vehicle are machined to restore the running surface or when they are replaced, the vehicle tachometer must be recalibrated to reflect the new diameter of the wheel. The vehicle speed indicator is related to the rotation speed of the wheel. Therefore, if the tachometer is incorrectly recalibrated, the vehicle can be moving at a higher speed than is indicated by the speed indicator. False indication of the vehicle speed can contribute to a collision involving the vehicle.

For simplicity, the OHA example is performed only on those tasks that are required for the actual tachometer recalibration. The hypothetical procedure number 001 lists these tasks as:

- Measure diameter of wheel

- Determine tachometer compensation from wheel wear table

- Open door to train control equipment (which is located in the vehicle equipment cabinet)

- Set wheel wear compensation switch to proper setting

- Close door to train control equipment.

Exhibit 6-4 is a sequence diagram of the above tasks.

RTD

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

Operating Hazard Analysis

Contract: PASSENGER VEHICLE   No.: A650
System: N/A
Subsystem: TRAIN CONTROL
Activity: RECALIBRATION OF TACHOMETER AFTER INSTALLATION OF NEW WHEELS

Hazard No.: OHA-246
Date: 3-12-87
Revision: A
Page 17 of 63
Prepared By: JOHN DOE

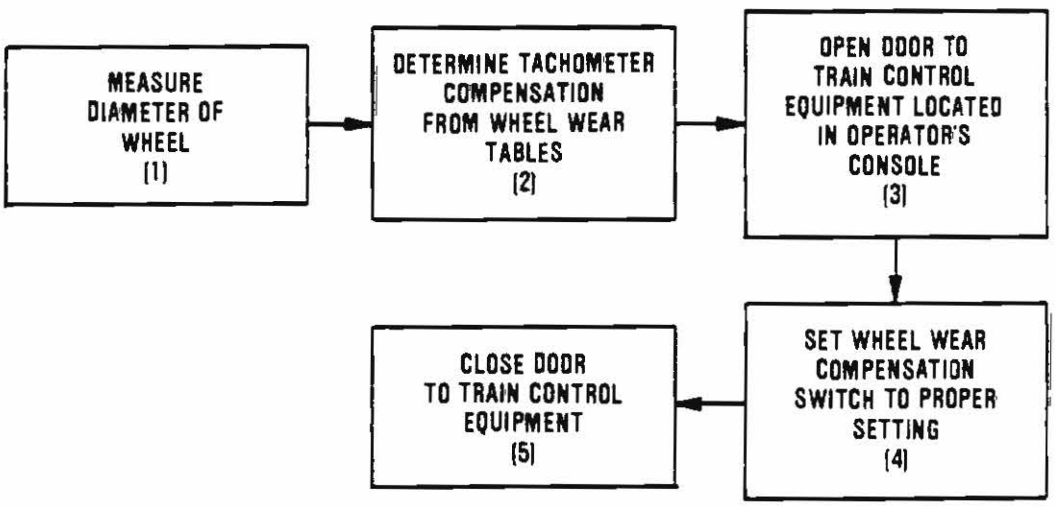
Task No.	Task Description	Hazard Description	Potential Accident/Injury	Hazard Category	Prevention Measures	Resolution
1	MEASURE DIAMETER OF WHEEL	INCORRECT MEASUREMENT	COLLISION OR OVERRUN	IC	CHANGE PROCEDURE TO INCLUDE: . CHECK BY SECOND PERSON . INSTRUCTION ON WHICH WHEEL TO MEASURE	PROCEDURE 001 CHANGED
2	DETERMINE TACHOMETER COMPENSATION FROM WHEEL WEAR TABLE	TABLE READ INCORRECTLY	COLLISION OR OVERRUN	IC	CHANGE PROCEDURE TO INCLUDE CHECK BY SECOND PERSON	PROCEDURE 001 CHANGED
3	OPEN DOOR TO TRAIN CONTROL EQUIPMENT	-	-	-	-	-
4	SET WHEEL WEAR COMPENSATION SWITCH TO PROPER SETTING	SET WRONG SWITCH SET SWITCH INCORRECTLY	COLLISION OR OVERRUN	IC	CHANGE PROCEDURE TO INCLUDE CHECK BY SECOND PERSON	PROCEDURE 001 CHANGED
5	CLOSE DOOR TO TRAIN CONTROL EQUIPMENT	-	-	-	-	-

SAMPLE

SCRTD 5-001

EXHIBIT 6-3

EXHIBIT 6-4
Sequence Diagram Example: Tachometer
Recalibration After Installation of New Wheels



7.0 CRITICAL/CATASTROPHIC ITEMS LIST

7.0 CRITICAL/CATASTROPHIC ITEMS LIST

Chapter 7.0 describes the nature and purpose of the Critical/Catastrophic Items List (C/CIL). A format with appropriate definitions and an example of the C/CIL are also presented.

7.1 PURPOSE

A Critical/Catastrophic Items List (C/CIL) is used to compile hazards that could affect the safe operation of the total system. A C/CIL is initiated after the initial PHA has been completed. Thereafter, it is continuously updated to include the hazards from other safety analyses. The C/CIL serves as a warehouse of all category I and II hazards identified in the safety analyses. A hazard resolution procedure should be established to periodically review the category I and II hazards from the C/CIL for immediate corrective action. The reviews of C/CIL should be continued until all hazards are satisfactorily resolved.

The purposes of a C/CIL are to provide:

- A convenient centralized location for the compilation of critical and catastrophic hazards
- Visibility for the review and immediate corrective action when category I and II hazards are identified
- The inputs for recommendations of changes or improvements in design, hardware, or procedures
- The documentation that all category I and II hazards are satisfactorily resolved.

7.2 APPROACH

The process to compile the C/CIL is relatively simple and involves documenting category I and II hazards from the following safety analyses:

- Preliminary hazard analysis
- Subsystem hazard analysis
- Interface hazard analysis
- Operating hazard analysis.

The corrective action is documented as each hazard is resolved. Updated C/CILs are submitted to the SCRTD on a periodic basis as defined by the contract specifications.

7.3 FORMAT

Exhibit 7-1 provides the format for the C/CIL. An explanation of various format headings is given below.

- Hazard Number is the unique reference number from the specific hazard analysis.

- Hazard Description is a brief description of the hazard from the referenced hazard analysis.

- Hazard Category is the qualitative assessment of hazard severity and probability of occurence

- Potential Accident/Injury is the anticipated accident or injury that may occur if both the hazard and triggering event are left uncontrolled

- Prevention Measures are the suggested solutions recommended by the safety analyst to eliminate or control the hazard or its effects.

- Resolutions Adopted are the measures actually incorporated to eliminate or control the hazard or its effects, or the rationale for acceptance of a hazard in its present form without incorporating any safety recommendations.

7.4 EXAMPLE

Exhibit 7-2 displays an example of a partially completed C/CIL.

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

Critical/Catastrophic Items List

Contract: ____________ No: ________
Date: ____________________
Revision: ____________________
Page ________ of ________
Prepared by: ____________________

Hazard Number	Hazard Description	Hazard Category	Potential Accident/Injury	Prevention Measures	Resolutions Adopted

SCRTD 5-001

EXHIBIT 7-1

RTD

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

Critical/Catastrophic Items List

Contract: VEHICLE No:
Date: 6-11-86
Revision: A
Page 8 of 21
Prepared by: JOHN DOE

Hazard Number	Hazard Description	Hazard Category	Potential Accident/Injury	Prevention Measures	Resolutions Adopted
5.1.1	FIRE IN VEHICLE	IC	LOSS OF LIFE OR SEVERE INJURY DUE TO FIRE, SMOKE OR TOXIC FUMES	1. CONFORM TO FIRE/LIFE SAFETY CRITERIA 2. ESTABLISH PROCEDURES FOR SAFE AND PROMPT EVACUATION	1. PROVIDE MATERIALS TO COMPLY WITH UMTA GUIDELINES 2. DEVELOPED PROCEDURE EP2.7.2 FOR EMERGENCY EVACUATION
5.1.3	INEFFECTIVE PROCEDURES FOR MANUAL TRAIN OPERATION	IC	LOSS OF LIFE OR SEVERE INJURY DUE TO TRAIN COLLISION OR DERAILMENT	1. PROVIDE SAFE TRAIN CONTROL 2. PROVIDE PROPER OPERATOR TRAINING FOR MANUAL	1. TC SYSTEM TEST VERIFIED IN ACCORDANCE WITH TEST PROCEDURES TC1-1.1 TO 10.5.8 2. ESTABLISHED SP 8.3.4
5.2.1	BROKEN OR CRACKED GLASS WINDOWS	IIB	INJURY FROM BROKEN/ CRACKED WINDOWS	UTILIZE LAMINATED SAFETY GLASS	SPECIFIED MATERIAL IN THE VEHICLE SPECIFICATION
5.5.1	INADEQUATE BRAKING	IC	LOSS OF LIFE OR SEVERE INJURY AS A RESULT OF TRAIN COLLISION OR DERAILMENT	1. PROVIDE INDICATIONS OF BRAKE MALFUNCTION 2. CONDUCT PERIODIC INSPECTIONS OF BRAKE EQUIPMENT 3. DESIGN TRAIN CONTROL SYSTEM BASED ON WORST CASE BRAKING	1. PROVIDED "BRAKE CONTROL FAILURE" ON OPERATOR CONSOLE 2. REFER TO MAINTENANCE PROCEDURE M6-14.4 FOR BRAKE EQUIPMENT INSPECTION 3. TRAIN CONTROL BRAKES TO BE VERIFIED IN ACCORDANCE WITH PROCEDURE TC5.2.12

SAMPLE

SCRTD 5-001

EXHIBIT 7-2

8.0 FAILURE MODE, EFFECTS, AND CRITICALITY ANALYSIS

8.0 FAILURE MODE, EFFECTS, AND CRITICALITY ANALYSIS

Chapter 8.0 describes the nature and purpose of the Failure Mode, Effects, and Criticality Analysis (FMECA). A format with appropriate definitions and an example of the FMECA are also presented.

8.1 PURPOSE

A Failure Mode, Effects, and Criticality Analysis (FMECA) is a design evaluation procedure. It documents all conceivable potential failures in a subsystem or component design, determines by single failure analysis the effect of each failure on subsystem operation, identifies failures critical to operational success or personnel safety, and evaluates each potential failure according to the combined influence of failure effect severity and probability of occurrence.

The purposes of a FMECA are to provide:

- The design engineer with a method of selecting a design with high reliability and high personnel safety potential during the early design phase
- An additional method to insure that all conceivable failure modes and their effect on operational success of the subsystem have been considered
- A list of potential failures which are ranked according to the magnitude of their effect and probability of occurrence
- Early criteria for test planning and the design of the test and checkout of subsystems
- A basis for quantitative reliability analysis
- Historical documentation for future reference to aid in analysis of field failures and/or consideration of design changes
- Input data for trade-off studies
- A basis for establishing corrective action priorities
- Assistance in the objective evaluation of design requirements related to redundancy, failure detection systems, fail-safe characteristics and automatic and manual override.

A FMECA is normally accomplished before, and provides basic information to, a reliability prediction. FMECAs should be initiated as an integral part of the early design process of subsystem functional assemblies and periodically updated to reflect design changes. An updated FMECA provides a major input to design reviews, inspections, and certifications.

8.2 APPROACH

A FMECA is be performed in two steps:

- Failure Mode and Effects Analysis
- Criticality Analysis.

The general approach for each of the steps is described below.

8.2.1 Failure Mode, and Effects Analysis

A Failure Mode and Effects Analysis (FMEA) studies the results or effects of single independent component failure in a subsystem. That is, each failure, as its effects are studied, is considered to be the only failure in the subsystem.

Accomplishment of a FMEA on a subsystem consists of the following general steps:

- Step 1 - Define the subsystem to be analyzed, and obtain all descriptive information available on this subsystem. The information should include such documents as functional block diagrams, subsystem descriptions, specifications, drawings, subsystem component identification coding, operational profiles, environmental profiles, and reports bearing on reliability (e.g., feasibility or reliability studies of the subsystem and other similar subsystems).

- Step 2 - Construct a reliability logic block diagram of the subsystem to be analyzed and for each equipment configuration involved in the subsystem.

  The diagrams should be developed starting at the top level of the subsystem, extending downward to the lowest level of subsystem definition at the time the analysis is made. These reliability logic block diagrams are not descriptive block diagrams of the subsystem to show the interconnection of equipment. The reliability logic block diagrams used for an FMEA show the functional interdependencies between the subsystem components so that the effects of a functional failure can be readily traced through the subsystem.

Step 3 - For each subsystem component, at the lowest level of subsystem definition, analyze each potential failure mode of the component and its effect on the subsystem. Where subsystem definition has not reached the piece part level, the subsystem component could be an assembly. Where subsystem hardware definition has not reached the stage of identification of the subsystem functions with the specific type of hardware that will perform these functions, the FMEA should be based upon failure of the subsystem functions, stating the general type of hardware envisioned as the basis for system design.

At least four generic modes of component or functional failure must be considered:

- Premature operation
- Failure to operate at a prescribed time
- Failure to cease operation at a prescribed time
- Failure while operating.

Other unique failure modes should be considered as applicable. The contractor should describe the specific failure mode, such as:

- Open circuit
- Short circuit
- Value increases
- Oscillates
- Excessive leakage
- No signal.

Each mode of failure should be identified on a separate form.

The FMEA assumes that only the failure under consideration has occurred. When safety or backup devices exist, this assumption should be broadened to include the failure conditions which resulted in the need for a backup function.

Step 4 - Document each potential failure mode of each subsystem component and the effects of each failure mode on the subsystem by completing a FMEA in the form shown in Exhibit 8-1.

EXHIBIT 8-1

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Failure Mode, Effects, & Criticality Analysis

Contract: ______________ No.: ____	FMECA No. ______________
System/Subsystem: ______________	Date: ______________
Equipment/Component: ______________	Revision: ______________
______________	Page ________ of ________
Drawing/Document No. ______________	Prepared By: ______________

General Description

Function:

Failure Mode:

Means of Detection:

Failure Rate:

Effects of Failure

Functional Component/Equipment:

Next Higher Subsystem:

Uppermost System:

Criticality Category: ______________

Corrective Action

8.2.2 Criticality Analysis

The Criticality Analysis (CA) determines a subsystem component's criticality relative to a defined loss statement such as operational loss, shutdown, etc. The criticality analysis is performed in the following two steps:

- Identification of critical failure modes in the FMEA for each equipment configuration.
- Assignment of the appropriate criticality category for each critical failure mode from the following categories, as repeated from Section 2.3.2.

Category 1	-	Failure which may result in subsystem shutdown or loss of life
Category 2	-	Failure which may result in a delay or personal injury
Category 3	-	Failure which may result in excessive unscheduled maintenance
Category 4	-	Failure which may result in non-disabling loss of assembly function.

For any category 2 failure (Failure which may result in a delay), the contractor should indicate whether the delay will be minor, moderate, or major, as defined below:

Passenger Vehicle Contract Only

- Minor Delay - The failure can be bypassed automatically (e.g., by line switch opening) or by action taken by the train operator without leaving the head end cab.
- Moderate Delay - The failure can be bypassed by train operator actions at the failed car.
- Major Delay - The failure requires maintenance assistance to be brought to the scene.

Train Control, Communications Contracts

- Minor Delay - The failure can be bypassed automatically or by action taken by Central Control operations personnel without leaving the Rail Control Center.
- Moderate Delay - The failure can be corrected by non-maintenance personnel working in the geographic area of the failure.

- Major Delay - The failure requires specific maintenance assistance to be brought to the scene.

8.3 FORMAT

Exhibit 8-1 provided the format for the FMECA. An explanation of various format headings, where different from those explained in Section 3.3, is given below.

- Equipment/Component is the name of the piece of equipment or the component which is under analysis. A part number should be identified where applicable.

- Drawing/Document Number is the number by which each piece of equipment or component can be referenced to a drawing or other ducument.

- Function is a concise statement of the function performed by the equipment.

- Failure mode is a concise statement of the failure, such as:

  - Electrical short
  - Valve stays closed
  - No signal generated.

- Means of detection is a description of the methods by which the failure can be detected. Identify which of the following categories the failure detection means fall under, such as:

  - On-board visual/audible warning devices
  - Automatic sensing devices
  - Central Control equipment console display
  - None.

- Failure rate is the generic failure rate of the component in failures per hour or cycle.

- Failure effect on component is a brief statement describing the ultimate effect of the failure on the function or component being analyzed, such as:

  - Component rendered useless
  - Component's usefulness marginal
  - Structurally weakened.

- Failure effect on the next higher subsystem is a brief description of the effect of the failure on the next higher level of the functioning entity within the system. This level may be typified by such items as batteries, communication receivers, transmitters, gear boxes, and motors.

- Failure effect on the uppermost system is a description of the effect of the component failure on the uppermost system. For major systems, these effects are divided into two groups:

    1. Failures affecting system operations. (Examples: operation ended, limited operation, degraded operation, delay, failure to start operation, etc.)

    2. Personnel safety. (Examples: loss of life, personnel injury, etc.)

  For subsystems where effects on the overall system are unknown, a failure's effects on the subsystem under analysis may be described as loss of subsystem inputs or outputs (examples: loss of signal output, loss of output pressure, shorted power input).

- Criticality category is the assignment of the category from section 2.3.2.

- Corrective action is a description of design provisions or compensating means to prevent the failure mode or minimize criticality.

8.4 EXAMPLE

Exhibit 8-2 displays an example of a partially completed FMECA with typical information.

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Failure Mode, Effects, & Criticality Analysis

Contract: TRAIN CONTROL No.: A620

System/Subsystem: N/A

Equipment/Component: VARISTOR/PUSHBUTTON REPEATER

Drawing/Document No. AT16P852

FMECA No. ATC 2-003

Date: 6-30-86

Revision: A

Page 12 of 17

Prepared By: JOHN DOE

General Description

Function: TRANSIENT PROTECTION FOR RELAY CURRENTS

Failure Mode: ELECTRICAL SHORT

Means of Detection: PANEL INDICATION

Failure Rate: LESS THAN 0.1×10^{-6} HOURS

Effects of Failure

Functional Component/Equipment: FAILURE TO CEASE OPERATION

Next Higher Subsystem: RELAY COILS ARE SHORT CIRCUITED AND AUXILIARY SWITCH CONTROL FUNCTION IS INOPERABLE. OTHER RELAY CONTACTS COULD FUSE DUE TO EXCESSIVE CURRENT.

Uppermost System: DEGRADED OPERATION

Criticality Category: 2

Corrective Action

VARISTOR OF APPROPRIATE RATINGS HAS BEEN SELECTED

SAMPLE

9.0 PREVENTIVE MAINTENANCE SCHEDULE

9.0 PREVENTIVE MAINTENANCE SCHEDULE

Chapter 9.0 describes the nature and purpose of the preventive maintenance schedule. A format with appropriate definitions and an example of a preventive maintenance schedule are also presented.

9.1 PURPOSE

The preventive maintenance schedule requirements are necessary to assure that the equipment/system availability for revenue service is not compromised by either lack of or lengthy maintenance and servicing activities.

Preventive maintenance includes all servicing, inspections, overhauls, or other tasks required on a scheduled basis.

It is important to establish a preventive maintenance repair time goal for each equipment/system at the start of the program. The equipment/system design should be continually reviewed along with the FMECAs and maintainability analyses to evaluate the degree of achievement of the maintainability requirements and goals. These efforts result in developing the following preventive maintenance information:

- A description of the maintenance actions.
- A summary of preventive maintenance and inspection manpower requirements for the system and major equipment.
- Depth and frequency of maintenance requirements at each level.
- Support equipment and tools or facilities required.
- Skill levels and number of personnel required.

These recommendations provide an input to the system maintenance concept, maintenance manuals, and procedures.

9.2 APPROACH

The process used to develop a Preventive Maintenance Schedule follows the following steps:

- <u>Step 1</u> - Identify each of the major subsystems/equipment contained in the total system.

- <u>Step 2</u> - For each of the subsystems/equipment, list the preventive maintenance tasks required.

- <u>Step 3</u> - Provide a brief description of each task or an applicable reference for the task description, such as a section from the maintenance manual.

- <u>Step 4</u> - Specify the preventive maintenance frequency for the applicable usage intervals based on the applicable usage criteria:

  - Mileage
  - Cycles
  - Time intervals.

- <u>Step 5</u> - Furnish the information on skill level, elapsed time, crew size, and labor hours related to each task. Skill levels should be limited to BASIC, INTERMEDIATE, ADVANCED. The contractor should define the meaning of each category relative to the skills required for the maintenance of their equipment.

A summary should then be prepared to add up the total manhours required per equipment and for the total system. The manhour requirements should then be compared with the preventive maintenance goals and/or requirements established by the contractor and the SCRTD.

9.3 FORMAT

Exhibits 9-1 provides the format for the Preventive Maintenance Schedule. The format headings were discussed above under approach.

9.4 EXAMPLE

Exhibits 9-2 provides an example of an appropriately detailed Preventive Maintenance Schedule for a gear unit.

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Preventive Maintenance Schedule

Contract: ______________ No.: ________	Date: ______________
System: ______________	Revision: ______________
Subsystem: ______________	Page ________ of ________
Equipment: ______________	Prepared By: ______________

Step No.	Recommended Action	Frequency	Skill Level	Elapsed Time	Crew Size	Labor Hours	Comments

- miles
- hours
- months
- cycles

EXHIBIT 9-1

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Preventive Maintenance Schedule

Contract: PASSENGER VEHICLE No.: A650
System: N/A
Subsystem: PROPULSION
Equipment: GEAR UNIT

Date: 7-26-86
Revision: C
Page 6 of 30
Prepared By: JOHN DOE

Step No.	Recommended Action	Frequency (MILEAGE/INTERVAL)	Skill Level	Elapsed Time (HOURS)	Crew Size	Labor Hours	Comments
2.0	GEAR UNIT-TYPE TS-460-8						
2.1	OIL ANALYSIS						
	A. CHANGE OIL, CLEAN RESERVOIR AND MAGNET (ALL CARS)	40,000/ANNUAL	INT.	.50	1	.50	PERFORM AS DETERMINED BY THE LUBRICATION
	B. DRAW OIL SAMPLE FOR ANALYSIS		INT.	.25	1	.25	PROGRAM WHICH WILL BE DETERMINED BY THE OIL ANALYSIS. SEE THE VEHICLE MAINTENANCE MANUAL, CHAPTER 3, PAGE 2
2.2	CHECK OIL LEVEL AND FEEL FOR GRIT AND METAL PARTICLES	10,000/QUARTERLY	INT.	.10	1	.10	
2.3	REMOVE THE COVER FROM THE HIGH SPEED RESERVOIR AND INSPECT FOR UNUSUAL OR EXCESSIVE METALLIC PARTICLES	10,000/QUARTERLY	INT.	.20	1	.20	
2.4	CHECK LOW SPEED BEARING END FLOAT	200,000	INT.	.50	1	.50	PERFORM INITIALLY AT 10,000 MILES
2.5	OVERHAUL THE GEAR UNIT PER CHAPTER 5 OF THE WORKSHOP MANUAL	500,000	ADV. ADV	1.0 16.0	2 2	2.0(ON CAR) 32.0(IN SHOP)	

SAMPLE

EXHIBIT 9-2

10.0 CORRECTIVE MAINTENANCE ANALYSIS

10.0 CORRECTIVE MAINTENANCE ANALYSIS

Chapter 10.0 describes the nature and purpose of the Corrective Maintenance Analysis (CMA). A format with appropriate definitions and an example of the analysis and necessary inputs to it are also presented.

10.1 PURPOSE

A Corrective Maintenance Analysis (CMA) is conducted to evaluate the maintainability parameters of subsystem and equipment design. This evaluation helps to identify and thereby reduce:

- The duration of the system downtime due to corrective maintenance
- The complexity of maintenance
- The maintenance support costs
- The potential for maintenance errors
- The maintenance personnel requirements
- The design-dictated maintenance activities and related costs.

One of the means to accomplish these goals is reviewing the design data and incorporating features in the design which will facilitate maintenance. The review of the system or equipment design should consider features such as:

- Provision of fault isolation/troubleshooting aids, including but not limited to:
  - Built-in test points
  - Failure indicators
  - Built-in test equipment.
- Identification by nameplates, color coding, number coding, or other means of all test points, fault indicators, modules, wire junctions, pipes, tubing, etc., to assist the maintenance repairman.
- Physical interchangeability of assemblies or components that are functionally interchangeable and prevention of physical interchangeability of assemblies or components that are not functionally interchangeable.

- Maximizing use of standard commercially available components and hardware wherever acceptable.

- Placement of components and equipment cabinets so that those items which are most frequently maintained are the most accessible. This determination should be based upon failure rates and frequency of calibration.

- Eliminating or minimizing the need of adjustment for shift, drift, and degradation.

- Minimizing the number of special tools.

- Designing panels and openings to be of sufficient quantity, size and placement to permit ready access from normal work areas.

- Assuring that adjustment controls, fittings, safety valves, etc., are directly accessible through panels and openings.

- Using self-retaining fasteners wherever possible.

- Avoiding special access opening tools unless considered necessary to prevent vandalism.

- Spacing cable connectors far enough apart so that they can be grasped firmly for connecting and disconnecting.

- Assuring proper labeling and keying of connectors so that they cannot be interchanged nor improperly installed.

- Providing for separation of control and power components.

- Providing handles, as applicable, on heavy components or less accessible components for ease of handling.

- Providing for visual inspection of equipment wherever possible.

- Eliminating torque specifications for fasteners, when practical.

Although incorporating the above design features may be highly desirable for ease of maintenance, the inclusion may not be cost effective. Therefore, in addition to the design features, the CMA should also consider the following inputs:

- Preliminary operational and maintenance concepts

- Impact of environmental conditions unique to Metro Rail

- Overall quantitative maintainability goals and requirements

- Personnel constraints

- Projected facility capabilities, the training program, mechanics' skills, test equipment, and tool availability

- Cost constraints.

The Corrective Maintenance Analysis translates the above inputs into detailed qualitative and quantitative maintainability requirements. The results of the CMA are used to develop recommendations for:

- Detailed fault isolation and troubleshooting procedures

- Training programs, skill levels, and staffing levels

- Subsystem, component, and piece part repair policy

- Depth and frequency of maintenance requirements at each level

- Required support equipment, tools, and facilities.

10.2 APPROACH

A CMA consists of the following activities:

- A breakdown of the system/subsystem into the elements of line replaceable units (LRU)

- A corrective action maintenance plan for each LRU

- Recommendations of support requirements.

Each system/subsystem should first be broken down into its various elements and their hierarchy in terms of functions and line replaceable units. The quantities of LRUs should also be identified. An example of a propulsion system LRU tree is shown in Exhibit 10-1.

Next, a corrective action maintenance plan for each LRU should be specified. This involves the following steps:

- Reviewing FMECAs for each LRU.

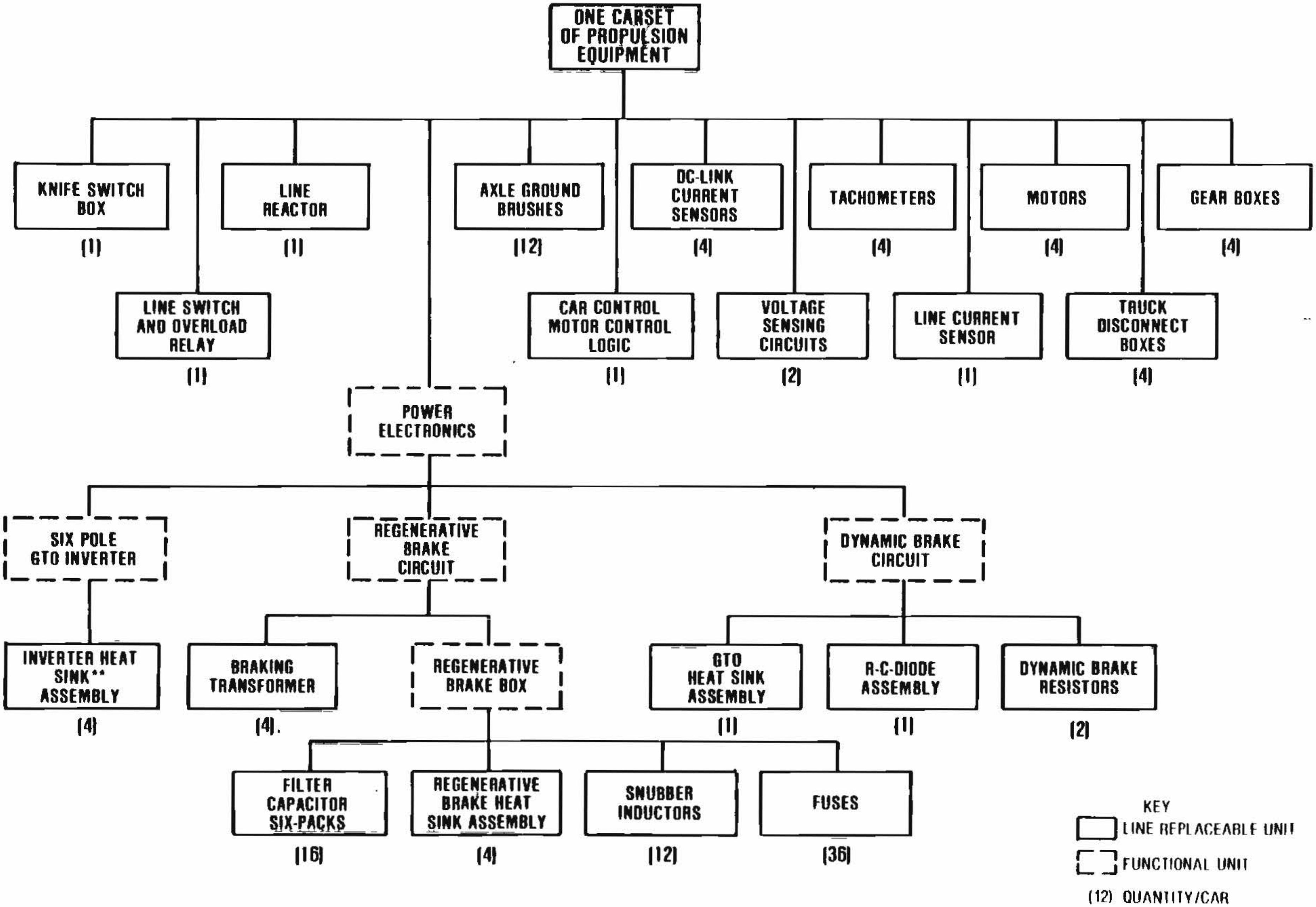


EXHIBIT 10-1
Example of LRU Tree

- Compiling the most prevalent failure modes and the failure modes with criticality categories 1 and 2. A Summary of Critical and Common Failure Modes is shown in Exhibit 10-2.

- Identifying the corrective maintenance actions for the most prevalent failure modes of each LRU. The actions are broken down into Fault/Isolation, Repair/Replace, Checkout, and Secondary Maintenance, if applicable. For each action, the skill level, crew size, time to repair, and labor hours need to be identified. This will provide the SCRTD with a realistic estimate of corrective maintenance labor requirements (both skills and quantity of personnel), as well as provide the contractor with baseline information for development of maintenance manuals.

For the purposes of the CMA, two levels of maintenance must be considered:

- Primary maintenance
- Secondary maintenance.

Primary maintenance includes troubleshooting and fault isolation, repair/replace, and checkout on failed equipment that has not been removed from the location in which it is normally installed.

Secondary maintenance includes repair of LRUs or components which have been removed during primary maintenance.

Following the identification of the tasks involved with primary and secondary maintenance, the labor required to perform fault isolation/troubleshooting, repair/replace, and checkout should be documented. For each category, the skill level (advanced, intermediate, basic) the crew size, the elapsed time, and total labor hours should be indicated.

In addition, the facilities, tools, and test equipment required should also be specified.

10.3 FORMAT

Exhibit 10-3 provides the format for the Corrective Maintenance Analysis (CMA). Headings are described below:

- Contract and No.: Same as described in Section 3.3.

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Summary of Critical and Common Failure Modes

Contract: ______________ No.: ______________	Date: ______________
System: ______________	Revision: ______________
Subsystem: ______________	Page ______ of ______
	Prepared By: ______________

Item No.	Equipment	Failure Mode	FMECA No.	Crit. Cat.

EXHIBIT 10-2

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Corrective Maintenance Analysis

Contract: ______ No.: ______
Subsystem: ______
Assembly: ______
LRU: ______
LRU Part No.: ______

CMA No. ______
Date: ______
Revision: ______
Page ______ of ______
Prepared By: ______

Failure Information (FMECA No. ______)

Failure Mode:

Means of Detection:

Effects of Failure:

Corrective Maintenance Actions

Primary Maintenance

Fault Isolation /Troubleshooting: ______

Repair/Replace: ______

Checkout: ______

Secondary Maintenance: ______

Skill Level	Crew Size	Elapsed Time	Labor Hours

MTTR

Labor Hours

Skill Level	Crew Size	Elapsed Time	Labor Hours

Tools/Test Equipment/Facilities

- Subsystem: A descriptive title which references the subsystem under analysis. Generally, the subsystems will conform to the chapter titles in technical provisions in the procurement specifications (propulsion, ATO, friction brake).

- Assembly: The subsystem should be further defined to describe the assembly under analysis.

- LRU: The line replaceable unit under analysis.

- LRU Part No.: Provide the part number of the LRU so that the corrective maintenance analysis can be tied back to the reliability analyses. The SCRTD will estimate annual corrective maintenance workload based on the failure rate and the labor hours to repair the LRU.

- CMA No.: A unique alphanumeric reference number assigned by the contractor.

- Date: Same as described in Section 3.3.

- Revision: Same as described in Section 3.3.

- Page: Same as described in Section 3.3.

- Prepared By: Same as described in Section 3.3.

Failure information for each LRU should be provided so that the SCRTD can relate the corrective maintenance actions to identified failures. The following information should be provided:

- FMECA No.: Reference one (or more) FMECA Nos. from which the failure was identified.

- Failure Mode: Identify the failure mode.

- Means of Detection: Identify the means by which the failure will be annunciated or detected.

- Effect of Failure: Describe the affect of the failure on the system or subsystem under analysis.

Corrective maintenance actions should be segregated into primary and secondary maintenance. Identify the steps, or tasks, for fault isolation/troubleshooting, replace/repair, checkout, and secondary (off-line) maintenance. Where there is no secondary maintenance (part is thrown out), it should be so stated.

- Skill Level: Same as described in Section 9.3.
- Crew Size: Same as described in Section 9.3.

- Elapsed Time: Same as described in Section 9.3.
- Labor Hours: Same as described in Section 9.3.

The elapsed time for primary maintenance should be added up to provide the mean time to repair (MTTR).

- Tools/Test Equipment/Facilities: Identify the requirements for tools, test equipment, or any facility requirements to repair the LRU.

10.4 EXAMPLE

Exhibit 10-4 and 10-5 provide examples of a partially completed Summary of Critical and Common Failure modes and a CMA.

EXHIBIT 10-4

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Summary of Critical and Common Failure Modes

Contract: VEHICLE No.:	Date: 6-11-86
System: N/A	Revision: B
Subsystem: PROPULSION	Page 3 of 8
	Prepared By: JOHN DOE

Item No.	Equipment	Failure Mode	FMECA No.	Crit. Cat.
1.0	KNIFE SWITCH BOX	OPEN FUSE	2.3.5	1
2.0	LINE SWITCH OLR	1. FAULTY MAGNET VALVE	2.4.6	2
		2. FAULTY CYLINDER	2.4.7	2
		3. FAULTY AIR REGULATOR	2.4.8	2
		4. OPEN FUSE	2.4.11	1
		5. OPEN OR SHORTED 1 OHM CHARGING RESISTOR	2.4.12	1
3.0	LINE REACTOR	SHORTED WINDING (FULL OR PARTIAL)	2.5.3	2
4.0	DYNAMIC BRAKE BOX (INCLUDES GATE DRIVER BOARDS)	1. SHORTED GTO OR SNUBBER CAPACITOR	2.9.4	2
		2. FAILURE OF GTO TO TURN ON	2.9.8	1
5.0	GEAR UNIT	BEARING FAILURE	2.9.2	1

SAMPLE

METRO RAIL PROJECT
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

RTD

Corrective Maintenance Analysis

Contract: PASSENGER VEHICLE No.: A650
Subsystem: FRICTION BRAKES
Assembly: TRACK BRAKE UNIT
LRU: PARKING BRAKE ACTUATOR
LRU Part No.: 11076-B

CMA No. PV-FB062
Date: 7-20-86
Revision: C
Page 12 of 26
Prepared By: JOHN DOE

Failure Information (FMECA No. B-2.5.32)
Failure Mode: UNREQUESTED PARKING BRAKE APPLICATION
Means of Detection: CONSOLE INDICATION "PARKING BRAKE ON"
Effects of Failure: TRAIN CANNOT MOVE

Corrective Maintenance Actions

Primary Maintenance	Skill Level	Crew Size	Elapsed Time	Labor Hours
Fault Isolation /Troubleshooting: 1. OPERATE THE PARKING BRAKE ON, OFF BUTTON TO RELEASE BRAKE 2. CHECK ALL CIRCUIT BRAKERS FOR TRIPPING 3. ISOLATE THE CAR WITH PARKING BRAKE ON BY OBSERVATION OF THE BRAKE SHOE APPLICATION	BASIC	1	0.25	0.25
Repair/Replace: MANUALLY RELEASE PARKING BRAKE ON AFFECTED CARS	BASIC	1	0.1	0.1
Checkout: PARKING BRAKE ON INDICATION SHOULD BE EXTINGUISHED. TRAIN CAN MOVE WITH REQUIRED ACCELERATION WHEN POWER IS APPLIED	BASIC	1	0.1	0.1
			MTTR 0.45	Labor Hours 0.45

Secondary Maintenance	Skill Level	Crew Size	Elapsed Time	Labor Hours
REPAIR BROKEN SPRING IN THE ACTUATOR, CHECK OUT FUNCTION	ADV	2	1.3	2.6

Tools/Test Equipment/Facilities
HEAVY MAINTENANCE TOOLS, PARKING BRAKE TEST STAND

SAMPLE

APPENDIX - LIST OF REFERENCES

LIST OF REFERENCES

1. Baltimore Region Rapid Transit System (BRRTS) Contract No. X0-02-02, September 1978, Train Control and Communications Contract Specifications Book.

2. Baltimore Region Rapid Transit System (BRRTS) and Metropolitan Dade County (MDC) Contract Nos. X0-06-02 and Y911, February 1979, Rapid Transit Passenger Vehicle Procurement Contract Specifications Book.

3. Hammer, Willie, 1972, Handbook of System and Product Safety.

4. Metropolitan Atlanta Rapid Transit Authority (MARTA), Critical/Catastrophic Items List.

5. MIL-HDBK-472, May 24, 1966, Maintainability Prediction.

6. MIL-STD-470, March 21, 1966, Maintainability Program Requirements (for Systems and Equipments).

7. MIL-STD-882A, June 28, 1977, System Safety Program Requirements.

8. Society of Automotive Engineers (SAE) Aerospace Recommended Practice 926, September 15, 1967, Design Analysis Procedure for Failure Mode, Effects and Criticality Analysis.

9. Westinghouse Corporation, March 1985, Vehicle Maintenance Concept for AC Drive Propulsion System, Critical Design Review.

10. Urban Mass Transportation Administration Report No. IT-06-0027-A, March 1973, Guideline Specification for Urban Rail Cars.

11. Urban Mass Transportation Administration, Office of Safety and Product Qualification, April 1981, System Safety Analysis, A Description of the Formats and Methodologies for System Safety Analysis of Fixed Guideway Transit System (Final Draft).

