

27842149

ESTIMATING METHODOLOGY AND PROCEDURES

WBS 14AAE

Prepared by:

DMJM/PBQD
Ways & Structures Consultant

February, 1983

2/4/83

TABLE OF CONTENTS

<u>Chapter</u>	<u>Page No.</u>
1.0 INTRODUCTION	1
2.0 ESTIMATE STRUCTURE	3
3.0 QUANTITY SURVEY	10
4.0 DIRECT COST ESTIMATE	34
5.0 INDIRECT COST ESTIMATE	36

ESTIMATING METHODOLOGY AND PROCEDURES
FOR THE
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT

1.0 INTRODUCTION

1.1 BACKGROUND

The Southern California Rapid Transit District (SCR TD) is in the preliminary engineering phase of a rapid transit starter line project in Los Angeles. To assist in this effort, SCR TD selected three primary general consultants, each with specific disciplinary responsibilities, to serve under the direction of an SCR TD deputy to the Chief Engineer. The specific disciplines are: Ways and Structures, Stations, and Subsystems. Even though each of these disciplines is, in a sense, independent, there are obvious areas of overlap and interdependence. These overlapping areas require the efforts of the groups responsible for the said disciplines to be fully coordinated and compatible.

One such area of overlap and interdependence is cost estimating. SCR TD will have the ultimate responsibility for coordinating and compiling the overall Metro Rail Project cost estimate. However, to facilitate this effort, the entire team must use a common approach and methodology to ensure that cost estimates produced by each disciplinary group are compatible and consistent in level of detail.

1.2 PURPOSE

The purpose of this Technical Report is to develop a uniform cost estimating methodology for use in the Metro Rail Project. The methodology includes various levels of cost estimating including concept, pre-preliminary and final preliminary estimates in terms of level of detail required, appropriate units, and contingency factors to apply.

1.3 TYPES OF ESTIMATES

1.3.1 Concept Estimate

The concept level estimates are prepared using gross units (i.e., per foot of double track line structure complete, per station (by type of station), per foot of track complete). Basic unit costs will be developed using the typical sections and designs rather than specific conditions; however, factors such as depth of cut

and cover section and tunnel construction methods must be reflected. These estimates will include allowances for all system items such as train control and traction power. Passenger vehicles may be costed as a separate line based primarily on numbers of vehicles required. Concept estimates will carry a 20 percent contingency and are primarily used in comparing alternatives on an order of magnitude cost basis.

1.3.2 Pre-Preliminary Estimates

Pre-preliminary estimates will be developed from 1" = 200' profile and architectural drawings or equivalent equipment descriptions such as block diagrams of systems or major functional capabilities. These estimates will be developed by quantity take-offs in appropriate units. Prepreliminary estimates may be required at several points through preliminary engineering to first establish an overall budget range and then to check design progress to ensure that the project remains within budget limits as design becomes more refined and definitive. Generally, pre-preliminary estimates will carry 20 percent contingency factors.

1.3.3 Final Preliminary Estimate

The final preliminary estimate will be prepared from 1" = 40' engineering and architectural drawings and the equivalent of more definitive descriptions of subsystems. These drawings will represent working drawings at approximately 30 percent completion, will be fully dimensioned, and will functionally describe the proposed systems. In addition, some details and finish schedules will be available. These drawings will permit accurate quantity take-offs and definition of fabrication/installation/construction methods. Generally, the final preliminary estimate will carry 15 percent contingencies.

2.0 ESTIMATE STRUCTURE

In general, all estimates will be prepared to identify those costs associated with the actual contracts for procurement, installation, and/or construction including all direct, indirect, contractor markup, and other elements of construction. Appropriate contingency items such as escalation to mid-point of complete contract packages, engineering and agency costs, and a factor of contingency will then be added to produce a total estimated project cost.

The general consultants will be responsible for preparing the cost estimate within their particular disciplinary areas (ways and structures, stations, subsystems) for submission to the respective SCRTD managers. In addition, the consultants may be required to provide partial estimates or cost data to other consultants when necessary to produce a complete cost estimate in the primary area. (For example, electrical equipment installed in stations, emergency systems installed in tunnels.)

2.1 PRIMARY RESPONSIBILITIES

Primary responsibilities within each disciplinary area include the following items:

2.1.1 Ways and Structures

The ways and structures consultant has primary responsibility for the cost of the following items:

1. Demolition
2. Maintenance and control of traffic
3. Clearing and grubbing
4. Utility work - existing and new installation
5. Underpinning
6. Station shells
7. Line structures
8. Yards
9. Shop buildings including all maintenance equipment, both fixed and portable
10. Track work
11. HVAC - fans, dampers, and equipment
12. Corrosion control
13. Noise and vibration

14. Surface restoration
15. Electrical - all trainway lighting, water removal, ventilation and power convenience outlets including conduits, control and power wiring, and operating assemblies (detectors, pump, fans, etc.)
16. Fire Protection - trainway wet and dry lines, sprinkler and gas or fire detection systems including all power and control wiring to a point of interface.
17. Conduits and Walkways - all conduits and patron or employee walkways located in the trainway.

2.1.2 Stations

The stations consultant has primary responsibility for estimates for the cost of the following items:

1. Station wall, floor, platform and ceiling treatment
2. Entrance plaza - walkway and canopies
3. Station lighting fixtures, conduits, and wiring
4. Landscaping
5. Signing and graphics - station and parking areas
6. Mapping
7. Art work
8. Modular equipment and benches
9. Ornamental metals, railings, grills, gates, doors
10. Parking lots (bus, kiss and ride facilities)
11. Plumbing and mechanical distribution systems for station facilities
12. Conduit and piping required for systemwide elements such as fire protection, fare collection, and security systems
13. Elevators
14. Escalators
15. Janitor/toilet room furnishings
16. Ancillary space such as mechanical rooms, equipment rooms, and control rooms, as necessary to house various systems and subsystems including traction power equipment

17. Electrical - complete station auxiliary electrical systems from the power source including switchgear, panels, fixtures, and wiring. Functions to be included are intrusion detection, lighting, clocks, and HVAC control and power
18. Fire protection systems - halon, wet lines, dry lines, portable extinguishers, sprinklers, and fire detectors including all power and control wiring to a point of interface
- 19 Security systems

2.1.3 Subsystems

The subsystems consultant has primary responsibility for estimates for the following items:

1. Passenger vehicles
2. Auxiliary vehicles
3. Traction power and distribution including contact rail, cover-board and mounting provisions
4. Train control systems
5. Communications systems
6. Fire and intrusion management - fire and intrusion management panels, wiring to the data transmission system (communications), and wiring to an interface point for fire detectors, flow switches, valve tamper switches, halon units, and intrusion devices
7. System testing
8. Start-up and training
9. Station control center booth
10. Fare collection systems
11. Operational graphics - all signs or lighted displays in/on the trainway and yard including non-patron oriented signage in stations and shop areas

2.2 GENERAL DEFINITIONS

In preparing the estimates, the following general items will be included. Each of the items, as defined below, applies to all levels of estimates (i.e., concept, pre-preliminary and final preliminary), except the level of breakdown will vary as will the level of detail in the quantity breakdown. Each of these general items is discussed more fully in subsequent chapters.