MIAMI
OP
PLAN

A - 21

Chicago Central Area Transit Project

Supervising Consulting Architects
C. F. Murphy Associates
Loebl, Schlossman, Dart & Hackl

Supervising Consulting Engineers
De Leuw – Novick

SUPERVISING CONSULTING ENGINEERS
DESIGN CONTROL PROGRAM PLAN
FOR THE
CHICAGO CENTRAL AREA TRANSIT PROJECT

Prepared by: De Leuw – Novick
Supervising Consulting Engineers

July 1976

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1. Introduction

1.1 General

The scope of work that is required to consummate the planning, design and construction of a rail rapid transit system includes a number of complex and inter-related engineering tasks. The design phase requires the coordinated efforts of a number of engineering and architectural organizations to execute the detail in accordance with the defined implementation plan.

The Supervising Consulting Engineer (SCE), in accordance with the proposed terms of consulting services agreement with the Chicago Urban Transportation District (hereinafter identified as the District), is responsible for the supervision of Chicago Central Area Transit Project (CCATP) engineering design. The SCE supervisory responsibility includes coordination and review of all phases of the work performed by Design Consultants, excluding Architecture which is to be performed by the Supervisory Consulting Architects.

This document, Design Control Program Plan, describes the SCE organizational responsibilities and it's policies and procedures for supervising the efforts and products of design consultants.

The District contracts with Architectural and Engineering Consultants, among others, to perform professional services required for final design, preparation of contract documents, and construction support services. Two design consultant classifications have been defined for the CCATP; Design Consultant-Section (DC) and Stage Design Consultant (SDC).

A DC provides professional services that are required for final design and preparation of Contract Documents for a section of the rapid transit facilities described in the DC contract with the District. These facilities include subway structures, surface accesses, stations, traction power substation structures, drainage, plumbing, fire protection, lighting, environmental control, utilities, and AC electrical power distribution systems for stations and ancillary equipment. The DC submits periodic and special reports, and participates in design reviews as specified in the DC contract, and described in this document.

An SDC provides all professional services for the design, preparation of Contract Documents and the rendering of support services during installation of those elements that will be operated on a system wide basis for the transit facilities (i.e., Communications, Traction Power, Train Control). The SDC submits periodic and special reports, and participates in design reviews as specified in the SDC contract, and described in this document.

The SDC is responsible for the control and supervision of the DC and SDC design efforts and products. The SCE submits periodic and special reports to the District relative to design, costs and schedules as described in this document. Also, the SCE prepares special design analyses and studies, as required.

1.2 Objectives

The SCE objectives are to ensure that the designs are executed without error or omission, with minimum change order requirements and control the performance, budget and technical quality of the design consultants. The Design Control Program Plan defines the proposed SCE organizational responsibilities and procedures for achieving these objectives.

Specifically the SCE Design Control Program will ensure that:

- The detail design, and contract documents are developed, reviewed, monitored, and finalized in a time and cost effective manner consistant with the planning documentation and District implementation goals.

- Periodic and special reviews of planning and design tasks and documentation are conducted with the Supervising Consulting Architects (SCA), Construction Management Consultant (CMC), District, and other organizations as specified by the District.

- The design process is technically refined and design uniformity is achieved.

- System components are compatible from one design section to another.

- The design process is documented in it's entirety and these data employed on subsequent design tasks.

- The design is consistant with criteria, drawings, specifications and other planning and design goals established by the District.

- Design decisions are substantiated by analyses and studies in coordination with cognizant organizations.

- SCA and CMC involvement are coordinated and integrated in the design process.

1.3 Scope

This plan describes and defines the supervisory control and monitoring plan, directives and procedures of the SCE for the design phase of the Chicago Central Area Transit Project (CCATP). Responsibilities of each system design control discipline are delineated; detailed procedures for data control and coordination of design reviews are described.

The aspects of system design covered by this document are:

- Design bases validation
- Accuracy and adequancy of design documents, calculations and analyses
- Design Cost Control
- Design Scheduling Control
- Constructability Features
- Environmental Protection during construction
- Documentation Control
- Inter-Organization Coordination
- Construction cost control
- Construction schedule control

Aspects of the design process not included in this document include:

- District Administrative controls and procedures for DC's and SDC's contractural obligations other than the above
- District and Project Procedures
- Supervising Consultant Architect (SCA) programs and procedures

- Construction Planning and Construction Management Consultants (CP/CMC) programs and procedures

- Agreements, plans and/or procedures between the District and other consultants, agencies and organizations

1.4 Project Organization

The organizational relationships between the District and the supervising and management consultants are shown on Figure 1-1. The SCE receives project direction from, and reports to, the Manager of Professional Services on all matters of planning and design. The SCE reports to the Executive Director on all matters affecting the SCE contract with the District. The SCE schedules design reviews and meetings in coordination with the Supervising Consulting Architect (SCA) and Construction Management Consultant (CMC). The CMC may be preceded on the project by a Construction Planning Consultant (CPC); if this is the case the term CPC and CMC should be considered synonymous for the purpose of this document. SDC's and DC's report to the SCE on all matters concerning the technical aspects of their work.

The SCE organization for planning and design of the CCATP is shown on Figure 1-2. A description of the SCE organizational elements for Design Control is provided in Section 2 of this document. It should be noted that all design control efforts of the SCE are integrated and coordinated internally, as well as with the SCA, CMC, the District and other agencies.

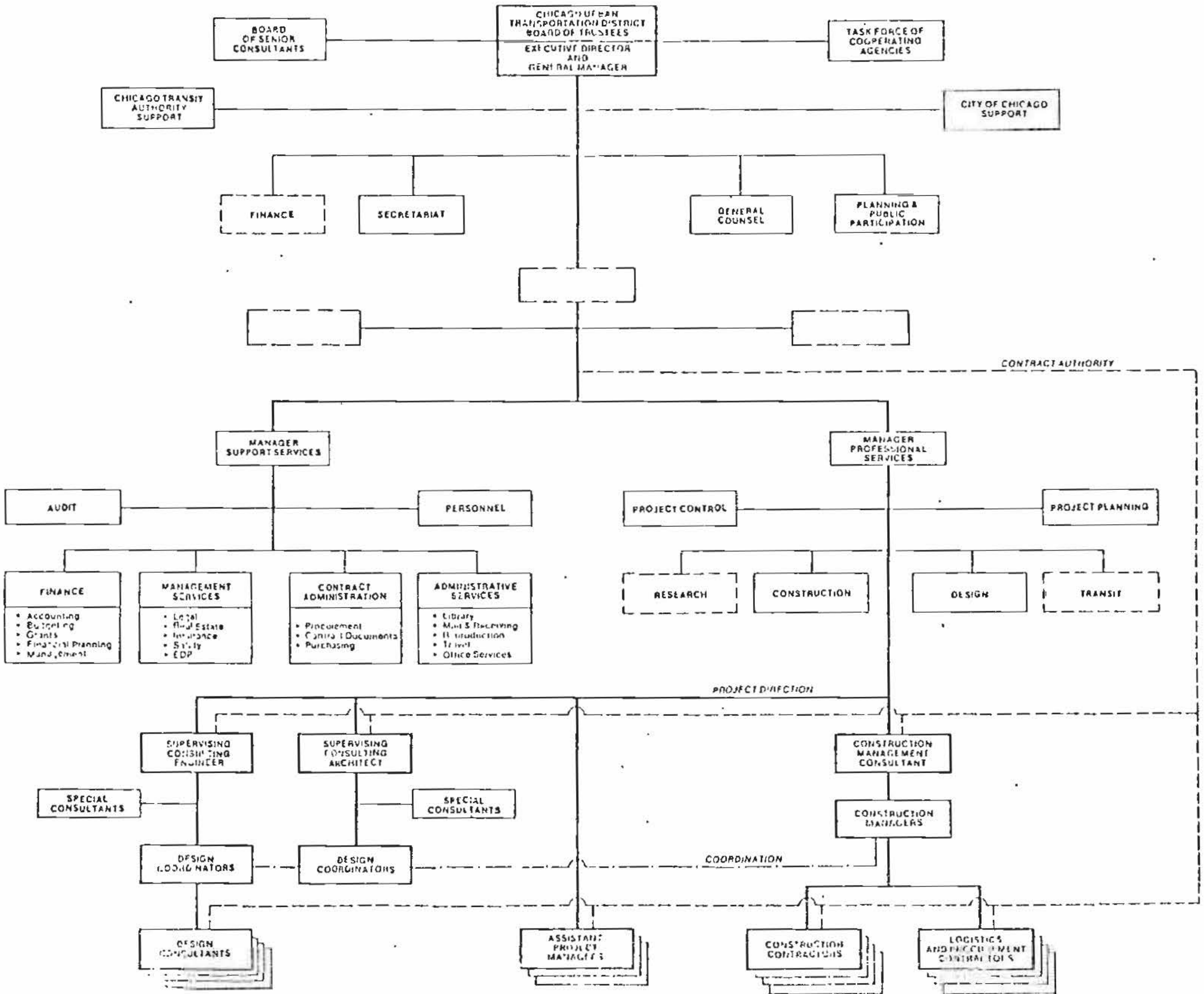
1.5 Bases for Design

The bases for design of the CCATP are documented in the District's Design Criteria, General Plans, Standard and Directive Drawings, and Standard Specifications. These documents were developed from detailed analyses and studies of transit system operating requirements and patron needs. Federal, State and City codes and regulations; transit industry design and operating criteria, unique engineering, architectural, and construction requirements are incorporated in these documents.

1.5.1 Data Provided to Design Consultants

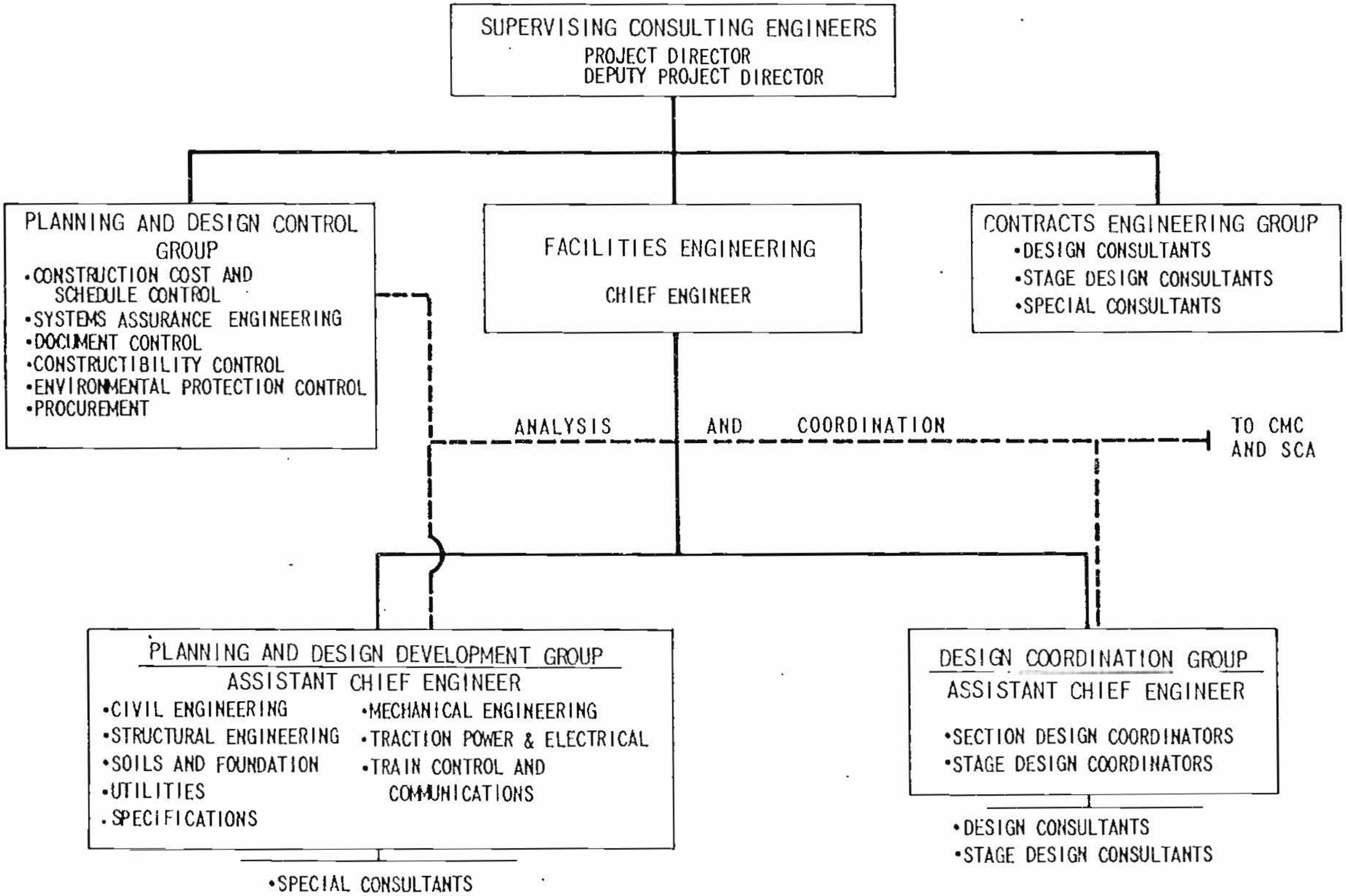
The District provides the bases for design documentation as described above and other pertinent information to the DC and SDC for their information and application. These documents, which are the bases for design include:

INTERIM AUSTERE ORGANIZATION



AUGUST 1, 1975

Figure 1-1



SUPERVISING CONSULTING ENGINEERS (SCE) ORGANIZATION CHART

FIGURE 1-2

- Available existing building plans
- Aerial Mosaic Maps
- Block Surveys
- General Plans, including:
  - Mathematized alignments and profiles
  - Traffic Master Plan
  - Existing Utility Drawings
  - Utility Restoration Drawings
- Manuals of Design Criteria
- Standard and Directive Drawings
- Architectural Materials Analysis
- Standard Specifications
- Soils and Foundation Reports
- Overall Project Schedules and Target Costs
- Construction Management Manual
- Construction Procurement Manual
- Construction Inspection Manual
- Construction Safety Manual
- Construction Safety Program and Reporting Procedures
- System Safety Engineering Design Criteria
- Reliability Engineering Design Criteria
- Maintainability Engineering Design Criteria
- Human Factors Engineering Design Criteria

- Utility Agreements between District and Owners

- Guidelines for Developing Schedules and Reporting

- Special Consultant Reports

1.5.2 Reports and Studies

Reports and studies that were used in the planning and pre-design phases to enforce planning decisions and substantiate the bases of design documents include, but are not limited to:

- Cost Critique of Preliminary Cost Estimate for the Monroe Line

- Corrosion Study - Distributor West and Stray Current Analysis for the District/ CCATP

- Architectural Station Concepts, Distributor Line

- Michigan/Franklin Station Alternatives

- Architectural Materials Analysis

- Architectural Cost Effectiveness Study of the Monroe Line

- Michigan/Franklin Station, Monroe Arcade Study

- Patron Appurtenances: Location and User Performance Analysis

- Architectural Station Concepts - Franklin Line

- Transit Car Configuration Analysis

- Phase I Preliminary Cost Estimate

- User Charges Study

- Report on the Analysis of Various Environmental Control Systems for the Distributor Subway

- Subway Tunnel Fire Hazards and Emergency Ventilation Considerations

- Noise and Vibration Study for the Distributor West Segment

- U and I/Halsted Station Alternate Concept Analysis

- Operational Capacity, Service and Safety Study

- Special Trackwork Systems for Subway Structures

- Subway Structures Track Systems

- Utility Tunnel Economic Feasibility Analysis in connection with construction of subways by the cut - and - cover method

- Fare Collection Equipment and Systems Study

- Preliminary Cost Estimate for the Franklin Line

2. Design Control Organization

The SCE organization for planning and design is shown on Figure 1-2 (see Section 1). To ensure that the supervision and control of the section and stage designs are executed in a cost and time effective manner the SCE maintains this organization structure for the design phase.

The responsibility of technical and administrative control of the products and progress of the DC and SDC are assigned to an SCE Design Coordinator. The Design Coordinator reports to the Assistant Chief Engineer of the Design Coordination group. The Assistant Chief Engineer is responsible for coordinating design action with the Chief Engineer and Project Director.

The Design Coordinator acts as a focal point for coordinating activities and answering inquiries from the design consultants, SCE Design Control Groups, SCA, CMC, District, other consultants and outside agencies. The Design Coordinator is supported by the Planning and Design Control Group, Planning and Design Development Section, and the Contracts Engineering group. Also, other design coordinators provide technical support on matters of mutual concern (i.e., interface compatibility, commonality of components and materials). Figure 2-1 depicts the design control coordination relationship within the SCE and between the SCE, design consultants and other organizations.

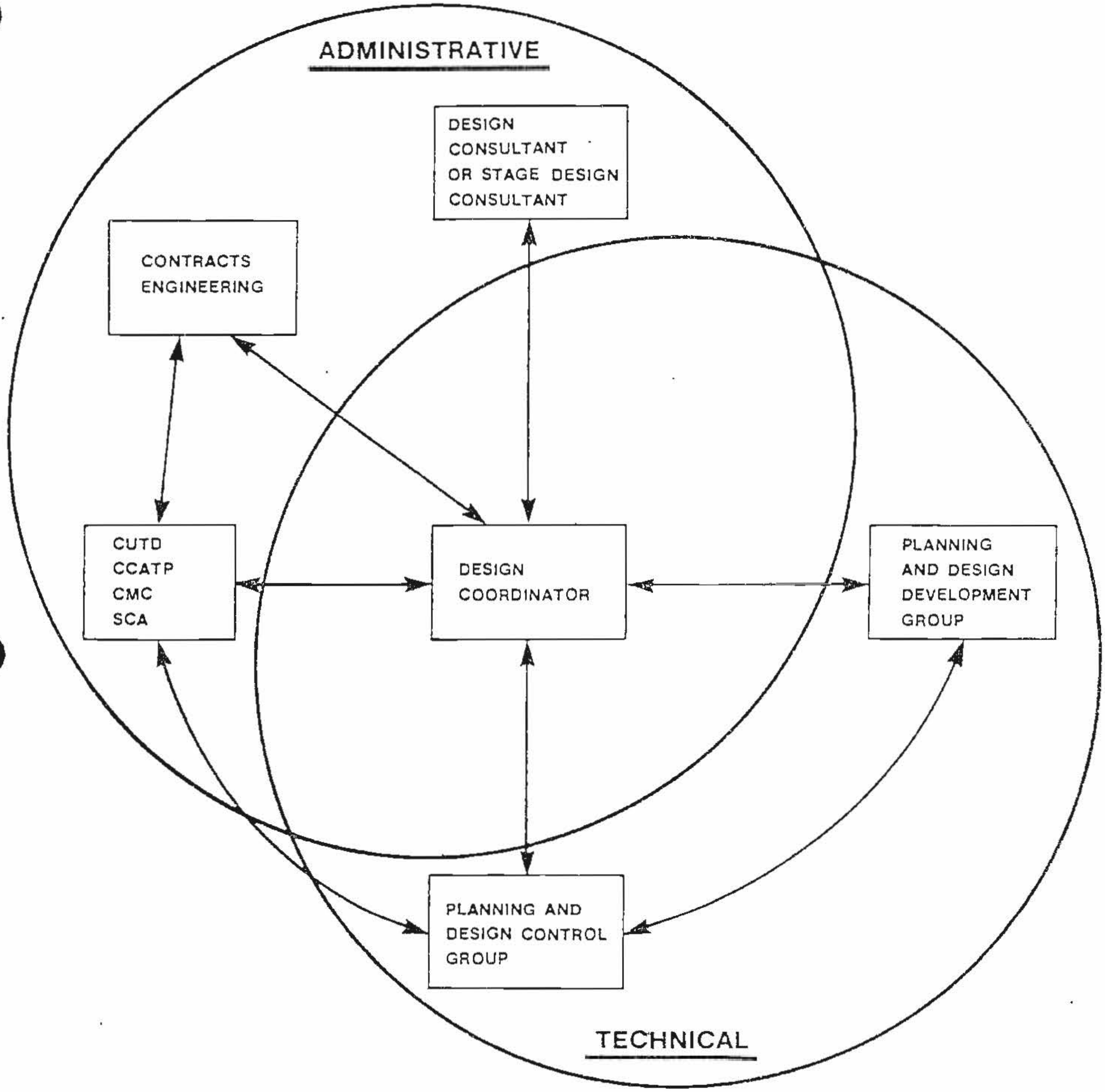
2.1 Task Descriptions and Responsibilities

The task description and responsibility of each design control group is defined as follows:

2.1.1 Design Coordination Group

A Design Coordinator is assigned by the SCE, to each SDC and DC, from the Design Coordination Group. The Design Coordinator is responsible for monitoring the consultant's compliance with the design scope of work and to provide liaison between the consultant and the District, CCATP, SCA, SCE and CMC.

Technical acceptability and timely completion of a section or stage design are the foremost goals of the Design Coordinator. To this end, the Design Coordinator reviews and approves design scheduling, arranges for proper and timely review submittals from the design consultant and encourages a complete review by the SCA, CMC, and District, within the time allotted for review. Monthly progress reports are prepared by the Design Coordinator



DESIGN CONTROL COORDINATION

FIGURE 2-1

for each design contract and the Design Coordinator is responsible for informing the District of specific problems which cause or may cause delay.

The Design Coordinator will schedule and supervise the conduct of all design meetings and reviews between the consultant and other organizations. The Design Coordinator will assign specific design documentation to the other SCE Design Control groups; assemble the resultant data and prepare appropriate reports and recommendations to the Design Consultant, SCE Project Director, and others, as appropriate. Also, the Design Coordinator will maintain a current file on costs, schedules and action items pertaining to the design section or stage, and similiar data for design sections and stages interfacing with the design section or stage. The Design Coordinator will ensure that all data are processed in accordance with the procedures specified by SCE Document Control.

At all times throughout the design and construction of a CCATP section the Design Coordinator is to maintain effective and continuing communication between the design consultants and cognizant organization. All new criteria and planning changes are to be transmitted to the Design Consultant after the Design Coordinator has evaluated them for applicability and acceptability. The Design Consultant is expected to use the Design Coordinator as his technical liaison with SCE staff, the District and other consultants except as otherwise arranged by the Design Coordinator. Timely review and proper response to Design Consultant's inquiries concerning engineering or architectural matters by other consultants are managed by the Design Coordinator. Throughout the performance of his duties and especially in communications with the Design Consultant, the Design Coordinator is obliged to seek performance which is in the best interest of the District.

2.1.2 Planning and Design Control Group

The Planning and Design Control Group is comprised of Construction Cost and Schedule Control, Systems Assurance Engineering, Document Control, Constructability Control, Environmental Protection Control, and Procurement.

2.1.2.1 Construction Cost and Schedule Control

Responsible for the preparation of cost and schedule estimates, and cost and schedule control for the products of the design related to procurement and installation for a construction section. Control of costs and schedules for design services are the responsibility of the Contract Engineering Group, see paragraph 2.1.3.

a. Construction Cost Control

Construction Cost Control is responsible for the preparation of the initial procurement and installation cost estimates. These cost estimates, when approved by the District as the project budget, are used in the negotiation of DC and SDC contracts. These estimates are based on the bases of design documentation, and studies and reports prepared by the SCE, SCA and other consultants.

Cost Control will review and analyze recommendations submitted by the DC's and SDC's for any adjustments or changes in the District's budget or Procurement and Installation Target Costs to the extent necessary to ensure the accuracy and adequacy of these data. Detailed calculations required as part of these analyses will be performed by the cognizant design development section, as required, and submitted to Cost Control for review. Construction Cost Control will correlate and evaluate the findings and recommendations of these data; a value engineering analyses of material selection, procurement schedules, alternate methods and materials, affects on capital and life cycle costs shall be conducted for construction costs that differ significantly from target cost estimates. The cost effectiveness of the design shall be measured against other design sections, and similiar and dissimiliar materials and/or methods on other transit system construction projects.

b. Construction Schedule Control

Construction Schedule Control prepares the initial procurement and installation schedules. These schedules, when approved by the District, are the bases of establishing schedules for the project implementation.

Schedule Control will analyze updated schedule data submitted by the DC's and SDC's to the extent necessary to ensure the accuracy and adequacy of the data.

2.1.2.2. Systems Assurance Engineering

Systems Assurance Engineering is responsible for the review and analysis of human factors, safety, maintainability, reliability and systems integration engineering aspects of the detailed design. The DC and SDC will prepare and submit detailed analyses of electrical, mechanical, train control, communications equipment and subsystems, structural systems and finishes. These include preliminary hazard analysis, fault free analysis, failure modes and effect analysis; reliability estimates, quality control and testing; and human factors evaluation for patrons and employees.

Systems Assurance Engineering will conduct studies and analyses independent of those of the SDC and DC. The findings of these studies and analyses will be correlated with the DC and SDC data and design changes implemented where required.

In addition to these analyses and reviews, the design consultants drawings, plans, calculations, design change proposals and special provisions to the standard specifications, applicable to Systems Assurance responsibilities will be reviewed for compliance, accuracy and adequacy. Study and analyses procedures described in the SCE Systems Assurance Engineering Program Plan shall be followed by the design consultants and SCE.

Systems Assurance Engineering is responsible for evaluating the capabilities of the DC's and SDC's to perform these tasks, and recommend alternatives when a design consultant's products are not responsive to the contract requirements.

2.1.2.3 Document Control

Document Control is responsible for the receipt, reproduction processing, inter- and intra-organizational distribution, control, and transmittal of all design documentation developed in the CCATP design process by the SCE, DC and SDC. Also, Document Control will maintain the SCE Central Data Bank for these documents.

Document Control will prepare distribution and action control procedures. These procedures will be based on agreements between the SCE, District, SCA and CMC.

Document Control will establish standard forms, and writing style guidelines for correspondence and record maintenance. A standard procedure for recording the receipt and transmittal of documents within the SCE and to other organizations will include date-time stamping and serialization.

Appropriate storage, i.e., file cabinets, shelves, flat files, 'plan-hold' racks, shall be employed to ensure data security and ease of retrieval.

In addition to supervisory and clerical staff, Document Control shall have qualified checkers to verify that drawings, plans and other documents are in compliance with the drawing standards defined in the design criteria.

2.1.2.4 Constructibility Control

Constructibility Control is responsible for the review and analysis of drawings, plans, calculations, construction and installation staging and schedules submitted by the design consultants. Designs will be examined to ensure that they are adaptable to logical sequencing and that they can be executed using methods and techniques common to the industry and familiar to constructors. Review considerations shall also be addressed to environmental consequences, community relations, safety to workmen and the general public, management of traffic, and construction logistics. Constructibility Control will coordinate their reviews with the CMC to ensure that the recommended materials or methods are compatible with the CMC requirements. These reviews will include material handling, storage and erection considerations, availability and application of special construction machinery; environmental problems and recommended control measures including monitoring instrumentation and data requirements. Constructibility Control will develop alternate solutions not addressed by the design consultant; cost-benefits analyses of design consultants recommendations and constructibility control solutions will be documented; resolution will be based on the joint agreement of the SCE, CMC and design consultant.

2.1.2.5 Environmental Protection Control

Environmental Protection Control is responsible for the review of the DC and SDC drawings, specifications and reports to ensure that environmental conditions imposed by the design are responsive to the design criteria. In particular air quality, noise levels, illumination intensity and color, temperature and humidity standards, sanitation, comfort and aesthetics will be addressed in terms of impact during construction and in the finished product. These reviews will be coordinated with Constructibility Control and the CMC.

Environmental Protection Control is responsible for independent analyses of environmental problems, i.e., noise, dust, gases, debris, and the development of alternate solutions to the design consultants procedures; a value analysis of monitoring and measurement methods and implementation program will be performed to ensure that the specified program provides the required control and data on the identified problem. As appropriate, special studies, including simulations and field measurements, will be conducted to ensure that the proposed design characteristics will result in an acceptable environmental condition. Data on environmental monitoring and control developed by other agencies shall be collected, evaluated and applied as appropriate to the CCATP Construction Program.

2.1.2.6 Procurement

Procurement will review the design consultants recommendations for procurement of materials and equipment prior to, or concurrent with, the construction phase. Factors such as economics, present and future availability, standarization, and storage prior to installation shall be considered.

Procurement will maintain a status file on materials purch[illegible], and procurements schedules. These data will be provided t[illegible] and coordinated with the CMC and Constructability Control.

Procurement will compare previously approved (by the District) procurement contracts with new proposals from design consultants and provide recommendations relative to the feasibility of procurement based on the above factors.

2.1.3 Contracts Engineering Group

C[illegible]acts Engineering has the responsibility to review and v[illegible]y the DC's and SDC's data submittals and in compliance with their respective contracts. The Contracts Engineering Group prepares listings of contract deliverables which will be used by the Design Control disciplines in evaluating the adequacy of the design consultant's periodic and special submittals. Requests for contract variances from DC's and SDC's are reviewed by Contracts Engineering Group; recommendations relative to the appropriateness of the variance and contractual impacts are provided to the Design Coordinator.

Contracts Engineering is responsible for the preparation of the initial design services cost estimates and schedules as part of the Negotiation Memoranda. These estimates, when approved by the District, are employed in the evaluation and selection of design consultants. These cost estimates and schedules are based on the bases of design documentation, and studies and reports prepared by the SCE, SCA and other consultants.

The design services cost estimates and schedules resulting from contract negotiations between the District and a design consultant shall be incorportated in the bases for design documentation. Contracts Engineering will utilize these data as the basis for subsequent review and analyses.

Contracts Engineering will review and analyze design schedule and cost data provided by the SDC's and DC's to the extent necessary to ensure the accuracy and adequacy of these data and conformance with the contract.

The Contracts Engineering section will review the design consultant's proposed construction contracts and provide appropriate recommendations relative to the adequacy and accuracy of the documents to the Design Coordinator.

When directed by the District, Contracts Engineering will prepare the drafts of contracts for Special Consultants and Procurements.

2.1.4 Planning and Design Development Group

Planning and Design Development Group is responsible for the engineering review and analysis of the civil, structural, soils and foundations, utilities, mechanical, traction power and electrical, train control, communications, and specifications documentation developed by the DC's and SDC's. This group will perform design alternative analyses and special product investigations, as required.

Each discipline will prepare a detailed check list that they will employ in the review process to verify compliance with the design criteria, general plans, standard drawings and specifications. Except for document format verification which will be accomplished by Document Control, this checklist will include items such as stationing, alignments, equipment size and placement, equipment operating characteristics, material selection, adequacy of special provisions, and interface compatibility. Also, when coordination and approval by outside agencies is required, e.g. utilities, the checklist will include space for recording the required action and compliance thereto.

As part of the review checklist process, each discipline will verify the design consultant's calculations by performing independent analyses and sample calculations of critical sections or components of the design. These data will be appended to the checklist and submitted to the Design Coordinator at the SCE coordination review.

Each discipline will prepare a detailed report on discrepancies identified by these reviews and analyses, and participate in the SCE coordination review to the extent necessary to resolve the problem.

3. Design Control Procedures

The procedures defined herein shall be followed by the SCE Design Control disciplines in the execution of their specified responsibilities (see Section 2). Changes to these procedures and new procedures will be distributed as developed and approved by the SCE Project Director. It is the responsibility of Document Control to ensure that additions or changes to these procedures are distributed to all Design Control disciplines immediately upon approval; the Design Coordinator is responsible for distributing changes and additions to these procedures to the affected DC or SDC under his cognizance.

Figures 3-1 and 3-2 depict typical DC and SDC contract processes that will be controlled and coordinated by the Design Coordinator; Tables 3-1 through 3-5 provide a listing of DC and SDC contract requirements that will be accomplished in the course of their work. The data presented in these figures and tables should be used by Design Control in identifying their individual specific task requirements and establishing their work schedule.

3.1 Design Cost Estimates

Task C-1 of SCE contract with CUTD provides that the SCE shall prepare a Negotiation Memorandum for each design contract. The Negotiation Memorandum is to be used in the negotiation of a design contract with a design consultant.

Design contracts will include the following:

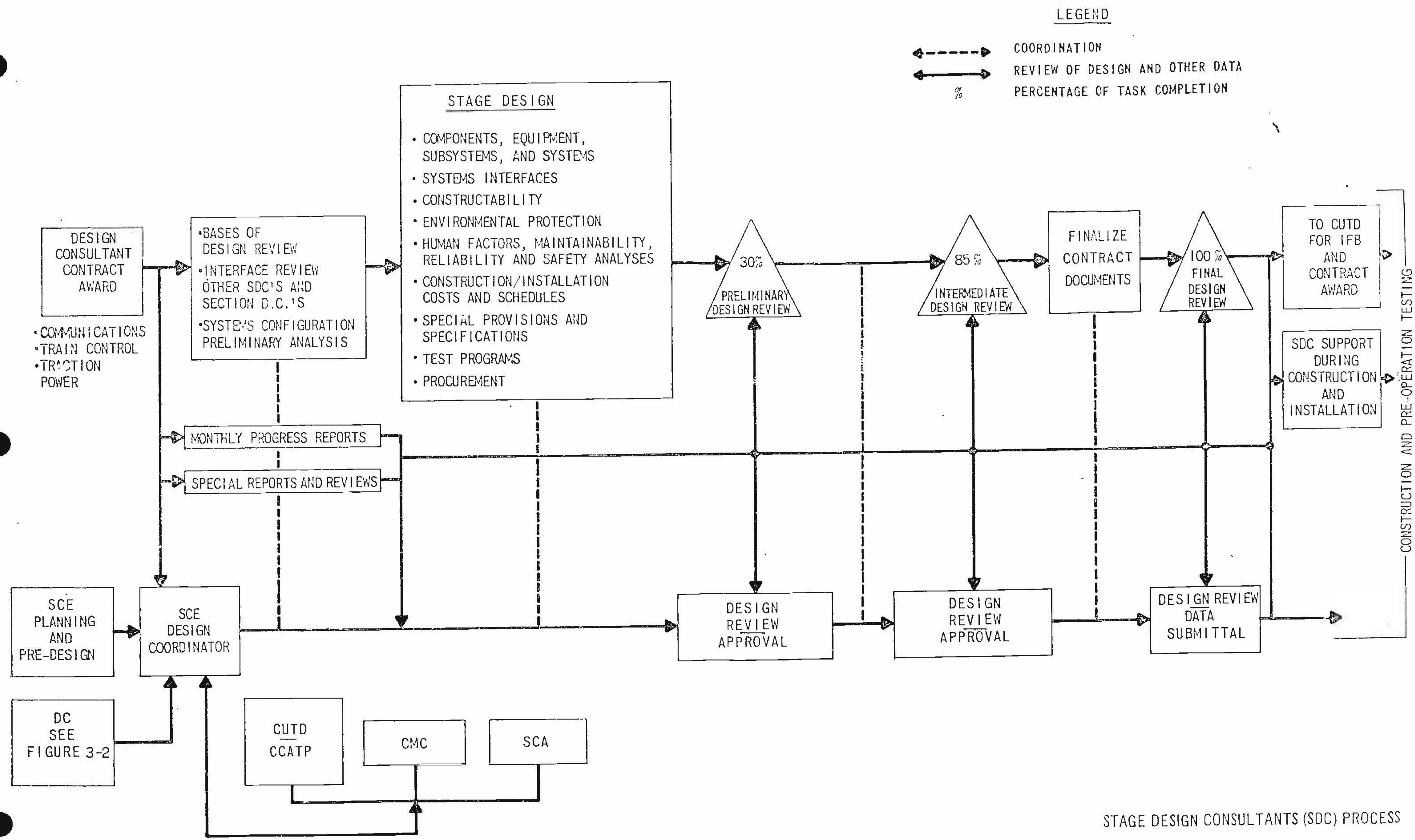
Scope I - Design Services

Scope II - Support Services During Construction

These procedures pertain to design cost estimates for Scope I services only.

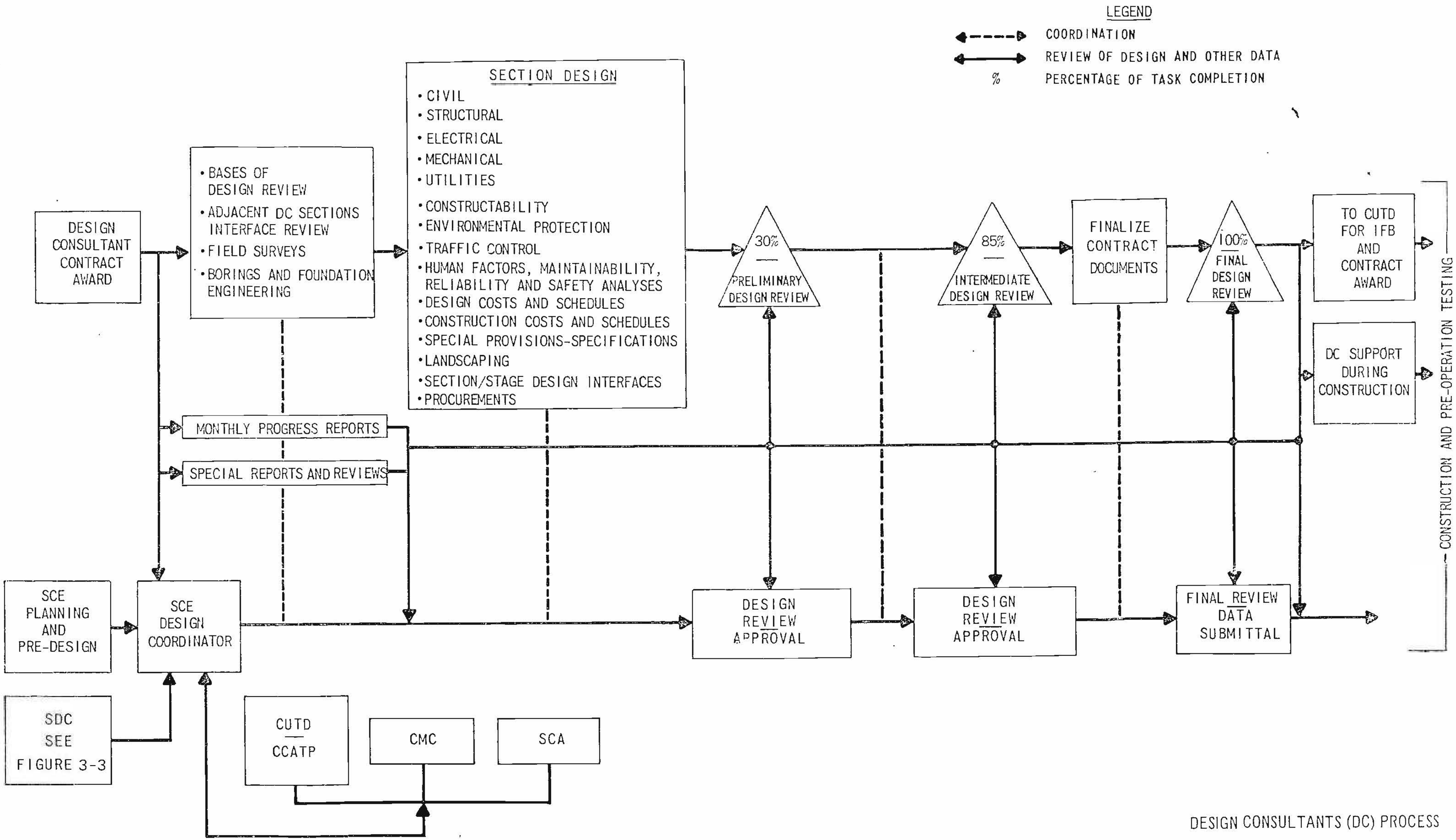
The Negotiation Memorandum, in addition to other pertinent information regarding the design contract, will include the following items:

a. Estimated number and types of contract drawings to be prepared by the DC.