2.2.1 Construction Schedule

The construction schedule is a bar chart of the major items of work. The schedule must be developed jointly by the general consultants and the SCRTD personnel so that it adequately considers all system components. The schedule should reflect, to the extent possible, categories of work and level of detail consistent with the cost estimate. As preliminary design progresses, the schedule will become more detailed.

2.2.2 Quantity Survey

The quantity survey is the quantity take-off -- the process of identifying, measuring, and calculating quantity information from drawings and/or specifications. Chapter 3 discusses quantity survey requirements and procedures in detail.

2.2.3 Direct Costs

The direct costs section is that part of an estimate in which the actual fabrication, installation, and construction costs of the individual pieces of a job are analyzed. The direct costs are developed as explained in Chapter 4.0. The quantity survey is the basis for the direct costs estimate.

2.2.4 Indirect Costs

(Sometimes called overhead costs.) That part of the estimate that analyzes the supervision, engineering, quality control, testing, software requirements, mobilization, job office, and such costs that cannot be charged to any particular bid item in the contract is known as the indirect costs section. The indirect costs must be spread evenly, as a percentage of direct cost, to each direct cost item. Chapter 5 discusses the development of indirect costs in detail.

2.2.5 Markup

The profit that the contractor expects to earn for his effort and expertise in building the work is known as markup. Markup is expressed in terms of a percent of the combined direct and indirect costs and is influenced by the ratio of labor to total cost. Work with a low labor/cost ratio, such as normal building construction and fabrication/installation of equipment, will carry a markup of 2 percent to 10 percent. Normal heavy construction work, such as cut and cover station work, will carry a markup of 10 to 12 percent. Tunnel work, with a relatively high labor/cost ratio, generally has a markup of 20 percent. Markup can also be influenced by economic conditions existing at the time of bidding. However, this can be forecast on only very short-term conditions.

2.2.6 Design Contingency

The contingency is stated in terms of percent of total bid dollars. The design contingency is applied as an allowance for uncertainties of design during the earlier stages of design. The need for this allowance disappears as the design progresses toward the 100 percent level. Since the final preliminary estimate level will approach the normal 30 percent level of design, a design contingency of 20 percent should be applied to the pre-preliminary estimate and a design contingency of 15 percent should be applied to the final preliminary estimate.

2.2.7 Escalation

Escalation is an additive factor applied to a contractor or project budget to cover increases in cost that can be expected to take place between the time the budget or estimate is prepared and the time the work will actually be constructed. Escalation protects the integrity of the estimate against higher costs resulting from increases in labor, permanent materials, equipment, fuel, interest, etc. All estimates are prepared in current day (1982) dollars and escalation is applied as a one-line item to the developed total project cost. It is recommended that the estimates prepared for this project be escalated to mid-point of construction or time of procurement by factors established by SCRTD.

2.2.8 Design and Construction Management Costs

Design and construction management costs are those project indirect costs for project design and for procurement and construction management during the construction phase. These costs can be estimated as a percentage of total facilities (including vehicles) cost, escalated to time of construction in the following manner: design, consulting, and construction management are estimated to be 13 percent.

2.2.9 Agency Costs

The project indirect costs for the SCRTD administration are known as agency costs. These costs are estimated to be 5 percent.

2.2.10 Insurance Costs

Insurance costs are the costs of insuring the facilities and contractors during construction for Employers Liability and General Builders Risk. This insurance is generally referred to as wrap-up insurance and is estimated to be 4.2 percent. This percentage is in accordance with the report entitled "Insurance Alternatives Analysis for the Construction of the Southern California Rapid Transit District Metro Rail Project" prepared for the District by David Ashley, January 4, 1982.

2.2.11 Real Estate Acquisition

The project direct cost of acquiring needed real estate for right-of-way and appurtenances of the facilities. This cost will be determined by the District based on right-of-way requirements and cost estimates developed by the special consultants for the District.

2.3 GENERAL ESTIMATE SUMMARY

Upon completion of estimation of all direct costs an Estimate Summary shall be prepared listing all direct costs summarized by category (see Example "A"), and a grand total of the direct costs entered under a heading entitled "Direct Costs". To this subtotal shall be added all other indirect costs as detailed below.

2.3.1 Indirect Costs (Overhead)

Indirect costs shall be entered as a lump sum figure derived from actual calculations or expressed as a percentage of the total of all direct costs. (See Chapter 5.0.) The sum of the direct costs and the indirect costs shall be entered as a subtotal.

2.3.2 Bonding

Bonding shall be entered as 1.0 percent of the subtotal of direct costs and indirect costs. A new subtotal shall be entered as the sum of bonding, direct cost, and indirect costs.

2.3.3 Markup (General Contractor Profit)

General contractors profit shall be entered as a product of the appropriate percentage (See Section 2.2.5) of the above subtotal. The sum of the General Contractors Profit and the above subtotal shall be in turn entered as a subtotal.

2.3.4 Contingency

Contingency shall be expressed as a percentage of the subtotal in 2.3.3 above. (See 2.2.6.) Contingency shall be added to the subtotal above and the resultant sum entered and titled "Total Project Cost".

2.3.5 Disclaimers

The following statement shall be entered below the title "Total Project Cost":

Above costs based on mid-1982 price and conditions without application of escalation, engineering costs, agency costs, or real estate acquisition.