STAGE DESIGN CONSULTANTS (SDC) PROCESS

FIGURE 3-1



DESIGN CONSULTANTS (DC) PROCESS

FIGURE 3-2

DC REQUIREMENTS OTHER THAN MONTHLY PROGRESS REPORTS AND REVIEW SUBMITTALS	MONTHLY PROGRESS REPORTS	PRELIMINARY REVIEW SUBMITTAL 30% COMPLETION	INTERMEDIATE REVIEW SUBMITTAL 85% COMPLETION	FINAL REVIEW SUBMITTAL 100% COMPLETION
1. Report to SCE for supervisory purposes. 2. Coordinate work with other DC's, SIC's, DC's-Up, private and public utilities, public agencies, railroads and other involved interests, through the SCE. 3. Prepare presentation documents, models as may be required for coordination activities. 4. Establish office in City of Chicago staffed by qualified personnel to perform the work. 5. Select staff resident coordinator. 6. Be represented at conference held in connection with work - prepare Memos of Records for such conferences. 7. Review all applicable data and criteria. 8. Coordinate with DC's of adjacent Section to establish definite Design Section Limits and to ensure coordination of design and construction with adjacent Sections. 9. Review plans by others of any proposed development that may affect design and construction of project facilities and recommend measures to minimize the effects. 10. As soon as possible after receipt of Notice to Proceed and prior to Preliminary Review Submittal, submit recommendations as to which items of construction should be included in separate construction contracts. 11. Request approval of deviations or exceptions to the Design Criteria, Standard Drawings and Specifications, etc., deemed necessary to solve particular design problems. 12. Procure rights-of-entry, permits, licenses, etc. 13. Perform detailed topographic surveys, including field checking of existing control data. 14. With assistance of Existing Utility Drawings, field check and verify locations and grades of affected utilities. 15. Establish construction limits. 16. Check mathematized alignments and profiles of transit tracks shown on General Drawings. 17. Determine if rights-of-way shown on General Plans are excessive or insufficient. 18. Review Soil and Foundation Report and make request for any additional soil investigations and analyses needed for design purposes. 19. As soon as possible after Preliminary Review Submittal submit written statement from each utility owner approving details (plans) of the DC for handling their facilities. 20. Prior to the Intermediate Review Submittal furnish schedules and identification of those utility items which must be completed prior to commencement of project construction and those which must be completed during project construction. 21. Investigation of certain existing structures to determine need for underpinning; submission of reports of investigation including recommendation and preparation of design and Contract Documents for the construction of underpinning of certain structures. 22. Within 30 days after receipt of Notice to Proceed, submit Design Network Schedules and Design Control Estimate for work to be performed. 23. At the earliest possible date, recommend in writing form an instrumentation program to be installed and monitored during construction for purpose of detecting movement of temporary and permanent structures.	Monthly Progress Reports consisting of: 1. Part I [illegible] description of [illegible] activities in progress during month; [illegible] coordination with others; and [illegible] by others which affect [illegible]. 2. Part II [illegible] activities on Design Network Schedules begun or completed; [illegible] activities in progress, estimated number of calendar days to complete; changes required in Design Network Schedules; total man-months of design effort expended during reporting period; and summaries of progress [illegible] for each identifiable construction contract. 4. Part III Actual incurred and estimated [illegible] through end of reporting [illegible] of cost to [illegible] remaining work for each work item in Design Control Estimate; and, [illegible] of design costs to be incurred in each of following three (3) months. 5. [illegible] drawings for each indentifiable construction contract.	Definitive layouts of important features. Include, but not limited, to the following for all [illegible], and for each construction [illegible], where applicable: [illegible] horizontal and vertical [illegible] transit tracks. [illegible] of structures showing conformity with adjacent Sections. [illegible] [illegible] [illegible] and cross-sections showing proximity of [illegible] [illegible] calculations. [illegible] and fan shafts, emergency [illegible] walkways, [illegible] and elevators. [illegible] stations and [illegible] locations. [illegible] and low [illegible] [illegible] and extent [illegible] applicable [illegible] plans and elevations of traction [illegible] equipment [illegible] layouts. [illegible] of auxiliary spaces (rooms) and [illegible] sizes and locations of equipment. [illegible] drawings of utility relocations. 4. [illegible] of traffic and construction [illegible] plans. [illegible] with respect to Design Systems [illegible] Program, including: [illegible] evaluation of the [illegible]. [illegible] Consistency with interface and [illegible] requirements of adjacent [illegible], etc. C. [illegible] methods for attaining reliability and maintainability as specified in Design Criteria. [illegible] Preliminary Hazard Analy[illegible] [illegible] Preliminary Human Factor [illegible] Report. [illegible] of construction [illegible] recommendations for [illegible] Target construction costs. G. Preliminary Construction Schedules (bar charts). I. Constructability. [illegible] specifications. [illegible] to be made and actions [illegible], District or others to [illegible]. [illegible] Landscaping Layout. [illegible] coordination of design of underpinning [illegible] structures with [illegible].	Completion such that work can be completed by incorporation of review comments without further review except to ascertain that comments have been appropriately incorporated. Include, but not limited to the following for all project facilities and for each construction contract where applicable: 1. Contract drawings, including equipment schedules and flow diagrams, substantially complete. 2. Design Calculations. 3. Assurances that requirements of Traction Power, Train Control, Communication Systems, etc. are included. 4. Electrical drawings for lighting and all AC electrical service. 5. Mechanical drawings, including design calculations. 6. Track bed layouts including details of all facilities pertinent thereto. 7. Special Provisions of Specifications. 8. Contract Documents for relocation of utilities. 9. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of design. B. Consistency with interface and confirmation requirements of adjacent Sections, etc. C. Reliability and maintainability specifications for all items in the design. D. Preliminary Hazard Analyses. E. Requirements and Plans for demonstration and verification of safety items and systems. F. Detailed Human Factors Engineering Report. G. Proposed changes in Construction Target Cost. H. Updated Construction Schedules (bar charts). I. Constructability. 10. Decisions to be made by SCE, District or others to assure progress on design. 11. Specific actions required by others to complement the design and without which construction cannot be executed on schedule. 12. Statement regarding utility work and relocations which must be completed prior to construction and which must be completed during construction. 13. Status of Coordination with DC's of adjacent Sections. 14. Control Monuments to be disturbed or [illegible] during construction. 15. Plans of demolition work in contract [illegible] Contract Documents for advance [illegible]. 16. Status of coordination of designs of underpinning for existing structures with structure owners.	Submittal for each construction contract to include: 1. Originals of contract drawings. 2. Prints of contract drawings. 3. Originals of all design computations. 4. Logs of survey data. 5. Originals of back-up calculations for contract quantities. 6. Originals and copies of Special Provisions of the Specifications. 7. Detailed Construction Schedules. 8. Final Estimates of Construction Costs. 9. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Consistency with interface and confirmation requirements of adjacent Sections, etc. C. Complete reliability and maintainability requirements and plans. D. Element Preliminary Hazard Analyses. E. Requirements and plans for demonstration and verification of safety items and systems. F. Comprehensive Human Factors Engineering Report. G. Proposed changes in Construction Target Cost (see item 8 above). H. Final Construction Schedules (see item 7 above). I. Constructability. 10. Specific actions required by others to complement the design and without which construction cannot be executed on schedule. 11. Statement that all necessary coordination with DC's of adjacent sections has been accomplished. 12. Statement by registered professional engineer that designs comply with requirements of regulating agencies, and that they have been checked for accuracy and completeness of detail. 13. Statement regarding coordination of designs of underpinning of existing structures with structure owners. 14. Design development report. 4/26/76 Requirements based on draft dated September 22, 1975, of Proposed Contract for Design Consultant Services.

TABLE 3-1

STAGE DESIGN CONSULTANT - TRACTION POWER - SCOPE 1 - REQUIREMENTS

SDC REQUIREMENTS OTHER THAN MONTHLY PROGRESS REPORTS AND REVIEW SUBMITTALS	MONTHLY PROGRESS REPORTS	PRELIMINARY REVIEW SUBMITTAL 30% COMPLETION	INTERMEDIATE REVIEW SUBMITTAL 85% COMPLETION	FINAL REVIEW SUBMITTAL 100% COMPLETION
1. Report to SCE for supervisory purposes. 2. Coordinate work with DC's, other SDC's private and public utilities, public agencies and other involved interests through the SCE. 3. Prepare presentation documents, models, etc., as may be required for coordination activities. 4. Prepare Contract Documents for early procurement by District of Traction Power Substation and Tie Breaker Station Equipment, and assist District in pre-bid conferences, in interpretation of Contract Documents, and in analysis and evaluation of procurement bids received. 5. Based on pertinent data received from successful bidders with respect to Traction Power Substation and Tie Breaker Station equipment, prepare equipment layouts in sufficient detail to permit the various DC's to properly design the substation structures. 6. Develop in coordination with Commonwealth Edison Co., the requirements for alternating current primary feeders to Traction Power Substations and furnish same to the DC's for incorporation of same into various DC Contract Documents. 7. Establish office in City of Chicago staffed by qualified personnel to perform the work. 8. Select staff resident coordinator. 9. Be represented at conferences held in conjunction with work-prepare Memos of Record for such conferences. 10. Review all applicable data and criteria. 11. As soon as possible after receipt of Notice to Proceed and prior to Preliminary Review Submittal, submit recommendations as to which items of materials should be included in separate procurement contracts, and which items of work should be included in separate installation contracts. Installation contracts to include: A. Procurement and installation of all materials and equipment not procured and furnished by the District. B. Installation of all materials and equipment procured and furnished by the District. 12. [illegible] of deviations or exceptions to design criteria, Standard Drawings and Specifications deemed necessary to solve particular design problems. 13. [illegible] rights-of-entry, permits, licenses, etc. 14. As soon as possible after Preliminary Review Submittal submit written statement from each affected utility company and public agency [illegible] the Traction Power Supply System [illegible] the particular utility company or public agency. 15. Within [illegible] days after receipt of Notice to Proceed, submit Design Network Schedules and Design Control Estimate for the work to be performed.	Monthly Progress Reports consisting of: 1. Part I Narrative description of major design activities in progress during month; coordination with others; and activities by others which affect design. 2. Part II Dates activities on Design Network Schedules begun or completed; for activities in progress, estimated number of calendar days to complete; changes required in Design Network Schedules; total man-months of design effort expended during reporting period; and summaries of progress (in percent) for each identifiable construction contract. 3. Part III Actual incurred and estimated [illegible] costs through end of reporting period; estimates of cost to complete remaining work for each work item in Design Control Estimate; and forecasts of design costs to be incurred in each of following three (3) months. 4. [illegible] for each identifiable [illegible] or installation contract.	[illegible] layouts of all important features. Include but not limited to the following, for the traction power facilities, and for each procurement or installation contract, where applicable: 1. Contract drawings and documentation of proposed system in sufficient detail to permit adequate [illegible] as to compatibility with all project features and to determine that System will function efficiently and is the most economical. 2. Sample calculations or written outline to convey the proposed design concept approach for all elements of the system. 3. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Consistency with interface and configuration requirements of adjacent structures, [illegible], and other elements. C. [illegible] methods for attaining reliability and maintainability as specified in [illegible] criteria. D. Preliminary Hazard Analyses. E. [illegible] Human Factors Engineering Report. F. [illegible] of procurement and installation [illegible] recommendations for [illegible] District's budget procurement and [illegible] costs. G. [illegible] Procurement and Installation [illegible] (bar charts). H. [illegible] 4. [illegible] recommendations for procurement [illegible] or installation contracts. 5. [illegible] made and actions to be taken by [illegible], District and others to assure [illegible] design.	Completion such that work can be completed by incorporation of review comments without further review except to ascertain that comments have been appropiately incorporated. Include but not limited to the following, for the traction power facilities, and for each procurement or installation contract, where applicable: 1. Contract drawings, including equipment schedules and flow diagrams, substantially complete. 2. Design calculations. 3. Special Provisions of Specifications. 4. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Consistency with interface and configuration requirements of adjacent structures, facilities, and other elements. C. Reliability and maintainability specifications for all items in the design. D. Preliminary Hazard Analyses. E. Requirements and Plans for demonstration and verification of safety items and systems. F. Detailed Human Factors Engineering Report. G. Proposed changes in Procurement and Installation Target Costs. H. Updated Procurement and Installation Schedules (bar charts). I. Constructability. 5. Decisions to be made and actions to be taken by SCE, District or others to assure progress of design. 6. Report outlining status of coordination with DC's and other SDC's.	Submittal for each procurement or installation contract to include: 1. Originals of contract drawings. 2. Prints of contract drawings. 3. [illegible] 4. Originals of [illegible] calculations [illegible] 5. Originals and copies of special provisions of the Specifications. 6. Detailed procurement and installation schedules. 7. Final estimates of procurements and installations. 8. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Consistency with interface and configuration requirements of adjacent structures, facilities, and other elements. C. Complete reliability and maintainability requirements and plans. D. Element Preliminary Hazard Analyses. E. Requirements and plans for demonstration and verification of safety items and systems. F. Comprehensive Human Factors Engineering Report. G. Proposed [illegible] in Procurement and Installation Target Costs (see [illegible]). H. [illegible] procurement and installation [illegible] (see Item [illegible] above). I. Constructability. 9. [illegible] required by [illegible] design and without [illegible] procurement and installation cannot be [illegible] on schedule. 10. Statement that all necessary coordination with DC's and other SDC's has been accomplished. 11. Statement by registered professional engineer that designs comply with requirements of [illegible] and that [illegible] have been checked for accuracy and [illegible]. 12. [illegible] Development Report. 4/26/76 Requirements based on draft dated September 15, 1975 of Proposed Contract for Stage Design Consultant Services for Traction Power Supply System.

TABLE 3-2

SDC REQUIREMENTS OTHER THAN MONTHLY PROGRESS REPORTS AND REVIEW SUBMITTALS	MONTHLY PROGRESS REPORTS	PRELIMINARY REVIEW SUBMITTAL 30% COMPLETION	INTERMEDIATE REVIEW SUBMITTAL 85% COMPLETION	FINAL REVIEW SUBMITTAL 100% COMPLETION
1. Report to SCE for supervisory purposes. 2. Coordinate work with DC's, other SDC's, private and public utilities, public agencies and other involved interests through the SCE. 3. Prepare presentation documents, models, etc., as may be required for coordination activities. 4. Establish office in City of Chicago staffed by qualified personnel to perform the work. 5. Select staff resident coordinator. 6. Be represented at conferences held in conjunction with work-prepare Memos of Record for such conferences. 7. Review all applicable data and criteria. 8. As soon as possible after receipt of Notice to Proceed and prior to Preliminary Review Submittal, submit recommendations as to which components of the Train Control System should be included in separate installation contracts. 9. Request approval of deviations or exceptions to Design Criteria, Standard Drawings, and Specifications deemed necessary to solve particular design problems. 10. Procure rights-of-entry, permits, licenses, etc. 11. As soon as possible after Preliminary Review Submittal submit written statement from each affected utility company and public agency approving the Train Control System as it relates to the particular utility company or public agency. 12. Within 30 days after receipt of Notice to Proceed, submit Design Network Schedules and Design Control Estimate for the work to be performed.	Monthly Progress Reports consisting of: 1. Part I Narrative description of major design activities in progress during month; coordination with others; and activities by others which affect design. 2. Part II Dates activities on Design Network Schedules begun or completed; for activities in progress, estimated number of calendar days to complete; changes required in Design Network Schedules; total man-months of design effort expended during reporting period; and summaries of progress (in percent) for each identifiable construction contract. 3. Part III Actual incurred and estimated invoiced costs through end of reporting period; estimates of cost to complete remaining work for each work item in Design Control Estimate; and, forecasts of design costs to be incurred in each of following three (3) months. 4. [illegible] drawings for each identifiable installation contract.	Definitive layouts of all important features. [illegible], but not limited to the following, for [illegible] control facilities, and for each installation contract, where applicable: 1. Concept drawings and documentation of proposed System in sufficient detail to permit adequate review as to compatibility with all project features and to determine that System will function efficiently and is the most economical. 2. Simple calculations or written outline to convey the proposed design concept approach for all elements of the System. 3. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Consistency with interface and configuration requirements of adjacent structures, facilities, and other elements. C. Proposed methods for attaining reliability and maintainability as specified in Design Criteria. D. Preliminary Hazard Analyses. E. Preliminary Human Factors Engineering Report. F. Estimates of installation costs with recommendations for adjustments in District's budget installation costs. G. Preliminary Installation Schedules (bar chart). 4. Outline of specifications for installation [illegible]. 5. Decisions to be made and actions to be taken by SCE, District and others to assure progress of design.	Completion such that work can be completed by incorporation of review comments without further review except to ascertain that comments have been appropriately incorporated. Include, but not limited to the following, for the train control facilities, and for each installation contract, where applicable: 1. Contract drawings, including equipment schedules and flow diagrams, substantially complete. 2. Design calculations. 3. Special Provisions of Specifications. 4. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Consistency with interface and configuration requirements of adjacent structures, facilities and other elements. C. Reliability and maintainability specifications for all items in the design. D. Preliminary Hazard Analyses. E. Requirements and Plans for demonstration and verification of safety items and systems F. Detailed Human Factors Engineering Report. G. Proposed changes in Installation Target Costs. H. Updated Installation Schedules (bar chart). I. Constructability. 5. Decisions to be made and actions to be taken by SCE, District or others to assure progess of design. 6. Report outlining status of coordination with DC's and other SDC's.	Submittal for each installation contract to include: 1. Originals of contract drawings. 2. Prints of contract drawings. 3. Originals of all design computations. 4. Originals of back-up calculations for contract quantities. 5. Originals and copies of Special Provisions of the Specifications. 6. Detailed installation schedules. 7. Final estimates of installation costs. 8. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Consistency with interface and configuration requirements of adjacent structures, facilities and other elements. C. Complete reliability and maintainability requirements and plans. D. Element Preliminary Hazard Analyses. E. Requirements and plans for demonstration and verification of safety items and systems. F. Comprehensive Human Factors Engineering Report. G. Proposed changes in Installation Target Costs (see Item 7 above). H. Final installation schedules (see Item 6 above). I. Constructability. 9. Specific actions required by others to complement design and without which installation cannot be executed on schedule. 10. Statement that all necessary coordination with DC's and other SDC's has been accomplished. 11. Statement by registered professional engineer that designs comply with requirements of regulating agencies and that they have been checked for accuracy and completeness of detail. 12. Design Development Report. 4/26/76 Requirements based on draft dated September 15, 1975, of Proposed Contract for Stage Design Consultant Services for Train Control System

SDC REQUIREMENTS OTHER THAN MONTHLY PROGRESS REPORTS AND REVIEW SUBMITTALS	MONTHLY PROGRESS REPORTS	PRELIMINARY REVIEW SUBMITTAL 30% COMPLETION	INTERMEDIATE REVIEW SUBMITTAL 85% COMPLETION	FINAL REVIEW SUBMITTAL 100% COMPLETION
1. Report to SCE for supervisory purposes. 2. Coordinate work with DC's, other SDC's, private and public utilities, public agencies and other involved interests through the SCE. 3. Prepare presentation documents, models, etc., as may be required for coordination activities. 4. Establish office in City of Chicago staffed by qualified personnel to perform the work. 5. Select staff resident coordinator. 6. Be represented at conferences held in conjunction with work-prepare Memos of Record for such conferences. 7. Review all applicable data and criteria. 8. As soon as possible after receipt of Notice to Proceed and prior to Preliminary Review Submittal, submit recommendations as to which components of the Communication Systems should be included in separate installation contracts. 9. Request approval of deviations or exceptions to Design Criteria, Standard Drawings and Specifications deemed necessary to solve particular design problems. 10. Procure rights-of-entry, permits, licences, etc. 11. As soon as possible after Preliminary Review Submittal submit written statement from each affected utility company and public agency approving the Communication Systems as they relate to the particular utility company or public agency. 12. Within 30 days after receipt of Notice to Proceed, submit Design Network Schedules and Design Control Estimate for the work to be performed.	Monthly Progress Reports consisting of: 1. Part I — Narrative description of major design activities in progress during month; coordination with others; and activities by others which affect design. 2. Part II — Dates activities on Design Network Schedules begun or completed; for activities in progress, estimated number of calendar days to complete; changes required in Design Network Schedules; total man-months of design effort expended during reporting period: and summaries of progress (in percent) for each identifiable construction contract. 3. Part III — Actual incurred and estimated invoiced costs through end of reporting period; estimates of cost to complete remaining work for each work item in Design Control Estimate; and, forcasts of desi[illegible] to be incurred in each of [illegible]ing three (3) months. 4. Required drawings for each identifiable installation contract.	Definitive layouts of all important features. Include, but not limited to the following, for the communication facilities, and for each installation contract, where applicable: 1. Contract drawings and documentation of proposed System in sufficient detail to permit adequate review as to compatibility with all [illegible] features and to determine that systems will function efficiently and are the most economical. 2. Sample calculations or written outline to [illegible] the proposed design concept approach [illegible] all elements of the Systems. 3. Documentation with respect to Design System Control Program, including: A. Economic evaluation of the designs. B. Consistency with interface and configuration requirements of adjacent structures, facilities, and other elements. [illegible] Proposed methods for attaining reliability and maintainability as specified in Design Criteria. [illegible] Preliminary Hazard Analyses. [illegible] Preliminary Human Factors Engineering Report. F. Estimates of installation costs with recommendations for adjustments in District's Budget installation costs. [illegible] Preliminary Installation Schedules (bar charts). [illegible] Constructability. 4. Outline of specifications for installation contracts. [illegible] Decisions to be made and actions to be taken [illegible] District and others to assure [illegible] design.	Completion such that work can be completed by incorporation of review comments without further review except to ascertain that comments have been appropriately incorporated. Include, but not limited to the following, for the communication facilities, and for each installation contract, where applicable: 1. Contract drawings, including equipment schedules and flow diagrams, substantially complete. 2. Design calculations. 3. Special Provisions or Specifications. 4. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Consistency with interface and configuration requirements of adjacent structures, facilities and other elements. C. Reliability and maintainability specifications for all items in the design. D. Preliminary Hazard Analyses. E. Requirements and Plans for demonstration and verification of safety items and systems. F. Detailed Human Factors Engineering Report. G. Proposed changes in Installation Target Costs. H. Updated Installation Schedules (bar chart). I. Constructability. 5. Decisions to be made and actions to be taken by SCE, District or others to assure progress of design. 6. Report outlining status of coordination with DC's and other SDC's.	Submittal for each installation contract to include: 1. Originals of contract drawings. 2. Prints of contract drawings. 3. Originals of all design computations. 4. Originals of back-up calculations for contract quantities. 5. Originals and copies of Special Provisions of the Specifications. 6. Detailed installation schedules. 7. Final estimates of installation costs. 8. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Consistency with interface and configuration requirements of adjacent structures, facilities and other elements. C. Complete reliability and maintainability requirements and plans. D. Element Preliminary Hazard Analyses. E. Requirements and plans for demonstration and verification of safety items and systems. F. Comprehensive Human Factors Engineering Report. G. Proposed changes in Installation Target Costs (see item 7 above). H. Final installation schedules (see item 6 above). I. Constructability. 9. Specific actions required by others to complement design and without which installation cannot be executed on schedule. 10. Statement that all necessary coordination with DC's and other SDC's has been accomplished. 11. Statement by registered professional engineer that designs comply with requirements of regulating agencies and that they have been checked for accuracy and completeness of detail. 12. Design Development Report.

4/28/76

Requirements based on draft dated September 15, 1975, of Proposed Contract for Design Consultant Services for Communication Systems.

TABLE 3-4

DC-UP REQUIREMENTS OTHER THAN MONTHLY PROGRESS REPORTS AND REVIEW SUBMITTALS	MONTHLY PROGRESS REPORTS	PRELIMINARY REVIEW SUBMITTAL 30% COMPLETION	INTERMEDIATE REVIEW SUBMITTAL 85% COMPLETION	FINAL REVIEW SUBMITTAL 100% COMPLETION
1. Report to the SCE for supervisory purposes. 2. Coordinate work with DC's, SDC's, [illegible] and public utilities, owners of affected structures, and other involved interests, through the SCE. 3. Prepare exhibits as may be required for coordination purposes. 4. Establish office in the City of Chicago staffed by qualified personnel. 5. Select staff resident coordinator. 6. Be represented at conferences held in connection with the work-prepare Memos of Record for all such conferences. 7. Review all applicable data and criteria. 8. As soon as possible and prior to review Submittal of the design of underpinning for each Category 1-A Structure (as defined in Design Contract), submit recommendation as to whether the underpinning and related work for the structure should be accomplished by more than one construction contract. 9. Request approval of deviations or exceptions to Design Criteria, Standard Drawings and Specifications, etc., deemed necessary to solve particular design problems. 10. Procure certain rights-of-entry, permits, licenses, etc. 11. Closely coordinate all investigations and designs of underpinning with the owners of the involved structures. 12. Make all necessary field surveys. 13. Investigations: A. Make investigations of existing structures adjacent to the proposed project facilities to determine those structures which will need underpinning and should be classified as Category 1 Structures as defined in the Design Criteria. B. Make investigations of existing structures required for the design of underpinning for all Category 1-A structures as defined in the Design Contract. C. Prior to commencement of investigation of any existing structure, submit a detailed investigation program for approval of the SCE. Requirements as to times of submittal of programs are set forth in Design Contract. D. For each existing structure investigated to determine need for underpinning and classification as a Category 1 Structure, submit a detailed report of investigation, including recommendations. 14. Review the Soils and Foundation Report for information that may be useful in the investigations and designs-Additional explorations required are to be included in the detailed investigation programs. 15. At early stage in design, determine if rights-of-way shown on General Plans should be modified because of underpinning of Category [illegible] structures and bring such required modifications to the immediate attention of the SCE. 16. Within times specified in the Design Contract, submit Network Schedules for investigation and Design, and Control Cost Estimates. 17. At earliest possible date, recommend in outline form an instrumentation program to be installed and monitored during construction for purpose of detection movement of temporary and permanent structures.	Monthly Progress Reports consisting of: 1. Part I Narrative description of major investigation and design activities in progress during month; coordination with others; and activities by others which affect design. 2. Part II Dates activities on Investigation and Design Network Schedules begun or completed; for activities in progress, estimated number of calendar days to complete; changes required in Investigation and Design Network Schedules; total man-months of design effort expended during reporting period; and summaries of progress (in percent) for each identifiable construction contract. 3. Part III Actual incurred and estimated invoiced costs through end of reporting period; estimates of cost to complete remaining work for each work item in Investigation and Design Control Cost Estimate; and, forecasts of design costs to be incurred in each of following three (3) months. 4. Required drawings for each indentifiable construction contract.	Definitive layouts of important features. Include, but not limited to the following for each Category 1-A Structure or for each construction contract if more than one contract is required for the structure, as applicable: 1. Drawings showing concepts of the design of the underpinning and related work-drawings to show proximity and interface with project facilities, adjacent structures, etc. 2. Sample design calculations. 3. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Analysis of design for consistency, compatability and continuity as well as interface with other elements and total design. C. Report listing specific safety requirements and manner in which these requirements are being incorporated in designs and Contract Documents for construction. D. Estimate of construction cost for underpinning which is to be basis for establishment of Construction Target Cost. E. Preliminary Construction Schedules (bar charts). F. Constructability. 4. Outline of Specifications. 5. Status of coordination with structure owners, the DC, and other affected interests, and the status of concurrence by the structure owners and other affected interests regarding underpinning plans developed to date. 6. Decisions to be made and actions to be taken by [illegible] of design.	Completion such that work can be completed by incorporation of review comments without further review except to ascertain that the comments have been appropriately incorporated. Include, but not limited to the following for each Category 1-A Structure or for each construction contract if more than one construction contract is required for the structure, as applicable: 1. Contract drawings substantially complete, including schedules of equipment and flow diagrams, as necessary. 2. Design Calculations 3. Special Provisions of the Specifications 4. Documentation with respect to the Design Systems Control Program, including: A. Economic evaluation of the design. B. Analysis of design for consistency, compatability, and continuity as well as interface with other elements and total design. C. Updated report listing specific safety requirements and manner in which these requirements are being incorporated in designs and Contract Documents for construction. D. Proposed changes in Construction Cost Target. E. Updated Construction Schedules (bar chart). F. Constructability. 5. Status of coordination with structure owners, the DC, and other affected interests, and the status of concurrence by the structure owners and other affected interests regarding the underpinning plans developed to date. 6. Actions required either by SCE, District or others to permit completion of design. 7. Actions required by others to complement the design and without which construction cannot be completed on schedule.	Submittal for each Category 1-A Structure or for each construction contract if more than one construction contract is required for the structure, as applicable: 1. Originals of the contract drawings. 2. Prints of the contract drawings. 3. Originals of all design computations. 4. Logs of survey data. 5. Originals of back-up calculations for contract quantities. 6. Originals and copies of Special Provisions of the Specifications. 7. Detailed Construction Schedules (bar charts). 8. Final Estimates of Construction Costs. 9. Documentation with respect to Design Systems Control Program, including: A. Economic evaluation of the design. B. Analysis of design for consistency, compatability, and continuity as well as interface with other elements and total design. C. Updated report listing specific safety requirements and manner in which these requirements are incorporated in designs and Contract Documents for construction. D. Proposed changes in Construction Cost Target (see item 8 above). E. Updated Construction Schedules (see item 7 above). F. Constructability. 10. Status of coordination with structure owners, the DC, and other affected interests, and the status of concurrence by the structure owners and other affected interests regarding the underpinning plans. 11. Actions required of others to complement the design and without which construction cannot be completed on schedule. 12. Statement by registered professional engineer, structural engineer or architect that the designs comply with the requirements of regulating agencies and that they have been checked for accuracy and completeness. 13. Design Development Report. 4/26/76 Requirements based on draft September 15, 1975, of Proposed Contract for Design Consultant Services for Underpinning

TABLE 3-5

b. Estimated number of man-hours to be expended by the DC for:

1) Engineering and architectural design of the facilities shown on the General Plans.

2) Preparing (drafting) the contract drawings.

3) Performing all other work (engineering and architecture, typing, drafting, and other) including special studies, surveys, investigations, reports, and other work essential to the design effort, but exclusive of (a) and (b) above, as may be required to comply with the various provisions of the design contract.

c. Estimated contract costs for performing the services set forth in the design contract by the DC. This estimate will be based on the estimated number and types of contract drawings and the total estimated number of required man-hours.

3.1.1 Responsibility

Estimates of the number and types of contract drawings and of the required man-hours will be prepared by the various SCE disciplines, with assistance from the SCA and other groups or disciplines as necessary. The estimate of contract cost for performing the services by the DC will be prepared by the SCE staff members responsible for preparation of the Negotiation Memorandum. The latter estimate will be compiled from the estimates prepared by the various SCE departments.

3.1.2 Forms

Two forms have been developed for use by all SCE disciplines, SCA and other groups or disciplines in preparing and submitting the required estimates. The purpose of the forms is to assure uniformity in the submitted estimates and to facilitate review thereof for adequacy, omissions or duplications.

Copies of both forms are attached. The forms are numbered in the lower left-hand corner for reference as follows:

Form CUTD-DC-1, Figure 3-3, is for estimating the number and types of contract drawings; and the number of design, drafting, and other man-hours expended in developing and preparing the final contract drawings.

Form CUTD-DC-2, Figure 3-4, is for estimating the man-hours expended for all items of work other than design and preparation of contract drawings.

Each SCE, SCA, or other discipline will complete both of the above forms for each design contract.

Sample completed forms CUTD-DC-1 and CUTD-DC-2, Figures 3-6 and 3-7, are also attached for reference and guidance in preparing the individual estimates. These completed forms are only examples, and should not be used as a basis for estimating similar types of contract drawings or items of work.

3.1.3 Multi-Discipline Activity

3.1.3.1 Contract Drawings

Some contract drawings will include designs involving more than one discipline. Such multi-discipline drawings will be identified by an asterisk (*) following the title or description.

SCE, SCA, and other disciplines involved in multi-discipline drawings will include the following on their Form CUTD-DC-1:

a) Number of drawings.

b) Title or description of drawings.

c) Estimated man-hours of engineering and architectural design applicable to that discipline.

d) Estimated "other" man-hours applicable to that discipline.

Only the SCE discipline with the predominance of design effort for a particular multi-discipline drawing will include the estimated drafting man-hours required to prepare the drawings. To make certain that all of the involved disciplines include the appropriate multi-discipline drawings in their forms CUTD-DC-1, the SCE discipline having the predominance of design effort for a particular multi-discipline drawing will be responsible for furnishing the necessary information regarding that particular drawing to other involved disciplines.

COST ESTIMATE | | ___ OF ___

FIRM AND ADDRESS

☐ SCOPE I ☐ SCOPE II

☐ REVISIONS ☐ OTHER

DESIGN SECTION DESCRIPTION

DESIGN SECTION ___________

CONST. SEGMENT ___________

LIST OF DRAWINGS - DISCIPLINE ___________________

NO. OF DWGS.	TITLE OR DESCRIPTION OF DRAWINGS	MAN-HOURS		
		DESIGN ENGR. & ARCH.	DRAFTING	OTHER ______
	TOTALS FOR THIS PAGE			

TOTAL MAN-HOURS ___________________

CUTD-DC-1 0176

FIGURE 3-3

COST ESTIMATE ______ OF ____

FIRM AND ADDRESS	☐ SCOPE I ☐ SCOPE II ☐ REVISIONS ☐ OTHER
DESIGN SECTION DESCRIPTION	DESIGN SECTION ________ CONST. SEGMENT ________

ITEMS OF WORK OTHER THAN DESIGN AND PREPARATION OF DRAWINGS

DISCIPLINE ____________

ITEM OF WORK	MAN-HOURS				
	ENGINEERING & ARCHITECTURE	DRAFTING	TYPING	OTHER ______	OTHER ______
TOTALS FOR THIS PAGE					

TOTAL MAN-HOURS: ____________

CUTD-DC-2 0176

FIGURE 3–4

FIRM AND ADDRESS	☐ SCOPE I ☐ SCOPE II ☐ REVISIONS ☐ OTHER
DESIGN SECTION DESCRIPTION	DESIGN SECTION ________ CONST. SEGMENT ________

SUMMARY OF MAN-HOUR REQUIREMENTS

DISCIPLINE OR ITEM OF WORK	ENGINEERING & ARCHITECTURE	DRAFTING	TYPING	OTHER ______	OTHER ______
MANAGEMENT & SUPERVISION					
CIVIL & GENERAL					
UTILITIES					
ARCHITECTURAL					
STRUCTURAL					
MECHANICAL					
ELECTRICAL					
SPECIFICATIONS					
COST ESTIMATES					
REPORTS					
SPECIAL STUDIES					
TOTAL					

CONTRACT COST ESTIMATE

DIRECT LABOR COSTS — *AVERAGE HOURLY RATE

ENGR. & ARCH. ______ M.Hs. @ $ ______ * = $ ______

DRAFTING: ______ M.Hs. @ $ ______ * = $ ______

TYPING: ______ M.Hs. @ $ ______ * = $ ______

OTHER: ______ M.Hs. @ $ ______ * = $ ______

OTHER: ______ M.Hs. @ $ ______ * = $ ______ SUBTOTAL $ ______ (a)

PAYROLL BURDEN AND OVERHEAD COSTS

PAYROLL BURDEN (______% OF ITEM (a)): $ ______

OVERHEAD (______% OF ITEM (a)): $ ______ SUBTOTAL $ ______ (b)

DIRECT LABOR COSTS, PAYROLL BURDEN AND OVERHEAD COSTS (ITEM (a) + ITEM (b)) $ ______ (c)

REIMBURSABLE COSTS

TRAVEL AND SUBSISTENCE $ ______

AUTO MILEAGE $ ______

COMPUTER $ ______

REPRODUCTION $ ______

______ ______

______ ______ SUBTOTAL $ ______ (d)

SUBCONTRACTORS

______ $ ______

______ $ ______

______ $ ______ SUBTOTAL $ ______ (e)

TOTAL ESTIMATED COST (SUM OF ITEMS (c), (d) AND (e)) $ ______ (f)

FIXED FEE (STATE BASIS) $ ______ (g)

TOTAL ESTIMATED CONTRACT COST (ITEM (f) + ITEM (g)) $ ______

CUTD-DC-3 0176

FIGURE 3-5

COST ESTIMATE | 12-5-76 | OF

FIRM AND ADDRESS

DISTRICT ESTIMATE

☒ SCOPE I ☐ SCOPE II
☐ REVISIONS ☐ OTHER

DESIGN SECTION DESCRIPTION

M-1

DESIGN SECTION 3M0010
CONST. SEGMENT 1M0010

LIST OF DRAWINGS - DISCIPLINE CIVIL

NO. OF DWGS.	TITLE OR DESCRIPTION OF DRAWINGS	MAN-HOURS		
		DESIGN ENGR. & ARCH.	DRAFTING	OTHER
	GENERAL			
1	COVER SHEET	16	40	
1	TITLE SHEET WITH KEY MAP	8	32	
1	INDEX SHEET	8	40	
3	SUMMARY OF QUANTITIES *	36	120	
3	SOIL BORINGS *	24	—	
	CIVIL DRAWINGS			
2	SYMBOLS AND GENERAL NOTES	48	80	
9	EXISTING CONDITIONS-PLAN OF SURFACE @ 1" = 10'	216	450	
3	BENCH MARKS & CONTROL TIES @ 1" = 40'	96	150	
	TYPICAL SECTIONS			
2	D STREET	48	120	
3	M AVENUE	72	180	
1	EXISTING SUBWAY	24	60	
1	MISCELLANEOUS	32	60	
	PLAN PROFILE @ 1" = 40'			
4	PROPOSED SUBWAY	320	320	
1	EXISTING SUBWAY	40	60	
2	D STREET	80	120	
3	M AVENUE	144	180	
3	GEOMETRIC PLANS	120	180	
6	SURFACE RESTORATION PLAN @ 1" = 10' *	300	360	
4	MAINT. OF TRAFFIC & STAGING PLANS *	480	288	
10	CROSS SECTIONS *	400	600	
12	UTILITY RELOCATION PLANS *	384	—	
75	TOTALS FOR THIS PAGE	2,896	3,440	0

TOTAL MAN-HOURS 6,336

SAMPLE

CUTO-DC-1 0176

FIGURE 3-6

COST ESTIMATE — CHICAGO URBAN TRANSPORTATION DISTRICT — 2-5-76 — ___ OF ___

FIRM AND ADDRESS

DISTRICT ESTIMATE

☒ SCOPE I ☐ SCOPE II
☐ REVISIONS ☐ OTHER

DESIGN SECTION DESCRIPTION

M -1

DESIGN SECTION 3M0010
CONST. SEGMENT 1M0010

ITEMS OF WORK OTHER THAN DESIGN AND PREPARATION OF DRAWINGS

DISCIPLINE CIVIL

ITEM OF WORK	MAN-HOURS ENGINEERING & ARCHITECTURE	DRAFTING	TYPING	~~OTHER~~ SURVEYORS	OTHER
SURVEYS (UTILITY LOCATIONS	120		40	800	
TOPOGRAPHY, R.O.W.)					
QUANTITY ESTIMATES	80		20		
SPECIAL STUDY & REPORT	160	20	40		
ON PAVMT. REPLACEMENT					
CONSTRUCTION COST					
ESTIMATES:					
CONST. TARGET COST	520		100		
ESTIMATE UPDATES	480		100		
TOTALS FOR THIS PAGE	1,360	20	300	800	

SAMPLE

TOTAL MAN-HOURS: 2,480

CUTD-DC-2 0176

FIGURE 3-7

3.1.3.2 Other Items of Work

Some items of work other than design and preparation of drawings may require the efforts of more than one discipline. When this occurs, only the SCE discipline having the major effort in any such item will include it on Form CUTD-DC-2. The SCE discipline having the major effort will include all of the estimated required man-hours to complete the item of work, and the other involved disciplines will omit that particular item of work from Form CUTD-DC-2.

3.1.3.3 Subcontracts

A separate Form CUTD-DC-1 and CUTD-DC-2 will be required for estimates of man-hours required for each subcontract anticipated in a design contract.

Responsibility for preparatic f man-hour estimates for subcontracts will be assigned the SCE discipline having the most familiarity with the subcontract effort.

3.1.3.4 Summary of Man-Hour Requirements

The SCE staff members responsible for preparation of the Negotiation Memorandum will receive Forms CUTD-DC-1 and CUTD-DC-2 from all disciplines and compile a Summary of Man-Hour Requirements on Form CUTD-DC-3, Figure 3-5. A copy of Form CUTD-DC-3 is attached for reference.

A separate Form CUTD-DC-3 will also be required for each subcontract anticipated in each design contract, for the purpose of determining a total estimated subcontract cost. All estimated subcontract costs will then be listed separately on the design contract cost estimate, Form CUTD-DC-3.