DMJM/PBQD

CONSTRUCTION COST ESTIMATE

SUMMARY

DATE AUG/82

NAME METRO RAIL PROJECTS

LOCATION N. HOLLYWOOD, CA

SUBJECT STATION "J"

JOB NO. WBS-14-BAE PHASE CONCEPTS

PAGE OF

Item	Description	Quantity	Unit	Unit Cost	Estimated Cost	Totals
<u>SUMMARY - STATION "J"</u>		<u>571' L x 64' W x 45' D @ 9' DEPTH</u>				
	<u>DEMOLITION</u>				<u>\$ 23,000 -</u>	
	<u>SHORING</u>				<u>261,360 -</u>	
	<u>UNDERPINNING</u>				<u>221,440 -</u>	
	<u>EARTHWORK</u>				<u>1278,600 -</u>	
	<u>CONCRETE WORK</u>				<u>429,210 -</u>	
	<u>STRUCTURAL STEEL</u>				<u>333,170 -</u>	
	<u>FIRE PROOFING</u>				<u>162,000 -</u>	
	<u>METAL DECKING</u>				<u>170,200 -</u>	
	<u>SITE RESTORATION</u>				<u>115,800 -</u>	
	<u>UTILITIES SUPPORT</u>				<u>371,200 -</u>	
	<u>TRAFFIC MAINTENANCE</u>				<u>14,000 -</u>	
	<u>DIRECT COST -</u>					<u>\$ 14,586,600 -</u>
	<u>GENERAL CONTRACTORS OVERHEAD</u>		<u>@ 10.0 %</u>			<u>\$ 1,458,700 -</u>
	<u>BONDING</u>		<u>@ 1.0 %</u>			<u>\$ 160,500 -</u>
	<u>GENERAL CONTRACTORS PROFIT</u>		<u>@ 4.0 %</u>			<u>\$ 648,200 -</u>
	<u>SUB-TOTAL</u>					<u>\$ 16,854,000 -</u>
	<u>CONTINGENCY</u>		<u>@ 20.0 %</u>			<u>\$ 3,371,000 -</u>
	<u>TOTAL</u>					<u>\$ 20,225,000 -</u>
<p><u>ABOVE COSTS BASED ON MID 1982 COSTS & CONDITIONS</u> <u>WITHOUT APPLICATION OF - ESCALATION, ENGINEERING COSTS,</u> <u>AGENCY COSTS OR REAL ESTATE ACQUISITION COSTS.</u></p>						
<p>Amounts Forwarded</p>						

3.0 QUANTITY SURVEY

3.1 QUANTITY SURVEY FORMS

3.1.1 Construction Type Contracts

Quantities should be taken off in a systematic manner, using Standard Form #1 for construction type contracts. The forms provide spaces for identification of the contract, the structure, the estimator, the date, and sheet numbering. The forms include a description column to identify and describe the particular item being measured; a number of pieces column; dimension columns for length, width, and depth; and then a number of blank item columns. The blank item columns should be assigned a heading to identify the particular type and quantity of material being identified (e.g., rock excavation, bottom slab concrete, exterior wall concrete, 2" rigid P.V.C. conduit) and the unit of measure used (cubic yards, cubic feet, lineal feet, square feet, each). Quantity survey forms are applicable only to the pre-preliminary estimates and the final preliminary estimate. Concept level estimates based on aggregate units (such as per foot of track work) will be developed on a single form containing quantities, units costs, and total costs as described in a subsequent chapter.

3.1.2 Design, Fabrication, and/or Installation of System Equipment Contracts

Quantities should be taken off in a systematic manner, using Standard Form #2 for contracts involving the design, fabrication, and/or installation of system equipment. Different from Standard Form #1 used for construction items, Standard Form #2 emphasizes equipment functions and descriptions of features that affect costs. Particular attention will be directed at defining contract limits in those cases where close interfaces exist with other work items. Similar to the construction estimating process, the quantity survey forms will only be applicable to the prepreliminary and final preliminary estimates. Concept level estimates will be based on general system/equipment descriptions and gross measures (length of electrified track, numbers of vehicles, etc.) and will similarly be developed on a single form.

3.1.3 General

Quantity units should be totaled at the bottom of each sheet for all items on the sheet, and a summary sheet tabulating take-off totals for groups of related items should be made. Drawing dimensions should be used to determine the size of a quantity, rather than scaling the drawings. On the pre-preliminary estimate drawings (1" = 200') dimensional detail will be lacking. The estimator will

find it necessary to estimate certain quantities based on standard or estimated relationships. For example, reinforcing steel may not be detailed in concrete exterior walls. The estimator will then estimate reinforcing steel on the basis of an agreed upon designated steel ratio per cubic yard in the exterior wall. Ratio and assumption must be noted on the quantity sheets.

Identification of both "neat" and "overbreak" quantities is an essential part of the quantity survey. Neat quantities are determined from dimensioned lines. Overbreak quantities allow for over excavation and are determined from judgment. In taking-off excavation quantities, both rock and common, it is essential that the neat and overbreak quantities be accounted for separately. The same is true for concrete quantities that are poured against excavation. Quantity surveys will be made for the following levels of estimate:

- Pre-Preliminary (1"= 200')
- Final Preliminary (1"= 40')

Quantity surveys of equipment/systems will have a corresponding increase in detail available as previously discussed in Section 1.3.

The difference between the two levels of estimate (pre-preliminary and final preliminary) is the degree of accuracy that is possible in the quantity survey for each due to the degree of design detail available. As indicated, the pre-preliminary estimate take-off may require the estimator to assume factors or other approximation methods for some quantities. To a lesser degree, some assumptions may be necessary in the take-off for the final preliminary estimate. However, all such assumptions or approximations must be clearly noted and explained. The methods for developing quantity surveys for pre-preliminary and final preliminary estimates are discussed below.

3.2 SPECIFIC ESTIMATE QUANTITIES - WAYS AND STRUCTURES

3.2.1 Demolition

Demolition is the removal of structures, buildings, retaining walls and other obstacles prior to start of construction. The hauling and dumping of demolition rubble and the dump charge for the same is a cost. Removal and/or relocation of underground and overhead utilities is a utility cost and not considered a demolition cost and is described in Section 3.2.4. Demolition items should be identified as follows:

- a. Pre-preliminary streets, sidewalks, driveways: square yard, type of material. For final preliminary add thickness.
- b. Pre-preliminary and final preliminary buildings: cubic foot, type of building, number of stories.

- c. Pre-preliminary retaining walls: lineal feet, type; final preliminary retaining walls: cubic foot, type.
- d. Pre-preliminary utility plugs: use an allowance unless building information is readily available.

3.2.2 Maintenance and Control of Traffic

Traffic patterns specified on the drawings for vehicles and pedestrians, where normal patterns will be interrupted or detoured, constitute a cost. The costs will consist of barricades, signs, temporary vehicle and pedestrian lights, temporary paving and walkways, pavement striping, and flagmen. When traffic maintenance is not shown on the plans and for the pre-preliminary estimate, an allowance of 1/2 of 1 percent of contract total is sufficient. The unit of measure for the final preliminary should be as follows:

- a. Barricades: lineal feet, type, and number of moves
- b. Signs: each
- c. Traffic lights: each
- d. Temporary surface paving: square feet, thickness, type
- e. Pavement striping: lineal feet
- f. Flagmen: person-day

3.2.3 Clearing and Grubbing

The area of a construction site that is overgrown with foliage, brush, scrub trees, and large trees that must be removed prior to commencing earthwork. The material must be disposed of in an approved manner, generally in a land fill for which there will be a dump charge. When clearing and grubbing is not shown on the plans and for pre-preliminary estimates, an allowance of 1/10 of 1 percent of the contract total is sufficient. For the final preliminary estimates, areas requiring clearing and grubbing will be identified. The unit of measure for the final preliminary estimate is the acre.