The total design contract cost estimate is then completed by combining direct labor costs of estimated man-hours required, payroll burden and overhead costs, reimbursable costs, subcontract costs, and an amount for fixed fee.

3.2 Bases for Schedules and Costs

3.2.1 Bases for Construction Schedules

Construction Schedules were developed by the SCE during the pre-design phase covering the principal procurement and installation activities. The DC's and SDC's will prepare and submit schedules for each procurement and installation contract in bar chart form showing the principal procurement and installation activities with milestones identified. The schedules will be coordinated with construction and installation schedules prepared by other DC's and SDC's. The schedules will indicate when materials and equipment to be procured and furnished by the District will be required at the installation sites by the installation contractors.

Preliminary procurement and installation schedules shall be submitted by the DC's and SDC's at the time of the Preliminary Review Submittal. Updated schedules will be submitted at the time of the Intermediate Review and Final Review Submittals.

3.2.2 Bases for Construction Cost Estimates

District budget procurement and installation costs were developed by the SCE and SCA as part of the pre-design scope of work. The DC's and SDC's will submit, at the Preliminary Review Submittal, estimates of procurement and installation costs together with recommendations for any adjustments or changes necessary in the District's budget costs. After review and approval, the specific cost ceiling will become the Procurement and Installation Target Cost.

The SDC will be responsible for reporting to the District any changes that may be required in the established and/or approved Target Cost.

The DC's and SDC's cost recommendations will be based on value engineering principles including alternative cost analyses, alternative material considerations and review of design for cost effectiveness.

3.2.3 Construction Schedule Control

Schedule Control will analyze and review construction schedule data submitted by the DC's and SDC's to the extent necessary to ensure the adequacy of the date; including currency, compliance with District objectives and coordination with schedules prepared by others. Schedule Control will update master schedule data and make recommendations to the District relative to adoption of changes in the schedules.

3.2.4 Construction Cost Control

Construction Cost Control will analyze and review construction cost data submitted by the DC's and SDC's. Preliminary

Design Review submittals of procurement and installation cost estimates, together with recommendations for any adjustments or changes necessary in the District's budget procurement and installation costs, will be reviewed. Recommendation regarding changes to the specific installation and/or procurement target costs will be provided to the District. Approval by the District will result in a change to the Installation and/or Procurement Target Cost. Submittals will be reviewed for conformance with Target Cost ceilings, for accuracy of data and for the adequacy of value engineering analyses for the economy of design.

3.3 Design Consultant's Briefings

To assure that design documents prepared by individual stage and section design consultants are responsive to the intent and objectives of the Bases of Design the SCE will present engineering briefing for design consultants. These briefing sessions will address the methods employed in developing pre-design documents and suggested methodologies for the design consultants. Emphasis will be placed on the development of special provisions to standard specifications, constructability and environmental protection considerations; human factors, maintainability, reliability and system safety analyses and studies, and cost and schedules preparation and reporting.

The Design Coordinator will prepare a detailed briefing program in coordination with the Design Control Disciplines, the District, CMC, and SCA. The Design Coordinator shall be the chairman and moderator for these briefings.

These briefings are a prelude to scheduled and special reviews and meetings that will occur in the process of design. The general procedures for review of engineering documentation conducted by the SCE are described herein.

3.4 Document Control

Design Control of data, and coordination during the design process may be classified as a closed-loop program. Figures 3-1 and 3-2 pictorially describes the data flow; Tables 3-1 through 3-5 list the tasks and data requirements for DC's and SDC's.

The review process for design consultants documentation is implemented through dissemination by Document Control. These control measures are based on response time requirements defined in the respective DC or SDC contracts or developed by mutual agreement with all parties concerned.

Figure 3-8 depicts the normal document flow of DC and SDC design data received by the SCE. Document Control shall establish detailed procedures for the distribution, coordination, maintaining and reproduction processing of these data.

Figure 3-9 (2 sheets) is the design consultant Document Distribution and Control Form that will be completed in coordination with the District, SCA, CMC and other organizations. Each organization will identify the number of copies of each document that they require for review or retention. The SCE, in coordination with the District, shall approve the distribution requirements. When approved, distribution and control shall be carried out by Document Control.

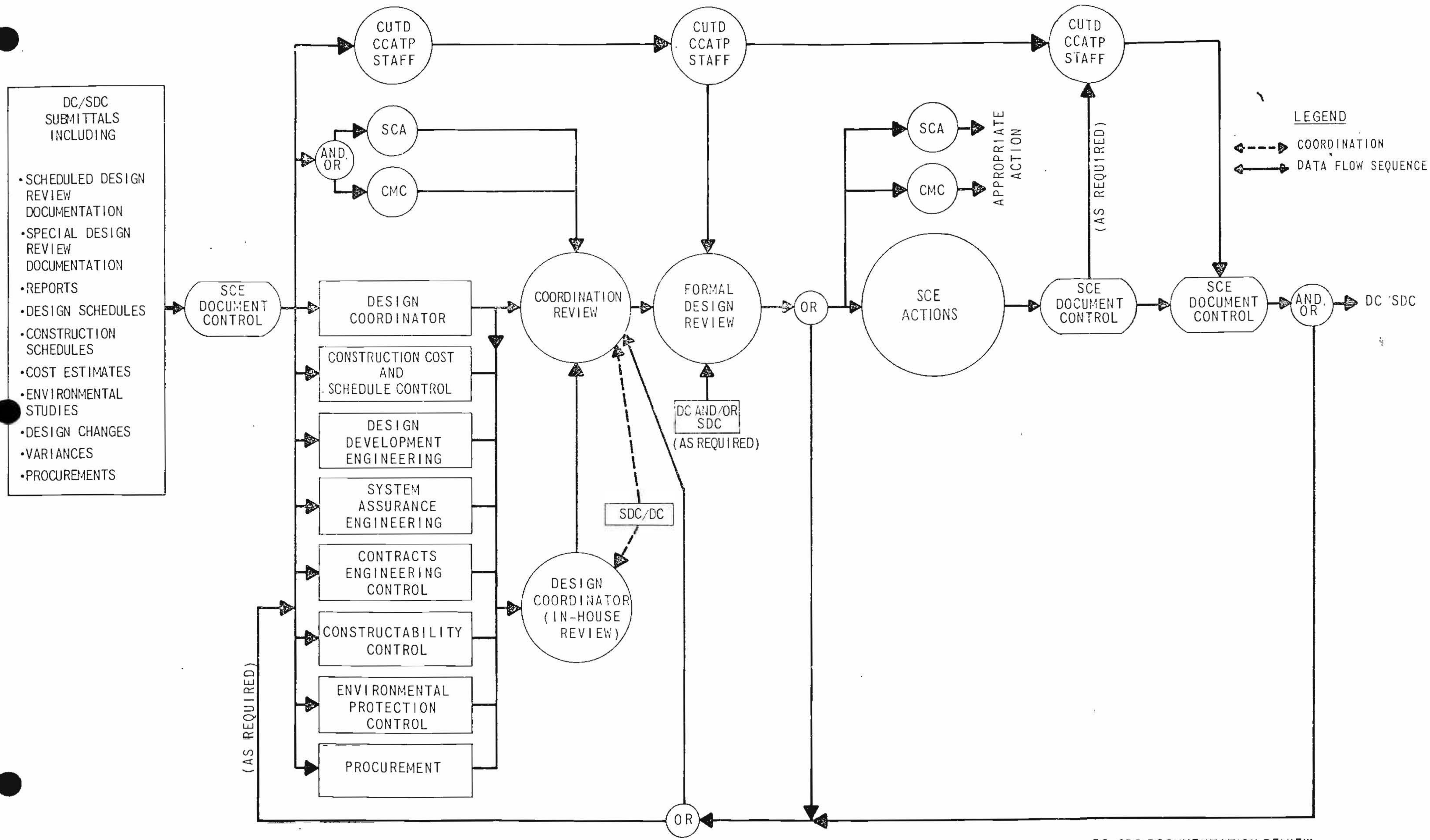
Document Distribution and Action Control tables will be prepared for each section and stage design contract immediately following contract negotiations between the District and the design consultant.

3.5 SCE Design Control Reviews or Meetings

The Design Coordinator will schedule and chair scheduled or special reviews and meetings between the SCE and DC's, SDC's, SCA, CMC, the District and others. The Design Coordinator will prepare the agenda and record the minutes.

A report on the discussions and decisions of each design review or meeting will be prepared by the SCE Design Coordinator or his designated SCE representative. SCE Form D-N 19, see Figure 3-10, shall be completed and distributed to each attendee the Design Coordinator (if not in attendance), the District and others as identified on the Document Distribution and Control Form.

Main points of the discussions and decisions should be described to the level of detail that will provide the Design Coordinator sufficient information to institute appropriate design action, if required. Action items established as a result of reviews or meetings shall be recorded on the Action Item Record, D-N Form 22. Figure 3-11.



DC-SDC DOCUMENTATION REVIEW
FIGURE 3-8

INTRA OFFICE

DOCUMENT DISTRIBUTION AND CONTROL

DATE: ______
LATEST REVISION: ______

CONSULTANT ______

DESIGN SECTION/STAGE ______ CONTRACT NO. ______ DATE: ______

FREQUENCY (1)/ CLASS. (2)	TITLE	ACTION ADDRESSEE/ NO. OF COPIES	INFORMATION ADDRESSEE/ NO. OF COPIES	ORIGIN-ATOR	RELEASING SIGNATURE	FILE		TOTAL COPIES REQ.	REMARKS
						MASTERS	NOTES		

SCE INTER OFFICE

DOCUMENT DISTRIBUTION AND CONTROL

DATE: ______

LATEST REVISION: ______

CONSULTANT ______

DESIGN SECTION/STAGE ______ CONTRACT NO. ______ DATE: ______

FREQUENCY (1)/ CLASS. (2)	TITLE	ACTION ADDRESSEE/ NO. OF COPIES	INFORMATION ADDRESSEE/ NO. OF COPIES	ORIGIN- ATOR	RELEASING SIGNATURE	FILE		TOTAL COPIES REQ.	REMARKS
						MASTERS	NOTES		

FIGURE 3-9 (SHEET 2 OF 2)

MINUTES OF REVIEWS/MEETINGS

DATE: ________________ TIME: _________ LOCATION: ______________________

SUBJECT: ____________________________ CONTRACT NO.: ___________________

REVIEW/MEETING REQUESTED BY: ____

ATTENDEES:

MAIN POINTS OF DISCUSSION AND DECISIONS REACHED:

SIGNATURE: ________________________ COPY TO: _________________________

TITLE: ____________________________ FILE NO: _________________________

ORGANIZATION: _____________________

ACTION ITEM RECORD

)NTRACT NO.________________________ DESIGN CONSULTANT____________________

:SIGN SECTION/STAGE____________________

\CTION TEM NO.	DATE	DESCRIPTION	CHANGE OR VARIANCE REQUIRED. YES/NO	REVIEW BOARD ACTION DATE	TO DISTRICT DATE	FROM DISTRICT DATE	DISPOSITION

;CE Form D-N 22 (FILE IN APPENDIX D - SCE SYSTEM DESIGN CONTROL PROGRAM MANUAL'

FIGURE 3-11

3.6 SCE Design Control Analysis

When, as a result of a review of design consultants data, meetings, changes in project concepts or plans, design reviews, and/or other circumstances, the design is or may be affected or a unique problem is identified; the responsible Design Control discipline shall institute an analysis to document the affect of the problem on the design or proposed construction, costs, and/or schedules. SCE Form D-N 20, see Figure 3-12, shall be completed for each design control analysis. This form is divided into three parts; I - Design Impact Analysis, II - Recommendations, and III - Review Action. Parts I and II will be completed by the cognizant system design control disciplines, and submitted to the Design Coordinator. The Design Coordinator will convene a design review meeting for resolution of the identified problem. An Action Priority will be assigned by the Design Coordinator based on the criticality of the problem. The Action Priority shall be stated in 24 hour days, e.g. Priority 2 = 48 hours or two consecutive working days and the suspouse date noted, e.g. Priority 1, January 10, 1976 (the day following the meeting). All items requiring cost or schedule changes, or changes to the Bases of Design will be submitted to the District for approval, Items not requiring these type changes shall be approved by the SCE Project Director or his designated representative. Action items will be assigned an identification code using the design section designator and sequential numbering (e.g. M-1-1: Monroe Design Section 1, Action Item 1). A copy of all action items will be maintained by the Design Coordinator and Document Control and recorded on Form D-N 22.

3.7 Design Change Control Authorization

Revisions to Bases of Design documents developed by the design review and analyses action will be processed by the Design Coordinator in coordination with the Chief Engineer.

3.7.1 Procedures

To assure adequate control and coordination, the procedures outlined below shall be followed in the revising and issuance of new or revised Directive and Standard Drawings, and Standard Specifications.

(a) The initiating engineering section (e.g. electrical) shall mark the proposed revisions

DESIGN FEATURE: ______________________________

DESIGN SECTION/STAGE: ______________ DATE: __________

CONSTRUCTION SECTION: ______________ CONTRACT NO.: ______

PREPARED BY: ____________________

I. DESIGN IMPACT: DESIGN DATA [] COST [] SCHEDULE []

ARCHITECTURAL ___
CONSTRUCTION ___
ENGINEERING ___

A. ITEM DESCRIPTION:

B. REFERENCE DOCUMENTS (DESIGN CRITERIA, PLAN, DRAWING, SPECIFICATION)

C. MODIFICATION - PROPOSED BY -DC-SDC-SCE-SCA-CUTD ______
(OTHER)

D. EFFECT ON:

1. Design Schedule:
2. Construction Schedule:
3. Reliability:
4. Safety:
5. Maintainability:
6. Patrons and/or Operations:
7. Other (Specify) __________:

E. ESTIMATED NET COST CHANGE-INCREASE (DECREASE):

1. Design $ __________
2. Construction $ __________
3. Installation $ __________
4. Maintenance $ __________

II. RECOMMENDATION(S):

SUBMITTED: ________________ DATE: __________

II. DESIGN REVIEW ACTION:

DATE RECEIVED: ____________

ACTION ITEM: ____________

PRIORITY: ____________

REVIEW DATE: ____________

________________________ ________
SCE DESIGN COORDINATOR DATE

CONCURRENCE:

CMC ________ APPROVED: ________________________ ________
SCE PROJECT DIRECTOR DATE

SCA ________

TRANSMITTED TO DISTRICT: YES/NO DATE: ________

DISTRICT ACTION: APPROVED/DISAPPROVED/OTHER

DATE RECEIVED: ____________

DISPOSITION:

on a copy of the drawings or specification in red. The original shall not be changed. If a new drawing or specification section is involved, prepare a preliminary drawing or original draft.

(b) Complete an Authorization Form, SCE Form D-N 21, see Figure 3-13, and forward the form, accompanied by the marked copy of document, or the new document, to the SCE Chief Engineer. The Chief Engineer will distribute the document to the cognizant SCE sections for initial in-house review.

(c) Upon completion of the initial review, the drawing or specification will be returned to the initiating section for incorporation, or resolution of review comments with the commenting parties, as appropriate. The document, with the appropriate changes marked as in (1) above shall be forwarded to the Design Coordinator who will request Change Control Review convene a design meeting.

(d) Change Control Review will include a designated Chairman, normally the assistant Chief Engineer of Design Coordination, the SCE and SCA Design Coordinators, the District Project Engineer, the CMC Coordinator, the heads of those Design Departments involved in or affected by the proposed change. This group will be expected to assess the effects of each proposed change on the various DC's, SDC's or contractual efforts currently being progressed.

The review group will either approve the proposed change, in which case the Chairman will sign the authorization form and forward it to the SCA Project Manager and SCE Project Director for their approval, or if approval is withheld, return the changes to the originator with its recommendation.

(e) When the "Recommend Authorization" section of the Authorization Form has been completed, the form and marked print, specification or new item, will be forwarded to District for approval.

(f) Upon receipt of approved authorization from the District, and the return of the marked or new

DESIGN CHANGE CONTROL
AUTHORIZATION FORM
Proposed Revision or New Directive or Standard Drawing, or Specification

Dwg. No./Spec. Sect. No. ____________ Marked-up copy attached: ☐
New copy attached: ☐
Date of Initiation ____________ Proposed by ____________

Proposed Revision No. ____________

Detailed Description and/or Reason for New Issue or Revision Including Cost Impact:

Answer All Questions

		YES	NO
1.	Does the above affect structural contracts?	☐	☐
	Is the change conditional upon the percent of discipline (e.g. Mechanical) completed?	☐	☐
	If Yes, state percent for cut off ____________		
2.	Does the above affect finish contracts?	☐	☐
	Is the change conditional upon the percent of discipline (e.g. Mechanical) completed?	☐	☐
	If Yes, state percent for cut off ____________		
3.	Should the above be implemented for contracts now under construction?	☐	☐
4.	Does the above affect a specific type of design or construction only?	☐	☐
	If Yes, state type(s): ____________		
5.	Does the above necessitate changes to other Directive or Standard Drawings or Standard Specifications?	☐	☐
	If Yes, state Dwg. No./Spec. Sect. No.: ____________		

Recommend Authorization for SCE dwgs. or specs.	CE	Rev. Gp. Chrmn.	Proj. Mgr. (SCA)	Proj. Dir. (SCE)
Recommend Authorization for SCA dwgs. or specs.	Sr. Arch.	Rev. Gp. Chrmn.	Proj. Dir. (SCE)	Proj. Mgr. (SCA)
CUTD Authorization:			Date:	

SCE FORM D-N 21

FIGURE 3-13

item, the originating SCE engineering discipline will revise the drawing or specification as appropriate. Revisions to Directive Drawings and on Standard Drawings prior to their issuance with Contract Documents for construction, will be identified by placing the revision number in a small rectangle immediately adjacent to the detail modified. Any revision to a Standard Drawing after issuance for construction will be identified as described in the Design Criteria, Section II.A.5.

3.8 Review of DC and SDC Technical Documents

The responsible Design Control disciplines will review the appropriate sheets or sections of the design consultant's data submittals as specified by the Design Coordinator. This review will be based on a detailed check list that shall include:

- Verification of compliance with data submittal contract requirements.
- Verification of compliance with standards for preparation of drawings, special provisions, and cost and schedule documentation.
- Validation of materials selection, equipment placement, and interfacing cabling, conduit or piping.
- Validation of section stationing for alignments, structures, shafts, pipes, cables, signaling, and track systems and similiar elements of the design.
- Validation of the adequacy and accuracy of design calculations by selected sampling and comparison.
- Analyses of proposed techniques and schedules for construction.
- Verification of compliance with environmental protection objectives.
- Validation of adequacy and accuracy of human factors, maintainability, reliability and systems safety analyses. Verification that the requirements developed by these analyses are incorporated in the design.

- Evaluation of cost and schedule compliance for the specific design disciplines products.

- Analyses of design and construction economics to ensure optimum cost effectiveness.

- Verification of adequacy of traffic control planning; compliance with master traffic control plan.

- Validation of adequacy and appropriateness of utilities design, coordination and agreements.

- Verification of compliance with approved change and variance action directives.

- Validation of field surveys, soil borings and similiar data.

- Evaluation of procurement recommendations or contracts.

The reviewing discipline will record the details of each review (or meeting); the responsible engineer will prepare and submit an SCE office memorandum to the Design Coordinator; this memorandum should include a brief description of the review, findings and recommendations. Where detailed analysis of a design was accomplished, an SCE Design Control Analysis, SCE Form D-N 20, see Figure 3-12, shall be completed and submitted to the Design Coordinator as an enclosure to the review memorandum. The Design Coordinator shall convene a meeting of the cognizant organizations for review and resolution of any problems; the specific review/meeting procedures as specified in this section, (i.e., Reviews and Meetings, Design Change Control).

4. SCE Design Control Reports

The Design Coordinator will prepare reports of meetings, reviews and analyses for distribution by Document Control.

The Design Coordinator will prepare a monthly report on the design consultant's progress, significant accomplishments, deficiencies and outstanding action items. The report will include action item tabulations and status, schedule status, and cost information. Items awaiting action by the District, or other consultants/organizations shall be identified and the affect on design schedules and costs enumerated. These reports will be submitted to the SCE Project Director for inclusion in the SCE Monthly Progress Report to the District.

TRIMET
RAIL
OPS

METROPOLITAN DADE COUNTY TRANSPORTATION IMPROVEMENT PROGRAM
STAGE 1 RAPID TRANSIT SYSTEM

OPERATING PLAN

METRORAIL

DADELAND SOUTH-OVERTOWN

FINAL

MAY 11,1984

the KAISER TRANSIT GROUP
a joint venture/ke/hwa/pbsj/csa/sca

SOUTH LINE
OPERATING PLAN
METRORAIL

DADELAND SOUTH-OVERTOWN

Metropolitan Dade County Transportation Improvement Program
Stage 1 Rapid Transit System

FINAL
MAY 11,1984

"The preparation of this document has been financed in part through a grant from the U.S. Department of Transportation, Urban Mass Transportation Administration, under the Urban Mass Transportation Act of 1964, as amended, and in part by Metropolitan Dade County and the State of Florida Department of Transportation."

the KAISER TRANSIT GROUP
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HARRY WEESE & ASSOCIATES, LTD.
POST, BUCKLEY, SCHUH & JERNIGAN, INC.

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PURPOSE

The purpose of this plan is to establish the operating plan for the South Line system from Dadeland South to Overtown which will be implemented on May 20, 1984. This plan will also provide the foundation for developing test procedures which will be used to evaluate operations personnel proficiency during Pre-Revenue Operational testing. It is intended that the operations described under cover of this report be implemented on May 20, 1984. Should it be determined that changes to the operations described herein are required, the plan will be revised accordingly. The revised plan will be subjected to an in-house review prior to implementation. The overall objective will be to provide a safe efficient operation.

SCOPE

The scope of this plan will focus on all operational aspects associated with Service Level 1 (Manual/ATP By-Pass) which will be the normal vehicle mode of operation for South Line operations.

- SERVICE LEVEL 1 (MANUAL/ATP BY-PASS)
  - o Vehicle and Wayside ATP not functional
  - o Vehicle operated in yard mode with Automatic Train Protection By-Passed
  - o Manual Enforcement of Train Separation

Service Level 1 will be discussed in sufficient detail in order that the readers of this plan, which includes those responsible for its execution, have a complete understanding of intended South Line operations. It is purposely intended that this plan focus strictly on those activities which are associated with train movement. All other activites which do not directly involve train movements are not covered in this plan.

SECTION 1
SYSTEM CONFIGURATION

1.1 Operating Route

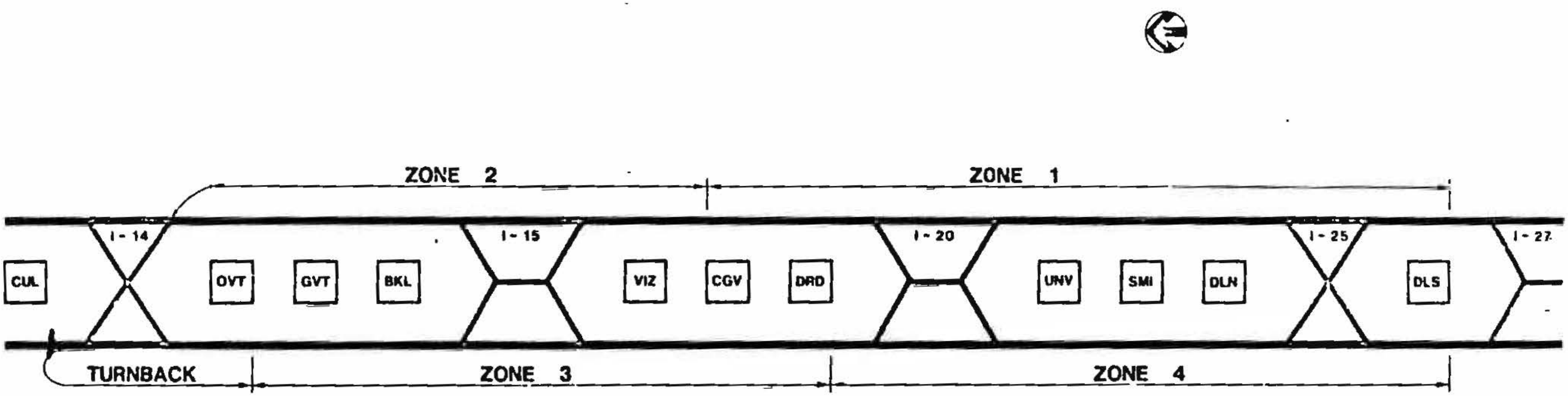
The operating route for the initial South Line system will use as its terminals, Dadeland South Station at the southern end of the system and Overtown Station at the northern end of the system. The total operating segment, including turn-back distance, is approximately 11 miles. Ten center platform stations, two crossovers, two pocket tracks and three tail tracks beyond Dadeland South are included in the route. For reference purposes, Figure 1-1 shows the total Stage I system which includes the South Line system.

1.2 Operating Hours and Service Levels

Stations within the south operating line will be open for weekday passenger services from 6:00 a.m. to 7:24 p.m. No train service will be provided on weekends or holidays. For South Line operations, no differentiation will be made between peak and off-peak service. The non-revenue operating periods will be used for acceptance testing, maintenance and non-revenue activities. The operating hours are based upon the first train departing Dadeland South at 6:00 a.m. and the last train departing at approximately 6:36 p.m. with the entire line cleared for revenue service trains by approximatley 7:24 p.m. The last southbound train will depart Overtown at 7:00 p.m.

A maximum of four (4) trains operating at any one time on the system in four-car consists will provide an approximate service level of one train every 12 minutes during all operating hours. For reliability purposes, trains will not operate in consists of less than four cars. Depending upon fleet availability, train lengths may be adjusted to six cars per train to accommodate increased patronage.

SOUTH LINE SYSTEM



1.3 Station Stops

Under normal operating conditions, all trains operating in revenue service will stop at all passenger stations. For headway maintenance and failure management, it may become necessary to have trains bypass certain stations. When this occurs, a station run-through speed of not exceeding 46 miles per hour will be established with appropriate horn sounding procedures followed. All trains will stop centered on the platform regardless of train size. Station dwell times will be adjusted by the Rail Attendant according to patron demand. Subject to variation by passenger flow fluctuations, dwell times at all stations, except Government Center, will average approximately 15 seconds. Government Center dwell will be approximately 45 seconds.

1.4 Speeds and Travel Times

Trains operating on the system will operate at speeds up to a maximum of 70 miles per hour. Table 1-1 shows the distances and estimated running time between stations. The times shown are based upon the vehicle operating in Performance Level 1 (not to be confused with Service Level 1) or maximum vehicle performance. It is calculated that a round trip will take approximately 48 minutes from terminal to terminal. This time includes station-to-station run time, 15 second dwell at each station except Government Center which will be 45 seconds, four minutes terminal time at Dadeland South and four minutes terminal time at Overtown. The terminal time allotted may be more than actually required, however, during failure conditions, the extra time will assist to expedite the failure recovery process.

Train speed will be controlled by the Rail Attendant on board each train. In controlling train speed the Rail Attendant will abide by posted speed limit signs which are installed on the guideway between the running rails for each direction of travel. The speed limit signs are posted in sufficient braking distance in advance of the speed restricted area. For example, if a Rail Attendant were operating in a track segment which permitted 70 miles per hour and encountered a 58 mile per hour speed limit sign, the Rail Attendant would immediately begin reducing train speed to 58 miles per hour. The Rail Attendant would begin to brake when the lead car of the train encountered the speed sign.. Conversely, if a sign were encountered which permitted an increase in speed, the Rail Attendant would immediatley increase speed when the lead car encounters the sign. Under no circumstances should train speed be in excess of posted speed.

TABLE 1-1

ESTIMATED STATION-TO-STATION TRAVEL TIMES

SOUTH LINE - STAGE I RAPID TRANSIT SYSTEM

DADELAND SOUTH TO OVERTOWN

STATION TO STATION		(MILES) DISTANCE	* (SEC) RUN TIME NORTH	SOUTH	(SEC) DWELL
Dadeland South	Dadeland North	.72	71	82	15
Dadeland North	South Miami	1.31	107	107	15
South Miami	University	1.00	88	88	15
University	Douglas Road	1.85	133	133	15
Douglas Road	Coconut Grove	1.12	94	96	15
Coconut Grove	Vizcaya	1.82	131	131	15
Vizcaya	Brickell	1.47	123	124	15
Brickell	Gov't Center	.79	90	80	45
Gov't Center	Overtown	.37	46	46	15
TOTALS		10.45	883	887	165

Run Time Calculations:

Travel Time Northbound	-	15.7 Minutes
Travel Time Southbound	-	15.7 Minutes
Dwell Time Northbound	-	2.8 Minutes
Dwell Time Southbound	-	2.8 Minutes
Turnaround Time Southbound	-	6.0 Minutes
Turnaround Time Northbound	-	5.0 Minutes
Total Run Time	-	48.0 Minutes

* Based upon vehicle operation on Performance Level 1.

1.5 Vehicle Requirements

Based upon providing the service levels described in Section 1.2 the table below shows the number of cars required for operations.

HEADWAY	NO. OF FOUR CAR TRAINS	NO. CARS OPERATING	NO. OF SPARE CARS	TOTAL CARS REQUIRED
12 Min.	4	16	8	24

It should be planned to have 2 four-car trains available for spares for recovery from delays and replacing in-service failures. Based upon this requirement, a total of 16 cars are required to operate and 8 cars as standbys for a total of 24 cars available for service.

1.6 Vehicle Storage

A total of 24 cars will be stored during the non-revenue operating hours. Storage space will be provided at various locations along the system and are as follows:

CAR STORAGE LOCATIONS

Number of Cars	Storage Location
4	Dadeland South No. 1 Tail Track
8	Dadeland South No. 2 Tail Track
4	Dadeland South No. 1 Platform
4	Dadeland South No. 2 Platform
4	No. 1 Track North of Culmer X-over

Track 3 at Dadeland South will, during revenue hours, be kept free of operable cars to permit repair of defective cars. Keeping this track clear will provide maneuvering space should it become necessary to replace vehicles, and for shuttling operations over the Florida East Coast right-of-way to the Palmetto yard maintenance facility. Mid-route pocket tracks will also remain clear under normal operating conditions for failure management purposes. The locations selected above place "ready" trains where operating personnel could easily place stored trains into service to replace failed trains or to expedite failure recovery.

The storage plan requires 4 cars (one four-car train) be stored on No. 1 track north of the Culmer crossover. These four cars will be stored at this location during revenue and non-revenue hours. The cars will be stored north of the Culmer crossover. The four-car train will be used as a spare to replace in-service failures or to recover from delays. For example, if it is determined that a defective northbound train cannot make its southbound return trip without risking additional delays, the defective train will be stored on No. 2 track north of Culmer crossover and the spare train will be placed into service. The defective train would, when headways permit, be routed to Dadeland South tail tracks. During revenue hours, a four-car spare train will be stored on the No. 1 station track at Dadeland South to be used to recover from delays or replace in-service failures in the same manner as described above for Culmer.

1.7 Sweeper Train

Prior to the start of revenue service, a 4-car "sweeper" train will depart from Dadeland South No. 2 station track. The sweeper train will depart Dadeland South Station at approximately 5:00 a.m. and make one complete round trip over the operating route. The train will be operated in the Yard Mode with ATP bypassed and not exceed 25 miles per hour. The purpose of the sweeper train will be to ensure that the guideway is clear of foreign objects and if necessary to carry personnel to open passenger stations. The train operator of the sweep train will inform the Central

Control Dispatcher at Dadeland South of the condition of the line prior to releasing the first revenue train.

After completion of a round trip, the sweeper train will be routed back to the No. 1 platform track at Dadeland South where it will then become a spare train. The spare train should be placed at the extreme south end of the platform to avoid passenger boarding confusion.

1.8 Interim Central Control (Rail Traffic Controller)

Until the Central Control Facility at Government Center is on line, an Interim Central Control will be established on a temporary basis for ensuring control, communications and co-ordination of the South Line Operation. "Central Control", as used in this document, will be located at the Dadeland South platform terminal supervisor's booth. Central Control will be manned on a 24-hour basis and be responsible for all revenue and non-revenue train movements made on the operating line. It will serve as the decision making area for day-to-day operation of the system. All authority for rail operations will be the responsibility of the Rail Traffic Controller assigned to work at this facility. Enforcement of Manual Block Procedures, adjustments required to train service and failure management strategies will be directed and controlled from this location.

In addition to assuming all decision-making responsibilities, equipment is provided in the supervisor's booth to control switches and signals (interlockings) at the crossover north of Dadeland South and the tail track area. It will be the Rail Traffic Controller's responsibility to align routes at either of these interlockings. The Rail Traffic Controller will ensure that trains are assembled and properly prepared, pre-departure tested (see 1.12) and positioned for the start of a.m. service.

The Rail Traffic Controller will be responsible for coordination and directing of field personnel emergency response teams, should the need arise. He will have available to him a current list of telephone numbers of all emergency response agencies. Personnel assigned to work at stations will report all alarms or unusual conditions to the Rail Traffic Controller. The Rail Traffic Controller will prepare a daily log accurately describing all routine and unusual conditions occurring on the system.

The Rail Traffic Controller will provide direction to all Dispatchers assigned to work remote interlocking local control panels. Final authority for all train movement will lie with the Rail Traffic Controller.

1.9 Interlocking Operation and Control

Switching movements as part of normal operations will occur at Dadeland South (Interlockings North and South of station) and Culmer crossover for turning back trains. As previously described, the Rail Traffic Controller at Central Control will control all switching movements of interlockings and in the Dadeland South immediate vicinity. A Dispatcher will be assigned to work in the Culmer Station train control room. It will be that Dispatcher's responsibility for switching movements involving the use of Culmer crossover. Mid-route interlockings at I-95 and Douglas Road will not normally be manned. Switches associated with these interlockings will be clamped in the normal position with all signals "bagged" (removed from sight). Mid-route pocket tracks will be used when failures occur which require single track operation or to lay up a disabled train. When these abnormal conditions occur, operating personnel qualified to operate the local control panels will be dispatched to the appropriate interlocking. Maintenance personnel will be responsible for removing all clamps from switches and uncovering signals when placing the interlocking into service.

1.10 Train Control

Train Control maintenance personnel will be available during all operating hours. A Train Control Coordinator will patrol the system and direct field train control maintenance personnel to problem areas. The coordinator will take direction from the Rail Traffic Controller.

A team of two train control maintainers will be located, one at Dadeland South and one at Culmer interlocking. They will be available to respond to failures at each terminal. Should a failure occur which necessitates local hand cranking of switches, the Rail Traffic Controller will inform the Train Control Coordinator who will direct field personnel to the appropriate interlocking to operate the switches.

1.11 Terminal Operations

During all operating hours, and when fleet availability permits, a four-car train will be stored on the No. 1 platform track at Dadeland South.

Trains southbound approaching Dadeland South will be normally routed from Track 1 to Track 2 over the Dadeland South crossover for arrival on the No. 2 station track. After expiration of its terminal time (nominally 4 minutes), the train will depart by schedule from the No. 2 track for its northbound trip.

Trains northbound approaching Overtown Station will continue to be routed on No. 2 track from Overtown to a routing from track 2 to track 1 at Culmer Crossover. The train will then change ends and move via track 1 south to Overtown.

Turning back of trains at both terminals will be performed using the "dropback" method for personnel. An extra Rail Attendant will be provided at Overtown and Dadeland South to assist in turning trains. The person assisting in turning will operate the train in the southbound direction.

1.12 Manual Block Description

For clarification purposes, this paragraph will serve as a definition of a manual block. A "block" is referred to operationally as a section of track with defined limits. The limits of a block can be defined by either (1) wayside signals or (2) stations and strategically placed personnel. In the first case, a section of track between two fixed signals is the defined block or in case (2), people replace fixed signals. Either case provides a definite controlling point with defined limits. Implementation of a manual block operation gives exclusive rights to a train to enter that block and continue movement to the limit of the block. In the case of wayside signals, a train enters the block at a signal and proceeds within that block until it reaches the next signal which is the limit for that block. When people are used, the train enters the block at a person location and continues movement until reaching the next person location. Other trains are not permitted to enter the block from either direction until the previous train given exclusive rights to the block clears that block. When people are used, the result is manual enforcement of train separation as opposed to ATP equipment enforcement. How a manual block will be implemented for the South Line system will be detailed in this plan in Section 2.2.

1.13 Pre-Departure Test

A. Pre-departure (walk-around) test of trains will be performed once every 24 hours at the tail track at Dadeland South. (This will necessitate each train being brought to the tail track at least once each 24 hours). The test will be performed by a Rail Attendant and as a minimum include the following:

1. Check to see that horns are functioning and head lights, tail lights and marker lights are illuminated.

2. From both lead cars, check that train line functions (i.e., doors (both sides), lights, and public address) are working throughout the train.

3. Observe outside condition of train for any obvious defects.

4. Check that all switches are in the manual mode.

5. Check that all end doors are not key-locked. End doors of a train must be dogged.

6. Check that all non-operating cab doors are locked and all non-operating door control panels are locked.

Any defects found must immediately be reported to the Rail Traffic Controller. The Rail Traffic Controller will arrange to have defects repaired prior to revenue dispatch.

1.14 Electrification

Contact rail will be energized on a 24-hour a day basis. No power shutdown will occur at the end of the operating hours. Any testing or maintenance activities requiring power removal will be requested through the Rail Traffic Controller at Dadeland South.

For the initial South Line operation, a temporary three- (3) zone Emergency Trip Station (ETS) will be in place. The delineation of ETS power zones are as follows:

ZONE 1 - Dadeland South Tail Track - Douglas Road Power Gap

ZONE 2 - Douglas Road Power Gap - Brickell Power Gap

ZONE 3 - Brickell Power Gap - Culmer Power Gap

Figure 1-2 schematically shows the limits of each ETS power zone.

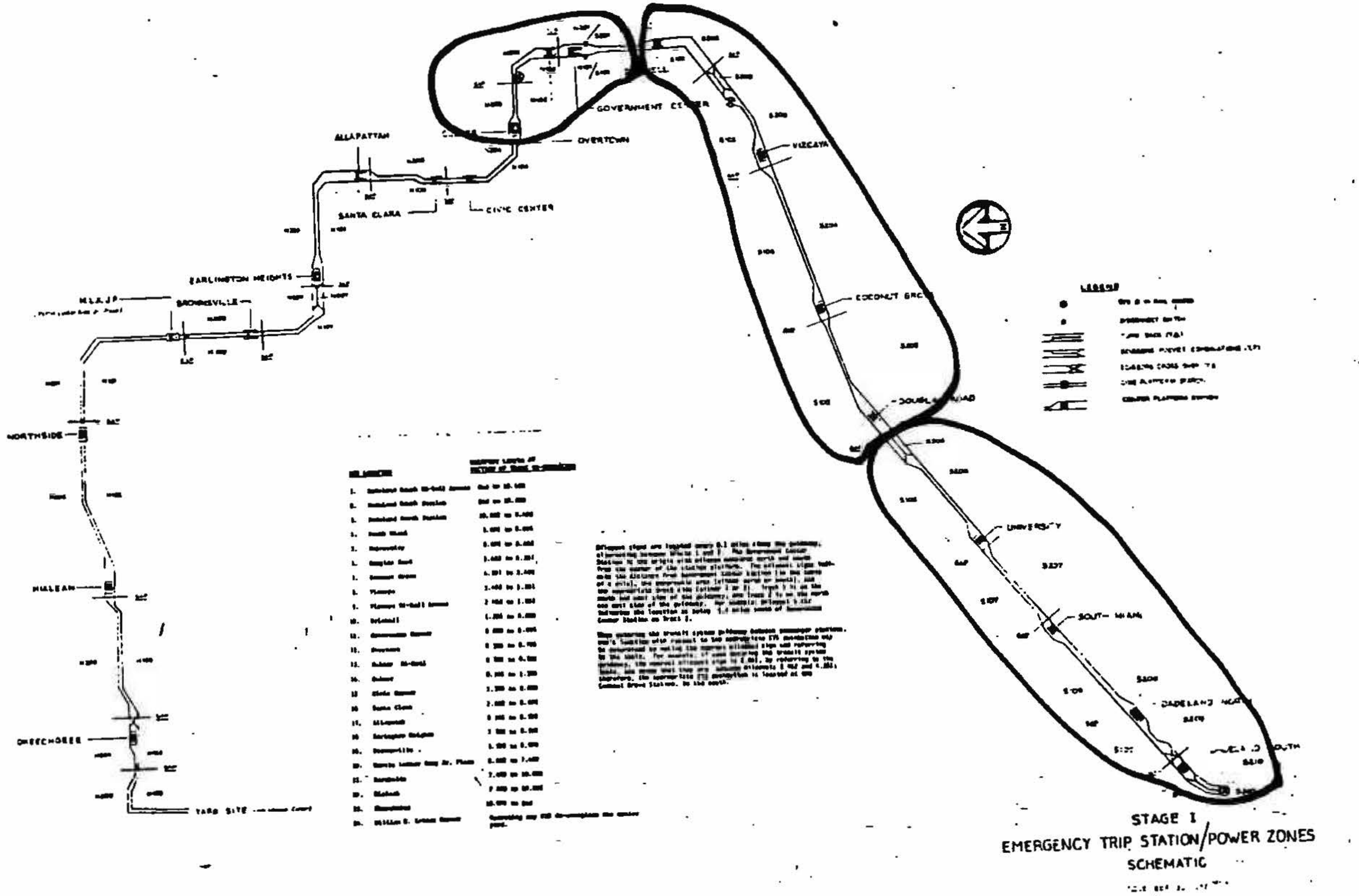


FiGure 1-2
Power Zones

ETS's are located at both ends of each station platform and at the three high-rail vehicle access locations. Activation of any ETS within a zone defined above will immediately remove power from both tracks within the limits of that zone. Restoration of power will require locally resetting the circuit breakers at each traction power substation within the affected power zone.

ETS pushbuttons are immediately available to the Dadeland South Rail Traffic Controller, and the Rail Supervisors at Coconut Grove, Douglas Road and Overtown stations, these persons being key participants in the Manual Block operation. One or more of these participants are physically located in each of the three power zones. If a condition exists which is determined by any of the Manual Block participants to require power removal, they will activate the ETS and immediately inform the Rail Traffic Controller of the condition. Power will not be restored until the person who activated the ETS advises the Rail Traffic Controller that the condition has been cleared.

When an ETS is activated, the Rail Traffic Controller will advise the Traction Power coordinator of the affected zone of the condition requiring an ETS activation. The coordinator will direct field personnel to the appropriate locations and await further direction from Central Control. Under no circumstances will power be restored without authority from Central Control.

During all revenue operating hours, a Traction Power coordinator will patrol the system, and direct field maintenance personnel who will normally be assigned to the Brickell and Overtown traction power substations. They will be on call and respond to directions given from the traction power coordinator.

1.15 Maintenance Operations

During operating hours, vehicle maintenance personnel will be strategically located along the system and will respond to train defects as directed by the Rail Traffic Controller. Repairs of a nature that will interfere with the operation of the train or result in a delay will be performed at the Dadeland South tail tracks and not while the train is in passenger carrying service. When it becomes necessary to correct a train defect at the tail tracks a relay train will replace the defective train.

1.16 Station Operations

Stations will be manned on a continuous basis during all operating hours. Opening and closing of stations will be performed by Rail Supervisors from the Operations department. All stations will be open by 6:00 a.m. and closed immediately after the last train of the day departs that station. Rail Passenger Guides (temporary employees) and MDTA personnel will provide station coverage.

The Rail Passenger Guides will perform duties such as escorting the handicapped to elevators, operating the elevator for the handicapped and securing it immediately after usage. If an audible alarm sounds within the station, the Rail Passenger Guide will notify the Central Control Dispatcher. Rail Passenger Guides will unlock restrooms for passengers who request admittance.

In addition to the Rail Passenger Guides, MDTA Planning Department staff will provide coverage at all stations during peak periods (7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m.). They will locate themselves in the station entrance area and provide passenger assistance as required and while on duty provide direction to Rail Passenger Guides.

SECTION 2
OPERATING CONFIGURATIONS

2.1 Operating Configurations

General: This section will develop the operating configuration which will be used for operation of the South Line system. This configuration is defined as Service Level 1 operation whereby vehicle and wayside ATP systems are not functional and vehicles are operated in the Yard Mode with ATP By-Passed. This configuration will utilize manual enforcement of train separation until such time that all ATP vehicle and wayside systems are safety certified. It is assumed for the purpose of developing this configuration, as a minimum, terminal interlockings will be certified, permitting remote operation.

2.2 Service Level 1 - Manual ATP By-Pass

Under this service level, trains are operated in the ATP By-Pass mode. This mode will be utilized because speed commands are not available or inconsistently available. In the ATP By-Pass mode, the train speed is controlled and regulated by the Rail Attendant. Automatic speed governing or speed regulations are not available in this mode. The Rail Attendant will regulate train speed in accordance with speed limit signs mounted on the guideway between the tracks for both directions of travel.

Below is a typical example of how those persons assigned to these locations will be involved in the movement of trains for a complete round trip.

STAFF LOCATIONS

SOUTH LINE OPERATIONS

	Rail Traffic Controller	Dispatcher	Rail Supervisor
Dadeland South Supervisor's Booth (Central Control)	X		
Douglas Road Train Control Room (Local Control Panel)		AS REQUIRED	
Douglas Road Station Platform			X
Coconut Grove Station Platform			X
Vizcaya Train Control Room Local Control Panel		AS REQUIRED	
Overtown Station Platform			X
Culmer Train Control Room (Local Control Panel)		X	

Note: Locations shown are staffed during all revenue operating hours.

FIGURE 2-1

Northbound

A. The Rail Traffic Controller (RTC) at the Dadeland South Central Control will align a route at the Dadeland South crossover and instruct the Rail Attendant on the first northbound train to operate in ATP By-Pass/Yard Mode to Coconut Grove Station (clearance point for 12 minute headway). The RTC at Dadeland South will enter on a train sheet the train number, Rail Attendant's name and departure time.

B. When the train arrives at Coconut Grove Station, the Supervisor on duty will note the time of arrival and verify the train by number and Rail Attendant. After receiving a clear block from Culmer, he will then instruct the Rail Attendant to proceed to Culmer Crossover and report in to Culmer when train has cleared the Culmer interlocking. When the train departs the Station, the Supervisor will inform Central Control that the train has departed Coconut Grove Station northbound. The train will be identified to Central Control by number. The time of departure will be based upon the time when the rear end of the train <u>physically clears</u> the platform limits. When the clearance is received from Coconut Grove, Central Control can then dispatch the next train from Dadeland South at the appropriate time to maintain a 12 minute headway. The Supervisor at Coconut Grove will note the train number, Rail Attendant's name, mode of operation and departure time on his train sheet.

C. After the northbound Rail Attendant notifies Culmer Control that the train is clear of the switches, Culmer Control will normal the switches and establish a route to Overtown. Upon receiving a clear block from the Rail Supervisor at Overtown, a signal will be displayed to the Rail Attendant and the southbound train will be given permission to proceed to Overtown and hold with the additional requirement that Culmer be notified when the southbound train reaches the turnback marker south of the interlocking. This will verify that the Culmer Crossover is clear for again aligning the switches track 2 to track 1. As soon as a clear northbound route can be established into Culmer interlocking, Culmer Control may give a clear block to Coconut Grove on track 2 for the next northbound train. The Dispatcher at Culmer will record the arrival and departure time, and train consist numbers of each movement through the interlocking.

Southbound

A. Upon receipt of a clear block from Douglas Road, the Rail Supervisor at Overtown will release the southbound train to proceed to Douglas Road and hold. The Rail Supervisor at Overtown will then inform the Dispatcher at Culmer that a train has departed southbound. This will enable the Dispatcher at Culmer to release the next train southbound to Overtown.

B. When the train arrives at Douglas Road, the Douglas Road Supervisor will instruct the Rail Attendant upon receiving clearance from the RTC for the train to proceed to Dadeland South Station. The Douglas Road Rail Supervisor will then inform Overtown the train has departed and the next train can be released from Overtown. The Douglas Road Supervisor will note the time of departure, Rail Attendant's name, train consist and mode of operation on the train sheet.

C. The RTC at Dadeland South will have established a route over the Dadeland South crossover from No. 1 track to whichever track is not occupied for arrival at Dadeland South Station. The Rail Traffic Controller will note the arrival on the train sheet.

The above procedure will be followed for all trains in revenue service.

2.3 Summary of Duties of Operating Personnel

2.3.1 Rail Supervisor at Coconut Grove Station

- Obtains clear block from Culmer, Coconut Grove to north of Culmer interlocking.
- Gives verbal instruction to northbound train to proceed to clear of Culmer interlocking and call Culmer upon arrival.
- Notifies RTC at Dadeland South that clear block is established from Dadeland South to Coconut Grove on track 2.
- Logs train arrivals and departures northbound, Rail Attendant name, train consist and mode of operation.

2.3.2 Rail Supervisor at Overtown Station

- Insures that all inbound passengers are off train before train departs to Culmer Crossover.
- Gives verbal instructions to southbound train to proceed to Douglas Road and hold.

- Notifies Culmer Control of clear block, Culmer to Overtown on track 1.

- Logs train arrivals and departures southbound, Rail Attendant name, train consist and mode of operation.

2.3.3 Dispatcher at Culmer Control

- Keeps switches in normal mode until is assured there are no trains north of interlocking as verified by Rail Attendant calling in from track 1 turnback point.

- Instructs southbound train to proceed on signal on track 1 to Overtown when clear block is established and establishes a route to Overtown Station.

- Establishes a route for northbound trains to turn back at Culmer Crossover.

- Notifies Coconut Grove Supervisor when clear block is established to Culmer.

- Logs train arrivals and departures from Culmer interlocking.

2.3.4 Rail Supervisor at Douglas Road

- Obtains clear block from RTC, Douglas Road to Dadeland South.

- Gives verbal permission to southbound train to proceed to Dadeland South Station.

- Notifies Overtown that train has cleared Douglas Road Station, establishing clear block, Overtown to Douglas Road.

- Logs train arrivals and departures, Rail Attendant name, train consist and mode of operation.

2.3.5 Rail Traffic Controller at Dadeland South

- Obtains clear block from Coconut Grove, Dadeland South to Coconut Grove.

- Gives verbal instructions to northbound train to proceed to Coconut Grove and hold.

- Establishes route through DLS Crossover.

- Notifies Rail Supervisor at Douglas Road of clear block, Douglas Road to Dadeland South.

- Logs train arrivals and departures, Rail Attendant name, train consist and mode of operation.

- Controls movements into and out of Dadeland South tail tracks.

- Makes announcements to Rail Attendants concerning special track conditions and speed restrictions.

2.3.6 Rail Attendant at Culmer

- Notifies Culmer Control when northbound train is clear of interlocking.

- Notifies Culmer Control when southbound train is clear of interlocking.

SECTION 3
COMMUNICATIONS

3.1 Radio Channels

The primary means of communications for dispatching on the South Line system will be radio. The primary radio unit for trains will be the CCU unit, but each Rail Attendant should carry a portable unit as a back-up. The portable should be carried in the "off" position when not in use in the cab.

The primary channel for train movement will be Radio Channel #1. This channel will be for <u>exclusive use</u> of train movements and its importance cannot be overemphasized. All other communications must either be accomplished by telephone or maintenance channels.

Channel #4 will be the backup channel for train movement.

Channel #5 will be the primary maintenance channel and Channel #6 will be its backup.

3.2 Special Orders

Special Orders will be issued when appropriate, by the General Superintendent of Operations/Maintenance and displayed in these places:

1. In the office of the General Superintendent of Operations and Maintenance, 44 West Flagler Street, Suite 300, Miami, Florida 33130;

2. The Interim Central Control Office at Dadeland South Station;

3. The Rail Supervisor Office at Dadeland South Tail Track;

4. The Rail Attendant's Lobby at Dadeland South Tail Track.

It shall be the responsibility of the Rail Traffic Controller to insure that all Special Orders are put into effect.

All Rail Controllers, Rail Supervisors, Yard Dispatchers and Rail Attendants will sign one copy of each Special Order which will be on file at the Flagler Street Office.

TRI-MET

RAIL OPERATIONS RULE BOOK

~~FIFTH DRAFT~~ - ~~AUGUST 28, 1984~~

Sixth DRAFT MAY 10 1985

(Format to be 4"x7", Typeset, With Colored Illustrations)

Send Comments to:

~~William Lieberman~~ Bob Douglas
DIRECTOR ~~Manager~~, Rail Operations ~~Planning~~
Tri-Met Light Rail
2222 N.W. Eleven Mile Avenue
Gresham, OR 97030
(503) 661-8121

Tri-County Metropolitan Transportation
District of Oregon

RAIL OPERATIONS RULE BOOK NO.________

This book issued to: ____

Please return to: Manager of Rail Transportation
Tri-Met Ruby Junction Light Rail
Operations Facility
2222 N.W. Eleven Mile Avenue
Gresham, Oregon 97030

Tear Here Tear Here

I certify that Rail Operations Rule Book No. ______ has been issued to me in good condition. I understand that I am to have a thorough knowledge of its content, keep it up-to-date and in good condition, and return it to Tri-Met when I leave the service of the District.

____
Signature of Employee

____
Employee Number

____
Date

RAIL TRANSPORTATION DEPARTMENT
TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT OF OREGON

FORWARD

Tri-Met's business is to move people. For our business to thrive, we must move our passengers safely, reliably and courteously. To insure this, is the intent of this Rule Book.

Our responsibility as Tri-Met employees is to perform as professionals. Suggestions are encouraged whenever a better way of doing something becomes evident.

All of us at Tri-Met must perform together to win and hold the public's confidence. Our future and the welfare of the public depends on it.

Bill Allen
Executive Director, Operations

James E. Cowen
General Manager

TABLE OF CONTENTS

USING THIS RULE BOOK

This Rule Book contains the current body of Tri-Met's Rail Operations Rules. It has been designed for three purposes:

(1) To identify Tri-Met's operating practices and standards;

(2) To aid in the instruction of these practices;

(3) To serve Employees as a reference manual whenever questions arise on the correct course of action.

At the front of this book is a tear-out sheet which certifies that the Employee has received the book and that it is in good condition. This sheet should be filled out by each recipient and submitted to the Manager of Rail Transportation. Operators are required to carry this book with them whenever they are on duty. Other Operations Employees are encouraged to have a copy close at hand for ready reference. Rule Books are the property of Tri-Met and must be returned when the Employee leaves service with the District.

The Rules are arranged in categories, as indicated in the Table of Contents and apply to all Rail Operations Division Employees. Each rule has an individual number and a title which summarizes its subject.

At the back of this book are other useful reference sections. Appendix A contains definitions of key words, listed in alphabetical order. Appendix B is an index of the Rules, which are listed alphabetically. Appendix C contains a number of important Standard Operating Procedures, including several for troubleshooting minor problems with the light rail vehicles. Finally, Appendix D presents maps of Tri-Met's Light Rail Main Line, showing switch and wayside signal locations.

A Standard Operating Procedures Manual is maintained in the operator report area. That book includes copies of standard forms and information about specific procedures of the Rail Operations Division, such as sign-up procedures and fares. You are encouraged to check that manual when you have questions that are not answered by this Rule Book.

Periodically, Rules will be added, deleted or revised. When this occurs, new pages will be issued to all holders of the Rule Book. Obsolete pages should then be discarded and the revised pages inserted in their proper order in the book. These revisions will require signature verifying that you have received them.

TYPES OF OPERATING REGULATIONS

A number of different types of regulations guide the operation of transit at Tri-Met. All are equally important for the safety and convenience of the public. All are equally binding on Employees. The following description lists the types of regulations currently in effect and help to distinguish their purposes and uses.

OPERATIONS POLICY STATEMENT: That overall philosophy which guides the provision of transit services at Tri-Met and the establishment of all other operations regulations; it is issued by the Executive Director of Operations. The Operations Policy Statement is printed on Page   of this book.

OPERATIONS RULES (or simply, RULES): The body of printed regulations which govern the operation of buses and trains, issued by the Executive Director of Operations. Those rules dealing with train operation are assembled in this Rail Operations Rule Book. (Those for buses appear in a separate Bus Operations Rule Book). The Rules governing the rail line are the principal type of regulation covered in this book. There are rules for the normal day-to-day operation of the rail line, as well as rules for special situations not encountered frequently.

ROUTE INSTRUCTIONS: The paddle, route map and route description of a specific train on a specific route. The Operator must follow route instructions unless otherwise directed by a Controller or Rail Supervisor or by Special Instructions or Train Orders.

SPECIAL INSTRUCTIONS: Printed regulations, issued by Rail Operations, which deal with recent or temporary operating situations not covered by the Rules. Special Instructions supersede or amend the Rules while they are in effect. They are posted in the Operator Report Area. It is the responsibility of all affected personnel to check this posting daily for new instructions.

TRAIN ORDERS: Temporary rules, issued by Rail Operations, which govern the operation of trains under special circumstances. Train orders are generally issued for conditions lasting for a day and will usually be reissued as Special Instructions for longer periods. In the interest of timeliness, Train Orders may first be issued verbally but will be followed by printed copies. Train Orders take precedence over Rules and Special Instructions while they are in effect.

OPERATIONS POLICY STATEMENT

The goals of Tri-Met are to plan, develop and operate public transportation services for the Portland metropolitan area. These services must be reliable, efficient and cost-effective. Each Tri-Met Employee has an important role in helping achieve these goals and can feel justifiably proud of our accomplishments to date. By the same token, the transportation of the public carries with it a continuing responsibility for the safety and comfort of our passengers. To achieve the goals described above, it is necessary to have a clear understanding of the general policies which guide transit operations at Tri-Met. These operations policies are summarized in the paragraphs below.

1. Safety. Safety shall be the overriding policy in all Tri-Met operations and shall take priority over all other operations policies. All Tri-Met vehicles, equipment and facilities shall be maintained at a level sufficient to ensure safe operation. Operators will take no actions which deliberately endanger passengers or the public at large. All Employees will take every reasonable precaution to avoid injury to themselves and others at their workplace. Employees shall never report to Tri-Met in a physical or mental condition which will impair the safe performance of their duties.

2. Reliability. Since the reliability and regularity of transit operations are the keys to attracting and maintaining ridership, Tri-Met Operators will strive for timely performance of passenger service. Running late may occasionally be necessitated by traffic, roadway, railway or weather conditions, but running early can never be justified. Trips may not be skipped or cut short unless so directed by Rail Supervisors or Rail Controllers.

3. Efficiency. All Tri-Met Employees shall strive to make the utmost productive use of their time on duty. Care shall be taken by Employees using Tri-Met facilities and equipment to avoid unnecessary use and needless damage; use for unauthorized purposes is prohibited. Procurement

of facilities and equipment will consider long-term cost-effectiveness in addition to purchase price. Suggestions will be encouraged from staff on ways to increase operational efficiency and effectiveness.

4. Cleanliness. It is the responsibility of Employees to keep Tri-Met vehicles, equipment and facilities clean and orderly, to the best of their abilities.

5. Courtesy. Tri-Met Employees shall consider the public their clientele. Those dealing with the public shall dress, speak, behave and carry out their duties in a manner reflecting respect and service to the public as specified by the Rules..

6. Authority. All Tri-Met Employees shall follow instructions regarding their duties as laid out in official printed comments (e.g., Operations Rule Books, Standard Operating Procedures, etc.) or as directed by their superiors. It is the responsibility of Employees to be familiar with the current printed directives dealing with their particular duties.

7. Certification. Tri-Met will set rules and procedures for the training and certification of its Rail Operators. All operators must have valid Oregon or Washington combined Driver-Chauffeur's licenses in good standing. Train Operators must be certified as Tri-Met Train Operators and must have satisfactorily completed Tri-Met's Train Operator training program. It is the responsibility of all Operators to keep their driver's licenses up to date; Train Operators must, in addition, pass an annual re-certification examination administered by Tri-Met. Tri-Met will be the sole certification agency for its Train Operators.

Bill Allen
Executive Director, Operations

I. GENERAL RULES

100 SAFETY OF THE PUBLIC

The safety of passengers and the public is the first consideration. All Employees must exercise constant care to prevent injury to persons or property.

101 CARE ON THE JOB

Employees are required to exercise due care in the course of their duties to prevent injuries to themselves, their fellow employees and the public. Care must also be taken to prevent damage to Facilities and Equipment.

102 USE OF BEST JUDGMENT

Employees involved in a situation not covered by written rules or verbal instructions of a supervisor must use their best judgment in selecting the safe course of action. Employees must report the action taken to their immediate supervisor as soon as possible. In case of doubt or uncertainty, the safe course of action must be taken.

103 AVAILABILITY OF RULES

Operators must have a copy of the Rules in their possession at all times while on duty. Employees who are not Operators, but whose duties are prescribed by these Rules, must have a copy of the Rules accessible to them while on duty.

104 KNOWLEDGE OF SPECIAL INSTRUCTIONS

Employees must be familiar with and obey Special Instructions. Operators must read the Special Instructions posted in Operator Report Areas and in the pouch before the start of each run and must sign the sheet indicating such. If in doubt as to their meaning, Employees must contact the Controller or Rail Supervisor for an explanation. Special Instructions are to take precedence over the Rules as long as they remain in force.

105 COMPLIANCE WITH RULES AND ORDERS

Employees must obey the orders of officials having authority over them. In cases of conflict between verbal orders of officials and written rules, the orders of the Controller or, if present, a Rail Supervisor, will prevail.

106 COMPLIANCE WITH EXAMINATIONS

Employees must pass the required examinations considered necessary by management to assure that they possess the physical fitness and job knowledge required to perform their duties.

107 DEFENSIVE DRIVING

Employees must operate Light Rail Vehicles (LRV) in such a manner as to identify accident producing situations soon enough to take reasonable and prudent action to avoid an accident. Responsibility to prevent or avoid an accident goes beyond carefully observing rules and regulations. Operators are expected to operate LRV in such a manner as to prevent accidents.

108 REPORTING DEFECTS

Employees must report to the Controller or Rail Supervisor immediately any dangerous conditions or other situations that could adversely affect safety or service.

109 TRESPASSERS

Employees must immediately report to the Controller any trespassers on Tri-Met property, including persons on or near the trackway. Employees should ask trespassers to leave if this can be done without delaying operations.

110 CARE ALONG THE TRACKWAY

Any person required to be on the trackway for any reason must gain authorization from the Controller. Persons authorized to be on the trackway or in any reserved right-of-way must use utmost care at all times, for the safety of themselves as well as others. Such persons must use appropriate safety apparel and equipment; they must provide appropriate hand signals for approaching trains. All tracks must be considered as operating tracks and persons must be alert for trains operating in either direction at all times. Persons should, however, walk facing the direction from which trains in regular operation will normally approach. They must report to the Controller when they are clear of the trackway.

111 AWARENESS OF TIME AND TRAIN OPERATING SCHEDULE

While on duty, Employees whose duties relate to the operation or supervision of trains, or with maintenance of way along the mainline track, must carry with them a current timetable for rail service. Such Employees must also carry a reliable watch adjusted daily to the correct time as displayed by the clock in the Ruby Junction Transportation Office.

112 AVOIDING CONTACT WITH ELECTRICAL APPARATUS

Employees must consider all overhead wires, pantographs, electrical switches and other electrical apparatus live at all times. Employees must not come in contact with electrical equipment and must attempt to prevent passengers or others from doing so.

113 CENTRAL CONTROL definition

A central location whereby all rail operations are directed and authorized by a Controller.

114 CONTROLLER

The Controller shall have absolute authority over all movement on the mainline, auxiliary and yard tracks.

II. TRAIN OPERATING RULES

A. General

300 QUALIFICATION OF OPERATING EMPLOYEES

No persons shall operate any piece of mobile railborne equipment on Tri-Met rail lines and property unless:

a. they are qualified and in possession of a current Tri-Met certificate of qualification for the type of equipment being operated; or,

b. they are under the direct supervision of a qualified Tri-Met Instructor or other Employee so designated.

301 RESPONSIBILITY FOR TRAINS

The Operator assigned to the movement of a train has full responsibility for its operation.

302 ADHERENCE TO TIMETABLE

Operators must operate trains in accordance with the timetable and must properly apportion running time between timepoints, subject to the rules. Operators must not arrive at a timepoint more than 59 seconds early and must not leave a timepoint early.

303 ESTABLISHING COMMUNICATIONS

Operators using the radio must be certain a clear channel is available. They must identify by train number, direction of travel and location. All messages shall be repeated to verify proper understanding.

304 INTERRUPTIONS OF COMMUNICATIONS

Operators will turn on the portable radio when leaving the active cab to continue communications. Disabled radio equipment must be reported to the Controller immediately.

305 PREPARING TRAIN FOR SERVICE

Operator must conduct an inside and outside pre-departure inspection before leaving the yard for service as per Standard Operating Procedures (SOP).

306 SECURING CAB DOORS AND WINDOWS

Cab doors and windows must be kept closed and locked when a train is in service or is being used for training or other demonstrations. Exception: cab windows may be open when an Operator is occupying an active cab.

307 READING MATERIAL IN CABS

Operations Rules, Train Orders, paddle or train operating instructions may be examined when necessary in the performance of regular duties but never while the train is in motion. No other reading material shall be allowed in train cabs, except as described in Rule 308.

308 PROHIBITION OF EATING, DRINKING, SMOKING OR READING IN CAB

It is forbidden for anyone to eat, drink, smoke or read unauthorized material in any cab of any train, whether in service or not. Food in containers, unlit smoking material and unauthorized reading material must be kept in the Operators pockets or stored in the cab storage compartment.

309 PERSONS IN TRAIN CABS

Operators must not allow any person without proper authorization to ride in the cab. Authorized persons in the cab must be reported to the Controller. Such persons must not engage in unnecessary conversation or in any action which will distract the Operator from the proper performance of duties.

310 TEMPORARILY LEAVING THE CAB

Operators should request permission from the Controller if they are leaving the cab for any unusual occurrence, stating the reason for leaving the cab, the estimated return time and the location. When permitted to leave the cab, Operators must secure the train against moving, remove the master controller key and lock the cab door.

311 TRAIN OPERATING LIGHTS:

Every LRV entering or operating on the mainline tracks must display two white headlights and two yellow marker lights on the front and two red tail lights with two red marker lights at the rear with respect to the direction of travel.

312 USE OF HIGH BEAM HEADLIGHTS

Operators may use the high beam headlights only during night hours and must dim headlights to low beam when approaching on-coming trains and street traffic.

B. Movement of Trains

320 COUPLING AND UNCOUPLING

Operators must use care in coupling and uncoupling cars on mainline or yard to avoid injury or damage.

a. Only qualified personnel shall have the responsibility of coupling and uncoupling the cars.

b. Before starting the procedure, care must be taken to ensure that cars coupling to or uncoupling from are properly secured, and that persons in or about such cars are notified.

c. A full stop must be made prior to coupling, with approximately ten feet between couplers. A second full stop must be made not more than three feet from the point where the coupling is to be made and the alignment of the couplers must be checked. Coupling speed is 1/2 MPH.

d. Personnel must never stand between cars that are coupling or uncoupling.

e. Coupling should be avoided on a curve, if possible.

321 SIGNALING BEFORE PROCEEDING IN YARD

Before setting a train in forward motion after any stop,in the yard or shop, Operators shall sound the Proceed signal on the bell.

322 TRAIN MOVEMENTS IN YARD

Operators must notify the Controller before moving any train within the yard limits at Ruby Junction. Operators of pull-in trains must stop at the Yard Limit sign and request yard instructions. Operations personnel must observe the same procedures within the confines of the maintenance building. Train movements may be made after informing other Employees in the immediate area, making a ground inspection of the train and governed by the Shop Foreman.

323 ENTERING OR LEAVING SHOP

Before entering or leaving the shop, Operators must bring their train to a full stop, wait for the shop door to be fully opened, and sound the Proceed signal on the bell. A speed limit of 3 MPH must be observed.

324 ENTERING OR LEAVING THE MAINLINE TRACK

Operators must obtain permission from the Controller before operating any train onto a mainline track from a yard or auxiliary track, and must report to the Controller when leaving a mainline track. The following information must be provided:

a. Train number, location and direction of travel assigned;
b. (When entering or leaving yard): car numbers of all cars in consist, and ATS Trip and By-Pass counter numbers for cabs at each end of train.

325 CONSOLE DISPLAY PANEL

Operators must observe the console display panel indications and report all malfunctions to the Controller.

326 FIRST TRAIN

The first train to operate over any section of the mainline track each day (or after an interruption of service) must proceed at restricted speed. The Operator must be especially alert to and stop short of: any obstructions on the track; damage to track, overhead wire, wayside signals or crossing gates; improperly lined switches; or any other condition or situation which could be hazardous to the operation of trains.

327 VISUAL OPERATION OF TRAINS

Operators must be visually alert at all times when operating their trains, including while under wayside signal protection, and must be prepared to bring their trains to an immediate stop should obstructions to safe operation be sighted.

328 STREET OPERATION

Trains in a street environment must be operated "on sight", with particular attention to traffic and pedestrians which may unexpectedly cross in front of the train. Operators must obey all applicable motor vehicle laws, as well as special signs and wayside signals which may govern train operation.

329 OPERATING WITH THE NORMAL CURRENT OF TRAFFIC

The normal current of traffic on mainline double tracks is to the right. Operators must not operate in the reverse direction on mainline double tracks unless specifically instructed to do so by the Controller, Special Instructions or when making authorized turnback moves. Operation in the reverse direction is governed by Rule 411.

330 REPORTING UNUSUAL STOPS

Operators must promptly report to the Controller all emergency stops, unusually severe stops and improper or missed station stops.

331 FOULING OTHER TRACKS

Trains must not be stopped with any portion fouling adjacent tracks unless the train is properly protected by red lights or red flags and authorized by the Controller.

332 ACCELERATING AND BRAKING

Operators must accelerate and brake their trains smoothly so as to avoid discomfort and injury to passengers and wear and damage to equipment.

333 TRAIN STOP SPACING

Operators must stop not less than 10 feet from trains, buses, persons, obstructions, improperly aligned switches and overhead wire or track defects. Exception: Operators storing trains in the yard must stop with couplers approximately 5 feet from those of other trains.

334 BLOCKAGE OF GRADE CROSSINGS

No part of a train shall be allowed to stop in any part of a public crossing at grade except in emergencies. If the train must occupy a crossing for longer than one minute for any reason, the Operator shall notify the Controller.

335 PERSONS ON SHELTER ROOFS

Operators must not operate a train in any station area where a person is on the roof of a station shelter unless train movement is governed by a flagger. Employees should not work on shelter roofs during service hours unless flaggers have been posted to govern train movement.

336 PERSONS BETWEEN TWO TRACKS

If two trains are about to pass a person who is in an area between the tracks where there is no safety walk or refuge, the Operators of both trains must bring their trains to an immediate stop and notify the Controller.

C. Passenger Service

340 CARRYING PASSENGERS

Trains are considered in passenger service from the time they leave Ruby Junction Yard to the time they return, and they must pick up and drop off passengers on demand, making proper station stops.

Exceptions: passengers should not be carried when:

a. deadheading from Gresham Terminal to Ruby Junction Yard;
b. leaving S.W. 10th and Morrison to enter the S.W. 11th Avenue terminal;
c. Operator is so instructed by the Controller or a Rail Supervisor.

341 PASSENGER STOPS: LOCATIONS

Operators must board or discharge passengers only at station platforms, except in emergency conditions. In such cases, Operators must first notify the Controller.

342 PASSENGER STOPS: CONDITIONS

Passenger stops must be made at stations under the following conditions:

a. whenever a stop request is made by passengers on-board a train;
b. whenever passengers are observed waiting on a station platform;
c. at all times at stations on S.W. Morrison and S.W. Yamhill Streets;
d. when directed by the Controller or Rail Supervisor;
e. when it is required for safety or emergency purposes to off-load a train of passengers.

Exception: A station may be passed without stopping when the Operator is so directed by the Controller, Rail Supervisor, or the operating schedule; such by-passes must be announced to passengers on board in advance of the station.

343 STOPPING TRAINS AT BERTHING MARKERS

Operators must stop trains in station areas only at the appropriate train berthing markers or at wheelchair lifts. Streets and crosswalks must not be blocked by trains.

344 STATION BY-PASS

Trains which do not stop at stations must not exceed 20 MPH passing the platform, as required by Rule 396d, and must sound a warning if passengers are upon the platform, as prescribed by Rule 352f.

345 ANNOUNCEMENTS TO PASSENGERS

Operators must announce, via the interior public address system, the following information:

a. The name of the next station and transfer point as it is being approached;
b. The boundaries of fare zones and Fareless Square, at the last station before they are crossed;
c. The reason for any delay of one minute or more;
d. The necessity for passengers to leave the train at the end of the line or in an emergency (in a manner that will not cause alarm).

In addition, line direction and destination must be announced to all visually handicapped passengers as they board.

Train Operators must announce at each station, via the train interior and exterior public address system, any special operating characteristics of the trip (such as a short turnback, express running, or skipping certain stations).

F. Soeed

395 OBSERVANCE OF SPEED SIGNS

Speed signs indicate the allowable train speed from the point where posted to the next speed sign.

a. Where the speed posted is more restrictive, the train must be completely decelerated by the time the leading cab reaches the sign.

b. Where the speed posted is less restrictive, the train must not be accelerated until the leading cab passes the sign.

Operators of trains of more than two cars must allow for extra clearance before accelerating beyond a speed sign.

396 MAXIMUM ALLOWABLE SPEEDS

Unless otherwise posted with a more restrictive speed, maximum allowable train speeds are as follows:

a. 1/2 mph when coupling or uncoupling.

b. 5 mph on any track which is not a mainline track;

c. 15 mph on a mainline track in Downtown Portland;

d. 20 mph when operating through a station without stopping;

397 SAFE STOPPING

Trains must be operated with such precaution that they can be stopped in time to prevent collisions, overunning stations, or running through damaged sections of track. During adverse weather conditions, Operators must operate trains below posted or allowable speed limits in accordance with their best judgment of a safe speed.

III. SPECIAL TRAIN OPERATING RULES

A. Protection of Trackway Personnel

400 ACCESS TO TRACK AREA

Any person required to be on the trackway for any reason must gain authorization from the Controller as prescribed by Rule 110. When so authorized, the Controller will relay this information by radio to all trains, and all Operators must acknowledge. Operators commencing duty will obtain such information from the Operator being relieved and from the Controller.

404 PROTECTION OF WORK AREAS

Before undertaking any work which may render the mainline track unsafe for train movement at normal speed, Employees must notify the Controller, who will relay that information to all trains concerned. Having obtained permission to restrict train speed, Employees will protect the work area by erecting signs or flags, as prescribed by SOPs.

B. Special Train Movements

410 OPERATING TRAINS FROM OTHER THAN FORWARD CAB

Operators must not operate trains from other than the forward cab of the lead car without authorization from the Controller. When so authorized, the Operator must station a qualified Employee as a flagger on the leading end of the train; the flagger must watch the track, wayside signals and switches and constantly keep the Operator informed as to the safety of proceeding. If communcations with the flagger are lost, the Operator must bring the train to a complete stop until communications are reestablished.

411 OPERATING AGAINST THE NORMAL CURRENT OF TRAFFIC

When authorized to operate against the normal current of traffic, as prescribed in Rule 329, Operators must comply with the following conditions:

a. Trains must be operated at restricted speed, governed by the Controller.
b. Wayside signals are not applicable to such trains.
c. Extra caution must be exercised in alerting motorists, pedestrians, maintenance personnel and other trains to the presence of the train which is reverse running; horn or bell sounds should be used as warning signals.

412 OPERATING BY TRAIN ORDERS

Train orders directing movement varying from, or in addition to, the regular operation of trains are issued by the Controller:

a. Train orders must be brief and clear, in the prescribed form and without erasure or alteration. Each order must be given in the same words to all persons or trains directly affected by it, so that each will have a duplicate of what is given to others.
b. A train must be governed strictly by the terms of train orders relative to its operation, and operators must not assume rights not conferred by such orders. In other respects, the train must be governed by the prescribed Rules.

c. When an order is issued stating that a train may use a section of track in a specified direction, the Controller will govern that section of occupied track.

d. Orders once in effect continue in effect until fulfilled, superseded or annulled.

413 OPERATING WITHOUT WAYSIDE SIGNALS IN A.B.S. TERRITORY

If it is necessary to operate without the protection of wayside signals, the Controller may authorize a train to bypass each wayside signal at specified locations.

a. The Operator must not proceed into an occupied block if a preceding train is in view, except if instructed to do so by the Controller.

b. Operators shall operate trains to maintain safe braking distance between trains under all conditions and at no time exceeding restricted speed.

c. Operators shall be solely responsible for safe operation when trains are operated without wayside signal protection.

414 MANUAL BLOCK SYSTEM (M.B.S.)

Whenever it is necessary to run a train against the normal current of traffic or to give a train exclusive right within a block or section of track between specific locations, the Controller must protect the track by a train order as prescribed in Rule 412 by issuing an M.B.S. clearance.

a. M.B.S. clearance must be repeated by Operators before being acted on, and do not become effective until the message has been repeated correctly and effective time has been given by the Controller.

b. M.B.S. clearance will be numbered consecutively each day, beginning at midnight. When transmitting each M.B.S. clearance the Controller must write the required information in a book provided for the purpose, reading aloud all applicable written and preprinted portions.

c. Employees repeating M.B.S. clearance must read aloud all applicable written and preprinted portions. The Controller must check and underscore each word and figure as it is repeated.

d. An M.B.S. clearance authorizes exclusive mainline track occupancy and flag protection is not required.

e. Specified locations will be used to designate the limits of an M.B.S. clearance.

f. A train authorized to proceed on an M.B.S. clearance must move in the direction and speed specified.

g. The Controller must be promptly advised when the train has cleared the limits specified on an M.B.S. clearance, or arrived at locations specified. The mainline track will be considered clear as the rear of the train passes each specified location.

h. Before cancelling an unfulfilled M.B.S. clearance a train affected must be clear of the main line protected track section.

i. Cancellation must be sent to, and acknowledged by, the Operator, who will state his/her name at time of cancellation, which must be recorded by the Controller. The Operator must immediately destroy his/her copy of the cancelled M.B.S. clearance.

j. An order which has been annulled or cancelled must not be reissued or reinstated under its original number.

k. An Operator being relieved must deliver all M.B.S. clearances still in effect to the relieving Operator and must know that they are understood by the relieving Operator.

l. A Controller being relieved must make a transfer of all M.B.S. clearances in effect. Such M.B.S. clearances will be carefully read aloud by the relief Controller and initialled in the presence of the Controller being relieved. Each must sign the transfer and know that the M.B.S. clearances are understood. All necessary information must also be transferred.

IV. ACCIDENT AND EMERGENCY RULES

502 ACCIDENTS: INJURIES OR DERAILMENT

The Operator must inform the Controller immediately of any accident, injury or derailment on the track, giving train number, direction of travel and location. The Controller will designate a person to take charge at the scene until relieved by emergency personnel.

503 ACCIDENTS: EMPLOYEE ACTIONS AT THE SCENE

Employees involved in, or witnessing, a Tri-Met related accident must remain at or near the accident location until relieved by orders of the Controller or Rail Supervisor. Employees in such circumstances should, if possible, assist in correcting any deficient condition. Employees must provide for the safety and comfort of all persons involved as well as for the protection of property.

504 ACCIDENTS: FORMS FOR PASSENGERS AND OTHER PARTIES

Operators whose vehicles have been involved in an accident must distribute and collect the required forms (see SOP No.).

Exception: The above forms may be distributed and collected by a Rail Supervisor at the Supervisor's discretion.

505 ACCIDENTS: EMPLOYEE REPORTS

A written report must be submitted by every Employee involved in or witnessing a Tri-Met related accident, personal injury, disturbance, passenger ejection or other unusual occurence. Such reports must be submitted to the Employee's supervisor no later than the end of the working day in which the accident occurs.