3.2.4 Utility Work

The quantity survey for utility work requires a take-off of existing utilities within the area of the construction site that must be relocated, temporarily or permanently, or supported in place and maintained. Utility work will also include all new Public Service Utilities required to service the new structure, but does not include any utilities within the new structure, which are taken off as either electrical, plumbing, or mechanical bid items. If

utility work is not detailed on the plans, an allowance of 4 percent to 6 percent of contract total is usually sufficient. For prepreliminary estimates, available utility drawings from utility companies and cities will be adequate to determine quantities. For the final preliminary estimate, field investigation is desirable. The types of utilities and the units of measure are:

- a. Storm and sanitary sewers: lineal feet, diameter, type of pipe, cubic yards of trench excavation, square feet of support of excavation
- b. Water, gas and steam lines: lineal feet, diameter, type, pressure, cubic yards of excavation, and square feet of support of excavation
- c. Electric duct lines for power, telephone, telegraph, traffic lights, police, and fire: lineal feet, type, size and number of ducts, cubic yards of excavation and square feet of support of excavation
- d. Manholes for all types of utilities: lineal feet, type, size
- e. Catch basins and storm drains: each, type, size
- f. Overhead power and utility lines: number of wires, poles, guywires

3.2.5 Underpinning and Compaction Grouting

Certain structures adjacent to the line will require underpinning and support or compaction grouting beneath their foundations when the normal ground support system employed is insufficiently stiff to prevent damaging settlements.

For the final preliminary estimate, recommended methods and preliminary schemes will have been detailed and the following measurements should be used:

- a. Root piles: number, size, length
- b. Jacked-down piles: number, size, length
- c. Steel wedging beams: pounds
- d. Concrete pile caps: cubic yards of concrete, pounds of reinforcement
- e. Underpinning pits: cubic yards of excavation, cubic yards of concrete
- f. Shoring: board feet of lumber

g. Drilling: lineal feet of drilling

h. Injection: cubic feet of grout.

3.2.6 Station Structures

These structures comprise the main station box, ventilation shafts, entrance structures, and adjacent power substations when these are located contiguously with the station boxes. They should be measured as follows:

a. Excavation: cubic yards in each formation

b. Dewatering: a lump sum allowance where dewatering is proposed

c. Support of excavation: square feet of the chosen support system (soldier piles and logging, slurry walls, etc.); number, size, length of sheets, tie backs, etc. For pre-preliminary estimates an allowance of approximately \$30.00 per square foot of ground support is usually sufficient.

d. Decking: number, size and pounds of deck beams; square yards and size of decking timber. For pre-preliminary estimates or if the decking system is not designed on the plans, a square yard measure of decking should be calculated.

e. Backfill: in cubic yards

f. Concrete: for the pre-preliminary estimate, if the detail on the plans is not sufficient to accurately measure all of the elements of concrete cost, then the concrete should be taken off by function in cubic yards and suitable costs per cubic yard can be applied as follows:

1. Architectural concrete @ \$210

2. Slab on grade @ \$120

3. Exterior wall @ \$170

4. Interior wall @ \$290

5. Supported slab @ \$300

6. Supported roof slab @ \$250

7. Platform @ \$300

For the final preliminary estimate, concrete shall be measured in cubic yards and the functional type of concrete (e.g., slab

on grade, exterior wall, interior wall, supported slab, platform, stair, and miscellaneous concrete. Also, concrete pours that are repetitive in function should be taken-off as a unit and the number of repeated pours so noted. All supported slab concrete, by definition, requires false work support. The false work support area should be taken-off in cubic feet and is the product of the supported bottom form (length and width) times the depth to the level from which the false work can be constructed. Over break concrete should be separated from neat line concrete. All concrete quantities in the separate categories of function should have the form work taken-off in square feet of contact area and listed with the functional concrete take-off. There are many miscellaneous additional costs involved in concrete construction that must be accounted for, such as:

1. Concrete cure - measured in square feet and is the sum of all contact formed area plus all concrete finished areas.
 2. Concrete finish - measured in square feet and is the surface area of concrete, in place, that will receive a screeded, float or trowel finish, and the area of concrete bond (where a new pour is placed against previously placed concrete and bonding is required) and the point and patch area measured in square feet, which is the sum of all exposed formed areas. Each type of finish must be taken-off and listed separately on the take-off form.
- g. Reinforcing steel: measured in pounds. (Steel ratio may be used where steel details are not available.)
- h. Water proofing: in square feet
- i. Structural steel: in pounds, member size
- j. Miscellaneous metal: in pounds
- k. Sheet metal duct work: in pounds, and any insulation in square feet
- l. Embedded pipe and sleeves: lineal feet, diameter and type
- m. Grating: square feet and type.

3.2.7 Mined Stations

Mined stations represent a unique condition and a separate estimating problem. The take-off cannot be categorized into units of work until the soils, structure, and method of construction have been determined. It is quite possible that the design indicated on the plans will present unique problems that will require unique methods, and until these decisions are made, a meaningful, useful quantity survey is impractical.

3.2.8 Line Structures

The line tunnels that connect the stations are comprised of twin bored tunnels, cut and cover twin cell boxes, cut and cover cross-over pocket track structures, line ventilation shafts, open cut structures, and cross-passages between tunnels.

For cut and cover and open cut structures the take-off should be made as stated in Item 3.2.6 above. For line tunnel sections in the pre-preliminary estimates, a typical cost per lineal foot of tunnel may be used. To the extent practical, the designs should indicate type of liner, type of excavation, etc., and determine beginning and ending station for each type variation. A "typical" design can then be prepared and a cost per foot determined. For line tunnel sections in the final preliminary estimates, the measurement should be as follows:

- a. Units of measurement should be in units per lineal foot of tunnel.
- b. Total tunnel length to be driven should be measured in lineal feet and should not include the length through ventilation shafts.
- c. Tunnel boring machines or shield tunnel excavation should be measured in neat cubic yards per foot, diameter, and circumference. Drill and shoot tunnel excavation should be measured in neat and overbreak cubic yards per foot and cross section in area square feet.
- d. Segmented concrete liners, in each diameter should be measured by length and number of bolts per ring.
- e. Grout: cubic feet per lineal foot.
- f. Invert concrete: cubic yards per lineal foot.
- g. Invert concrete finish: square feet per lineal foot.
- h. Track drain pipe: diameter and type.
- i. Track drain inlets: each, type, and size.
- j. Reinforcing steel: pounds per lineal foot.
- k. Floating slab: each by cubic yard concrete, pounds resteel, and square feet of surface area.
- l. Mined cross passages: each, length of each, plus a takeoff for each item measured.