506 ACCIDENTS: GIVING OUT INFORMATION

Employees involved in Tri-Met related accidents must give only their name, reporting work location, Employee Number, and time of accident to persons requesting information. Train Operators must give the train and car numbers, but need not give their driver's license number. No further information about an accident may be given to anyone except police or

Tri-Met officials. Other persons, including attorneys, should be referred to the Claims Office (238-4895) for information. Employees are not to contact injured parties without the consent of the Manager of Insurance/Claims.

507 PROTECTION OF DEFECTIVE TRACK

In emergency situations, when the track or a switch mechanism is suddenly found defective, any Employee shall, by the use of proper flags, lights or other signals, make every effort possible to stop trains in both directions and notify the Controller.

508 LOWERING PANTOGRAPH AFTER COLLISIONS

Immediately following a train collision of any type, the Operator must lower the pantograph in order to shut down all 750-volt internal train power systems and notify the Controller.

509 FLOODED TRACK OR STATION

Any Employee observing a flood condition on or near the track or a station must notify the Controller immediately. If the water level is below the top of the rail, Operators may proceed, but must not exceed 10 MPH. If the water level is at or above the top of the rail, Operators must stop the train and await further directions from the Controller.

510 FIRE ON A TRAIN

The Operator must inform the Controller immediately of a fire on a train giving the Train Number, direction of travel and location. The train must be moved to the nearest passenger station if possible, governed by the Controller. Passengers must not be permitted to exit to the roadbed except as a last resort. Avoid the use of the word "fire". Ask passengers to evacuate the train due to an emergency condition.

511 FIRE ON OR NEAR THE TRACK

Any Employee observing fire or smoke on or near the track or a station must notify the Controller immediately. Operators observing such conditions must stop the train if the fire is near enough to affect train movement, notify the Controller and remain stopped until authorized to proceed by the Controller or by a Rail Supervisor on the scene.

512 TRACTION POWER FAILURES

The Operator must immediately inform the Controller of a traction power failure giving the Train Number, direction of travel and location. If possible, the Operator should coast the train into the next station governed by the Controller.

V. CONDUCT AND RESPONSIBILITY RULES

A. EMPLOYEE RESPONSIBILITIES

900 IDENTIFICATION

Employees must have their Tri-Met Employee Identification Card and drivers license in their possession at all times while on duty. Train Operators must have their Train Operator's Certification Card in their posession when operating trains.

901 HOME TELEPHONES AND ADDRESSES

Employees must maintain a way of reaching them at home by telephone and keep their immediate supervisor advised of this telephone number and their current home address.

902 PROMPTNESS

Employees must report for duty at the prescribed time and place, ready to perform their duties. Employees who report late, or who fail to report, will be subject to disciplinary action.

903 RESPONSIBILITY FOR DUTIES

Employees must not permit others, even though qualified, to perform any part of the Employees' assigned duties, unless authorized to do so by their immediate supervisor.

904 ASSIGNMENT CHANGES

Employees must not change their scheduled hours, assignments or duties unless authorized to do so by their immediate supervisor.

905 ON DUTY DURING PAY TIME

Operators are on duty from the time they report in or relieve another Operator to the time they report off or are relieved by another Operator.

906 RESPONSIBILITY FOR EQUIPMENT

Employees must have the proper equipment and supplies before starting their assignment and must report any items that are defective to their supervisor.

907 PROPERTY ISSUED TO EMPLOYEES

Employees are responsible for Tri-Met property issued to them, and must return such property when scheduled or requested. Employees must immediately report to their supervisor the loss of such property and reimburse Tri-Met for the items in question.

908 PROTECTION OF TRI-MET PROPERTY

Employees must, within reasonable limits, protect Tri-Met property from fire, loss or damage.

909 MAINTAINING A VALID DRIVER'S LICENSE

All Employees whose duties include the operation of any motor vehicle, train or other mobile rail equipment are required to maintain a valid Oregon or Washington driver's license. All Operators and Instructors are required to maintain a valid Oregon or Washington combined driver-chauffeur's license. All suspensions and revocations of such licenses must be reported immediately to the Employee's supervisor and will be cause for the suspension of Operator duties.

910 EMPLOYEE HEALTH

Employees must continue to be medically qualified to perform their usual and customary duties. Employees whose health becomes impaired to the extent that safety is threatened must notify their supervisor immediately.

911 USE OF MEDICATION

Employees who take medication which may cause dizziness, drowsiness, impaired judgement or any other abnormal reaction must notify their supervisor and consult a physician regarding the reaction.

912 CLOTHING

Employees designated to wear uniforms must wear only the prescribed uniform. Others must be dressed as is appropriate for their position. Clothing worn while on duty must be kept clean and in good condition.

913 HAIRSTYLES

Employees shall maintain a high standard of personal cleanliness and neatness. Hair, mustaches and beards must be neatly trimmed. Any style that impairs vision is prohibited.

914 USE OF SUNGLASSES

Employees must not wear sunglasses during hours of darkness, in tunnels, and in other circumstances when visibility is reduced.

915 EMPLOYEE INJURIES

Employees shall make a prompt report to their supervisor of each industrial injury or occupational illness, regardless of the degree of severity. This must be done prior to the end of the assigned shift.

B. EMPLOYEE CONDUCT

920 PERSONAL CONDUCT

Employees must give full attention to the performance of their duties, and must not engage in conduct including, but not limited to, the following:

a. Using or being under the influence of illegal drugs or controlled substances.

b. Using or being under the influence of alcohol or narcotics at any time between first report and the end of the tour of duty or while on Tri-Met property.

c. Taking medication of any kind that will impair performance or safety while on duty.

d. Possessing a weapon not authorized by the General Manager while on duty.

e. Fighting while on duty, on Tri-Met property or in uniform, except in self defense or in defense of another person.

f. Sleeping while on duty.

g. Falsifying sickness or injury or being absent from work without just cause or permission of supervisor.

h. Falsifying any statement or record pertaining to one's responsibilities or employment at Tri-Met.

i. Insubordination.

j. Conduct resulting in conviction for a crime while on duty.

k. Interfering with another Employee's performance on duty.

l. Theft while on duty, on Tri-Met property or in uniform.

m. Gambling while on duty, on Tri-Met property or in uniform.

n. Leaving assigned location without authority, including failing to wait for proper relief.

o. Leading fellow Employees into a wildcat strike, slowdown, attempting to cause a disruptive action or participating in such an action.

p. Personal use of Tri-Met telephones unless authorized by their supervisor.

q. Personal use of Tri-Met vehicles or other equipment unless authorized by their supervisor.

r. Soliciting, canvassing, circulating petitions or collecting money other than fares while on duty, on Tri-Met property or in uniform, without written permission from the General Manager, except as regards to Union activities permitted under Oregon State Law. All Employee political activity is subject to ORS 260.432.

s. Smoking in "no smoking" areas.

t. Discarding trash or other items on streets, right-of-way or Tri-Met vehicles and property while on duty.

u. Using any sort of audio or video device while operating a vehicle on duty, except for those devices specifically authorized by the Executive Director of Operations.

v. Eating or drinking while on duty in areas where prohibited or while operating a vehicle.

w. Allowing unauthorized person(s) to operate equipment or train.

921 EMPLOYEE COURTESY

Employees on duty, on Tri-Met property or in uniform must be courteous and orderly.

922 MISUSE OF PROPERTY

Employees must not misuse or convert to private use, any Tri-Met property. Employees must immediately report to their supervisor anyone observed to be stealing, damaging or defacing Tri-Met property.

C. DEALING WITH PASSENGERS

930 RULES FOR PASSENGERS

Passengers are not permitted to engage in the following practices on Tri-Met property and should be diplomatically informed of such by Employees. If passengers do not comply, Employees should contact the Controller for assistance. Care should be taken to avoid a confrontation.

a. Engaging in activity prohibited by law or local statute;

b. Interfering with the operation or movement of trains or the general operation at rail stations;

c. Carrying any substances which could cause accidents, injure people or soil clothing;

d. Carrying packages or articles which will present a hazard to others, especially those which will block aisles and stairways;

e. Carrying sharp implements, unless they are fully sheathed or carrying any type of weapon;

f. Bringing unfolded strollers and carriages onboard vehicles or on stairways;

g. Engaging in loud, offensive or unruly conduct;

h. Playing radios or tape decks, except when using earphones;

i. Consuming food or drink or bringing aboard food or drink in open containers;

j. Smoking;

k. Bringing aboard animals, except for hearing-ear dogs for the deaf and seeing-eye dogs for the blind, and small animals housed in suitable, fully enclosed carrying containers;

l. Littering;

m. Spitting or relieving oneself other than in restrooms;

n. Failing to vacate seats reserved for the elderly and handicapped when requested by a Tri-Met Employee;

o. Canvassing or collecting money without written authorization from the General Manager.

p. Conversing unnecessarily with Operators;

931 INFORMATION TO PASSENGERS

Employees must respond to questions from passengers in a courteous, accurate and complete manner. In order to assist passengers, Employees must be familiar with Tri-Met fares and have a general knowledge of Tri-Met routes, the Tri-County area and its principal points of interest. Each Operator leaving from the shop or yard must check the pouch to make sure there is a supply of public timetables for the route and determine if there are Rider Alerts to be distributed.

932 SLEEPING PASSENGERS

Operators should cautiously attempt to awaken passengers sleeping on trains at the end of each trip. If unable to do so, the Operator must contact the Controller for assistance. Employees shall notify the Controller of any persons observed sleeping in stations, transit centers or passenger shelters.

934 INTOXICATED PASSENGERS

Intoxicated persons are permitted to ride trains and to wait in stations only if they do not become a public nuisance. If such persons engage in disorderly conduct which is threatening to the safety of others, Employees should call the Controller for assistance.

935 MISUNDERSTANDINGS WITH PASSENGERS

In case of misunderstandings with passengers, Employees must, if requested, courteously provide their Employee Number and must inform the passenger to contact Tri-Met offices for further consideration.

936 PASSENGER EJECTIONS

Employees should ask unruly passengers to leave a train or station area if necessary to ensure the well being of other passengers. Any ejections should immediately be reported to the Controller. If unruly passengers refuse to cooperate, Employees must contact the Controller for assistance.

Exception: unruly passengers who are apparently unable to take care of themselves (young children, the disabled, people of unsound mind, etc.) should not be asked to leave. Employees should contact the Controller for assistance.

937 DISTURBANCES

Employees observing a disturbance on a train, station area or other Tri-Met property, must immediately notify the Controller. In cases of potential violence, the police will also be notified. Employees must never engage in a physical struggle except to defend themselves or other parties. Employees must notify the Controller when the disturbance has ended.

938 LOST ARTICLES

Operators must inspect their train for lost property at the end of each trip and at the yard. A Lost Article Tag should be filled out and attached to each item found. Articles should be turned in to the Rail Operations office at the end of the Operator's run or to the relief Operator in the case of a mainline relief. If money or items of value are found, the Controller must be informed immediately.

Exception: If someone claims a lost article before it is turned in, the Operator should first ask for a description of the item. The name, address and signature of the claimant must then be written on the Lost Article Tag. The item may then be returned to the claimant and the tag turned in to the Rail Operations office.

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Parsons Brinckerhoff

Parsons
Brinckerhoff
Quade &
Douglas, Inc.

project management manual

First Printing, November 1986

Parsons
Brinckerhoff 100 YEARS

FOREWORD

This Project Management Manual is issued for the use and instruction of all Parsons Brinckerhoff Quade & Douglas, Inc. staff at all levels involved with the management and administration of projects. The policies and procedures presented are obligatory. The guidelines and examples provided are recommended approaches and should be considered a minimum standard to be followed as a general rule. Some departure from the approaches outlined may be necessary on selected projects when client, location, or other outside circumstances so dictate. In such instances, the full intent of this manual is still to be followed.

The objective is to establish a uniform approach to project management by achieving reasonable consistency, predictability, and reliability in the management of all projects and thereby improving on project performance, client satisfaction, and the overall profitability of the firm. To achieve this objective, each project manager is expected to be fully conversant with the contents of this manual.

The manual is presented in five parts. Each part has a particular role in describing the art and techniques of project management.

I **Introduction and Chapter 1** speak to the corporate culture of Parsons Brinckerhoff and to our concern for and attention to our clients' needs and projects and to our Parsons Brinckerhoff people. The roles and responsibilities of those directly involved with projects are defined with respect to the "strong project manager" form of project management covered by this manual.

II **Chapters 2 through 6** are devoted to project management fundamentals. These chapters use checklists and illustrative examples to define and describe fundamental requirements and techniques employed in project management. These chapters should be reread periodically as a reminder of the many details that are involved in project management.

III **Chapters 7 through 14** are devoted to project management standards and procedures. These chapters provide direction, forms, and techniques that are required for a project manager to function effectively within the PBQD system.

IV **Chapters 15 through 17** cover contract-related matters as viewed from the position of a project manager. Contract procedures and Administration, Chapter 15, ties directly to the Contracts Manual. Chapter 17 covers the topic of negotiations and deserves special attention. For those involved for the firm with projects undertaken in joint venture, Chapter 16 provides definitions and practical guidelines.

V **The Appendices** contain **(A)** a listing of references, **(B)** acronyms and abbreviations used, and **(C)** a chronology of "lessons learned" that every project manager is asked to contribute to, as appropriate, as a means of sharing experience to continue to improve on our successes and learn from our mistakes. Finally, **(D)** provides a set of the preprinted company forms employed in projects.

In this manual, where the words "manhours" or "mandays" appear, they are understood to refer to women as well as to men in such context. Parsons Brinckerhoff Quade & Douglas, Inc. is an equal opportunity employer.

This manual reflects the ideas and experience of many persons involved in the management of projects throughout the firm. Their contributions are acknowledged and appreciated. Since this manual is a reflection of experience, it must be treated as a living document. It will change and grow in content as our collective experiences grow. Comments and suggestions regarding the manual are sought from all users. Such input should be sent to the Deputy Chief Operating Officer in the New York office. Coordinated revisions will be made from time to time as required to keep this document current. The technique of "whole page" substitution will be used. To make this process effective, each manual is numbered and assigned to an individual who will also be required to return that manual to the company as an accountable document.

All are again reminded that "lessons learned" items are sought now and at any time in the future.

Paul H. Gilbert
Deputy Chief Operating Officer
Parsons Brinckerhoff Quade & Douglas, Inc.
November 1986

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12. Project Quality Control Plan

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12. Project Quality Control Plan

The firm's policy is to provide quality professional services in satisfying our clients' needs. Quality professional services are at the heart of our continuing success.

Quality is achieved through the efforts of skilled professionals, effectively employing their judgment and experience and following a deliberate program of quality control (QC) and quality assurance (QA). This QC/QA program is defined by stated policy, effective procedures, and applicable standards of practice.

12.1 POLICY

PBQD's Operating Policy 5, OP-5, Quality Professional Services, provided at the end of this chapter as Exhibit 12.1, sets forth the policy on quality control and quality assurance for the project. Definitions of terms, roles, and responsibilities are provided. Quality assurance for the project is an assigned responsibility of the regional manager. Quality control for the project is an assigned responsibility of the project manager. The effective discharge of these responsibilities is part of the annual performance evaluation of both individuals.

For the project, the project manager must prepare a project quality control plan (PQCP) that clearly defines the specific roles and responsibilities of the project team members and of specialists external to the team with respect to quality services.

OP-5 must be read, understood, and applied by every project manager and every key project team member and participant.

At the working level, the QC/QA policy for the project team is this:

> **No document will be released from PBQD or officially transmitted to a client or any third party without first having received a suitable quality review.**

12.1.1 Quality Control -- Project Definition

Quality control for the project formalizes the traditional checking, reviewing, examining, and supervising of the professional services process. This control is a deliberate process, planned and carried out under the supervision and authority of the project manager.

12.1.2 Quality Assurance -- Project Definition

Quality assurance for the project formalizes and documents the traditional supervisory overview role of the regional manager. Responsibility for quality assurance falls under the regional manager's normal supervision of the project manager and exercise of reasonable overview of the professional services produced within the regional manager's jurisdiction. The thorough implementation of this task involves prudent selection of well-qualified individuals to review the project; to verify the success of the QC program; and to observe the technical adequacy, clarity of presentation, practicality, constructibility, conformance to professional standards and practices, and overall suitability of the solution to the problem. QA does not include detailed checking of calculations or drawings. These are properly QC functions.

QA review and comment at the conceptual level can be most beneficial. Input from the more experienced people who normally perform in QA roles often provides a better, more efficient, and more effective conceptual approach.

QA may be performed by in-house experts or by individuals drawn from outside PBQD. The use of resource groups, technical committees, peer groups, consultant advisory panels, and individual consultants on project teams has become commonplace in PBQD proposals and in subsequent projects. These resources are appropriately a key part of the project QA function as well.

12.2 PROCEDURES AND PLANS

Development of procedures and plans to implement the policy set forth in OP-5 is generally a regional responsibility. This approach is more suitable than centralized implementation because of the wide range of clients, variation in local laws and practices, mix of disciplines, and differences in depth of staff and resources that are represented in the PBQD regions. To provide coordination and consistency in approach, specific regional procedures and project quality control plans prepared to implement the provisions of OP-5 will be forwarded to the deputy chief operating officer for information and comment. The chief operating officer is the final authority on the adequacy of all QC/QA plans and procedures. Examples of regional procedures and project plans are available from the deputy chief operating officer.

12.2.1 Guidelines for Project Quality Control Plans

The following are guidelines for developing project QC/QA procedures within the regions. More specific guidelines for a typical design project quality control plan are provided as Exhibit 12.2.

- The project plan will be prepared under review of a senior member of the regional staff assigned as the QC/QA supervisor for the region.
- A senior member of the project team will be assigned as the QC supervisor for the project.
- The project quality control plan should be prepared at the start of the project; the regional manager will verify its implementation.
- Qualified personnel will be assigned to the project team. The project manager has the obligation and authority to seek removal of anyone assigned to the project who cannot perform the required work adequately.

- The project quality control plan format provided by OP-5 is intentionally general. Basic elements of a plan are described, but these must be adjusted with some judgment to provide the level of detail appropriate to each specific project. Plans need not be extensive; they should provide basic direction, preferably in outline form, and be specific to the project.

- The plan must be:

  - Tailored to the nature and complexity of the work involved

  - Respectful of the level of experience of the project staff in dealing with the issues raised by the project

  - Responsible to the obligations described in the contract

  - Sensitive to the budget and the schedule

  - Scaled to suit all the requirements.

12.2.2 PQCP for a Project

- The development of the PQCP for projects that are relatively simple and/or small will be dramatically different from that for projects that are large and/or complex. For a small project, the project manager with the cost center manager/area manager/principal-in-charge, as appropriate, will collaborate to satisfy the intent of the policy with a suitable plan. For a large project, the project manager and all or some of the principal-in-charge, principal or senior professional associates, regional manager, deputy chief operating officer, and chief operating officer, as appropriate, may collaborate in forming the plan and identifying suitable people to participate. In all cases, it is the regional manager's responsibility to see that the appropriate level of attention is provided for the plan's formulation and implementation. An example of a PQCP for a more complex project is provided as Exhibit 12.4, and of a less complex project PQCP as Exhibit 12.5. Other examples are available from the regional manager or the deputy chief operating officer.

12.2.3 Quality Control-Related Reviews

- o Quality-related reviews will be both scheduled and unscheduled. They may involve internal project team staff, PBQD staff, special consultants, the client, or third-party agency reviews and comments. All should be viewed and treated as constructive and potentially beneficial to the quality of the project.

- o The comments from all quality-related reviews should follow a set project procedure similar to the following:

  - Comments may be received from a reviewing party as marked-up sketches or drawings, as written notes, or in memoranda or letter forms. The preferred form from a single source, such as a client, is a single set of coordinated notes. All comments will be logged in. Verbal comments should be discouraged but if they are significant, the comments should be written down by the project manager or other responsible person. This written form of the verbal comment should then be verified with the source before it is processed.

  - All comments will be processed, and the disposition of each will be made a matter of record. Exceptions taken to externally generated comments will be routed to the regional QC/QA supervisor for review. All open issues will be resolved before the work product leaves the control of PBQD.

  - Project documentation files will contain a copy of client and third-party agency review comments together with a record of the disposition of each.

- Suitable project forms may be developed to serve the review comment/response/resolution process. (see Exhibit 12.4)

12.2.4 Computer Applications Quality Control

The expansion of the use of micro and mini computers and associated software in the development, analysis and production of the deliverables produced by the firm in both planning and design services brings with their added power, capacity and productivity, a much increased need for careful selection, diligent checking and quality control. PBQD will employ a rigorous quality control procedure on every project where computers are used to aid in producing the deliverable end product. Such a procedure is described in Exhibit 12.3.

12.2.5 Communications and Project Documentation

o For all project communications, proper controls are a part of the quality control process (see Chapters 6 and 14).

o Project documentation files are an essential part of project quality control (see Chapter 14).

12.2.6 Quality Control and Subcontracting

When PBQD is the prime consultant and is subcontracting significant portions of the services, quality control procedures and plans should reflect a heightened level of attention to QC/QA concerns. A proportionately greater budget for QC and QA will probably be warranted. Such extra attention should be reflected in the project budget as negotiated and in the terms of the subcontracts.

12.3 QUALITY PERFORMANCE OVERSIGHT

Quality performance oversight is the responsibility of the chief operating officer. Quality performance oversight includes the periodic review of QC/QA procedures and plans in use on all projects and the formulation of additions or revisions to procedures to implement QC/QA policy. Quality performance oversight includes deployment of special technical or management resources where necessary. As part of quality performance oversight, the chief operating officer will coordinate the effective use of the professional resources of the firm and foster professional responsibility and excellence of services throughout PBQD.

OPERATING POLICY - 5

QUALITY PROFESSIONAL SERVICES

It is the policy of Parsons Brinckerhoff to provide quality professional services in satisfying our client's needs, consistent with the fee and other constraints established by our client. Quality professional services are at the heart of the continuing success of Parsons Brinckerhoff and shall remain a primary responsibility of every member of the Parsons Brinckerhoff organization.

Quality professional services are achieved through the efforts of properly qualified professionals employing their skills effectively to produce quality results, following a deliberate program of quality control and quality assurance as set forth in clearly stated policy, effective procedures, and applicable standards of practice.

DEFINITIONS

The use of the terms quality control, quality assurance, standards of practice, project quality control plan and quality performance oversight within this policy shall be understood to have the following meanings:

Quality Control
Quality control refers to those actions, procedures, and methods that should be routinely employed at the project level, usually within the technical disciplines of the organization and under the jurisdiction of the project manager to produce the desired result of quality professional services.

Quality Assurance
Quality assurance refers to those actions, procedures and methods to be employed at the regional, divisional, area or corporate levels to observe and assure that each project employs prudent quality controls and produces the desired result of quality professional services.

Standard of Practice
Standard of practice refers to those standards of care, procedures and guidelines, methods and checks to be routinely employed by each discipline as generally accepted to be prudent and responsible by the industry (i.e., Ref. PEPP-NSPE Guidelines) in performing its professional services of the discipline within a project. Standards of practice may change from time to time and from project to project and must be maintained current to the requirements for each.

Project Quality Control Plan (PQCP)
For each project, the PQCP defines and displays for the use of all participants, what will be done to achieve the project goal of quality professional services, by whom, when, and for what cost. Interfaces and points of coordination are defined and specific responsibilities clearly set forth. The scale, detail and form of the PQCP will be suited to the scope of each respective project. Relatively small projects may require only a single-page memorandum to describe the applicable PQCP.

Exhibit 12.1

Quality Performance Oversight (QPO)
QPO refers to the requirements of the chief operating officer to employ those means necessary to monitor the affirmative implementation of this policy to achieve the essential goal of quality professional services.

IMPLEMENTATION

As defined here, quality control is normally a project responsibility while quality assurance is normally an area, regional, divisional, or operating company responsibility for each project. The principal exceptions to these normally assigned responsibilities may occur with projects that are either relatively small or clearly large in scale. In the instance of a small project, the project manager and area manager will act together to satisfy the intent of this policy. For larger projects, where there are formed essentially stand-alone organizations and often project organizations involving either or both joint venture associates and/or subconsultants performing significant shares of the services, the project manager, the principal-in-charge, the regional manager and the chief operating officer will act together to satisfy the intent of this policy. In all cases, the chief operating officer shall have the responsibility for quality performance oversight (QPO) and for appropriate procedures, guidelines, and standards of practice.

This policy further recognizes the significant role that subcontracted professional services currently play in professional services. Additional attention to quality control as well as to quality assurance will be warranted where Parsons Brinckerhoff must accept some degree of responsibility for the total project as the prime consultant while subcontracting to other firms significant portions of the services. Such additional attention shall be responsibly reflected in the PQCP, the project budgets, and in the terms of each subcontract.

Quality control on the project is, in all cases, fundamentally the responsibility of the project manager (PM). At the same time, providing quality professional services to the project is the responsibility of each professional working under the PM and contributing services to the project. A project quality control plan (PQCP) will be produced and administered by the project manager for the purposes of describing the actions required to be taken, by whom, and when, and the budget set aside to provide for verifying essential quality in the process of meeting project obligations.

Quality assurance for a project is the responsibility of the area, division, or regional manager or the chief operating officer depending upon the operating organization to which the project is assigned. This responsibility begins with the careful review and approval of the scope of services during the proposal/contract development stage and continues with the following:

- Providing and assigning properly qualified technical, managerial, and administrative resources to perform the tasks of the project.

- Assuring that the PM understands the PM role and responsibilities, authorities and resources to provide quality professional services on the project.

- Assuring that an appropriate PQCP is prepared and followed by the project manager.

- Assuring that suitable technical resources are employed to provide timely, periodic overview of the concepts; the proper integration of technical disciplines; and the execution, presentation, and completion/delivery of the project results.

RESPONSIBILITIES

The specific responsibilities and authorities for quality professional services of each party with a project leadership role in the firm are as follows:

Chief Operating Officer: The chief operating officer (COO) is responsible for setting operating policy and implementing procedures for achieving quality professional services which includes the responsibility for maintaining a competent professional staff, for developing appropriate procedures for quality control and quality assurance, and for providing quality performance oversight for the entire operation. For certain major projects, the COO may be responsible for quality assurance.

Regional or Division Manager/Area Manager: The regional, division or area manager (RM/DM/AM), depending upon the local operating plan, is responsible for, 1) organizing, training, and maintaining a competent staff; 2) establishing appropriate scopes of services; and 3) costing and staffing proposals, presentations, negotiations, and projects. The RM/DM/AM or the COO will appoint the project manager and the principal-in-charge for each project. The RM/DM/AM will assure that a PQCP is prepared at the appropriate level of detail for each project and that the plan is diligently carried out by the project staff. The RM/DM/AM shall have quality assurance responsibility for all projects assigned within that jurisdiction.

Principal-in-Charge: Each project undertaken has a principal-in-charge (PIC) whose responsibilities within the project are specifically defined in the project management plan. One of the responsibilities of the PIC normally shall be to support the PM in the development and execution of the project quality control plan. The PIC will review the PQCP at the outset, assess the appropriateness of the plan to the complexity and requirements of the project, and assist in identifying appropriate technical resources to employ. The PIC may take an active role in the PQCP execution when the PIC has the technical credentials and available time to devote to such efforts. The PIC will sign off on the PQCP, indicating approval, before it is passed to the RM, DM, AM or COO for approval.

Project Manager: Each project undertaken by the firm is accomplished under the direction of a designated project manager whether that party is given the title project engineer/architect/planner, project director, or resident engineer, etc. The project manager's responsibilities are to organize and sometimes perform the services under the contract, apply resources, and monitor progress to produce quality professional services on time and within budget. Thus, the project manager is the operative individual responsible to produce the project deliverables to a quality consistent with the intent of the client as indicated by the terms of the client contract and consistent with applicable standards of practice.

The assignment of appropriately qualified personnel to the services of the project is a vital element in achieving quality professional services. The project manager, with the responsibility for achieving quality professional services on the project, has the authority to recommend the replacement of any person assigned to the project who lacks the skill, training or experience to perform the services indicated in accordance with the standards of practice that apply. Where such a recommendation is not acted upon by the employing organizational manager, the PM and that manager will forward an explanation of their respective views to the RM or COO, as appropriate, who will resolve the issue.

Exhibit 12.1

In planning the services to be accomplished, the project manager allocates resources to the production of the various deliverables, establishes coordination and review procedures appropriate to the specific project, sets budgets, schedules the various activities, identifies potential problem areas and resolves them in a timely manner, and adjusts the plans as the job progresses to meet the needs of the project.

As part of the initial project planning process, the project manager shall draft the project quality control plan (PQCP) which identifies the elements of quality control to be followed, the resources to be applied to these quality control activities, and the interaction of these activities with the other elements of the services. The project manager, in coordination with the PIC, RM, DM, AM, as appropriate, will identify the specific personnel to provide the quality control reviews; allocate time, effort, and budget to the quality control function and review; and revise these allocations of resources appropriately as the project progresses. Reserving PQCP funds in the project budget shall be accomplished at the beginning of each project. Performance under the PQCP will be a point of performance review and evaluation for the project manager.

Technical Discipline Leaders: The technical discipline leader, who may be the cost or production center manager, is responsible to the project manager and/or the area, regional, or division manager for the quality of services produced within that particular technical area of activity. Specific quality control responsibilities of a technical discipline leader include:

- o Establish operating guidelines and assign specifically accountable responsibilities within the unit.
- o Implement the use of standards of practice for production in such areas as reports, drawing production, calculations, analytical records, and computer computations that are followed by technical staff assigned to projects.
- o Implement a standard checking procedure for the services produced within the unit such that all products produced are checked, initialed, and dated by a properly qualified professional and that they meet the established standards.
- o Monitor the checking procedures periodically to determine that approved procedures are being followed.
- o Maintain the level of technical training of the staff essential to the standards of the firm.
- o Keep the project manager advised of any unusual circumstances or problems that may require PM attention to include the quality of the deliverables, the performance within budget and schedule, and the cooperation among disciplines.
- o Assist and cooperate with the project manager in accomplishing in-house review of interfacing design discipline services.
- o Review and sign off on completed services before transmitting to the project manager for submission to the client.

Principal, Senior, and Professional Associates: Within Parsons Brinckerhoff, those technical professionals who have been recongized by their peers for their distinguished personal

Exhibit 12.1

technical achievement have been authorized by the company to use the titles of professional associate (PA), senior professional associate (SPA), and principal professional associate (PPA). Such individuals are unique technical resources, recognized in specific and defined technical practice areas, and represent the primary cadre of capable technical personnel essential to quality professional services. Such recognized professional personnel shall be called upon to fill any project assignment that is in the best interest of the client and the firm.

Both professional associates and senior professional associates will normally be called upon to fill technical leader assignments on projects and to provide quality control checking and review. Both senior professional associates and principal professional associates will normally be called upon to fill quality assurance assignments. Likewise, individuals with such credentials may also be called upon by the COO to provide quality oversight reviews. In particular, the PA, SPA, and PPA, from their positions throughout the firm, are available to provide the following:

- o Contribute through their example and sharing of technical knowledge and skills to the quality of technical performance within their respective areas of professional practice.
- o Provide the primary, in-house resources to review technical services being performed by the firm.
- o At the request of the COO, RM, DM, AM, PM, or a technical discipline leader, provide audit of the adequacy of skills and technology of the staff assigned to a project. Timely advice in this regard is also appropriately sought by the project/proposal managers during the proposal formulation stage.
- o At the request of the PM or the PIC, review the technical adequacy and performance of subcontractors, joint ventures, consultants, and associates, both prior to selection at the time of proposal preparation and then during the performance of the project scope of services.
- o Disseminate the current state-of-the-art of each discipline and provide information on the tools, techniques, and methods within each discipline so they are available to those working on the projects.
- o Assist the RM, DM, AM, technical discipline leaders in organizing services, in assuring that concepts and approaches are appropriate, and in defining scopes of services, costing, and staffing for projects, proposals, presentations, and negotiations.

Technical Directors: As a specially designated group within the cadre of principal and senior professional associates, the technical directors (TD) may be called upon to provide any of the services for which they are technically qualified as described herein for the PPA and SPA and in addition, the TDs will be responsible for the following special activities related to the provision of quality professional services:

- o Provide discipline-specific technical quality assurance methodology as required and unique to a specific discipline area.

- o Develop, in coordination with their resident area, division, or regional managers, the technical skills of staff in areas of technical specialty through reviews, discussions, training, and mentor relationships.

- o Advise with regard to discipline-specific in-house technical capabilities and outside special expertise that can be made available when needed.

PROJECT QUALITY CONTROL PLAN

The need for and budget to support the preparation and execution of the project quality control plan (PQCP) for new projects shall be established in the proposal and pricing stages of project development to reflect both client and Parsons Brinckerhoff requirements. A general format and content is prescribed for the project quality control plan (PQCP), adjustable to suit the level of detail appropriate, the actions necessary to be taken, the coordinating procedures required, and the relative complexity of the quality control function necessary to meet the requirements of each project. For small projects, the PQCP may be reduced to a one-page memorandum, but cannot be eliminated as a requirement. Each project manager will develop a written PQCP in memorandum form at a level of detail appropriate to that project. The PQCP shall be reviewed by the PIC and approved by the area manager, regional or division manager, or COO as appropriate. The PQCP will contain the following elements as a minimum.

1. Define the project, the deliverables with their related schedule, and the expected results per the client contract.

2. Describe specific quality control procedures to be applied to various elements of the services to include the level and frequency of review required.

3. Identify elements of the project, if any, requiring special quality control attention or emphasis.

4. Define quality control responsibilities, and authorities within the project team (i.e., who is responsible for what by surname).

5. Name external technical experts required, if any, anticipated timing of needs, expected availability, and coordination required.

6. Estimate the resources required for the quality control functions to include specific timing, budgets, and manpower requirements.

7. Define the requirements for documentation, for the filing of design notes, calculations, drawings, and supporting materials, and for the specific assigned responsibilities in satisfying these requirements.

8. Define procedures for resolving differing technical viewpoints.

9. Define design change control procedures to be employed.

10. Define approval procedures.

Exhibit 12.1

QUALITY PERFORMANCE OVERSIGHT

Quality performance oversight (QPO) is the responsibility of the chief operating officer (COO). QPO will include the periodic review of quality control procedures in use within projects and the formulation of additions to or revision to procedures to implement this policy. QPO will include bringing to bear special technical or management resources wherever the performance of the firm will benefit.

Exhibit 12.2
Project Quality Control Plan Guidelines
Typical Design Project

The following guidelines will assist in coordinating and meeting reasonable standards with PQCPs prepared for design projects.

A. Purpose

The purpose of quality control is to ensure that the clarity, completeness, coordination of documents, accuracy, and constructibility of the project are maintained; that the project meets the client's objectives; and that the requirements of our contract with the client have been met.

B. General Procedures

The following general procedures are recommended:

1. Require that all concepts, technical calculations, report drafts, analyses, drawings, and specifications be formally checked to conform with the firm's standards at appropriate milestones.

2. Require that copies of all design computations and drawings be signed and dated by both the designer and the checker and kept in the project file.

3. Use a standard contract document/deliverables review checklist for each discipline and phase to aid in checking contract documents and deliverables.

4. Use rigorous quality control procedures where computers are used to contribute to the project deliverables in accordance with the firm's Computer Applications Quality Control Procedures (included in this manual as exhibit 12.3).

5. Use a standard policy for marking and filing design computations and drawings.

6. Ensure that, where applicable, the client's and the firm's standards have been used optimally.

7. Include a value engineering review in the development of all projects, even the small ones.

8. Obtain a quality assurance review of final deliverables and any key intermediate products. Check to be sure corrections were completed.

9. Develop a list of problem areas encountered during construction or other implementation of the firm's work and provide cause/effect and cure descriptions as input to the "lessons learned" file, as appropriate.

10. Develop standard procedures or checklists for interface coordination between disciplines.

C. Checking Procedures

These checking procedures are recommended:

1. Check these areas: design calculations, contract drawings, contract specifications, shop drawings, project design budget and schedule, and work by subconsultants.

2. Use the ACEC checking format -- "Redicheck: A System of Interdisciplinary Coordination" -- that is provided as pages 4 and 5 of this exhibit.

D. Review Procedures

1. Make all review assignments specific to a person. Clearly define what is expected/required. Define the level of effort expected/budgeted.

2. For all review meetings: Prepare an agenda defining specific topics and parties responsible and circulate to participants at a reasonable period of time ahead of the review meeting.

3. For conceptual and preliminary designs: Provide review prints and conduct briefings with reviewers at least one week prior to discussion or submission to client.

4. For reports: Provide working draft copies of the report for review and comment at least 10 working days prior to submittal to client. Provide chapters piecemeal if necessary to gain review and meet delivery schedule --but get the review.

5. For Design Drawings:

   a) If no progress submittals are required by the client, nevertheless provide for such milestone check points internal to the project according to normal checking and review procedures.

   b) Normal 30 percent review: Provide one set of prints and outline specifications for internal review at least two weeks prior to scheduled submittal date.

   c) Normal 60 percent review: Provide one set of prints and progress specifications for review concurrently with submittal to client.

   d) Normal final submittal: Provide sets to reviewers not less than one week prior to scheduled final submittal. If additional reviews are noted to be necessary by any of the reviewers, the additional reviews will be arranged by the project manager. No open action items, lacking resolution and disposition from QC reviews, will be permitted where final submittals are concerned.

   e) Retain for project documentation the final check points from all reviewers, including the client. Utilize the red/green/yellow color code to verify the action on comments.

6. For Specifications: In addition to the sequence of reviews noted above to take place with the drawings, carry out a detailed review of the specifications at the 90 to 95 percent design complete point. Provide full sets of specifications to the estimators (an excellent source of drawing and specification reviews) and to designated specifications reviewers at this point.

7. Monthly Progress Reports: Review final draft copy with a senior responsible party other than the project manager. The area manager, cost center manager, principal-in-charge, regional manager, or deputy project manager are likely candidates.

REDICHECK Plan and Specification Review

1. Preliminary Review

a. Quickly make an overview of all sheets, spending no more than one minute/sheet to become familiar with the project.

2. Specification Check

a. Check specs for bid items. Are they coordinated wih the drawings?

b. Check specs for phasing of construction. Are the phases clear?

c. Compare architectural finish schedule to specification index. Ensure all finish materials are specified.

d. Check major items of equipment and verify they are coordinated with contract drawings. Pay particular attention to horsepower ratings and voltage requirements.

e. Verify that items specified "as indicated" or "where indicated" are in fact indicated on contract drawings.

f. Verify that cross referenced specification sections exist.

g. Try not to indicate thickness of materials or quantities of materials in specifications.

3. Plan Check Civil

a. Verify that site plans with new underground utilities (power, telephone, water, sewer, gas, storm drainage, fuel lines, grease traps, fuel tanks) have been checked for interferences.

b. Verify that existing power/telephone poles, pole guys, street signs, drainage inlets, valve boxes, manhole castings, etc., do not interfere with new driveways, sidewalks, or other site improvements.

c. Verify that limits of clearing, grading, sodding, grass or mulch are shown.

d. Verify fire hydrants and street light poles are shown in their intended locations.

e. Verify profile sheets show other underground utilities and avoid conflicts.

f. Verify horizontal distances between drainage structures and manholes match with respect to scaled dimensions and stated dimensions on both plans and profile sheets.

g. Verify provisions have been included for adjusting valve box and manhole castings (sewer, power, telephone, drainage) to match final of finish grade of pavement, swales, or sidewalks.

h. Verify all existing and proposed grades are shown.

4. Plan Check Structural

a. Verify column lines on structural and architectural.

b. Verify all column locations are same on structural and architectural.

c. Verify perimeter slab on structural matches architectural.

d. Verify all depressed or raised slabs are indicated.

e. Verify slab elevations against architectural.

f. Verify all foundation piers are identified.

g. Verify all foundation beams are identified.

h. Verify roof framing plan column lines and columns against foundation plan column lines and columns.

i. Verify perimeter roof line against architectural roof plan.

j. Verify all columns and beams are listed in column and beam schedules.

k. Verify length of all columns in column schedule.

l. Verify all sections are properly labeled.

m. Verify all expansion joint locations against architectural.

n. Verify dimensions.

o. Verify that drawing notes do not conflict with specifications.

5. Plan Check Architectural

a. Verify property line dimensions on site plan against architectural.

b. Verify building is located behind set back lines.

c. Verify all concrete columns and walls against structural.

d. Verify on site plans that all existing and new work is clearly identified.
e. Verify building elevations against floor plans. Check in particular roof lines, window and door openings, and expansion joints.
f. Verify building sections against elevations and plans. Check roof lines, windows and door locations.
g. Verify wall sections against architectural building sections and structural.
h. Verify masonry openings for windows and doors.
i. Verify expansion joints through building.
j. Verify partial floor plans against small scale floor plans.
k. Verify reflected ceiling plans against architectural floor plan to ensure no variance with rooms. Check ceiling materials against finish schedule, check light fixture layout against electrical, check ceiling diffusers/registers against mechanical, check all soffits and locations of vents.
l. Verify all room finish schedule information including room numbers, names of rooms, finishes and ceiling heights. Look for omissions, duplications and inconsistencies.
m. Verify all door schedule information including sizes, types, labels, etc. Look for omissions, duplications, and inconsistencies.
n. Verify all rated walls.
o. Verify all cabinets will fit.
p. Verify dimensions.

6. Plan Check Mechanical and Plumbing

a. Verify all new electrical, gas, water, sewer, etc. lines connect to existing.
b. Verify all plumbing fixture locations against architectural. Verify all plumbing fixtures against fixture schedule and/or specs.
c. Verify storm drain system against architectural roof plan. Verify that pipes are sized and that all drains are connected and do not interfere with foundations. Verify wall chases are provided on architectural to conceal vertical piping.
d. Verify sanitary drains system pipe sizes and all fixtures are connected.
e. Verify HVAC floor plans against architectural.
f. Verify sprinkler heads in all rooms.
g. Verify all sections are identical to architectural/structural.
h. Verify that adequate ceiling height exists at worst case duct intersection.
i. Verify all structural supports required for mechanical equipment are indicated on structural drawings.
j. Verify dampers are indicated at smoke and fire walls.
k. Verify diffusers against architectural reflected ceiling plan.
l. Verify all roof penetrations (ducts, fans, etc.) are indicated on roof plans.
m. Verify all ductwork is sized.
n. Verify all notes.
o. Verify all air conditioning units, heaters, and exhaust fans against architectural roof plans and mechanical schedules.
p. Verify all mechanical equipment will fit in spaces allocated.

7. Plan Check Electrical

a. Verify all plans are identical to architectural.
b. Verify all light fixtures against architectural reflected ceiling plan.
c. Verify all major pieces of equipment have electrical connections.
d. Verify location of all panel boards and that they are indicated on the electrical riser diagram.
e. Verify all notes.
f. Verify there is sufficient space for all electrical panels to fit.
g. Verify that electrical panels are not recessed in fire walls.
h. Verify that electrical equipment locations are coordinated with site paving and grading.

Exhibit 12.3

COMPUTER APPLICATIONS
QUALITY CONTROL PROCEDURES

A wide variety of computer software is used to solve technical problems. This practice raises quality control concerns regarding the appropriateness of the solution algorithm employed by the software creator relative to the problem that is to be solved. The software may also be misapplied, by accident or oversight, in producing an answer that is used. And finally the results produced by the software and analyst may be improperly interpreted when applied to the project feature. In each of these areas of concern, the issue of adequate quality control, review, and checking arises. While our basic quality control procedures cover these matters, special attention must be directed to controlling quality with respect to computer-assisted solutions to technical problems and design. The responsibilities of those using such tools and techniques are as follows:

1. The User/Analyst - The user of software that is to be employed to solve technical and design problems will verify that the software is appropriate to the problem to be solved, including its constraints and requirements, and will make an entry to that effect in the design calculation notes and sign it. When original software is created to solve a problem, it will be used only when it is fully documented on hard copy and when that documentation is included in the design notes.

2. The Discipline Leader - The discipline leader and/or the project manager will also indicate satisfaction with the choice of software by so noting in the job notes.

3. The Checker - The checker will check and verify all input for the computer-assisted solution, will check and verify the constraints or boundary values (i.e., end conditions, maximum or minimum range of acceptable answer, etc.) set into the solution, the transfer of the computer-generated results to the next step in the design process, and finally, the reasonableness of the final result. This last step is very important and may require a significant degree of experience and judgement to be performed adequately.

4. The Reviewer - As a matter of quality control of a computer assisted design solution, the review, depending on the importance of the design and the need for precision in the result, employ alternate software to solve the same problem and then to compare the results.

5. Responsibility - All parties involved in selecting and applying computer software, and checking and reviewing of results will sign the design notes and indicate their role.

xhibit 12.4

DOWNTOWN SEATTLE TRANSIT PROJECT
FINAL DESIGN

QUALITY ASSURANCE

AND

QUALITY CONTROL PLAN

WITH

QUALITY CONTROL PROCEDURE

SI-QC-001

MASTER COPY

APRIL 1986

The Parsons Brinckerhoff Team

Exhibit 12.4

PARSONS BRINCKERHOFF

DOWNTOWN SEATTLE TRANSIT PROJECT

FINAL DESIGN

QUALITY ASSURANCE
AND
QUALITY CONTROL
PLAN

April 1986

Submitted William L. Barnes 4/16/86
DSTP Project Director — Date

Approved 4/16/86
Principal-in-Charge — Date

Approved 28 April 1986
Regional Manager — Date

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CONTENTS

1. GENERAL

1.1 This Quality Assurance and Quality Control Plan covers the project management, design management, and design execution for the Final Design Engineering phase of the Downtown Seattle Transit Project. It is the objective of this plan to outline a procedure for producing quality design documents that are consistent with the standards of PB and the profession.

1.2 The procedures outlined in PB Project Management Policy (PMP)-5 , Quality Professional Services, the Far West Region Operational Plan, and the Far West Region Project Manager's Manual are incorporated in this plan.

1.3 This document establishes a plan for Quality Assurance, in accordance with PMP-5 and for Project Quality Control management and review, to achieve the goal that the services provided meet the firm's standards.

1.4 Designated elements of the Downtown Seattle Transit Project are being planned and designed by Parsons Brinckerhoff and by firms subcontracted to Parsons Brinckerhoff. In addition to its own tasks, Parsons Brinckerhoff provides technical and administrative support and overall coordination with Metro and PB Subconsultants.

1.5 For purposes of clarity, definitions applicable to DSTP Quality Assurance and Quality Control efforts are contained in Attachment A.

2. ORGANIZATION

2.1 The Project Director (PD), in accordance with responsibilities outlined in PMP-5, is responsible for Quality Control on the Project.

2.2 The PD accomplishes Quality Control with Project resources under DSTP Quality Control Procedures.

2.3 Documentation of DSTP Quality Control is accomplished, under the direction of the PD, by QC Procedures, QC Checklists, and the application of Configuration Management Document Control Procedures.

Exhibit 12.4

2.4 Project staff with Quality Control responsibilities are:

TITLE	INDIVIDUAL	QC RESPONSIBILITY
Project Director	W. L. Barnes	The DSTP Project
Deputy Project Director	F. E. Elliott	Architectural Design
Manager, Facilities Engineering	K. K. See-Tho	Engineering
Manager, Technical Services	I. M. Kaupe	Civil and Utilities
Manager, Systemwide Facilities	E. T. Ireton	Systems
Manager, Project Control	D. R. Wilks	Project Control
Manager, System Integration	D. K. Bloomfield	Verification and Interfaces

In addition, Quality Control of specific technical work within a discipline is the responsibility of the Section Manager (SM). A "section" on the DSTP, is defined as an organization of one or more technical disciplines. Section Managers are also referred to in PMP-5, as Technical Disciplines Leaders.

Specific Quality Control responsibilities of a Section Manager will include:

(1) Establishing operating guidelines and assigning specifically accountable responsibilities within the section.

(2) Implementing the use of standards for production in such areas as reports, drawing production, calculations, and computer computations.

(3) Implementing a standard checking procedure for the services produced within the section such that all products produced are checked, initialed and dated by a properly qualified professional.

(4) Monitoring the checking procedures periodically to assure that approved procedures are being followed.

(5) Maintaining the level of technical training of the staff essential to the standards of the Firm.

(6) Keeping the Project Director advised of any unusual circumstances or problems that may require PD attention to include the quality of deliverables and performance on budget and schedule.

Exhibit 12.4

(7) Assisting and cooperating with the Project Director to accomplish in-house review of interfacing design disciplines and services.

(8) Reviewing and signing off completed services before transmitting to the Project Director for submission to the client.

2.5 The Committee of Principals is comprised of principals from Parsons Brinckerhoff and the major subconsultant firms.

<u>Committee of Principals</u>

ABKJ	Tom Kane
TRA	Jerry Williams
URS	Walt Berschauer
PBQ&D	Paul Gilbert (PIC)
PBQ&D	Bill Barnes (PD)

The Committee of Principals will be briefed periodically on staff performance, productivity and quality by the PD. The principals will then take the actions indicated within their respective organization to improve performance as required.

2.6 Quality Assurance is the responsibility of PBQ&D's Regional Manager (RM)/Chief Operating Officer (COO). The RM/COO is supported by the Resource Group as required, on a schedule set by the PD.

2.7 Within Parsons Brinckerhoff, there are technical professionals who have been recognized by their peers for their high personal technical achievement. These professionals are recognized in specific and defined technical practice areas and represent the primary cadre of the quality technical personnel required to provide quality professional services. These, along with a select group of outside consultants, form the Technical Resource Group and shall be called upon to fill any project assignment in the best interest of Metro or Parsons Brinckerhoff as outlined in PMP-5.

Technical Resource Group

Project Management	Jim Lammie (PB)
Quality Control	Bill Lathrop (PB)
Operations	George Krambles (Consultant)
Architectural Design	Vincent Kling (Consultant)
Specifications	Eli Abdallah (PB)
Structural	Bill Armento (PB)
Tunnel Engineering	Elwyn King (PB)
Geotechnical Engineering	Birger Schmidt (PB)
Mechanical Engineering and Fire/Safety-HVAC	Norm Danziger (PB)
Construction	Al Mathews (Consultant)

Additional quality review support may be drawn from Parsons Brinckerhoff or outside sources as necessary, as determined and scheduled by the PD.

2.8 Reviewers will send comments or reports to the responsible Construction Contract Unit (CCU) Coordinator as defined in 4.5 of this Plan.

3. PRODUCT

3.1 All documents to be produced by Parsons Brinckerhoff and/or its Subconsultants for Final Design are covered by this Plan.

3.2 Final Design Deliverables are Bid Documents represented by each contract unit.

3.3 Parsons Brinckerhoff's Subconsultants, listed in Attachment B, participate in the design for the specialties indicated.

4. PROCEDURES

4.1 Quality Control for specific technical work on the Project will be the responsibility of the Section Managers (SM), and will involve the principles and procedures described herein for critical aspects of the work. All technical items will be discussed among the PD and SM's, before being initiated, as to format, objectives, level of effort, techniques, and disciplines involved. This may or may not include advance consultation with Metro. The Manager of Project Control (MPC) will specify any special control tools such as bar charts and budgets for the specific tasks to be used for monitoring the work and to be maintained by the SM's. During the course of any particular task, the PD will monitor the quality of the work and adjust personnel resources assigned to the task, as required and appropriate. This will necessitate discussions with SM's, reviews of interim results, and active participation in the work.

4.2 Other groups of individuals will be used by the PD and PIC for monitoring the technical work, including: (1) The Committee of Principals,comprised of senior personnel from Parsons Brinckerhoff and the major Subconsultant firms, and (2) the Technical Resource Group, which consists of a panel of experts to be drawn upon individually as warranted to deal with specific types of technical issues. No specific agenda has been set for the last two groups, nor are they expected to convene formally as study committees, but they will be consulted on Quality Control Design Reviews, issues/problems, policy matters, commitment of resources, and on the overall quality of the work and recommendations for improvement.

4.3 It is Parsons Brinckerhoff's responsibility to maintain a high level of quality in the work of the Subconsultants. All Subconsultant work is planned to be accomplished through a team approach; i.e., each major task area with its SM includes Subconsultants(s) as well as Parsons Brinckerhoff personnel. All Subconsultant work is subject to review procedures prescribed elsewhere in this Quality Control Plan and to the principles outlined above. Parsons Brinckerhoff, therefore, has a great measure of access and control in all areas of the ongoing technical work. Additionally, the PD will coordinate closely with the senior members and key personnel of each Subconsultant firm. Subconsultants are required to follow their own internal Quality Control procedures. All deliverables called for in the Scope of Services, which are produced by the Subconsultants, will be subject to review by the appropriate SM, and submitted in draft form for approval by Parsons Brinckerhoff prior to finalization and submission to Metro.

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4.4 Design Review Process and Quality Control

(1) The Design Review process for Final Design will culminate with approval of Bid Documents by Metro. To achieve that end, the Parsons Brinckerhoff Team will submit work elements or deliverables for Metro review as work progresses until final action is taken. Final Design elements will be submitted for review to Metro, and to others as determined by Metro, at the 60 percent and 90 percent design review milestones. Review comments will be clearly documented and dispositioned. Metro will coordinate its comments into a single set of coordinated notes for action and/or response by the Consultant.

(2) The listing, by Contract, of the DSTP Design Review CCU Coordinators is as follows:

Contract No.	Project Description	CCU Coordinator
CU-01(CU-601)	Utilities Relocation Steam and Water Only	Imants M. Kaupe
CU-02(CU-201)	Tunnel	Tom L. Conley
(CP-202P)	Pioneer Square Station (Excavation Only)	Jeffrey R. Wolfe
(CU-602P)	Private Utilities	Imants M. Kaupe
CU-03(CP-101)	International District Station	Jeffrey R. Wolfe
(CP-202P)	Remainder Pioneer Square Station	Jeffrey R. Wolfe
(CP-203)	University Street Station	Jeffrey R. Wolfe
CU-04(CP-301)	Westlake Station	Paul J. Berkley
(CP401)	Convention Center Station	Paul Berkley
CU-05 New Task	Work with (WSDOT)	Jeffrey R. Wolfe/ Robert C. Brannon
CU-06 (CP603)	Storm Drains	Richard B. Ellis/ Robert C. Brannan
(CP-801)	Surface Improvement	Richard B. Ellis/ Robert C. Brannan

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Contract No.	Project Description	CCU Coordinator
CU-07(CQ-802)	Ancillary Power	Earl T. Ireton
(CY-831)	Elevators/Escalators	Earl T. Ireton
(CY832)	Emergency Ventilation	Earl T. Ireton
CU-08(CQ-801)	Traction Power Procurement	Earl T. Ireton
CU-09(CY-801)	Traction Power Installation	Earl T. Ireton
CU-10(CY-861)	Signaling	Earl T. Ireton
(CY-871)	Communications	Earl T. Ireton
(CY-881)	Supervisory and Control	Earl T. Ireton
CU-11(CU-901)	Signaling and Graphics	Earl T. Ireton
CU-12(CY-891)	Fare Collection	Earl T. Ireton

(3) Design Quality Control will be based on generally accepted standards of design and will be in accordance with the methodology set forth below. There will be two parts to the conduct of Design Quality Control.

(a) Part 1 constitutes work prepared directly by Parsons Brinckerhoff, who will review and check the designs, plans, specifications, and price analyses it prepares in accordance with the review process outlined in Subsection (c) below.

(b) Part 2 constitutes work prepared by Subconsultants. In addition to the reviews performed during the process, Parsons Brinckerhoff will be responsible for performing periodic reviews of the Subconsultants' technical work. Parsons Brinckerhoff will be responsible for performing submittal reviews of the Subconsultants' initial, 90 percent, and other submittals. Parsons Brinckerhoff's review is not intended to eliminate the responsibility of the Subconsultants to review and check their own calculations and the documents they prepare.

It is understood that each Subconsultant firm is professionally responsible for its own final products, including completeness, conformance to standards and

xhibit 12.4

criteria, general safety needs, and estimated costs. Reviews of subconsultant submittals will be performed by reviewers who are especially cognizant of DSTP project standards and criteria. These reviews will be augmented, as needed, by technical specialists.

The Geotechnical Engineer (Birger Schmidt) will perform the technical review of all geotechnical-related work efforts of the Subconsultants. The Chief Architect (F.E. Elliott) will perform the technical review of all landscape architectural-related work efforts of the Subconsultants. The Consultant's technical review will be performed in accordance with Subsection (c) below.

(c) Outline of Review of Final Engineering and Design Documents.

The reviewers will generally review documents for:

- o Conformance to published or approved project standards, criteria, specifications, and other requirements.
- o Adequacy, clarity, and ease of interpretation.
- o Constructibility.
- o Compatibility of interfaces.
- o Obvious errors and discrepancies.
- o Coordination with related designs and project elements.
- o Incorporation of approved Design Change Orders.

4.5 Sub-tier Quality Program documents, such as Quality Procedures, will be submitted to, and approved by the Project Director prior to implementation.

4.6 Disagreements about quality reviews, Project design or other matters will be brought to the attention of the Project Director. The Project Director, consulting if necessary with the PB Technical Director, and/or Principal-in-Charge, will render a decision on the action to be taken.

5. CRITICAL ELEMENTS

5.1 Critical Elements of the DSTP requiring special Quality Control attention and emphasis are:

a) Coordination of interfaces between disciplines

b) Subconsultants quality interface and quality verification

6. BUDGET

6.1 The budget is approximately $79,000 for Quality Assurance Task B3.5. This Task is for the preparation of the Quality Assurance Plan and Procedures, and also for operating the Plan and Procedures.

6.2 The Quality Control efforts within the design discipline sections are supported by budgetary allocations contained within the specific tasks.

6.3 The Project Director, in coordination with the Section Managers, is responsible for completing the PB Quality Control Program.

7. RECORD OF REVIEW

7.1 The assigned CCU Coordinator will maintain a design review log to record quality control measures taken during the review of drawings and specifications.

7.2 All reviewer's comments, with appropriate corrective action taken, will be in writing and on forms provided for this purpose. It is the responsibility of each Section Manager to assure that all comments and responses at each design review level are sent to the CCU Coordinator.

8. QUALITY VERIFICATION

8.1 The Project Director is responsible for the review of all PB prepared or managed drawings and specifications. Results of any earlier Quality Control reviews will be given to the Project Director and, as required, Technical Director.

8.2 Quality Review Documentation will be subject to the Quality Verification process at the Pre-Final (90 percent) review level. This Quality Verification will follow standard verification procedures. Other Quality Verification checks of the Quality Control Review process will be conducted at random intervals, but not less than once a quarter.

8.3 Quality Verification results will be reported to the Project Director with a copy to Quality Assurance/Quality Control files.

ATTACHMENT "A"

DSTP QUALITY PROGRAM DEFINITIONS

DESIGN INPUT - Those criteria, parameters, bases, or other design requirements upon which detailed final design is based.

DESIGN OUTPUT - Documents, such as drawings, specifications, and other documents, defining technical requirements of structures, systems, and components.

DESIGN PROCESS - Technical and management processes that commence with identification of design input and that lead to and include the issuance of design output documents.

DOCUMENT - Any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures, or results.

QUALITY - Conformance to requirements.

QUALITY ASSURANCE - The planned actions necessary to provide confidence of conformance to requirements. Quality Assurance on the DSTP is normally a regional responsibility.

QUALITY ASSURANCE/CONTROL INSPECTOR - An inspector authorized to accept or reject materials, systems, structures, components, equipment, operations, test, etc., on the basis of inspection plans.

QUALITY ASSURANCE PLAN - The document that contains the detailed planning, responsibilities, and interfaces necessary for the implementation, control and maintenance of a Quality Assurance Program.

QUALITY ASSURANCE PROGRAM - All those planned and systematic actions necessary to provide adequate confidence that structures, systems, or components, are designed, manufactured, tested or installed in accordance with applicable drawings, specifications and codes.

QUALITY CONTROL - The process of examination of design conformance to requirements. Quality Control on the DSTP is normally a project responsibility.

QUALITY INSTRUCTIONS - Those documents which define the manner and sequence of performing specific quality functions such as surveillance, inspection, tests, installation and operation.

QUALITY PROCEDURES - Detailed procedures documenting the control features of each element of the Quality Assurance Program.

QUALITY REVIEW - A review conducted by qualified personnel to assure document and drawing compliance with Project Quality Plans and Procedures. Quality reviews are normally performed at Design Review Milestones.

QUALITY SURVEILLANCE - The quality function entailing preplanned witnessing of designated operations to verify that an action has been, or is being accomplished in accordance with specified requirements.

QUALITY VERIFICATION - An auditing process that verifies compliance with Project Quality Plans and Procedures.

Exhibit 12.4

ATTACHMENT "B"

DSTP FINAL DESIGN
SUBCONSULTANT LIST

Andersen Bjornstad Kane Jacobs, Inc. (ABKJ) - Underpinning, Building Survey, Structural

Morrison-Knudsen Engineers, Inc. - Traction Power/Contact Systems

TRA - Architecture

URS Engineers, Inc. - Utilities

Shannon & Wilson (S&W) - Geological Exploration, Testing

The Kling Associates - Architecture

Mr. George Krambles, P.E. - Operations

Lea, Elliott, McGean & Co. - Vehicle

J. W. Leas & Associates - Fare Collection

Al Mathews Corporation - Tunnel

Horton Dennis & Associates - Surveying, Mapping

Systems Architects Engineers - Engineering Support

INCA Engineers - Structural, Other Engineering Support

Tyman H. Fikse - Tunnel

Lin & Associates - URS (SS)

Arai/Jackson Architects & Designers - Architects & TRA (SS)

Market Street Computer Systems - Scheduling/Document Control

Geo-Resource Consultants, Inc. - (SS)

Elaine Day LaTourelle & Associates - Archeology, E&H - TRA (SS)

Railway Systems Engineering - Signal, Command & Control - (SAB Engineering)

Chute Engineering - Engineering Support

Meridith Construction Inc. - Access Pit Construction & Specification Support

Lewis & Zimmerman Associates - Scheduling

Anne C. Symonds, P.E. - Mechanical - URS (SS)

Norton Corrosion Ltd. - Corrosion Control - S&W (SS)

Pitcher Drilling - Drilling - S&W (SS)

Smitty's Drilling - S&W (SS)

National Concrete Cutting - Geological - S&W (SS)

Hart Crowser - Archeology

S/SA Consultants, Inc. - Systems Assurance

Rolf Jensen & Associates - Fire/Life Safety

Centrac - URS (SS)

Robert Shinbo - TRA (SS)

Techstaff - TRA (SS)

CTS - Engineering

SS = Tier II Subconsultant

METRO
Municipality of Metropolitan Seattle
Downtown Seattle Transit Project

DSTP PROCEDURE

PARSONS BRINCKERHOFF QUADE & DOUGLAS INC.

Approved: ______________________ Date ________
Project Director

Submitted: ______________________ Date ________
Manager System Integration

Prepared: ______________________ Date ________

Title: QUALITY CONTROL PROCEDURE FOR FINAL DESIGN

Procedure No: SI-QC-001

Revision: 0

Date: April 14, 1986

I. SCOPE:

1.1 The purpose of this directive is to describe the procedures for verifying that all technical work produced by the Parsons Brinckerhoff Team in support of the Downtown Seattle Transit Project (DSTP) meets the quality standards of Parsons Brinckerhoff, and the standards of practice of the various technical disciplines contributing to the project.

1.2 The procedures outlined herein are applicable to the DSTP Final Design Phase and include all engineering and architectural drawings, specifications, schedules and estimates produced for construction or procurement by Parsons Brinckerhoff and its subconsultants for the DSTP Final Design.

1.3 Specifically, this procedure implements the DSTP Final Design Quality Assurance and Quality Control Plan, dated March, 1986.

II. RESPONSIBILITIES:

2.1 This Quality Procedure shall be followed by all members of the Parsons Brinckerhoff (PB) Team assigned to the DSTP and all Subconsultants assigned tasks in support of the DSTP for the Final Design Engineering Phase of the Project.

2.2 The Project Director (PD) is responsible for Quality Control (QC) of the Final Design services of the project. In the absence of the PD, the Deputy Project Director (DPD) will assume the PD's responsibility for Quality Control.

2.3 The Principal-in-Charge (PIC), together with the Committee of Principals, will support the PD in the development and execution of the DSTP Quality Assurance and Quality Control Plan.

2.4 Section Managers are responsible to the PD for the Quality Control of all PB and subcontractor work accomplished within, or under, their direction.

2.5 All persons within a particular Section are responsible to the Section Manager for the quality of their individual work.

2.6 All subcontractors are responsible for the Quality Control of their own work and for the Quality Control of all work produced by any sub-subcontractor in support of their particular disciplines. Subcontractor Quality Control standards must equal or exceed PB standards. In addition, PB Section Managers are responsible for Quality Assurance review of all deliverables by subcontractors assigned to their sections.

2.7 The Project Director appoints a responsible individual to function as a Construction Contract Unit (CCU) Coordinator for each Design Contract. For the purposes of this procedure, the title CCU Coordinator will be a functional designation. The CCU Coordinator is responsible for coordination of all design work, across all interfaces and disciplines pertinent to a particular Contract Deliverable Package. In addition, the CCU Coordinator is responsible to the PD for coordinating the design review process throughout all design review stages. The CCU Coordinator shall ensure that all required cognizant personnel are on distribution lists for, and that they receive, all relevant design review packages, memos, comments, responses, and other documentation pertinent to the design and design review process, and shall keep records of all reviews, review personnel, comments and resolutions.

The listing, by Contract, of the DSTP Design Review CCU Coordinators is as follows:

Contract No.	Project Description	CCU Coordinator	
CU-01 (CU-601)	Utilities Relocation Steam and Water Only	Imants M. Kaupe	IMK
CU-02 (CU-201)	Tunnel	Tom L. Conley	TLC
(CP-202P)	Pioneer Square Station (Excavation Only)	Jeffrey R. Wolfe	JRW
(CU-602P)	Private Utilities	Imants M. Kaupe	IMK
CU-03 (CP-101)	International District Station	Jeffrey R. Wolfe	JRW
(CP-202P)	Remainder Pioneer Square Station	Jeffrey R. Wolfe	JRW
(CP-203)	University Street Station	Jeffrey R. Wolfe	JRW
(CU-602P)	Utilities	Imants M. Kaupe	IMK
CU-04 (CP-301)	Westlake Station	Paul J. Berkley	PJB
(CP-401)	Convention Center Station	Paul Berkley/ Kevin Peterson	PB/KP
CU-05 New Task	Work with (WSDOT)	Jeffrey R. Wolfe/ Robert C. Brannan	JRW/RCB
CU-06 (CP-603)	Storm Drains	Richard B. Ellis/ Robert C. Brannan	RE/RCB
(CP-801)	Surface Improvements	Richard B. Ellis/ Robert C. Brannan	RE/RCB
CU-07 (CQ-802)	Ancillary Power	Earl T. Ireton	ETI
(CY-831)	Elevators/Escalators	Earl T. Ireton	ETI
(CY-832)	Emergency Ventilation	Earl T. Ireton	ETI
CU-08 (CQ-801)	Traction Power Procurement	Earl T. Ireton	ETI
CU-09 (CY-801)	Traction Power Installation	Earl T. Ireton	ETI
CU-10 (CY-861)	Signaling	Earl T. Ireton	ETI
(CY-871)	Communications	Earl T. Ireton	ETI
(CY-881)	Supervisory and Control	Earl T. Ireton	ETI
CU-11 (CU-901)	Signaling and Graphics	Earl T. Ireton	ETI
CU-12 (CY-891)	Fare Collection	Earl T. Ireton	ETI

2.8 The Manager, System Integration shall be responsible for conducting Quality Verification Reviews to assure compliance with this procedure.

III. PROCEDURES:

3.1 The development of specifications and drawings shall, as a minimum, include inputs from the following sources:

a) Project Design Criteria
b) Other codes and references, as contained in Section 10.0 of the Engineering Design Criteria, DSTP - PB Catalog Number D04.05
c) City of Seattle UBC Supplement, September 1983 edition
d) The Standard For Preparation of Drawings, as contained in Section 11.0 of the Engineering Design Criteria, DSTP - PB Catalog Number D04.05
e) DSTP Preliminary Engineering Deliverables, as listed in Attachment A to this Procedure
f) Uniform Federal Accessibility Standards (UFAS), August 1984 edition
g) All Geotechnical data and reports
h) Utility Data, Agreements, Controls and Restraints
i) Right-of-Way, Easements and Agreements
j) Mapping and ground control
k) Direction from the Project Director

3.2 During design development, cognizant engineers and architects shall informally coordinate with other affected parties within the design team to obtain design consistency, compatibility of interfaces, and cross-checking of design details.

3.3 Throughout the period of detailed design, supervisory QC reviews, drawing checking, and signatures/initialling on drawings shall be accomplished as follows:

a) QC checking and signatures/initialling shall be accomplished in accordance with specified drawing check procedures as contained in Section 11.8 of the Drafting Standards, DSTP-PB Catalog No. D04.05.

b) All deliverables produced by PB staff and/or subcontractor personnel shall be QC checked and initialled by the supervisory/senior person in charge as to technical accuracy, completeness, and appropriateness during the design process and, as a minimum, prior to each design review level.

c) All calculations to support design drawings shall have the original (not a copy) calculations checked and reviewed by a qualified senior person in the discipline field. The senior person shall sign and date their review on the originals. These will then be preserved according to Document Control procedures as part of the Project record.

3.4 Resource Group members shall be scheduled by the PD/Section Manager, as needed, to provide Quality Assurance (QA) reviews of work accomplished following the review criteria of Para. 3.5d, below. This shall be accomplished at appropriate intervals so that contract deliverables at various stages of progress may be reviewed. Documentation of such QA reviews shall be accomplished as follows:

a) Individual Resource Group members shall use the DSTP "Review of Drawings and Specifications" form (Attachment B) to list and describe comments.

b) A copy of the comments shall be sent to the appropriate CCU Coordinator, the Cognizant Section Manager, and the Project Director.

c) The individual Resource Group member shall meet informally with the appropriate design team members to discuss all QA comments. The parties shall strive for agreement on disposition/resolution of all comments, and annotate designer replies on the form.

d) A copy of the Resource Group member's QA review comments and the agreed resolutions thereto shall be prepared and forwarded by the cognizant Section Manager to the appropriate CCU Coordinator.

3.5 In order to provide for a Quality Control review of all contract documents, when contract deliverables reach design review milestones, the design package shall be subject to a formal, in-house, review process as follows:

a) The CCU Coordinator shall duplicate and distribute the required number of copies of the package to the following persons for review prior to the scheduled Design Review meeting as follows:

1. Project Director
2. Manager of Architecture
3. Manager of Facilities Engineering
4. Manager of Project Control and Administration
5. Manager of Systemwide Engineering
6. Manager of System Integration
7. Manager of Technical Services
8. Others, as applicable.

b) The CCU Coordinator shall provide a cover letter (Request For Review) together with a routing slip, which identifies reviewers as actionees. Additionally, "The Review of Drawings and Specifications" form (Attachment B) shall accompany each package. Instructions shall include a suspense date for return of comments to the CCU Coordinator.

c) Section Managers shall coordinate the review and responses within their sections.

d) Reviewers shall generally review the documents for:

1. Conformance to approved project standards, criteria, specifications, and other requirements.
2. Adequacy, clarity and ease of interpretation.
3. Constructibility.
4. Compatibility of interfaces.
5. Obvious errors and discrepancies.
6. Coordination with related designs and project elements.
7. Cost effective application of the necessary standards.
8. Incorporation of approved Design Change Orders.

e) Reviewers shall return all comments on "Review of Drawings and Specifications" forms, annotated and initialled as appropriate, to their respective Section Managers, who shall in turn initial and return them to the CCU Coordinator. When necessary for clarification, marked up drawings may also be returned as a supplemental attachment to, but not a replacement of, written comments. Each reviewer shall initial the routing slip to indicate accomplishment of the review, and shall sign the "Review of Drawings and Specifications" form.

f) The CCU Coordinator shall disseminate review comments to the responsible Section Managers for resolution. Inter-discipline coordination shall be encouraged. Proposed resolutions for review comments shall be annotated on the respective "Review of Drawings and Specifications" forms, initialled, and the forms returned to the CCU Coordinator.

g) The CCU Coordinator shall schedule an in-house review meeting one week prior to scheduled delivery of the contract package. All open action items shall be incorporated and/or resolved and initialled prior to the contract package being released for delivery to Metro.

h) The CCU Coordinator shall provide the appropriate design review package to the client well in advance of the formal design review meeting.

i) Comments received from the client shall be logged in and disseminated by the CCU Coordinator to the cognizant Section Managers for resolution by the affected disciplines. Where client generated, or client forwarded, comments cross discipline interfaces or affect more than specific limited details, the CCU Coordinator shall advise the PD. The PD shall determine specific response actions.

j) The CCU Coordinator shall establish the formal design review meeting dates and places and notify required participants. Formal design review meetings shall provide a forum for comment resolution. Results of these meetings shall provide the basis for the next incremental design review submittal, which shall incorporate all necessary comment resolutions. The CCU Coordinator shall take minutes at these design review meetings, to include such information as list of participants, issues raised, agreements reached, action assigned, and open items.

k) At the 100 percent design level, all changes and final comments shall be resolved/incorporated and the updated package distributed for a final internal QC review prior to the contract packages being delivered to Metro.

l) At the 100 percent design submittal level, the Principal-in-Charge, Project Director and Chief Architect, or Chief Engineer as appropriate, shall sign the deliverables. Drawings shall be sealed by the Project Director.

m) The CCU Coordinator shall transmit the design package to the client and to in-house distribution, as appropriate.

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	PARSONS BRINCKERHOFF QUADE & DOUGLAS INC.	
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		Revision: 0
	ATTACHMENT A	Date: April 14, 1986

DSTP PRELIMINARY ENGINEERING DELIVERABLES

Indexed By Deliverable Number

PE Deliv. Number	TITLE	DSTP-PB Catalog Number(s)
01	Project Management Plan, Parts I and II (DRAFT)	A01.01, A01.02
02	Project Management Plan - Final update letter	A01.03
03	Project Progress, Cost Reports (monthly reports)	A01.04
04	Ground Control Survey Field Notes and Calculations	B02.01
05	Topgraphic Base Maps	B03.03
06	Topographic Survey Field Notes	B04.06
07	Utility Composite Maps	B05.02
08	Geotechnical Literature and Library Search - Pine Street and Third Avenue	B06.02
09	Geotechnical Investigations Report	B06.05
10	Building Interface Survey - Existing Structure Information, Tax Records, One Tenth Foundation Drawings	B09.02, B09.03, B09.04
11	Operational Studies and Plan	C02.06
12	Fare Structure/Collection study	C06.03
13	LRT Design Requirements, Draft	C07.01
14	Stray Current Corrosion Study Report	C09.02
15	System Safety and Security Plans	C10.01
16	Structural Configurations Study Recommendations	D03.01
17	Final Configuration Report	D03.04
18	Design Criteria and Standards - Preliminary Design Criteria - Engineering	D04.05, D04.06, D04.07, D04.08
19	Alignment Drawings - 90 Percent Complete	D05.02
20	Alignment Drawings - Final (Part of Deliverable 50)	N01.01
21	Preliminary Structural Design Drawings - 90 Percent Complete	D06.01
22	Preliminary Structural Design Drawings - Final (Part of Deliverable 50)	N01.01
23	Utility Relocation Plans - 90 Percent	D07.01
24	Utility Relocation Plans - Final (Part of Deliverable 50)	N01.01
25	Right-of-Way Plans - 90 Percent	D08.01
26	Right-of-Way Plans - Final (Part of Deliverable 50)	N01.01
27	Design Criteria and Standards - Architectural Sections	E02.02
28	Station Programs Report	E02.02
29	Station Conceptual Design Drawings - 90 Percent	E05.01
30	Station Conceptual Design Drawings - Final (Part of Deliverable 50)	N01.01

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DSTP PRELIMINARY ENGINEERING DELIVERABLES
Indexed By Deliverable Number

PE Deliv. Number	TITLE	DSTP-PB Catalog Number(s)
31	Street/Highway Connection Plans, I-5 Ramp Connections 90 Percent	F04.01
32	Street/Highway Connection Plans, I-5 Ramp Connections - Final (Part of Deliverable 50)	N01.01
33	Surface Improvements Conceptual Drawings - 90 Percent	F03.01
34	Surface Improvements Conceptual Drawings - Final (Part of Deliverable 50)	N01.01
35	Mode Changeover Project	G02.01
36	Implementation Schedule Network - Preliminary	G04.01
37	Implementation Schedule (CPM) Network - Final	G04.03
38	Schematic Plans of Phased Development - Preliminary	G05.01
39	Schematic Plans of Phased Development - Final	(Not issued as of 14 April 86)
40	Systems Performance Requirements Report	I01.01
41	Transit Vehicle Report - Preliminary	I02.01
42	Transit Vehicle Report - Final	I02.02
43	General Provisions/Standard Specifications - Bidding Requirements, Contract Forms, and Conditions	J01.02
44	Technical Specifications - Draft Specifications Section Identification and Outline Div. 1 - 16	J02.02
45	Specifications Report	J02.03
46	Contract Packaging	K01.01
47	Contract Packaging	K01.02
48	Midpoint Capital Cost Estimate	K03.02
49	Capital Cost Estimate/Cash Flow Curves	K04.01, K04.02
50	Preliminary Engineering Report, Volumes I and II	N01.01
51	Revised Final Design Scope	N02.02

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Parsons Brinckerhoff Quade & Douglas, Inc. • Seattle, Washington

REVIEW OF DRAWINGS AND SPECIFICATIONS

PROJECT	PROJ. NO.	REVIEWER	REVIEW DATE	DISCIPLINE	SHEET OF
DESIGNER	SUBJECT				

REF. SHEET NO	COMMENT NO	REVIEW COMMENTS	DESIGNER REPLIES BY: DATE:

Quality Control Review
Comment and Response Form
(Not to Scale)

xhibit 12.5

GOVALLE WASTEWATER SERVICE AREA

INTERCEPTION AND DIVERSION SYSTEM

CITY OF AUSTIN
PUBLIC WORKS DEPARTMENT

PROJECT QUALITY CONTROL PLAN

for

Conceptual, Preliminary and Final Design

April 4, 1986

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.
In Association with
Dannenbaum Engineering Corporation
Trinity Engineering Testing Corporation
Frank J. Dillard & Associates, Inc.
L. Edwin Garner

GOVALLE WASTEWATER SERVICE AREA
INTERCEPTION AND DIVERSION SYSTEM

PROJECT QUALITY CONTROL PLAN

Submitted to:

CITY OF AUSTIN

WATER AND WASTEWATER UTILITY DEPARTMENT

Submitted by: Brian Van Weele
Brian J. Van Weele, Project Manager

Approved by: Wallace E. Dunn
Wallace E. Dunn, Principal-In-Charge

Date: April 4, 1986

xhibit 12.5

GOVALLE WASTEWATER SERVICE AREA
INTERCEPTION AND DIVERSION SYSTEM

PROJECT QUALITY CONTROL PLAN

TABLE OF CONTENTS

1.0 GENERAL

1.1 Project Description

The City of Austin, Texas, through its Water and Wastewater Utility Department, has engaged the services of Parsons Brinckerhoff Quade & Douglas, Inc. (PB), to perform the engineering analyses, planning and design for the construction of the Govalle Wastewater Service Area Interception and Diversion System. This system will be designed to provide for the diversion of flows from the Govalle service area to the South Austin Regional Wastewater Treatment Plant.

The project has been divided into three phases. Under Phase I, PB will conduct studies, analyses, evaluations, and calculations and prepare a planning, preliminary engineering and environmental considerations report. Phase I is scheduled for completion by May 5, 1986. Under Phase II, PB will prepare detailed final plans, specifications, contract documents and cost estimates for the construction of the system as approved. Phase II is scheduled to be completed by August 18, 1986. Under Phase III, PB will provide construction management services. Construction of the project facilities is scheduled to be completed by April 1, 1988. If authorized by the City of Austin, PB will furnish specific post-construction phase services related to operations and maintenance of the facilities.