- m. Drill and shoot tunnel concrete lining: invert concrete in cubic yard per lineal foot (neat and overbreak), lining concrete in same
- n. Special provisions for prevention of methane gas, special liners: type and length.

3.2.9 Yards

Quantities to be determined for yard construction include all work up to and including sub-ballast. There can be grading, paving, fence work, utility work, drainage, water lines and fire lines, yard lighting foundations and electrical duct work. The measurement of all items has been previously described in this chapter with the exception of:

- a. Sub-ballast: square yards, type, and depth.
- b. Crusher run aggregate: square yards, type, and depth.
- c. Curbing: lineal feet, type, and cubic yards per lineal foot.
- d. Lighting foundations: each, cubic yards of concrete and pounds of reinforcing steel per each and anchor bolts.
- e. Fencing: lineal feet, type, height, number of gates and type.
- f. Hydrants: each, model.
- g. Valve vaults: each, size, cubic yards of concrete, and pounds of rebar.
- h. Duct banks: type and linear footage.

3.2.10 Shop Buildings

The shop buildings will consist of at least a maintenance shop, blowdown building, and car washing facilities. Included will be maintenance shop equipment, bridge cranes, offices, and a parts warehouse. The unit of measure for most items included in these facilities has been previously described in this Section. The following list includes remaining items as yet covered and their units of measure.

- a. Guard rail: lineal feet, type
- b. Top soil: cubic yards
- c. Seeding: square yards
- d. Track work: lineal feet, weight of rail, type of fastenings
- e. Light weight concrete (insulation): cubic yards

- f. Brick work: square feet and size of brick
- g. Concrete block: square feet and size of block
- h. Structural steel: pounds and number of pieces
- i. Metal roof deck: square feet, type, and gauge
- j. Miscellaneous metal: pounds and description
- k. Finish carpentry: description
- l. Built-up roofing: square feet, type; and square feet and type of insulation
- m. Doors and frames: each, type and size
- n. Glazing: square feet and type
- o. Finish hardware: description
- p. Cement plaster: square feet and description
- q. Drywall: square feet and type
- r. Ceramic tile: square feet
- s. Quarry tile: square feet
- t. Acoustical walls and ceilings: square feet and type
- u. Resilient floors: square feet and type
- v. Fire proofing: square feet and type
- w. Painting: square feet and type, number of coats
- x. Lockers: each, size, and type
- z. Fuel storage tanks: each, size, and type
- aa. Cranes: each, type, and capacity
- bb. Shop equipment: each, type, and weight
- cc. Turntables: each, size, type, and drive
- dd. Battery room equipment: description
- ee. Blinds and shades: each, type, and size

- ff. Ceiling system: square feet and type
- gg. Plumbing: complete item take of all piping, valves, fixtures, traps, elbows, etc., in each or lineal feet with description or type
- hh. Elevators: each, type, lift in feet
- ii. Electrical: complete item take-off of all fixtures, switches, wire, cable, ducts, starters, converters, cabinets, etc., in each or lineal feet with description or type
- jj. Pneumatic distribution systems: type and linear feet

3.2.11 Track Work

Track work includes the procurement and installation of the running rails and turnouts, cross-overs, track fasteners, ties, tie blocks, tie plates, insulators, support brackets, cover board, track ballast, second pour concrete, angle bars (fish plates) and insulated joints. The unit of measure should be as follows:

- a. Track, main track: lineal feet and type (direct fixation, ballasted, concrete ties, timber ties, aerial, subway)
- b. Track, yard track: lineal feet and type
- c. Turn outs: each, number or size, weight, and type of track way
- d. Cross-overs: each, weight, and type of track way
- e. Track fasteners: included in track
- f. Ties: included in track, turn outs, or cross overs
- g. Track ballast: cubic yards
- h. Second pour concrete: included in track
- i. Angle bars: each and weight
- j. Insulated joints: each and weight

NOTE: An interface point must be established at each turnout and cross-over to define track (main or yard track) from all inclusion turnout and cross over limits.

3.2.12 Corrosion Control

The collection of stray currents by means of anodes, electrodes, and associated conduits and wiring. For the pre-preliminary estimates, an allowance per foot of track when corrosion control is anticipated may be used based on a "typical" protection system. The unit of measure for the various items in the final preliminary estimate should be:

- a. D.C. power supply: each, type, and size
- b. Anodes: each, type, and size
- c. Electrodes: each, type, and size
- d. Conduit: lineal feet, type, size, and depth in ground
- e. Wiring: lineal feet, type, and size/gauge
- f. Junction boxes: each, type
- g. Switches: each, type, and voltage

3.2.13 Noise and Vibration

The attenuation of air movement noise, rolling stock operating noise, and vehicle sound dampening components will be designed into various pieces of the structure or equipment. There will be no estimate or construction contract, per se, for noise and vibration.

3.2.14 Parking Lots

(Bus, kiss and ride facilities.) The construction of a parking lot with surface bus facilities as well as automobile drop-off areas. There will be earthwork, drainage, paving, curbing, walkways, utility work, fencing, lighting, seeding, sodding, landscape work, and in some areas, structure. All of these items have been previously addressed in other portions of this section.

3.2.15 Surface Restoration

This item includes restoring areas disturbed by the construction activities on street, walkway and alleyway paving; seeding, sodding and replanting of foilage; replacing meters, light standards and traffic lights; and restoration of traffic striping. All of these items have been previously addressed in other portions of this section.

3.2.16 Ventilation - HVAC, Fans and Dampers

The furnishing and installing of the heating, ventilating, and air conditioning systems and the air distribution system. The units and units of measure are:

- a. Air handling unit: type, cfm, horsepower, and voltage
- b. Heating/ventilating units: same as above, plus kilowatts
- c. Filters: each, type, cfm efficiency
- d. Fans: each, type, cfm, horsepower, and voltage
- e. Heaters: each, type, kw
- f. Electric duct heaters: each, type, kw
- g. Electric convectors: each, type, kw
- h. Air conditioning units: each, type, tons capacity, cfm, voltage
- i. Chillers: each, type, tons capacity, kw input, voltage
- j. Condenser: type, capacity heat rejection, horsepower (fan and pump), voltage
- k. Refrigerant receiver: each, type, capacity gallons
- l. Expansion tank: each, type, capacity gallons
- m. Glycol charge tank: each, type, capacity gallons
- n. Air separator: each, type
- o. Pumps: each, type, gpm, head, horsepower
- p. Motor operated dampers: each, size, type, differential static pressure
- q. Smoke dampers: each, size, type
- r. Manual operated damper: each, size, type
- s. Concrete pads: each, size
- t. Duct work: pounds, type, gauge
- u. Duct lining: square feet, type, thickness
- v. Duct insulation: square feet, type, thickness