1.2 Project Quality Control

It is the policy of the Project Team to strive for excellence in the quality of the professional services furnished to the Client. Attainment of this objective is accomplished by adherence to established procedures formulated to control the quality of the work. These procedures have been modified to specifically meet the objectives of the City of Austin and are outlined in this Project Quality Control Plan (PQCP).

2.0 ORGANIZATION

2.1 Quality Control Staff

The individuals with quality control responsibilities are identified by staff position in Table I. The Project Manager has the primary responsibility for Quality Control and specifically the implementation of this Project Quality Control Plan.

xhibit 12.5

TABLE 1

QUALITY CONTROL STAFF

Staff Position	Individual	Firm, Title
Principal-in-Charge	Wallace E. Dunn	Senior Professional Associate Parsons Brinckerhoff Vice-President
Project Manager	Brian Van Weele	Senior Professional Associate Parsons Brinckerhoff Vice-President
Technical Support Committee, Tunnels	Thomas R. Kuesel	Chairman of the Board Parsons Brinckerhoff Principal Professional Associate Senior Vice President
Technical Support Committee, Deep Excavations	Birger Schmidt	Technical Director for Geotechnical Engineering Parsons Brinckerhoff Vice-President
Technical Support Committee, Wastewater	Wayne G. Ahrens	Dannenbaum Engineering Corporation, Principal
Technical Manager, Tunnels	Elwyn H. King	Parson Brinckerhoff Principal Professional Associate
Technical Manager, Estimating/Scheduling	Richard A. Roberts	Parson Brinckerhoff Senior Project Consultant
Technical Manager, Wastewater Facilities	David L. Parkhill	Dannenbaum Engineering Corporation, Associate
Special Consultant, Geology	L. Edwin Garner	Consulting Geologist
Special Consultant, Instrumentation	Frank J. Dillard	Frank J. Dillard & Associates, Principal
Constructibility Review	William Pease	Parsons Brinckerhoff Senior Construction Manager
Constructibility Review	Alfred Woods	Dannenbaum Engineering Corporation, Engineer

2.2 Reporting Structure

The organization chart shown on Figure 1 illustrates the reporting structure for implementation of the PQCP.

2.3 Duties and Reponsibilities

Quality control begins with putting the right person on the job from the onset. Each member of the Project Team is individually responsible for controlling the quality of the product from the project design engineers up through the hierarchy to the Principal-In-Charge. Each engineer assigned as a member of the team is experienced, knowledgeable and works very closely as a team with the quality control management staff identified in Section 2.1. The duties and responsibilities of the quality control management staff in coordinating and guiding the project efforts are briefly described below:

a. Principal-In-Charge -- Responsible for allocation of resources and monitoring of the project to ensure adherence to the established quality control plan. He will provide peroidic audits to review technical performance of PB staff and subcontractors.

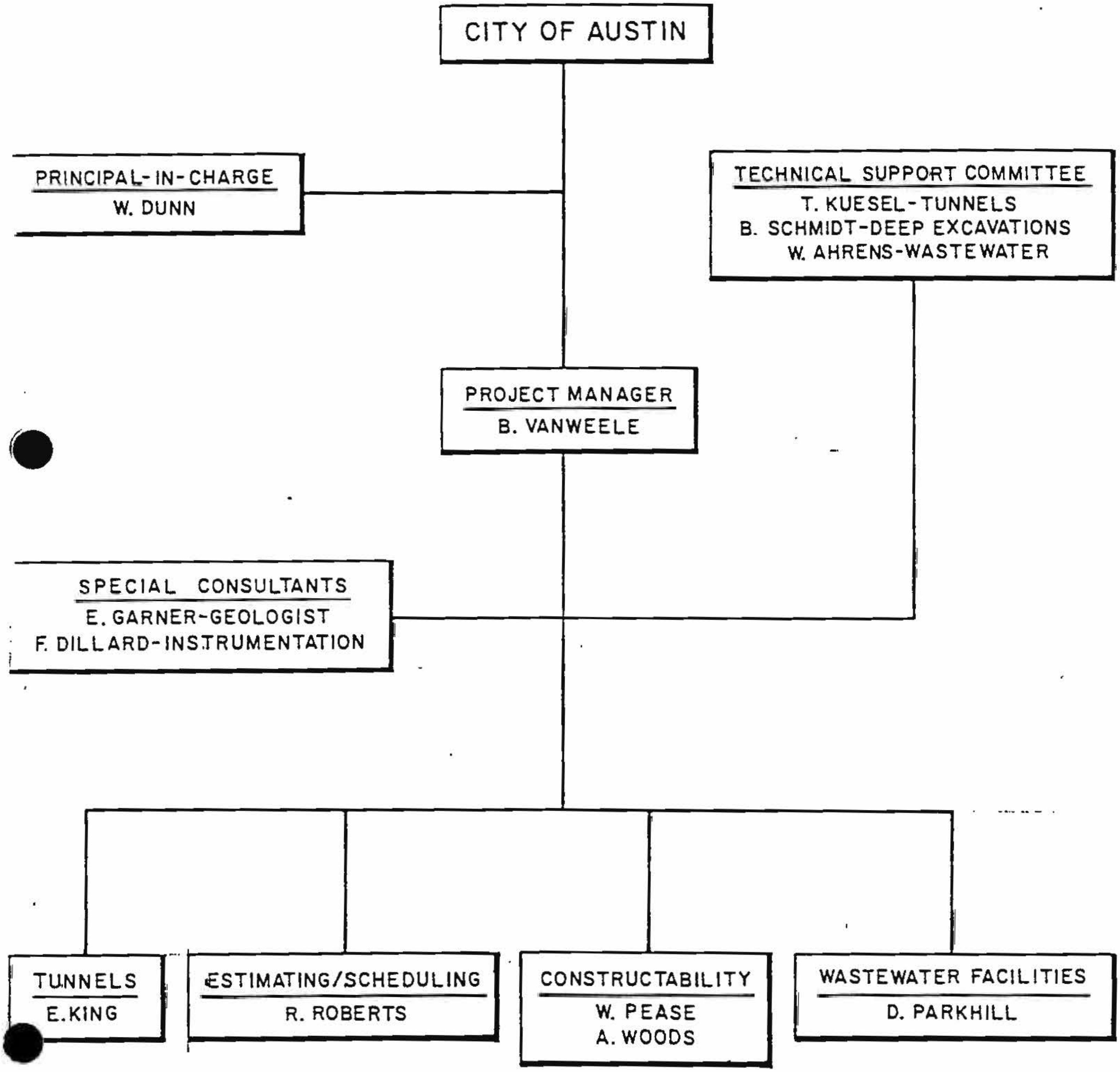
b. Project Manager -- Allocates resources to various elements of the work, establishes and implements the project quality control plan, schedules the various activities and adjusts plans as the work progresses to identify potential problem areas and resolve them in a timely manner. Responsible for technical review and approval of project documents before issuance to the Client; and weekly contact with and reporting to the Client to assure the Client's satisfaction with the progress and performance.

   The Project Manager prepares and monitors the implementation of the PQCP. The Project Manager identifies the quality control actions required to be taken, the resources to be applied to these quality control actions, and interaction of these activities with the other elements of work. In this process, it is essential that the Project Manager clearly identify the personnel involved and their duties; allocate time, effort and funds to the quality control function; and review and revise these allocations of resources appropriately as the work progresses.

xhibit 12.5

FIGURE 1

QUALITY CONTROL ORGANIZATION CHART



c. Technical Support Committee -- Comprised of the most senior technical staff with extensive experience in their individual areas of expertise. These three individuals review the basic concepts and design criteria in the initial stages of development so that the succeeding work will proceed based on the proper assumptions. They review the work for practibility, feasibility, constructiblility,, conformance to professional engineering standards and practices and compliance to project standards.

d. Technical Managers -- Responsible to the Project Manager for the quality of the work produced within his particular area of activity. This objective is accomplished by continuous close interaction with the project design engineers through a concerted team effort. In a supervisory capacity, the technical manager establishes operating guidelines and areas of responsibility within the activity; monitors the work periodically to assure adherence to the contract scope and to the established checking procedures; advises the project manager regarding the progress of the work and of any circumstances that may require particular attention; reviews the work with the Project Manager and with the technical managers of the interfacing design disciplines; reviews completed work before it is transmitted to the Project Manager for approval and submittal to the client.

3.0 PRODUCT

3.1 Project Documents

a. Task I Report -- To include description of the data base, design criteria and preliminary analysis of geologic/geotechnical considerations, alternate routes and wastewater facilities sizing and configuration. Specific documents to be reviewed for quality control during the preparation of this report include conceptual design calculations, preliminary design criteria, conceptual level cost estimates and preliminary layouts.

b. Task II Report -- To include description of the preliminary screening process for the various alternatives, preliminary design of three alternatives and selection of the final recommended alternative. The preliminary design will cover the engineering aspects, construction, environmental, operation and maintenance and surveying program.

Exhibit 12.5

c. Geologic/Geotechnical Report -- Description of analysis and conclusions drawn from the previously existing and new geologic, geotechnical and tunneling data, design criteria, construction considerations and cost estimates for excavation, rock support, lining procedures, shafts and muck haulage and disposal.

3.2 Critical Elements of the Project

a. Construction scheduling
b. Construction costs
c. Operational and functional reliability and compatibility of the project facilities with existing wastewater facilities
d. Geotechnical restrictions
e. Permitting requirements/environmental effects

3.3 Elements Requiring External Technical Expertise

a. Local Geology -- A number of alternatives to be evaluated in detail involve the excavation of a tunnel from the Govalle Service Area to the South Austin Regional Wastewater Treatment Plant. To provide the project team with an in-depth understanding of the local geologic and geomorphic conditions pertinent to the project work, the services of Mr. L. Edwin Garner, Consulting Geologists, were procured. Mr. Garner has acquired extensive experience through working on regional and state-wide projects in Texas, and has developed numerous publications and reports on the Austin area in particular. Due to the critical nature of the scheduling of the work, Mr. Garner's participation is of special significance.

b. Instrumentation -- Mr. Frank Dillard, Consulting Engineer, will provide specialized services in guiding and coordinating the instrumentation design and cost estimating efforts. Mr. Dillard has provided services to municipalities and private industries in the areas of process definition, design and control. He has specifically performed instrumentation and facilities design on potable water treatment and distribution projects water treatment and distribution projects as well as secondary and advanced wastewater treatment systems.

4.0 PROCEDURES

4.1 Review Process

a. Internal Review -- The technical managers will work very closely with the Project Engineers, Project Manager and specialists assigned to the quality control function.

Weekly meetings will be held with all project staff to assure interdisciplinary coordination and exchange of information. This open forum for overall review on a regular basis will assure that any modifications in concept or design criteria are communicated promptly to the other members of the team so that they may evaluate and discuss the potential impacts on their respective activities.

The technical support committee will be called in for evaluation and review at various critical points in the analysis and design process to be determined by the Project Manager as the work progresses. The findings of the studies and analyses will be reviewed with them before preparation of the report.

At the time that material is submitted for quality control review, sufficient detailed information and backup data shall be included so that the reviewer may respond promptly.

b. Client Review -- Weekly meetings with the client, Project Manager and selected members of the project staff as appropriate to review the details of the alternatives under consideration, work completed during the reporting period and anticipated work during the next period.

This information will also be submitted to the client in written form as a weekly project status report.

The Project Manager will also participate in project meetings every three weeks which will involve the client's representatives as well as managers of the various other treatment plants and projects.

Exhibit 12.5

4.2 Resolution of Disputes

During the review and checking process, if the checker is not in agreement with the results of the design task being checked, he will review the matter with the technical manager or the Project Manager, if the checker is the technical manager. This individual will review the matter with the design engineer. If the problem cannot be resolved at this level, the Technical Support Committee and/or the Principal-In-Charge will be consulted for final resolution.

5.0 MANPOWER ESTIMATE

Following is a breakdown of the estimated manpower in hours required for the quality control function by category and task:

Category	Task I Data Collection, Review and Conceptual Design	Task II Evaluation of Alternatives	Total
o Management	3	7	10
o Spec./Sr. Eng.	18	32	50
o Engineer	10	2	12
o Env./Planner	-	5	5
o Clerical	8	2	10
TOTAL	39	48	87

6.0 RECORDS

6.1 Preparation of Engineering Design Calculations and Drawings

Engineering design calculations, drawings and reports will conform to the procedures established in Parsons Brinckerhoff's Technical Practices and Procedures Manual and Quality Control Procedures Manual. Calculations will be performed on the standard Parsons Brinckerhoff Computation Sheet shown on Figure 2. The calculations shall be signed and dated by the preparer ("made by") and shall be independently checked and signed by the checker prior to issue. The box in the upper right-hand corner of the Computation Sheet shall contain the work breakdown job number. Calculations will be performed in the format shown in Figure 3; all information requested will be provided as appropriate. After the calculations have been completed and checked as being satifactory, the checker

Parsons Brinckerhoff Computation Sheet

FIGURE 2

Exhibit 12.5

Page ______ of ______

Made by ______

Date ______

Checked by ______

Date ______

Subject ______

will date and sign the appropriate spaces in the upper right-hand corner of the calculations sheet.

Conceptual and preliminary design sketches and drawings will be dated and numbered, but will not bear the design engineer's registration stamp and signature. The format shown in Figure 3 will be required, as appropriate, for all computations.

Conceptual and preliminary design sketches and drawings will be dated and numbered, but will not bear the design engineer's registration stamp and signatures.

6.2 Checking and Approval Procedures

The flow chart shown in Figure 4 illustrates the sequence to be followed for checking and approving design calculations and drawings.

Any calculations or drawings which have been superceded will be marked accordingly, signed and dated by the cognizant engineer. Calculations which have been superceded will be attached to the back of and filed with the new calculations.

No project documents will be submitted to the client without prior review and approval by the Project Manager.

6.3 Documentation Of Formal Reviews

The results of formal reviews by the technical support committee will be documented in written form. Any recommended measures or changes will be described sufficiently to minimize the time required to effect the recommendation.

FIGURE 3

CALCULATIONS FORMAT

Purpose:

Provide a concise, but complete, statement of the problem.

BASIC DATA:

List known data, limitations, possible restraints, and facts pertinent to the problem. Identify references for data.

ASSUMPTIONS:

State assumptions used in the calculations.

SKETCH:

Use sketch(es), as applicable, to define or clarify the system being examined.

FORMULAS:

List formulas to be used. Explain notation symbols. Include references.

CALCULATIONS:

Include and organize sequentially all steps of the calculations required to permit an independent review. If computer analysis is used, include printout with an explanation of the format. Include figures used in calculations.

Suggest that formulas and notations be written on left side of page as the steps of the calculations are developed.

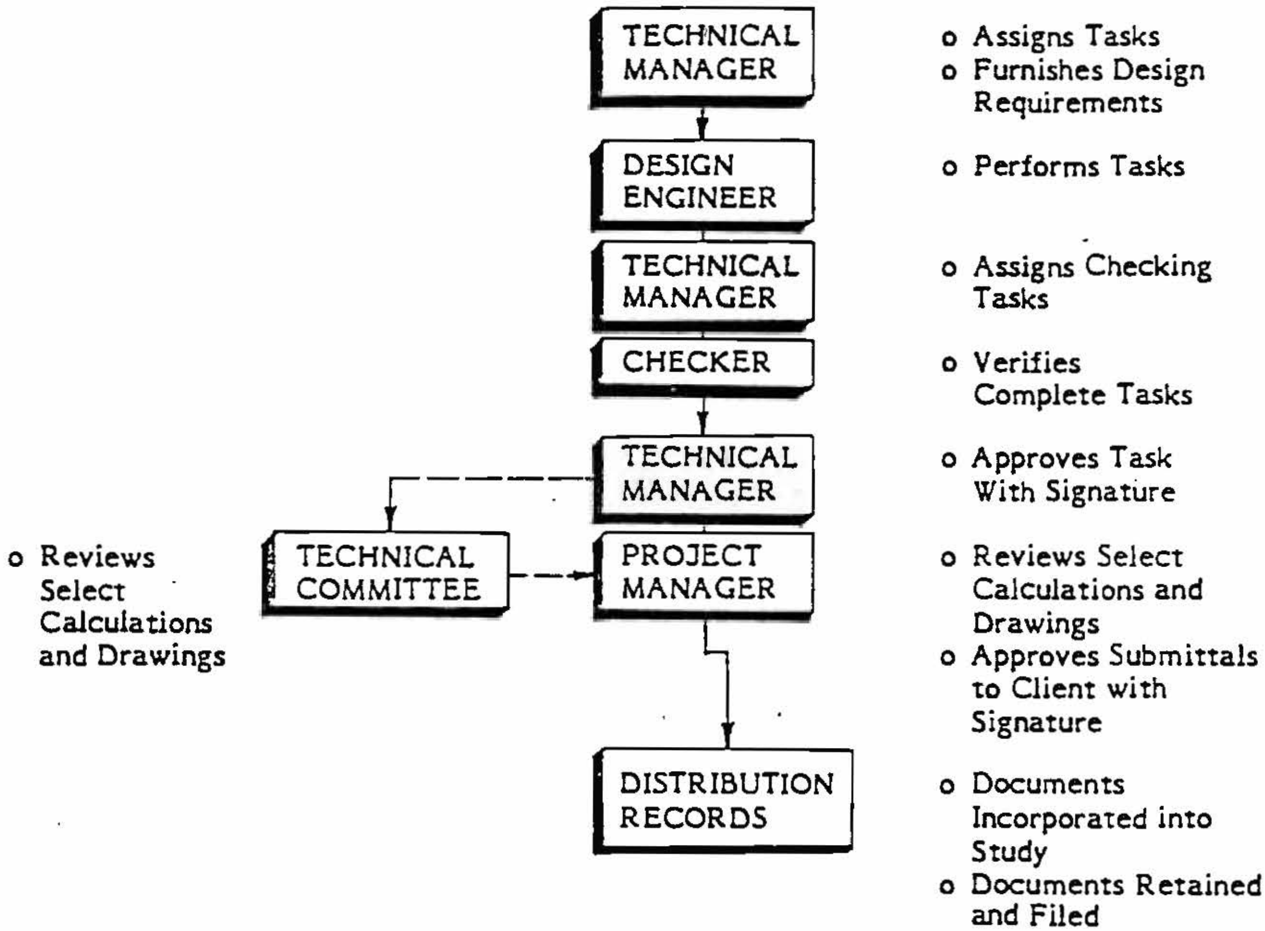
CONCLUSION:

Provide solution and/or recommendations. If practical, enclose conclusion with rectangular box or underline.

Exhibit 12.5

Figure 4

PROCEDURES FLOWCHART
FOR CALCULATIONS AND DRAWINGS



APPENDIX A

PROJECT MANAGEMENT REFERENCES

PARSONS BRINCKERHOFF DOCUMENTS

Contract Policy Manual: (Draft, September 1981)
Operational Plan and Procedures Manual: (See regional references)
Personnel and Administrative Policies, (last issue 11/84; revisions issued as appropriate)
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4) Beck, J.R. "Time Management."

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Stasiowski, Frank A. Negotiating Higher Design Fees. New York: Whitney Library of Design, 1985.

METRO RAIL TRANSIT CONSULTANTS
DMJM/PBQD/KE/HWA

Procedure No: 001

Originator: Interface Management

Procedure Title:

Approved:

INTERFACE PROGRAM PLAN

OUTLINE

INTRODUCTION

Projects, that have multiple systems and facilities and have numerous contracts, require extensive planning and organization to identify and maintain physical and functional interfaces between contractual participants. The plan, herein presented, is designed to assist SCRTD Metro Rail Project participants in understanding the methodology used in developing the interfaces. The plan's ultimate goals will be the identification and control of each interface between contractual units of the Project. This will allow a comprehensive test program that verifies that all parts of the project perform together as intended.

I. POLICY

The Metro Rail Project will identify and control all physical and functional interfaces between systems, construction, and/or procurement contracts of the project and establishes guidelines to be used for identifying contract internal interfaces. This shall be done to ensure that the various elements of the project fit and function across contractual boundaries when combined to form the total Metro Rail Project.

II. SCOPE

This Interface Program Plan applies to all systems, constructions, or procurement contracts and any design effort required in the implementation of those contracts.

III. PURPOSE

The purpose of this plan is to establish uniform procedures to identify, define, document, and control interfaces that cross contractual boundaries (external interface). It also establishes guidelines to be used for interfaces that do not cross contractual boundaries (internal interface).

IV. OBJECTIVE

The objectives of this plan are:

A. To ensure that all contract external interfaces are identified, documented, and controlled on both sides of the interface.

B. To verify that uniform criteria on both sides of the interface exist.

C. To establish procedures that will identify all participants of an interface.

D. To ensure all participants of an interface assess any proposed interface change prior to approval and implementation of the change. ← tie into chng control

E. To provide procedures for identifying contract internal interfaces. define

V. DEFINITIONS

A. Interface - The point at which two or more facilities, systems, subsystems, parts or functions meet physically or functionally.

B. Contract Internal Interface - An interface totally within the contractual bounds of a construction or procurement contract.

C. Contract External Interface - An interface that crosses construction or procurement contractual boundaries and responsibilities.

VI. INTERFACE IDENTIFICATION

Contract external interfaces will be identified utilizing a building block approach. Each step in this approach further defines where and what interfaces exist between contractual or procurement units.

The steps and procedures utilized to isolate a specific interface are a series of matrices that graphically depict the interfaces between contractual units. The subsequent matrices will further identify interfaces leading to the specific interface and all the parameters of that interface, both physically and functionally.

Each external interface will be detailed on numbered Interface Data Sheets (IDS) for identification and control (Figure 4).

Information regarding the matrices or IDS may be obtained from MRTC Interface Management.

VII. INTERFACE DOCUMENTATION

Each contract external interface shall be documented on both sides of the interface. This documentation will be listed on the IDS. The use of existing or planned documentation is encouraged, provided it adequately describes and controls all parameters of the interface. If the documentation is not adequate, revisions may be required. If the interface is very complex, Interface Control Documentation (ICD) will be initiated to define and control the interface. Design and/or Systems Engineering shall be responsible for the preparation of ICD's if required.

VIII. INTERFACE CONTROL

Each contract external interface must be controlled on both sides of the interface. Any change to an external interface is, by definition, a Class I change and falls under the Configuration Management System assuring assessment of proposed changes by all parties in the interface.

Configuration Management shall assure that proposed changes to any external interface are reviewed and assessed by all responsible participants of that interface, including Interface Management, prior to the presentation to the Change Control Board.

IX. CONTRACT INTERNAL INTERFACES

Each contracting unit (system, construction, or procurement) shall be required, by contract, to address interfaces, both internal and external to that contract. Each contracting unit shall be responsible for the interfaces within the bounds of the contract (internal interface). This plan should be used as a guide by the contracting unit in planning, and maintaining Interface Management for that contract unit.

X. INTERFACE NUMBERING

A unique number shall be applied to each external interface that will:

A. identify that interface as a total entity and as separate parts.

B. recognize that interface as a separate entity, but easily associate it with duplicate interfaces elsewhere in the project.

This numbering system will be devised and applied by MRTC Interface Management; an example of this numbering system is located under Appendix A.

XI. RESPONSIBILITIES

Implementation of this plan requires a closely coordinated effort from the various disciplines and departments of MRTC. Primary responsibilities for the various phases of this task are depicted in Figure 1.

CONTRACT EXTERNAL/INTERNAL INTERFACE RESPONSIBILITY CHART

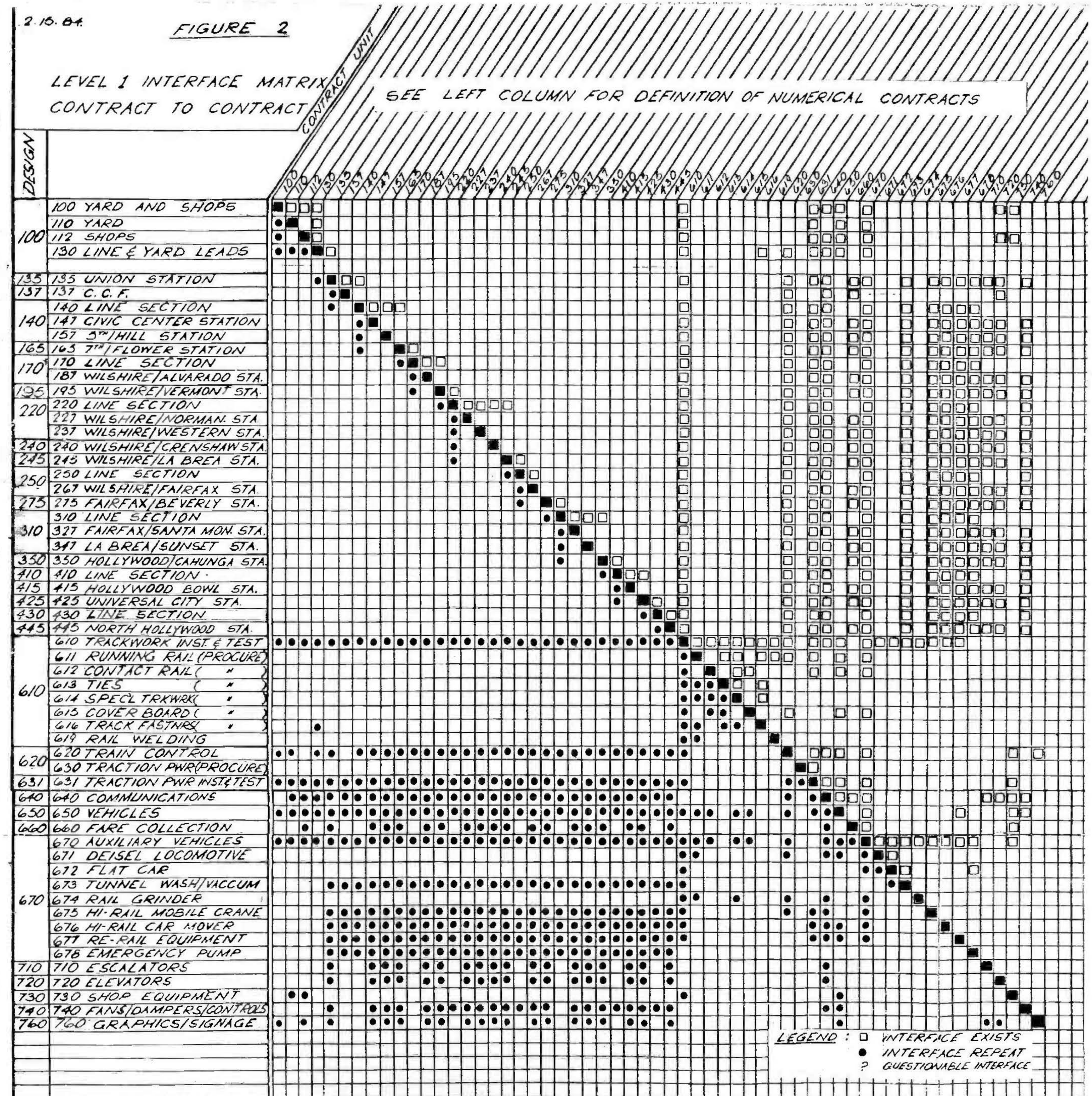
DISCIPLINE	IDENTIFICATION/DOCUMENTATION			CONTROL	TEST
	LEVEL 1 MATRIX Contract vs Contract	LEVEL 2 MATRIX Contract vs Contract Element Breakdown	INTERFACE DATA SHEET Each Interface parameter limit		
INTERFACE MANAGEMENT	Prime	Prime	Support/Integrator	Review	Support
DESIGN	Support	Support	Prime		Support
CONFIGURATION MANAGEMENT	Support	Support	Support	Review	Control

FIGURE 1

2.15.84

FIGURE 2

LEVEL 1 INTERFACE MATRIX
CONTRACT TO CONTRACT



2.II.3. FIGURE 3

LEVEL II MATRIX
CONTRACT ELEMENT BREAKDOWN VS CONTRACT UNITS

ELEMENT:

PROJECT CONTRACT UNITS

- A100 YARD & SHOPS
- A110 YARD DEMOL/GRADING
- A112 YARD & SHOPS CONSTRUCT.
- A130 LINE & YARD LEADS
- A137 C.C.F.

STATIONS

- A135 UNION STATION
- A147 CIVIC CENTER STA.
- A157 5TH/HILL STA.
- A165 7TH/FLOWER STA.
- A187 WILSHIRE/ALVARADO STA.
- A193 WILSHIRE/VERMONT STA.
- A227 WILSHIRE/NORMANDIE STA.
- A237 WILSHIRE/WESTERN STA.
- A240 WILSHIRE/CRENSHAW STA.
- A245 WILSHIRE/LA BREA STA.
- A267 WILSHIRE/FAIRFAX STA.
- A275 FAIRFAX/BEVERLY STA.
- A327 FAIRFAX/SANTA MON. STA.
- A347 LA BREA/SUNSET STA.
- A350 HOLLYWOOD/CAHUENGA STA.
- A415 HOLLYWOOD BOWL STA.
- A423 UNIVERSAL CITY STA.
- [illegible] WOOD STA.

LINE SECTIONS

- A170 LINE
- A220 LINE
- A330 LINE
- A310 LINE
- A410 LINE
- A430 LINE

TRACKWORK

- A610 BALLAST & TIES
- A611 RUNNING RAIL
- A612 CONTACT RAIL
- A613 TIES
- A614 SPECIAL TRACKWORK
- A615 COVER BOARDS
- A616 TRACK FASTENERS
- A620 TRAIN CONTROL
- A630 TRACTION POWER (PROCURE)
- A640 TRACTION POWER INST/TEST
- A650 COMMUNICATIONS
- A660 VEHICLES
- A670 FARE COLLECTION

AUX. VEHICLES

- A671 AUX. VEHICLES
- A673 DIESEL LOCOMOTIVE
- A674 FLAT CAR
- A675 TUNNEL WASHER/VACUUM
- A676 RAIL GRINDER
- A677 HI-RAIL MOBILE CRANE
- A678 HI-RAIL CAR MOTOR
- A680 EMERGENCY EQUIPMENT
- A685 EMERGENCY PUMP
- A690 ESCALATORS
- A700 ELEVATORS
- A710 SHOP EQUIPMENT
- A720 FANS/DAMPERS/CONTROLS
- A730 GRAPHICS/SIGNAGE

INTERFACE DATA SHEET

____________ SYSTEM SUBSYSTEM: ____________ CONTRACT NO.: ____________ SPEC. REF.: ____________	LOCATION: IDS CROSS REF.:	INTERFACE NO. TYPE: TECHNICAL ☐ PHYSICAL ☐ CLASS: I ROUTINE ☐ II COMPLEX ☐
INTERFACES WITH: ____________ CONTRACT NO.: ____________ SPEC. REF.: ____________	ATTACHMENTS:	

FUNCTIONAL DESCRIPTION:

TECHNICAL SPECIFICATIONS:

PHYSICAL DESCRIPTION:

ORGANIZATION CONTACTS:

COMMENTS:

REFERENCES:

REVISION		PREPARED BY		IMPLEMENTATION RESPONSIBILITY (Third Party):
NO.	DATE	INITIALS	DATE	

FIGURE 4

APPENDIX A

INTERFACE NUMBERING

1. INTRODUCTION

Large and complex projects involving many contracts require close attention to interfaces between those contracts. Each interface crossing contractual boundaries (external interface), physically or functionally, shall have a unique identification number assigned to it. This reference number shall be utilized to reduce confusion and allow easy reference to a specific interface by all participants in that interface.

2. SCOPE

This procedure applies to all external interfaces of the SCRTD Metro Rail Project and should be used as a guide in the treatment of interfaces totally internal to a contract.

3. RESPONSIBILITY

MRTC Interface Management shall:

- ° Maintain the Master Rail Project Interface List (MRPIL).
- ° Apply the appropriate interface number to each identified external interface.

MRTC Systems and Facilities Design Divisions shall:

- ° Provide the parameters and parameter limits for each external interface identified.

4. MASTER RAIL PROJECT INTERFACE LIST (MRPIL)

4.1 MRPIL OUTLINE

I. - Introduction
II. - Level I Interface Matrix - (Figure 2)
III. - Level II Interface Matrices - (Figure 3)
IV. - Standard Element Breakdown - (Appendix A)
V. - Divisions per Contract Unit
A. Subdivisions per Interfacing Contract Units
B. Subsets per Standard Element Breakdown

The MRPIL shall be developed by MRTC Interface Management in conjunction with the MRTC Systems and Facilities Design Divisions. This document shall be maintained by MRTC Interface Management and shall be available upon approved request to parties with vested interest.

4.2. The MRPIL shall be composed of Interface Data Sheets, IDS (reference figure 4). Each IDS containing the pertinent data for each external interface.

4.3. The major divisions of the MRPIL shall be the contracting units identified in the Contract Unit Description.

4.4. Subdivisions of each division shall be each contract unit that such division interfaces with and include other external interfaces including, but not limited to the following:

Bus
Sewage
City Water

4.5. Each subdivision shall be further divided into its elements as per the SCRTD Metro Rail Project Standard Element Breakdown. (Appendix A).

5. INTERFACE NUMBERING

The number applied to each interface shall consist of a 12 digit number as defined below:

Contract Unit	Interfacing Contract Unit	Standard Breakdown	Interface Number
EXAMPLE 1 9 5 Wilshire/Vermont Station	7 1 0 Escalators	0 3 Electrical	0 0 0 1 First Electrical interface identified at Wilshire/Vermont Station with the escalators.

STANDARD CONTRACT ELEMENT BREAKDOWN

INTRODUCTION - This standard breakdown will allow a unified approach to identify interfaces which physically or functionally cross SCRTD Metro Rail Project contract boundaries or limits.

A610 TRACKWORK INSTALLATION & TEST

Running Rail (A611)

Rail Welding (A617)

Contact Rail (A612)

- Insulators
- Associated Hardware

Coverboards (A615)

Ties (A613)

- Fasteners
  - Yard
  - Mainline

Special Trackwork (A614)

Yard Trackwork (Later)

- Ballast
- Stopping Devices
  - Sand Box
  - Bumping Posts
- Turn-outs
- Cross-over

A620 AUTOMATIC TRAIN CONTROL

Automatic Train Protection

- Vehicle Detection
- Vehicle Separation
- Speed Limit Selection
- Safe Passage Through Switches and Interlocking
- Over Speed Protection
- Brake Assurance
- Vehicle Door Interlock
- Roll Back

Automatic Train Supervision

- Auto and Manual Dispatch at Terminals
- Train/Wayside Communications
- Auto-Routing and Traffic Control at Turn Back
- Monitor and Display of Train Movement and Route Alignment
- Status and Alarm Display
- Dwell Control
- Enter and Exit (NX) System Computer Software

Track Switches and Signals

Note

The above will be placed on hold pending Element Breakdown by the responsible Engineer for contract A620.

A630/631 TRACTION POWER

A630 - FURNISH

Emergency Trip Equipment

DC Distribution Panelboards

Negative Bus Boxes

Annunciator Panels

DC Disconnect Switches

Wire and Cable

Cable Splices and Terminations

Raceway: Systems

Supports

Accessories

A631 - PROCUREMENT

Traction Power

- ° High Voltage AC Switchgear
- ° AC - DC Convertors
  - ° Mainline
  - ° Yard-Shops
- ° DC Switchgear
- ° Battery and Accessories

Auxiliary Power Equipment

- ° Aux. Power Transformer
- ° 480V Switchgear

A630 - INSTALLATION AND TEST

Applies to all the above

A640 - COMMUNICATIONS

Radio

- ° Base Stations
- ° Train Radios
- ° Other Vehicle Radios
- ° Portable Radios
- ° Pager Receivers

Cable Transmission

- ° Fiber Optic Cable
- ° Coaxial Cable
- ° Multiplex Equipment

SCADA

- ° Remote Terminal Units (RTU's)
- ° Central Data Processing
- ° Software

Telephones

- ° PABX
    - ° Administrative
    - ° Emergency
    - ° Customer Assistance
    - ° Maintenance
    - ° Special Services
- ° Public
- ° Fire

Public Address

CCTV

Fire and Intrusion

- Fire Detection
- Intrusion Detection
- Fire Suppression
- Controlled Access
- Emergency Management Panel

Gas and Seismic

- Combustible Gas Detection
- Hydrogen Sulfide Detection
- Seismic Detection

Central Control and Yard Control

- CCF Consoles
- CCF Displays
- CCF Voice Recorders
- Yard Consoles
- Yard Display

Local Wire/Cable

A650 - VEHICLES

Carbody

Furnishings

Trucks and Suspension

Couplers, Drawbars, and Draft Gear

Aux. Electrical Apparatus

Propulsion

Braking

Auto. Train Control

Communication

HVAC

Graphics/Signage (A760)

Doors

Oper. Cab and Controls

Automatic Train Operation

- Speed Regulation
- Program Station Stop
- Mode Control

A660 - FARE COLLECTION

Gates

- ° Regular
- ° Handicapped

Ticket Vendors

Addfare Machines

Bill Changers

Counters

- ° Coin
- ° Bill

Magnetic Encoders

Auto. Fare Collection Control

Central Data Processor

Revenue Carts

Revenue Transport Vehicles

Ticket Verifier

A670 - AUXILLARY VEHICLES

Diesel Locomotive	(A671)
Flat Car	(A672)
Tunnel Wash and Vac	(A673)
Rail Grinder	(A674)
Hi-Rail Mobile Crane	(A675)
Hi-Rail Car Mover	(A676)
Re-Railing Equipment	(A677)
Emergency Pump Equipment	(A678)
Rubber-Tire Fleet	
Hi-Rail Track Geometry Car	
Aux. Generator Apparatus	
Refuse Collection Vehicle	
Revenue Collection Vehicle	

A710 - ESCALATORS

Mechanical

Electrical

Safety Devices

Openings

Structural Support

A720 - ELEVATORS

Mechanical

Electrical

Safety Devices

Openings

Structural Support

A730 SHOP EQUIPMENT

Fixed

Mobile

A740 - FANS, DAMPERS, AND CONTROLS

Mid-Tunnel

Emergency

Under-Platform

Vent Shafts

ALL - STATIONS

- Mechanical Equipment
- Electrical Equipment
- Communication Equipment
- Architectural Finish
    - Ceiling
    - Floors
    - Walls
- Fire Protection
- Graphics/Signage (A760)
- Utilities
    - Water
    - Sewage
    - Electricity
    - Natural Gas
- UPS
- Emergency Service Gate
- Lighting
- Landscaping
- Parking
- Bus
- Telephones (Public)
- Vending Machines
- Kiss and Ride
- Platform

ALL STATIONS (CONT'D)

- Trail Tracks
- Cross-Overs
- Pocket Track
- Track Fixation
- Mezzanine/Concourse
- Ancillary Rooms
- Vent Shafts
- Heating/Air Conditioning
- Emergency Management Panel
- Passageway
- Stairs

ALL LINE SECTIONS

Tunnel Liner

Race Ways

Vent Shafts

Cross - Passages

Lighting

Track Fixation

Walkway

Handrail

Graphics/Signage (A760)

Drainage

Fire Protection

Invert

Acoustics

Yard Leads

A100 - MAIN YARD AND SHOPS

Construction Train Storage Yard	(A110)
Shops	(A112)

A110 - CONSTRUCTION TRAIN STORAGE YARD

Demolition

Grading

Drainage

Utility Relocation

A112 SHOPS

Yard Control Building (Tower)

Maintenance-of-Way Building

Vehicle Wash Facility

Light Repair

Service and Inspection

Major Repairs

Traction Power Substation

Main Shop Building

Exterior Lighting

Fire Protection

Security

Fuel Storage

Blowdown Facility

Miscellaneous Shops

Systems-Wide Stores

Car Cleaning Building

Graphics/Signage (A760)

A 137 - CENTRAL CONTROL FACILITY

Mechanical Eq. Room

Electrical Eq. Room

Fire Command Console

Operations Room

Communications Room

Transit Police Room

Data Processing Room