- w. Diffusers: type and size
- x. Acoustics: type and square feet
- y. Sound attenuators: type, size, each
- z. Room thermostat: type, voltage each
- aa. Air compressor: type, each, cfm, and horsepower
- bb. Pneumatic tubing diameter: type, lineal feet
- cc. Pneumatic fittings: each
- dd. Receiver tank: psi and gallons, each
- ee. Air dryer: each, size
- ff. Bulb insertion thermostat: each, type, voltage
- gg. Wiring: lineal feet, gauge
- hh. Conduit: lineal feet, type, diameter
- ii. Limit switch: type, each
- jj. Temperature transmitters: each, type, and temperature range
- kk. Receiver controls: each, type, and temperature range

3.3 SPECIFIC QUANTITY ESTIMATE - STATION AREAS

3.3.1 Station - Wall, Floor, Platform and Ceiling Treatment

This item includes the architectural treatment of exposed surfaces in the stations and will include all finishes for these surfaces. The unit of measure should be as listed below:

- a. Precast concrete wall panels: each by type, thickness, length, width, surface treatment, and total square feet of each kind
- b. Unit masonry walls: square feet, type, and size of block or brick; reinforcing in pounds
- c. Granite: wall panels, stair landings, flooring, base, fascia strips, and platform edge in square feet of each and thickness. Stair treads in lineal feet and size.
- d. Stainless steel cladding: in square feet and gauge

- e. Miscellaneous metal for wall panels: in pounds per shape, size, galvanized or not galvanized
- f. Stainless steel modular wall panels and/or baked enamel metal panel system: in square feet and type
- g. Pavers, inside: square feet and type
- h. Pavers, outside: square feet and type
- i. Glazing: square feet and type
- j. Ceramic tile: square feet and type
- k. Acoustical ceilings: square feet and type
- l. Acoustical panels: square feet and type
- m. Resilient flooring: square feet and type
- n. Painting: square feet, number of coats, and type
- o. Sandblast finish of concrete: square feet

3.3.2 Entrance Plaza - Walkway and Canopies

Structural steel should be measured in pounds and shape, size, and number of pieces. All other items have been previously addressed.

3.3.3 Station Lighting Fixtures

Station lighting fixtures are the take-off of all fixtures, conduit, and wiring in the station. The conduit and wiring are measured as heretofore specified; the fixtures are measured in each of a type (e.g., enclosed fluorescent, bare lamp fluorescent, low brightness fluorescent fixtures, or high-pressure sodium fixtures).

3.3.4 Landscaping

Landscaping includes the furnishing and planting of trees, shrubs, ground cover, vines, fertilization, topsoil, seeding, mulching, and planting bed retainers. The units of measure should be as follows:

- a. Seeding and mulching: square yards
- b. Topsoiling: cubic yards
- c. Plants and trees: height or diameter
- d. Planting bed retainer: each, size, and type

3.3.5 Signing and Graphics

Signing and graphics include the fabrication, installation, and testing of pylons; illuminated and nonilluminated overhead signs; station identification signs; door, gate and wall-mounted signing; and map frames and titles in the immediate station area. The units of measure should be:

- a. Pylons: each by type
- b. Overhead signs: lineal feet of carrier track and type of sign
- c. Station identification: each
- d. Door signs: each
- e. Gate signs: each
- f. Wall signs: each
- g. Map holders: each
- h. Exposed conduit with fittings: lineal feet and size
- i. Wire: lineal feet and gauge
- j. Junction boxes: each, by type

3.3.6 Art Work

Art work is usually competitively selected to fit within an established budget. Measurement does not apply.

3.3.7 Modular Equipment and Benches

Modular equipment and benches include the station modular equipment such as emergency wall or freestanding cabinets for fire extinguishers and hose valves, public telephone recessed cabinets, drinking fountains, trash receptacles, ash urns and benches. A takeoff of all modular items by the each and type with a description as required.

3.3.8 Ornamental Metal

Ornamental metal includes the ornamental handrails and their metal or glass grills, gates, doors, and louvers. The units of measure are:

- a. Metal handrails: lineal feet, type, plus all fastenings
- b. Glass railing: square feet and type, plus all fastenings
- c. Grills: square feet and type

- d. Gates: each, type
- e. Doors: each, type, with hardware
- f. Louvers: square feet and type

3.3.9 Janitor/Toilet Room Accoutrements

Janitor/toilet room accoutrements consist of partitions, mirrors, paper dispensers, mop sinks, water closets, urinals, lavatories, handholds, etc. The units of measure for these items are as follow:

- a. Partitions: each by type and square feet
- b. Mirrors: each by type and square feet
- c. Paper dispenser: each and type
- d. Mop sinks, waterclosets, urinals, lavatories: each

3.3.10 Security Systems

Security systems consist of door intrusion control and annunciation, common corridor intrusion and annunciation, and closed circuit television and monitors. Each emergency exit hatch, rolldown grille, entrances to corridors and ancillary spaces, end of platform gates, restroom doors, and emergency cabinet doors will have a door switch, bypass switches, timed bypass switches, or annunciating switches with the necessary wiring to station attendants control center booth panelboards. There may be personnel and vehicle intrusion fencing/detecting systems and the required wiring to alarms or signals. The unit of measure for these systems should include:

- a. Conduit: type, size, and lineal feet
- b. Wiring: type, gauge, voltage, and lineal feet
- c. Switches: type, size, voltage, each
- d. Alarms: each, type
- e. Fencing: type, height, and lineal feet
- f. Panelboards: each, type, size

3.4 SPECIFIC ESTIMATE QUANTITIES - SYSTEMS

3.4.1 Station Control Center Booth

The station control center booth is the station attendant's security booth, normally constructed of violence secure material, which houses the security control systems. A complete take-off of all materials that make up the booth is required if free standing (if not, incorporate into station). The unit of measure for these materials has been previously addressed in this section.

3.4.2 Fare Collection Equipment

Fare collection equipment consists of ticket vending machines, bill changer, passimeter console, flush console, entry console, exit console, handicapped/emergency gate, monitoring and auditing equipment, fare boxes, registering panels, control panels, and emergency fare boxes. Revenue transfer and counting as well as encoding will also be included. Initial start-up items such as fare media will be costed separately along with contract software items such as training and maintenance. All items are counted by each and type.

3.4.3 Passenger Vehicles

Passenger vehicles will primarily be costed on the basis of quantities required and configuration. Major configuration issues that must be examined include:

- Single ended or double-ended
- Basic car structure material (aluminum versus steel)
- Propulsion design (cam versus chopper)
- AC requirements
- Degree of standardization of basic dimensions (length, height, and width)

With these configuration characteristics identified, a cost per vehicle can be generated. Other cost estimates, not directly related to vehicle quantities, will be identified and costed. These include:

- Spare parts
- Test equipment and special tools
- Training
- Maintenance and Operations Manuals
- Acceptance and Systems Testing Programs

3.4.4 Auxiliary Vehicles

Auxiliary vehicles are the maintenance vehicles such as a locomotive (diesel or diesel electric), self-propelled crane, flatcars, high rail trucks, etc. Each type of vehicle should be described by function and capacity.

3.4.5 Traction Power

The traction power consists of all traction power equipment, wire, cable, and conduit from the incoming utility line disconnects to the electrical distribution system to the third rail and to station auxiliary equipment. Depending upon the incoming voltage, there will be a high voltage, switchgear assembly at each substation for terminating incoming utility power and for distributing power to A.C./D.C. conversion equipment and to distribute A.C. power to the station auxiliary power system. The mounting devices for the contact rail and the coverboard, as well as the stinger system for the shop building, shall also be included. The unit of measure for all items in these systems should be:

- a. Wire: lineal feet, conductors, type, size
- b. Cable: lineal feet, conductors, type, size
- c. Conduit: lineal feet, type, size
- d. High voltage switchgear assembly: each, type, voltage
- e. A.C. to D.C. conversion assembly: each, type, voltage
- f. A.C. secondary auxiliary substation assembly: each, type, voltage
- g. U.P.S. system: the battery, battery charges, and accessories
- h. Annunciator panel: describe in detail
- i. Cable trays: size, material, and lineal feet
- j. Junction and pull boxes: each
- k. Battery disconnect switch and distribution panel: each, voltage, type
- l. Contact Rail: lineal feet, type, size
- m. Contact rail side approaches: each
- n. Insulators: each

- o. Coverboard: lineal feet, type, size extent of coverage
- p. Stinger: number of installation, length of travel, type

NOTE: In all the above assemblies, the type and voltage of transformers, converters, and rectifiers and the number of each must be stated.

3.4.6 Train Control Systems

Train control systems provide the function of train protection, train operation, and train supervision. The system will encompass the apparatus situated along the wayside, in stations, in storage and maintenance yards in the operations control center, and on the vehicles. Wayside equipment includes track circuits, switch and lock movements, and signals. Station equipment includes speed control/train detection and interlocking systems. Yard control equipment includes yard control power, switch machines and signals, derails, switch stands, and interlocking systems. Operations control center equipment includes status boards, control consoles, and supervisory computers. Vehicle equipment includes automatic train protection and automatic train operation equipment. All of this specialized equipment can best be taken off and listed and priced by an engineer especially trained in this discipline. Costs will be generated based on the following factors:

- a. Length of tracks - mainline and yard
- b. Number of track circuits
- c. Number of interlockings
- d. Number of stations
- e. Number of speed commands given to vehicle
- f. Number of vehicles required
- g. Location of central control relative to mainline

3.4.7 Communications Systems

Communications systems can consist of a PABX telephone system for voice communication between administrative, operational, and maintenance facilities with capability to hook into commercial dial phones; a cable transmission system with two-way communication of voice and digital messages; a data transmission system with the capability to transmit, store, display, and record digital data; and an emergency telephone system to connect patrons, operations, and security with central control; two-way radio system between maintenance, yard, train, and security with console at central control;

and a public address system for stationwide announcements and a station intercom system. A dedicated fire department communications system may also be a part of this section.

Also included will be a CCTV system to encompass cameras mounted within passenger stations, local control devices, recording equipment, and monitors at the station (if utilized) and at a central location.

The units of measure for conduit, wire, and cable have been previously addressed in this section. The special equipment involved in communications must be clearly described and counted by each and all appurtenant equipment such as recessed boxes, cabinets, consoles, and wayside pickups.

3.4.8 Elevators

Furnishing, installation, and sometimes the interim maintenance of the elevators prior to revenue services comprise the elevator type or electrohydraulic type is used. Usually the electrohydraulic elevator more efficiently fits the requirement. Elevators are to be counted by each.

3.4.9 Escalators

Furnish, installation and sometimes the interim maintenance of the escalator prior to revenue services comprise the escalator cost. Generally, in transit stations, either the Class A - up to 20 feet vertical rise - or a Class B - over 20 feet vertical rise - is specified. Escalators are to be counted by each and type.

3.4.10 Mechanical and Electrical Installations

Mechanical and electrical installations will comprise miscellaneous installations not otherwise covered in this section. The units of measure for miscellaneous items are mentioned throughout this section.

3.4.11 Fire Protection System

The fire protection system includes the control, supervision, and power for fire alarms, smoke and fire detectors, fire standpipe and valves, equipment cabinets, sprinklers, and halon systems. All piping, valves and wiring for this equipment has been addressed previously. This item will include wiring and intrusion and fire management panels. The equipment must be separately listed by each, type, size or capacity. The structural aspects of the above items may be integrated into line section contracts (Item 3.2.8), shop building contracts (Item 3.2.10) or station structure contracts (Item 3.2.6).

3.4.12 System Testing

System testing is a verification program to coordinate testing between all system elements. This test program is over and above those contract compliance tests which are costed as part of each system cost. The costs will be estimated based on the degree of system integration deemed necessary and the projected schedule of procurement and instruction phasing.

- a. Verify the compatibility of equipment, facilities, software and procedures, and their ability to function as a total system under normal, adverse, and emergency conditions.
- b. Identify equipment and facilities that require modification to meet operational requirements.
- c. Identify software and procedures that require modification to meet operational requirements. The testing program is a highly labor-intensified program and is estimated in man-weeks and specialized equipment. The testing cost should be approximately \$425,000 per station and \$450,000 per mile of the system in 1982 dollars.

3.4.13 Start-up and Training

Start-up and training includes the development of a schedule to coordinate contractor activities and SCRTD activities with initial third-rail energization and test train operation. In coordination with the approved schedule, provisions for training classes for start-up operating personnel must be developed to ensure safe test train operation, which also includes the manning of traction power and train control and communications. This item will also include such activities as shop and storage layout plans, preparation of operations and maintenance procedures, design and implementation of a management data system for operations and maintenance, and establishment of a manpower activation schedule. These costs will be estimated based on similar activities on other projects adjusted for local or site-specific program conditions.

4.0 DIRECT COST

4.1 GENERAL

As defined in Chapter 2.0, direct cost includes all labor, construction equipment, and material used in the actual construction of the facilities. Material may be permanent installation (such as concrete and steel used in tunnel or station box construction) or may be temporary (such as decking). Labor includes all labor categories employed in the work up to and including the general foreman. Other supervisory and management personnel costs are included in the indirect cost described in Chapter 5.0. All categories of cost will be based on current 1982 Los Angeles area prices and reflect current labor agreements and equipment and material conditions.

4.2 UNIT PRICES

An inventory of all construction tasks necessary to the building of a facility shall be made. (See Sections 3.2, 3.3, and 3.4 - Specific Estimate Quantities - for examples.) A unit price for task shall be developed by one of the following:

1. An average of direct quotes from suppliers, subcontractors, vendors, etc. Where possible use a minimum of three quotes.
2. A "built up" unit cost developed from a detailed analysis of material, labor, and equipment requirements with applicable subcontractor overhead and profit, sales taxes, etc.
3. Use of cost information derived from construction cost estimating manuals such as "Means", "Lee Saylor", "Dodge" or other reliable references. All such unit prices shall be adjusted to reflect current Los Angeles area costs by reference to the "City Cost Indexes". Example: "Means" 1982 Building Construction Cost Data book, page 70; Item 3.1-35-100 - Forms in Place - Elevated Slabs; gives a unit price of \$3.90 per square foot. This price must be adjusted to reflect Los Angeles conditions by prorating against the City Cost Index for Los Angeles on page 375. Thus: multiply Material - \$1.26 times 1.001 and Labor (Inst.) \$1.77 by 1.158. Then, multiply the sum by the factor of $\$3.90/\3.03 (total including overhead and profit/total) to arrive at the adjusted unit price for Forms in Place - Elevated Slabs Los Angeles area of \$4.17/square foot versus the "Means" unit price of only \$3.90/square foot.

Unit prices developed shall be recorded on Standard Form #2 and stored in a unit price book or folder for future reference.

4.3 ESTIMATE PREPARATION

On Standard Form #2 list all the major components of a system followed in each instance by the items that comprise the component.

Example:

CONCRETE WORK

Formwork

Elevated Slab Deck	square feet
Elevated Slab Edge Form, 6" Thick	lineal feet

Concrete

6" Thick Elevated Slab	cubic yards
------------------------	-------------

Reinforcing Steel

#3-#7 Rebar	pounds
-------------	--------

Concrete/Curing Finish

Elevated Deck Slab, Trowel Finish	square feet
Elevated Deck Slab, Point and Patch	square feet
Elevated Slab Deck Edge Finish	square feet

STRUCTURAL STEEL

Columns	Tons
Framing	Tons

The appropriate quantities and units will be obtained from the Quantity Survey. Unit costs will be obtained from the Unit Cost Book mentioned in Section 4.2 above.

The product of the quantity and unit price will be entered into the "Estimated Cost" column for each of the items comprising a major component. The total of all item costs for a major component will be entered in the total column.

The sum of all costs in the total column shall be entered at the end of the estimate and titled direct costs. Below the direct costs shall be entered the indirect costs and contingencies.

(See Chapter 5.0.)

5.0 INDIRECT COST

5.1 Overhead Costs (Sometimes referred to as overall conditions.)

Overhead costs shall include all costs not termed direct costs. Costs normally in this category are:

5.1.1 Contractor's wages of supervisory personnel above the rank of general foreman, office manager, timekeepers, secretaries, engineers, project, office, schedule, form, and cost engineers, surveyors, purchasing agent, warehousemen.

5.1.2 Temporary buildings: offices, warehouses, saw yards, change-houses, repair shops.

5.1.3 Temporary utilities: water, power, telephone, sewers, installation.

5.1.4 Temporary job construction: walks, fences, roads, yard rent, signs.

5.1.5 Job transportation: pickups; sedans; ambulance; fuel, oil, and gas; and maintenance labor for same.

5.1.6 Job office expense: light, water, heat, rent, stationery, telephone and telegraph, travel expense, computer time, dues, licenses, consultants.

5.1.7 Insurance and taxes; workman's compensation, public liability and property damage, F.I.C.A., unemployment, etc. - on direct labor; building risk; bonds; and equipment.

5.1.8 Employee mobilization: move in, move out.

5.1.9 Quality control

5.1.10 Demobilization

5.1.11 Finance costs

5.2 APPLICATION OF OVERHEAD COSTS

Refer to the overhead cost checklist and use Standard Form #2 to enter all items of overhead cost in the description column by occupation or function. From the schedule, enter the appropriate time in days, weeks, or months from each descriptive item. To extend the estimate, enter the unit cost or lump sum cost for each descriptive item in the appropriate column and total all columns.

Where practical, the overhead cost shall be derived by actual computation of cost factors involved. If impractical, then the overhead cost shall be considered to be 10.0 percent of the total direct cost.

5.3 BONDING

Performance bonding and builders insurance will be combined and expressed as 1.0 percent of the sum of the direct cost plus overhead cost.

INDIRECT EXPENSE CHECKLIST

Project Manager	Office Manager
General Superintendent	Accountants
Shift Superintendent	Bookkeepers
Mechanical Superintendent	Personnel Manager
Electrical Superintendent	Equipment Timekeepers
Steel Superintendent	Payroll Timekeepers
Carpenter Superintendent	Stenos and Clerks
Concrete Superintendent	Janitor
Masonry Superintendent	Telephone Operator
Master Mechanic	Purchasing Agent
Safety Engineer	Expediter
Doctors	Warehouse and Material Superintendent
Nurses	Warehouseman
First-Aid Attendants	Temporary Job Buildings:
Quality Control Man	Office
Assistant Superintendents	Warehouse
Project Engineer	First Aid
Office Engineer	Shops
Field Engineer	Owner's Office Expenses (may be Direct Cost)
Form Engineer	Photographs
Schedule Engineer	Light, Water, Heat, Rent
Cost Engineer	Stationery and Supplies
Material Engineer	Telephone and Telegraph
Draftsman and Blueprinter	Travel Expenses
Surveyors	

INDIRECT EXPENSE CHECKLIST (Continued)

Computer Use Charge	Personnel Move In and Out
Engineering Supplies	Maintenance of Pickups
Fire Protection Supplies	Maintenance of Sedans
Medical Supplies	Maintenance of Ambulance
Preblast Survey and Lab Tests	Maintenance of Job Shops and Buildings
Legal Expense and Audit Expense	Security Guard Service
Engineering and Consultant Expense	
Donations and Entertainment	
Permits and Licenses	
Safety Supplies	
Medical Examinations	
Association Dues	
Workman's Compensation, P.L. & P.D., F.I.C.A., Unemployment Insurance on Direct Labor <u>only</u>	
Builder's Risk	
Auto and Truck Insurance	
Hazard Insurance	
Business Tax	
Personal Property Tax	
Bonds:	
Contract	
Subcontract	
Supply	
Fidelity	